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Assessing gull abundance and food availability in urban parking lots

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Abstract: Feeding birds is a common activity throughout the world; yet, little is known about the extent of feeding gulls in urban areas. We monitored 8 parking lots in central Massachusetts, USA, during the fall and winter of 2011 to 2013 in 4 monitoring sessions to document the number of gulls present, the frequency of human–gull feeding interactions, and the effectiveness of signage and direct interaction in reducing human-provisioned food. Parking lots were divided between "education" and "no-education" lots. In education lots, we erected signs about problems caused when people feed birds and also asked people to stop feeding birds. We did not erect signs or ask people to stop feeding birds at no-education lots. We spent >1,200 hours in parking lots (range = 136 to 200 hours per parking lot), and gulls were counted every 20 minutes. We conducted >4,000 counts, and ring-billed gulls (*Lorus delawarensis*) accounted for 98% of all gulls. Our educational efforts were minimally effective. There were fewer feedings ($P = 0.01$) in education lots during one of the monitoring sessions but significantly more gulls ($P = 0.008$) in education lots during 2 monitoring sessions. While there was a marginal decrease ($P = 0.055$) in the number of feedings after no-education lots were transformed into education lots, there was no difference in gull numbers in these lots ($P = 0.16$). Education appears to have some influence in reducing the number of people feeding gulls, but our efforts were not able to reduce the number of human feeders or the amount of food enough to influence the number of gulls using parking lots.

Key words: bird feeding, food, human–wildlife conflicts, provisioning, ring-billed gull, urban

Feeding birds is a common human–wildlife interaction in North America. Recent estimates for the United States indicated that almost 53 million people fed wildlife around their homes annually (U.S. Census Bureau 2011). Most people (95%) fed birds, while about 15 million (28%) fed other wildlife, such as deer and bears. In addition, about 5.4 million people fed wildlife away from home an average of 11 days (U.S. Census Bureau 2011). Providing supplemental food to birds has been associated with birds nesting earlier in the year during the breeding season, longer nesting periods, and increased production of young (Jones and Reynolds 2008). Feeding birds is generally encouraged by several prominent organizations, including Cornell Laboratory of Ornithology's Project Feeder Watch. Supplying food to wildlife may provide some specific, limited benefits and is often used in the recovery of endangered birds (Sutherland et al. 2004). Conversely, feeding birds also has been implicated in altered behavior patterns among birds, malnourishment, the spread of diseases, dependency, and habituation (Orams 2002, Rollinson et al. 2003). As a result, many state and federal wildlife agencies and professional wildlife organizations discourage the practice of feeding avian species that may generate nuisance problems (O'Leary and Jones 2006, Wildlife Society 2006).

Given its popularity in the United States, feeding birds likely brings pleasure to its participants, but the reasons people feed birds are complicated. In Brisbane, Australia, people who fed birds indicated that in addition to giving them pleasure, feeding also served as "environmental atonement" (Jones and Reynolds 2008). These people felt that they were providing food to birds in reparation for human environmental impacts or habitat destruction; many people said that they fed

Figure 1. Woman feeding gulls (*Larus* spp.) in parking lot. Many people feed wildlife out of concern for the animals' welfare.

birds out of a humane concern for the animals (e.g., the birds were cold, hungry) and felt the animals benefited from being fed (Figure 1; Jones and Reynolds 2008). Given the underlying psychological reasons behind the activity, it is likely that some participants have very strong positive convictions about feeding.

Ring-billed gulls (*Larus delawarensis*) are a common inland species in North America and are quick to identify and exploit readily available food sources. Populations of ring-billed and herring gulls (*L. argentatus*) have increased significantly since the 1960s; this increase often is attributed to the exploitation of anthropogenic food resources, particularly landfills (Horton et al. 1983, Belant 1997). Gull use of landfills has been studied frequently, resulting in a common paradigm that gulls rely extensively on landfills during both the breeding and nonbreeding seasons for their sustenance (Horton et al. 1983, Sol et al. 1995, Brousseau et al. 1996, Belant et al. 1998, Duhem et al. 2003). However, the exploitation or dependence of gulls on human-provisioned food (i.e., handouts) has received considerably less attention.

