

RESEARCHING THE USE OF EFFIGIES AS A BEST MANAGEMENT PRACTICE FOR
REDUCING CORVID PREDATION ON BEACH-NESTING BIRDS ON THE
SOUTHEASTERN ATLANTIC COAST

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ABSTRACT

RESEARCHING THE USE OF EFFIGIES AS A BEST MANAGEMENT PRACTICE FOR REDUCING CORVID PREDATION ON BEACH-NESTING BIRDS ON THE SOUTHEASTERN ATLANTIC COAST

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The southern coast of New Jersey is home to several endangered bird species including the least tern (*Sternula antillarum*) and piping plover (*Charadrius melodus*). The populations of these two species of shorebirds are declining rapidly, essentially because of human activities. In recent decades, coastal development in southern New Jersey and an influx of human residents and visitors to the region have severely degraded this beach habitat. In addition to human disturbances on their nesting areas, predation from mammals and avian species are one of the most influential factors that determine the survival of these endangered ground nesting birds. The primary avian species of concern include gulls and corvids, notably the American crow (*Corvus brachyrhynchos*) and the fish crow (*Corvus ossifragus*) which are pervasive avian predators of shorebird eggs and chicks in this coastal area. Both corvids and gulls have been able to thrive in human developed areas due to their ability to exploit food, habitat, and other resources created by humans that benefit their survival. To deter the impact of corvid predation, one technique that requires more research is the use of scare tactics such as effigies. Studies have shown that crows have the ability to discern death of their own species and will avoid an area that they perceive to be dangerous (Swift & Marzluff 2015). The Nature Conservancy (TNC) of New Jersey developed a plan to research the effectiveness of crow effigies as a source of predation management. The hypothesis is that once crows are conditioned with bait to feed at a specific location, they will no longer approach the bait at that location once an effigy is introduced. If successful, effigies will be used to diminish corvid presence near nesting sites which will thus reduce predation on tern and plover eggs and chicks. Although this hypothesis was not able to be tested due to sustained interruptions from gulls and an absence of data because crows did not consistently visit bait plots, a combination of research from the literature review as well as firsthand observations are used to formulate recommendations for revisiting this study with more success in the future. Better understanding of corvid behavior and their responses to effigies will support conservation organizations as they attempt to mitigate threats and challenges posed by these natural avian predators.

Introduction

During the years 2016 and 2020 the eggs of all beach-nesting shorebirds at the Cape May Meadows were lost to predators (TNC, para. 4). Along the southeastern Atlantic coast, least terns (*Sternula antillarum*) and piping plovers (*Charadrius melodus*) have seen a population decline due to human disturbances in nesting areas and significant predation by mammalian species such as red foxes (*Vulpes vulpes*), raccoons (*Procyon lotor*), and coyotes (*Canis latrans*) as well as avian species including gulls and corvids (Strickland 2015). This is a significant problem because the piping plover population is federally threatened and the least tern is endangered in New Jersey and California as well as threatened in states including Florida (Burger 1989). The dominating influence that predators have on the reproductive success of ground nesting birds makes them the largest source of nest failure, which is why coastal land conservation management plans largely focus on methods for mitigating losses from predators (Smith and Edwards 2018). Long-established practices such as exclosures, as well as emerging management practices like repellants, have substantially thwarted mammal predation; however, avian species continue to pose a threat to recovery.

Predation by avian species such as raptors, gulls, and corvids as well as mammalian species contributes significantly to eastern shorebird population declines (Liebezeit and George 2002). From a conservation perspective, appropriately assessing the complexities of predator behavior, historical associations with shorebirds and human activities, and methods for hunting and predating requires intensive knowledge of each specific predator. This study focuses solely on corvids and not all shorebird predators in order to devote all research efforts towards a single prevalent species in order to be useful for conservation purposes.

Crows are members of the intelligent corvid family which also includes magpies, ravens, and jays. Corvids are known for their adept foraging skills and excellent memory which enable these predators to thrive alongside human communities, especially in areas of disturbed habitat caused by human development (Krol and Hernick 2020). While research on using crow effigies to deter these predators from nests is still in its infancy, early indications are that this approach has the potential to be an effective best practice management technique to protect breeding success of threatened shorebird species.