In Massachusetts, inland populations of ring-billed and herring gulls increase dramatically during the fall and winter. Anecdotal observations and a pilot study conducted during 2010 to 2011 suggested that gulls were being provided a substantial amount of anthropogenic food through direct provisioning throughout the greater Worcester, Massachusetts, area (D. Clark, personal observation). Locally fed gulls were travelling to Wachusett Reservoir to roost each night. The Wachusett Reservoir serves as the treated, but unfiltered, water supply for 2.2 million consumers in greater Boston, and roosting gulls may cause serious water quality problems (Metropolitan District Commission 1992).

Our objectives were to assess the relative abundance of inland wintering gulls at various parking lots where feeding occurred, quantify the amount of food being fed to gulls, assess the effectiveness of educational signs and public outreach in reducing the feeding of gulls, and evaluate whether preventing feeding events or removing offered food would influence the number of gulls using the parking lots. We used an experimental framework, incorporating randomly selected treatment (people feeding gulls approached) parking lots and control lots (observation only), coupled with before and after tests, to determine the effectiveness of educational signage and public interaction in limiting or preventing public gull feeding.

Study area

This study was conducted in central Massachusetts during September to April 2011–2013. As part of a larger ecological study of ring-billed gulls, we used wing-tag resightings, satellite telemetry, and field observations to identify foraging sites in urban parking lots in and around Worcester (Clark 2014). Eight parking lots in the cities of Worcester, Leominster, Hudson, Northborough, and Shrewsbury, Massachusetts, were s elected as sites where the public regularly fed gulls (Figure 2). These lots were located 12 to 21 km from Wachusett Reservoir a nd r anged i n s ize from 1.4 to 8.7 ha of open area (i.e., parking spaces). These lots contained a varied number of retail stores and were all located in urban or suburban settings surrounded by roads, residential areas, and other development. Most (7 of 8) of the parking lots had ≥1 fast-food restaurant, and all lots had a similar layout, with light poles and large areas of empty parking spaces.

Methods

Experimental design

Parking lots. One of the parking lots was used in a pilot study (2010 to 2011) to assess public feeding of gulls and was kept as an education lot. Four of the remaining 7 parking lots identified were randomly selected as education lots, and the remaining three were assigned as no-education lots. Treatment lots were posted with educational signage to discourage feeding; those lots received 3 to 12 small (46 × 61 cm) DO NOT FEED signs that were attached directly to light poles about 3.5 m off the ground. Small signs were positioned at strategic locations around each lot where feeding had been observed; sign density was determined by the size of the lot and limitations imposed by the property owners. Two towns (Worcester and Leominster) within the study area had specific regulations against feeding wildlife (including gulls). In these towns, the small signs included language that feeding gulls was illegal and cited the specific regulation (Figure 3a). Signs posted in other towns did not include this language, but were otherwise identical (Figure 3b). In addition, 4 of the 5 treatment lots received a large (1.2 m × 1.5 m) educational sign that was anchored to 3-m posts on the perimeter of the lot for maximum visibility; the owner of 1 lot did not grant permission for the large sign (Figure 3c). The large sign was focused on providing specific information about why feeding gulls was discouraged, including information about the impacts both on the environment (water quality) and gulls (diet and disease). These signs included larger text and a photo. All signs were posted about 2 months prior to the study. The 3 remaining parking lots served as controls, and no signage was installed.

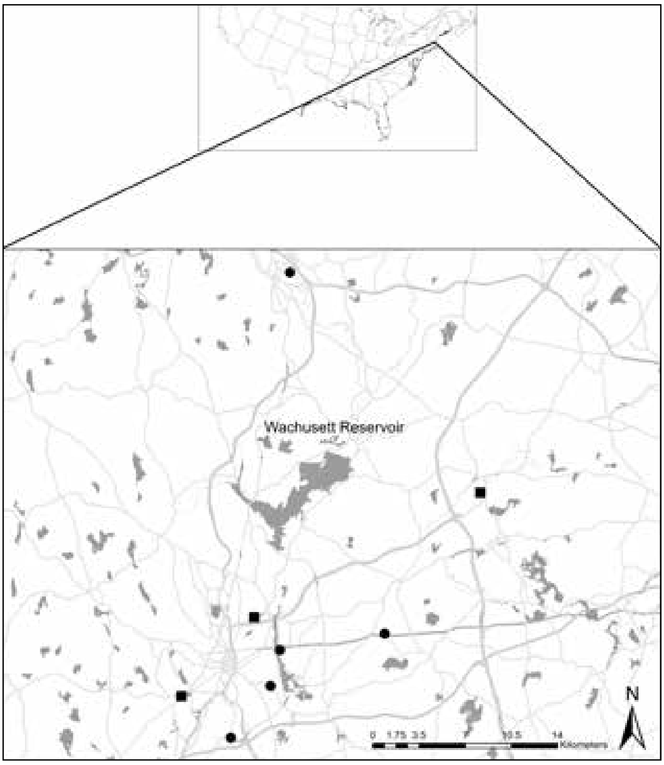


Figure 2. Locations of treatment parking lots (gull feeders approached and educated), signified by black dots, and control parking lots (gull feeders not approached), signified by black squares, in relation to Wachusett Reservoir, Massachusetts.

Public interaction. Parking lots were monitored during 4 sessions: (1) September 26 to October 22, 2011; (2) January 1 to January 20, 2012; (3) November 7 to December 2, 2012; and (4) December 3, 2012, to March 27, 2013. These sessions were chosen based on the availability of monitors. During the first 2 monitoring sessions, each day was divided into 4 shifts: early morning (0600 to 0900 hours), late morning (0900 to 1130 hours), early afternoon (1130 to 1400 hours), and late afternoon (1400 to 1630 hours). Three shifts were completed in each parking lot for Session One (~36 hours total) and 1 to 2 times in each lot for Session Two (~21 hours total). Parking lots were allocated randomly to each day-time shift and assigned to a single monitor, except for a large (8.7 ha) parking lot where 2 monitors were assigned. Fifteen different monitors received training and participated during Sessions One and Two. During monitoring Session Three, parking lots were randomly chosen to be monitored, and monitoring events lasted 2 to 9 hours. Lots were monitored for 150 hours (range = 10 to 37 hours). During Session Four, no-education lots were reassigned as treatment parking lots to test the effectiveness of education in a before and after approach. All 8 lots were monitored an average of 88 hours (range = 75 to 124 hours). Educational signage was erected, and feeding was discouraged in these former control

Figure 3a. Small educational sign used to discourage gull feeding in cities where the activity was prohibited. **3b.** Educational sign used in cities where gull feeding was not prohibited in central Massachusetts. **3c.** Large educational sign used to discourage gull feeding in parking lots in central Massachusetts.

lots. During Session Three and Session Four, monitoring was conducted by 2 monitors.

At treatment lots, personnel were instructed to closely observe the lot and identify all potential feeding events. If a feeding event was identified or suspected (e.g., swarm of gulls, mobbing behavior), monitors quickly made their way to the location of the feeding and recorded the gender of the person feeding gulls and their vehicle license plate number. All people feeding gulls were approached on foot by the monitor. Once they were approached, the monitors identified themselves, handed the person an informational brochure, and then described the negative implications of feeding gulls. All people feeding gulls were asked if they had seen the DO NOT FEED signs and if they would stop feeding gulls in the future. Monitors also answered any questions. When possible, monitors noted the type of food (bread, French fries, popcorn, etc.) being offered; an approximate amount was determined by assigning the feeding to one of 3 categories: minor (a few pieces of food, typically associated with the person offering gulls some of their own meal), moderate (more than a few pieces of food, typically associated with food being brought specifically to the parking lot for gulls), and major (multiple loaves of bread or boxes of cereal that were specifically brought to the parking lot for gulls). Monitors removed as much of the food as possible and noted the percentage removed. Other available food (e.g., garbage) not associated with a feeding was identified and removed when possible. Monitors assigned to control lots observed and recorded all feeding events, but did not approach any people feeding gulls.