The focus of this study is to reduce crow predation, notably the American crow (*Corvus brachyrhynchos*) and the fish crow (*Corvus ossifragus*), on endangered and threatened shorebirds

at The Nature Conservancy's Cape May Meadows location. Although crows have been documented as significant predators here, the Cape May Meadows Management Plan written in 2017 only briefly mentions predation by crows on shorebirds. The plan maintains the need to discuss more ways to increase shorebird presence and nesting success at the preserve, but does not mention how and updates to the plan have not yet been made. The results of this study will provide TNC with research-based recommendations on how to reduce crow predation and increase nesting success of shorebirds at their preserve.

Literature Review

The New Jersey Atlantic coast population of piping plovers (*Charadrius melodus*) is listed as both federally threatened and state endangered, whereas least terns (*Sternula antillarum*) are listed as endangered in New Jersey, but are not listed as such at the federal level. Predation from mammals and avian species coupled with human disturbances and habitat loss is largely responsible for the New Jersey endangered status of these beach-nesting shorebirds.

Plovers and terns are particularly vulnerable to predators because their nests consist of mere scrapes in the sand in areas with sparse vegetation, leaving them largely unprotected and exposed to predators. Evolution has provided plovers and terns with camouflaged eggs that blend into the surrounding substrate as a method for avoiding detection from predators. Ground nesting birds employ a variety of nest-defense behaviors such as active and passive deception in order to defend their eggs and chicks (Smith and Edwards 2018). Active deception involves distraction ploys such as feigning an injury or in most cases "flushing" which is when an incubating adult perceives an imminent predatory threat and flees the nest in order to lure the predator's attention away from the eggs. Passive deception occurs when an incubating adult detects a predator from a significant distance away from the nest. The parent then flushes the nest with the intention that they and their eggs go unnoticed by the predator. In addition to these behaviors, terns and plovers are known to dive-bomb and defecate on potential predators deemed threatening to nests, including unassuming pedestrians who get too close (Blodget and Melvin 1996).

Anthropogenic disruptions responsible for plover and tern mortality include habitat loss, introduction of novel predators such as cats and dogs, attraction of mammalian and avian predators, and accidental trampling or driving over nests and chicks (U.S. FWS 2007). Coastal development physically destroys and alters breeding and nesting habitat by building, paving, and

deteriorating habitat required by shorebirds. Development also draws humans into plover and tern space making them susceptible to fatal off-road vehicle and foot traffic and nest-abandonment behavior by incubating parents (Mengak et al. 2019). People walking their dogs either on or off the leash pose the risk of trampling or consumption of eggs by these pets. Humans leave trash on beaches that attracts mammals such as raccoons (*Procyon lotor*) and coyotes (*Canis latrans*) which are known to prey on the eggs and young of piping plovers and least terns (Strickland 2015).

Current coastal conservation management plans offer guidance with evaluating and mitigating these human disturbances. The Atlantic Flyway Shorebird Initiative developed one such management plan for shorebirds in the northeastern United States which identified and outlined human disturbance activities that ranged from beach driving to coastal engineering (Mengak et al. 2019). Best practices include restricting human activity during breeding season, using effective signage, utilizing volunteers or stewards, and implementing strategic public access points (Mengak et al. 2019).

Western populations of similar shorebirds offer other examples to follow to develop management plans for protecting these coastal species. UC Santa Barbara's Coal Oil Point Reserve (COPR) is home to western snowy plover (*Charadrius alexandrinus nivosus*) and occasionally California least tern (*Sterna antillarum browni*) wintering and breeding habitat. Their Snowy Plover Management Plan includes similar methods and implementations aimed at supporting breeding populations of these vulnerable species. A docent program, predator control practices, installation of protective roost fencing, and an educational outreach program have been initiated. Docents provide enforcement of rules and prohibited activities which reduced trespassers and unleashed dogs on the beach. To reduce crows, docents chased them away from the beach, cleaned up litter, and installed secure lids on trash cans to prevent crows from foraging for trash which is an attractant for these plover predators.