Gull counts. We counted gulls in all parking lots at the beginning of every shift and about every 20 minutes, thereafter. Gulls were identified to species, such as ring-billed, herring, or great black-back (*Larus marinus*) gulls, using binoculars when necessary. In addition, all leg-banded or wing-tagged gulls were noted, and individual gulls were identified when tag numbers could be read. During early morning and late afternoon shifts, the time gulls first arrived in parking lots was recorded, as well as the time when all gulls had left the lot for the day.

Data analysis

We conducted an analysis of variance (ANOVA) to test for differences in gull numbers and gull feedings between education and no-education parking lots. The dependent variables were mean number of gulls, mean number of total feedings per hour, and mean number of major feedings per hour recorded in each parking lot for each observation period during each session. Independent variables were treatments (education versus no-education), session (1 to 3), and parking lot (1 to 8). We used treatment-by-session, treatment-by-lot, and session-by-lot interactions to examine differences in numbers of gulls and feedings between parking lots with and without education. We used descriptive statistics (mean ±SE) to illustrate differences in gull numbers and feedings between education and no-education parking lots. To test for differences before and after the 3 control lots became treatment lots, we used ANOVA to compare average number of gulls and feedings in these 3 lots during the control period and after we began educating the public.

Table 1. Summary of reasons why monitors could not interact with gull feeders in parking lots in central Massachusetts, 2011 to 2013.

Reason	Number
Feeder gone upon arrival (did not see feeder)	58
Dump-and-run feeding (saw feeder)	36
Short-watch feeder (could not get there in time)	18
Unknown	12
Approached feeder, but feeded left	10
Feeder on foot; entered store while feeder approached	8
Language barrier	3
Feeder approached, but refused to speak	2

Results

Relative abundance of gulls

Over 4,200 separate gull counts were conducted in the 8 parking lots during the 4 sessions. Most (98%) were ring-billed gulls, while about 1.4% were herring gulls, and only 0.06% were great black-back gulls. On average, <30 gulls were observed in parking lots during each count, although the maximum number of gulls observed was ≥250. We were able to document 44 and 63 first arrival and last departure times, respectively, for gulls entering and leaving parking lots. Gulls arrived an average of 10 (±1.5) minutes before sunrise, although some lots did not have any gulls until shortly after sunrise. Gulls tended to leave parking lots an average of 54 (±8) minutes before sunset, and in only 1 case were any gulls present after sunset.

Frequency of feedings

We spent 1,278 hours in parking lots and observed 611 gull–food interactions. Most (n = 555) of the interactions were human-provisioned feedings, and the rest (n = 56) were gulls scavenging parking lot garbage. More people providing food were men (55%) than women (41%), and a small percentage (4%) were men and women feeding together. We were able to approach people feeding gulls only 34% (n = 187) of the time; the reason we could not approach was noted 147 times (Table 1). People who fed gulls were commonly observed dumping food while driving through the lot; they never stopped to observe the birds or the feeding.

When asked, most (91%) people feeding gulls indicated that they had not seen the DO NOT FEED signs. Only 9% (n = 14) of the respondents said they saw the signs. When asked if they would stop feeding gulls in the future, 141 people (75%) indicated they would stop feeding, while 46 (25%) said no or were noncommittal.

Removal of offered food

People who fed gulls offered a variety of food (Table 2), although bread, baked products, and French fries constituted most of feedings. While we were unable to quantify major feedings, most constituted >5 loaves of bread or >3 boxes of cereal. Monitors identified 231 different individuals feeding gulls from their vehicles and another 30 individual people feeding gulls while walking through a parking lot. Of the 231 individuals identified through their vehicle license plate numbers (plate numbers and vehicle descriptions of feeders were written down and referenced during feeding events), 32 people were seen feeding twice, three were seen 3 times, and 1 feeder was seen feeding on 4 occasions.

Effectiveness of signs and outreach

Our efforts to reduce the number of human-provisioned feeding events were minimally successful. During most of the study, there were no significant differences in the number of feeding events between education and no-education parking lots. There were significantly fewer total feedings in education lots ($\bar{x}$ = 0.32,

Table 2. Types and amounts of food fed to gulls in parking lots in central Massachusetts.

Food item	Amount of food provided[a] Minor	Moderate	Major	Total
Bread	77	39	40	156
French fries	118	21	4	143
Lunch items (sandwich, etc.)	37	10	3	50
Unknown	44	3	0	47
Baked goods (pretzel, bagel)	15	4	6	25
Crackers	15	4	2	17
Chips	9	4	4	17
Cereal	1	8	8	17
Leftovers (rice, spaghetti)	4	9	4	17
Other (candy, nuts, cheese)	16	1	0	17
Fruit	15	0	0	15
Popcorn	5	4	4	13
Pet food	0	3	7	10
Pizza	6	1	2	9

[a] Minor = a handful or less; Moderate = more than a handful; Major = >3 loaves of bread, >3 boxes cereal, etc.

SE = 0.05) compared to no-education lots only during Session One ($\bar{x}$= 0.60, SE = 0.12; $F_{1,76}$= 6.38, P = 0.01; Figure 4). The number of major feedings was significantly lower in education lots ($\bar{x}$= 0.05, SE = 0.03) than in no-education lots ($\bar{x}$= 0.24, SE = 0.07; $F_{1,46}$ = 8.03, P = 0.007) only during Session Two.

Number of gulls using these parking lots was variable. While there were significantly fewer gulls in education lots during Session One ($F_{1,963}$= 6.96, P = 0.008), significantly more gulls were seen in no-education lots during other sessions (Session Two: $F_{1,600}$= 7.12, P = 0.008; Session Three: $F_{1,469}$= 7.88, P=0.005). After no-education lots were transformed into education lots, there was a marginally significant decrease in the total number of feedings ($F_{1,91}$= 3.74, P = 0.055), but no difference in the number of gulls using these lots ($F_{1,91}$ = 2.05, P = 0.155; Figure 5a, b).

Discussion

To our knowledge, this is the first study to quantify the abundance of gulls and gull feedings in urban parking lots in North America. Our results suggest that feeding gulls is a common activity during winter, conducted by casual visitors, as well as people dedicated to making specific visits to parking lots to provide large quantities of food. In turn, this activity attracts many gulls to these parking lots. While we documented 3 species of gulls, most were ring-billed gulls.

During our study, gulls arrived at parking lots within minutes of sunrise, suggesting that these gulls had traveled directly from their nighttime roost to the lot. It is unclear whether these gulls were foraging exclusively on human-derived food and whether this diet may lead to short or long-term health problems. However, it seems likely that human-provisioned food in urban parking lots may be a relatively important component of the diet of ring-billed gulls during winter, given the arrival and departure times, the frequency of sightings of many different individually tagged gulls in parking lots (both within and outside central Massachusetts), and the number of sightings of some individuals (some gulls were seen >40 times in parking lots over multiple years).

Providing supplemental food to gulls may have many ecological impacts. Gulls are diet generalists; they can change diets throughout the year, and individual diet preference is not fixed (Pierotti and Annett 1990), although our data (multiple sightings of the same individuals in parking lots) would suggest that some individuals specialize on human-provisioned food. A variety of research has reported on the prevalence of human-derived food in the diet of gulls and suggested that its availability can improve reproductive success or winter survival (Horton et al. 1983, Pons and Migot 1995, Weiser and Powell 2010). Adult male silver gulls (*L. novaehollandiae)* specializing on anthropogenic food in Hobart, Australia, were