American crows (*Corvus brachyrhynchos*) and fish crows (*Corvus ossifragus*) are species in the corvid family that are prolific predators of shorebirds. Their predation on eggs and chicks is widely recognized as a significant ecological factor that may limit population sizes in breeding populations of ground nesting shorebirds such as plovers, terns, sandpipers, and killdeer (Peterson and Colwell 2014). In states such as New Jersey, New York, Massachusetts, South Dakota, and California, predation by corvids on least terns and piping plovers has been well documented

(Brown et al. 2011). Throughout the state of California, American crows (*Corvus brachyrhynchos*) and common ravens (*Corvus corax*) have proven to be the most impactful nest predators on western snowy plovers (*Charadrius alexandrinus nivosus*) and California least terns (*Sterna antillarum browni*) (Liebezeit and George 2002).

Habitat modification has proven to be a successful technique supporting reproductive success of shorebirds, particularly plovers. One study done by Murphy et al. (2003) showed that the reproductive output of the piping plover was improved through the use of exclosures topped with strings or netting. Pearson et al. (2016) concur that predator exclosures had a clear positive influence on plover nest survival especially when it came to mammalian predators. However, predation attempts by avian species cannot be so easily deterred because they possess the ability to fly over nest exclosures and fences. Habitat modifications that can be directed towards bird predators include removing anthropogenic food sources such as litter, enhancing shorebird nesting habitat such as removing all or most vegetation, and relocating predator nests (Liebezeit and George 2002). Additional methods include lethal removal, behavioral modifications, and effigies.

Lethal removal of corvids is a drastic management technique which is not favored by most wildlife managers due to its harsh nature and because results are temporary with limited or no benefits after one year (Liebezeit and George 2002). Furthermore, this technique has ethical implications and does not generally garner public support.

Behavioral modifications for managing avian predators include Conditioned Taste Aversion (CTA), visual and auditory repellents, sterilants, and effigies. CTA involves distributing bait designed to mimic characteristics of actual prey with chemically laced substances in order to elicit illness in the predator, causing the predator to associate sickness with the intended prey. Repellents involve startling the corvid from the target location either through visual or auditory means such as balloons and streamers or loud noises blared through an auditory device. Sterilants are intended to cause temporary and, in some cases, long-term infertility, but have not been widely tested on avian species.

Effigies are a method of corvid management which also requires more research. An effigy is a life-size representation of an animal which is made to look as realistic as possible. Effigies can be a taxidermy carcass from an actual animal or they can be artificial. Previous studies which are cited in this literature review have manipulated effigies to look both alive and

dead for the purpose of eliciting specific reactions from corvid subjects. The use of effigies with corvids is a promising method because of their unique responses to dead conspecifics. This is discussed in more detail later in this section.

Encroachment by humans into natural areas and the ensuing transformation of these lands have negative impacts on wildlife diversity. As described earlier, humans negatively affect shorebird populations in coastal communities primarily by contributing to habitat loss and degradation. However, some species like members of the corvid family have been able to adapt and flourish in human dominated areas. Conversion of forests and pasturelands into agricultural fields, large urban cities, and patchy suburban landscapes supports this generalist species and increases in their populations (Marzluff et al. 2001). This has adverse implications for the prey of these birds; not only does human influence contribute to a decline in vulnerable shorebirds, it also amplifies the abundance of their predators, as is the case with corvids. On the Atlantic Coast, human activities have been documented as exacerbating natural predation by mammals and avian species, a major cause that negatively affects piping plover reproductive success (Cape May Comprehensive Plan 2004).

Crows are intelligent, curious, and omnivorous which leads them to look for food in a vast variety of places (Kilham 1989). They predate on eggs and the young of birds, mammals, fish, and amphibians (Miller et al. 2014) and cooperatively forage for insects, berries, and nuts. Their primary diet depends on their surrounding environment, but corvids will eat almost anything edible (Peterson 1980) which is why they have been able to thrive in urbanized areas where an abundance of anthropogenic food sources exist (Preininger et al. 2019).

The increase in corvid populations in human cultivated areas, particularly in urban areas, is a trend occurring worldwide (Marzluff et al. 2001) and the causes are undoubtedly linked to human activities (Liebezeit and George 2002). Corvids possess the ability to exploit resources that strongly support their food and habitat needs. They are generalists and can survive on many different food types such as human refuse in the form of discarded food scraps from restaurants or street litter. In addition, they thrive on insects and worms in gardens and fruits and vegetables grown on farms. Artificial human amendments to the landscape such as utility poles and suburban amenities provide perching and nesting habitat suitable for corvid use. American crows commonly and successfully breed close to human activities (Marzluff et al. 2001) which is in sharp contrast to breeding outcomes in shorebirds living near human settlements.