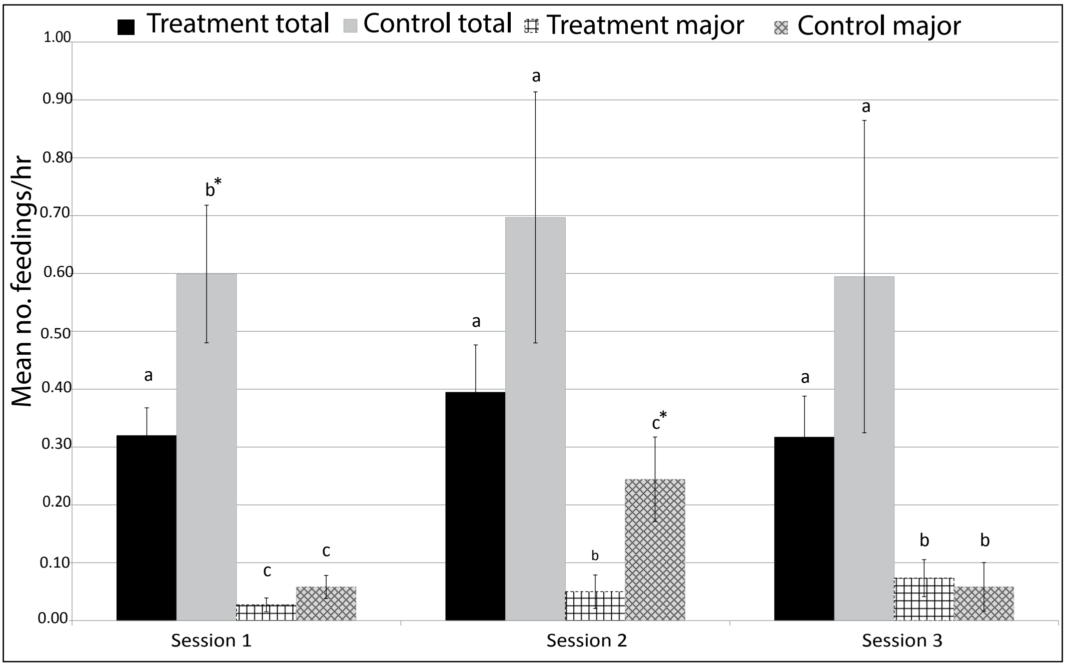
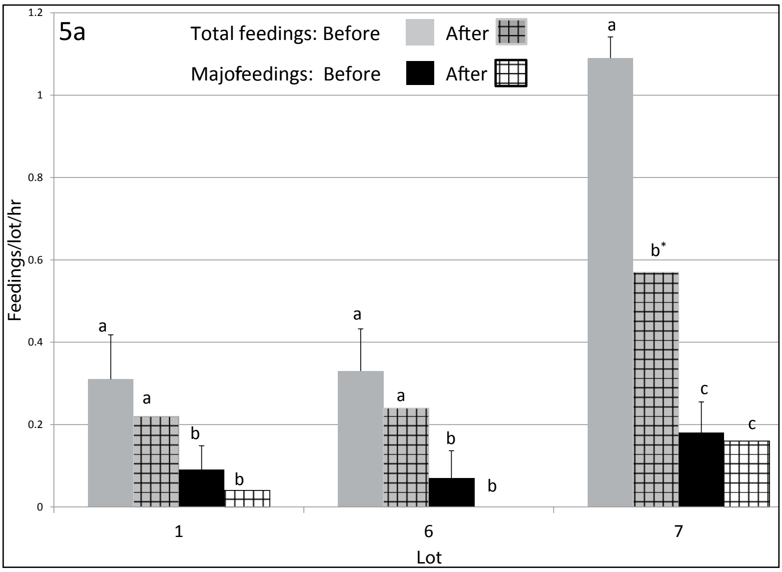


Figure 4. Mean number of total and major (several loaves of bread, boxes of cereal, etc.) feedings/hour seen in treatment (feeders approached and educated) and control (feeders not approached) parking lots during 3 sessions (Session 1= September to October 22, 2011; Session 2: January 1 to January 20, 2012; and Session 3: November 7 to December 2, 2012). (* = significant difference in the number of feedings. Total = total number of times gulls were fed in each parking lot [treatment and control] during each session. Major = total number of major feedings for each lot during each session.

significantly heavier than males captured in nonurban areas where human-derived food was not available (Auman et al. 2008). Auman et al. (2008) suggested that the urban birds were in better condition than the nonurban birds. In contrast, Pierotti and Annett (1990) proposed that reproductive performance was a better measure of individual fitness than caloric intake. They studied the breeding ecology of herring gulls in Newfoundland where individuals specialized in either anthropogenic (garbage) or natural foods. While garbage had the highest caloric value per meal and also the most fat and protein per gram, the eggs of these specialized gulls were most likely to be infertile or did not develop. Pierotti and Annett (1990) suggested that contaminants in the food and insoluble calcium were potentially responsible and challenged the idea that gulls benefit from human-derived food. Further, western gulls (L. occidentalis) feeding primarily on human refuse showed reduced egg hatching and fledging success and had a shorter lifespan (Pierotti and Annett 2001). Western gull chicks that were experimentally fed an exclusive human-derived diet experienced abnormal development or death (Pierotti and Annett 2001).

While the ecological impacts of human-derived food are not well-understood, there is clear evidence that gulls feeding on anthropogenic food can have societal impacts. Anthropogenic food sources concentrated in or near urban areas can attract large groups of gulls, leading to property damage (Haag-Wackernagel 1995, Belant 1997), aircraft hazards (Gosler et al. 1995, Dewey and Lowney 1997), or increased risk of disease transmission and surface water contamination (Benton et al. 1983, Nugent and Dillingham 2009).

While a variety of food was provided to gulls, bread was the most common food offered. This is consistent with feeding studies of other species, including ducks, magpies (*Gymnorhina tibicen*) and butcherbirds (*Cracticus* spp.) in Australia (Rollinson et al. 2003, Chapman and Jones 2009), and black currawongs (*Strepera fuliginosus*) in Tasmania (Mallick and Driessen 2003). Bread is likely a common offering because it is relatively inexpensive, easy to obtain, and



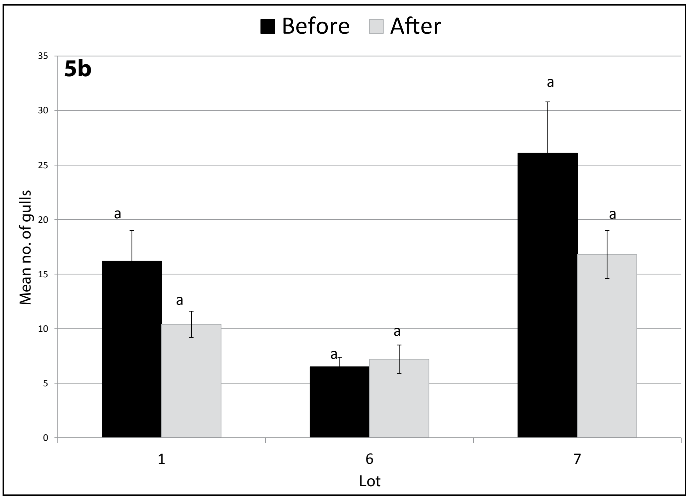


Figure 5a. Mean (±SE) number of feedings/hour before and after educational efforts. (* = significant difference). **Figure 5b.** Mean (±SE) number of gulls seen in control (feeders not approached) lots before and after educational efforts.

readily accepted by gulls and other wildlife.

We were surprised by the behavior of the people who fed gulls, and we recognized at least 3 groups: (1) feed-and-watch; (2) short-watch; and (3) dump-and-run. The people in groups 1 and 2 spent at least some time watching the gulls eat. However, the large number of people who dumped food in parking lots without stopping their vehicles, or stopping only briefly to unload food, would suggest that a direct visual reinforcement (i.e., the gulls consuming the food that was left for them) was unnecessary. It is plausible that these people stopped and witnessed previous feedings and were reassured that the food would be consumed by gulls and, therefore, did not need to witness every feeding event. It is also possible that these individuals were motivated to feed for other reasons (e.g., getting rid of leftover food, feeling that were providing food for hungry wildlife), and that interacting with wildlife was not their primary motivation.