In studies that require bait to attract crows, researchers have found that unshelled peanuts are effective (Greggor et al. 2016; Greggor 2016). Although numerous anecdotal accounts of using dry dog food to attract neighborhood crows are widespread, Cheetos have been proven to be a successful attractant used in scientific trials. During her doctoral work at the University of Louisiana at Lafayette, Rhea Esposito carried out research involving American crows and Black-billed magpies (*Pica hudsonia*) using Cheetos as bait (Esposito 2016). She discovered that Cheetos were favored by both the crows and the magpies, and the snack's bright orange color allowed her to clearly see when the birds were taking the bait.

This study was also significant in that it reaffirmed the evidence that crows are neophobic, meaning they have an extreme or irrational fear of things new or unfamiliar. Her findings revealed that between the two corvids, crows have higher levels of neophobia than magpies, as displayed by their longer latency to approach new food sources and slower habituation to those food sources (Esposito 2016).

Different species determine if novel objects or food sources are dangerous or beneficial through exploration, particularly when they are young (Miller et al. 2015). The propensity to explore novel sources with extreme caution and a long latency period offer protection from new stimuli that are potentially harmful or dangerous, enhancing survival (Greggor 2020). Although neophobic behavior mitigates the risk that exploratory behavior provokes, this trait may cause neophobic species to miss out on advantageous resources that aid in survival (Greenberg and Mettke-Hofmann 2001).

Evidence has shown that in experiments designed to determine how corvids respond towards novel food sources, ravens and various types of crows exhibit definite neophobic behavior (Heinrich 1988; Greggor et al. 2016). Heinrich (1988) described how he observed ravens in New England approaching a new bait source: "After coming to within 5m of the bait, the raven almost always made sudden violent vertical leaps assisted by one or more wing beats. It then approached a few more steps and again repeated the leaps". He ascribes this display of neophobia to a learned response resulting from the history of raven persecution by humans in this area and unintentional ensnaring in traps meant for coyotes (Heinrich 1988). In this instance neophobia was a trait that evolved in ravens in this particular area from negative and perilous experiences with novel stimuli.

In one study by Greggor et al. (2016), corvids were less likely than other bird species to visit familiar feeding tables containing novel items, even when these items were something they may have naturally encountered such as rocks and leaves. During the control trials when these novel items were not present, the probability that the crows would visit the feeding table increased (Greggor et al. 2016). These results determined that corvids are neophobic and exhibit a wariness towards novelty not seen in other species of birds.

Labeling corvids as neophobic may come as a surprise because of the empirical evidence presenting corvids as bold, opportunistic feeders (Miller et al. 2014). Many researchers also acknowledge the paradox that corvids fear new stimuli while also possessing innovative behavioral and social abilities that have given them a reputation among ornithologists and animal behaviorists as highly intelligent (Greggor et al. 2016; Emery & Clayton 2004). Understanding the capacity and dexterity of corvid cognitive and social aptitudes is the first step towards making sense of this paradox.

The corvid family that includes ravens, magpies, and jays displays cognitive abilities that rival those of primates. Corvids are known to construct and utilize tools, exhibit long-term memory, identify and react to dead conspecifics, and demonstrate vocal learning (Veit and Nieder 2013). Many researchers contend that this is a result of convergent evolution relative to primates, in which complex cognitive abilities evolved over hundreds of millions of years to adapt to similar ecological conditions (Emery & Clayton 2004). In addition to developmental and social factors, this intelligence has been linked to the size of corvids' brains and more importantly the development of the nidopallium caudolaterale (NCL). This structure is analogous to the prefrontal cortex (PFC) in mammals which is the area responsible for executive functions that guide behavior and operating spatial memory. This structure provides corvids with a survival advantage: their cognition does not restrict them to fixed stimulus–response associations, but rather allows them to observe, respond, and adapt to ever-changing environments (Veit and Nieder 2013).

Social learning and acute memory are also highly developed adaptations amongst corvids. The social nature of these birds facilitates their ability to spread information among their group, including information about danger. In one fascinating study by Cornell et al. (2011) researchers discovered that American crows have the ability to distinguish between individual faces and to remember certain faces that have either helped or harmed them in the past.