It is evident from our results that our signs, or the way we posted them, were ineffective in preventing feedings in these lots because the vast majority of people feeding gulls never noticed them, even though in several cases they were standing directly in front of one. In contrast, Mallick and Driessen (2003) reported that about 70% of visitors to a national park in Tasmania had seen their "Keep Wildlife Wild" anti-feeding sign; however, the sign did not change any pre-existing opinions about feeding. Ballantyne and Hughes (2006) tested different language in bird-feeding signs and concluded that the most persuasive signs provided clear reasons why not to feed and were designed to convince people that feeding is detrimental to the birds' health. In these situations, no-feeding signs were located at the entrances to parks and were clearly visible to the public as they entered. In contrast, our small signs were scattered on light poles around the parking lots, had relatively small fonts, were placed well above the ground, and may have been obvious only to people who parked directly in front of them. While our larger signs were more obvious and appealed to the health of the gulls, they often were located on the edge of a parking lot, and some were occasionally partially obscured by snow. It is likely that our signs were not directly in the cone of vision of drivers or became lost in a multitude of existing urban signage and blended into the urban "noise" (Morris et al. 2001).

Our educational efforts showed limited and variable effectiveness in reducing the number of feedings or the number of gulls in these parking lots. Even when there were significantly fewer feedings in treatment lots, gulls in some cases were more numerous in education lots than no-education lots. It is likely either that our educational campaign was not able to reduce the amount of available food to gulls or was not conducted long enough to reach most of the people.

Anecdotal conversations with feeders suggested that most were ignorant of where gulls went when they left a parking lot and were unaware of the implications of their actions (i.e., feeding gulls attracts more gulls that roost on water supply reservoirs). In addition, most feeders indicated that they fed gulls out of concern for the birds, which is consistent with other feeding studies (Mallick and Driessen 2003, Ballantyne and Hughes 2006). When educated, most of the feeders we encountered verbally agreed to stop feeding. However, these responses could have been influenced by the monitors (state employees) and how we approached them (state vehicles); in some cases individuals we had approached were seen feeding again. Further, our approach allowed us to interact with only a minority of the feeders and remove only a small percentage of the provisioned food. It is likely that a broader educational approach may be more effective. In Basel, Switzerland, a large informational campaign was initiated to discourage feeding of pigeons (Columba livia; Haag-Wackernagel 1995). Pamphlets and posters were placed around the city, and the campaign message was spread through television, radio, newspapers, and magazines. Within 2 years, their reduction goals were met; however, the educational effort was also coupled with a trap and kill program precluding any conclusions about the impact of the informational campaign. A similar campaign to trap and kill gulls in Massachusetts would likely provoke strong resistance from the general public and be extremely difficult to institute.

Our efforts to foster a behavioral change in people and have them stop feeding gulls relied on an information-intensive campaign that assumed people would stop feeding gulls once they became educated on the topic. However, research in social marketing suggests that enhanced knowledge has little or no impact on behavior, and most failed attempts to elicit behavioral changes in people underestimate the difficulty of changing behavior (McKenzie-Mohr 2000). Future efforts to reduce the number of people feeding birds in central Massachusetts, or elsewhere, should focus on using community-based social marketing techniques to elicit change. Social marketing emphasizes that any program begins with an understanding of the barriers that people perceive exist from engaging in (or stopping) an activity and highlights the importance of delivering programs that target specific segments of the public (people who feed gulls) and works to overcome barriers of this group (see McKenzie-Mohr and Smith 1999 for a discussion on social marketing). Continued efforts could focus on individuals dedicated to gull feeding and identifying what barriers exist from stopping their behavior.

Our data suggest that limiting or eliminating human-provisioned food is challenging, and prohibitive and educational signage alone will likely not change people's behavior. Our ground-based educational program had limited success in preventing feedings or reducing the number of gulls utilizing parking lots. A broader educational campaign using social marketing techniques that specifically targets people who provide food to gulls, supplemented with local ordinances and fines to discourage dedicated feeders from continuing, might be an effective strategy.

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