Researchers wore a rubber caveman mask when trapping and banding crows which became a source of stress for the birds. The control face was a rubber mask of former Vice President Dick Cheney which did not evoke a reaction. The “dangerous” caveman mask elicited scolding and mobbing behavior from 20% of crows, which is consistent with predatory identification behavior (Cornell et al. 2011). Five years after the initial trapping took place, the number of crows who mobbed and scolded the caveman mask increased to 60%. This indicates that crows who were not personally trapped or even alive at the time of the first study contributed to mobbing and defense behaviors. This signifies cross-generational social learning of a predator in which individual crows learned of a threat and shared this information with their young as well as with peers (Cornell et al. 2011).

Using effigies as a management practice to reduce corvid occurrence still needs more research, but recent studies highlight the potential for success. The rationale behind this practice stems from the research suggesting that “crows and some other corvids recognize dead conspecifics as cues of danger and use such information to inform future actions and learn novel threats” (Swift & Marzluff 2018). In other words, crows recognize death of their own kind and will perceive the area surrounding a dead conspecific to be dangerous and will thus avoid it.

Swift and Marzluff (2015) have extensively studied corvid reactions to “dead” effigies. Their experiment paired crow effigies either with a red-tailed hawk or a human, and also tested crow responses to a pigeon (*Columba livia*) effigy. Trials were accompanied by crow distress calls. All trials elicited strong responses from corvids, except for trials involving a pigeon. Their findings suggest that for crows, effigies perceived as dead represent a pertinent danger akin to the presence of a predator, whereas heterospecific effigies do not (Swift & Marzluff 2015).

Another study by Swift & Marzluff (2018) again tested crow reactions to conspecific and heterospecific effigies that were made to look either alive or dead. Heterospecific effigies included both an Eastern gray squirrel (*Sciurus carolinensis*) and a pigeon in a dead posture. Results showed that crows are more likely to mob and scold crow effigies in a dead posture than they are a heterospecific effigy in a dead posture (Swift & Marzluff 2018). Behavior responses to crow effigies also included recruitment of nearby crows signifying that this is a teaching opportunity: a dead crow signals the presence of imminent danger and other crows are mobilized to disclose this crucial information. Swift and Marzluff (2018) deduced that these behaviors

suggest that crows can tell the difference between seemingly dead and live effigies and that dead conspecifics elicit a danger-response.

Avery et al. (2008) conducted a study aimed at dispersing bothersome roosts of up to 40,000 crows in Lancaster, Pennsylvania using effigies. This study used 3 different types of effigies: carcasses, taxidermic effigies, and artificial effigies. Findings indicate that all 3 effigies were effective at eliciting desired crow responses (Avery et al. 2008). Researchers were able to successfully relocate the large crowd of birds to a wooded location away from urban businesses. The initial effigies were placed during November of 2005 and then again in October of 2006. Although previously a preferred roosting area, findings discovered that only 5,000 to 10,000 crows returned to this same site in 2006, a fraction of the number from the previous year (Avery et al. 2008). Effigies were then erected in this location which dispersed the remaining group. This study concluded that effigies were effective at disbanding and relocating large roosts of crows.

Effigies have been utilized to prevent corvid consumption of crops, for dispersal of large roosts in urban settings (Avery et al. 2008), and for the protection of endangered species (Boarman 2019). This capstone research intends to test the use of effigies as a best-practice management technique for reducing crow predation on ground-nesting piping plovers and least terns on the southeastern coast of New Jersey. The hypothesis is that once crows are conditioned to feed at a specific location, they will no longer feed at that location once an effigy is introduced. The findings would then be used to prevent corvids' presence at plover and tern nests during the nesting season and thereby increase breeding success for these ground-nesting shorebird species.

Research Methods

Prior to selecting a location site for bait plots, observations were conducted throughout Garrett Family Preserve and Cape May Meadows in Cape May, New Jersey from May 18, 2020 until June 23, 2020. The purpose of these initial observations was to determine a suitable location for the experiment. Suitability included a space that crows frequented and could be clearly seen and observed for long periods of time. Three different sites within these two preserves were subsequently selected to study the use of effigies in deterring crow species.

Trials at each site consisted of the researcher arriving onsite and setting the bait out. Observations were made from arrival until when the researcher collected the bait and departed.

Trials lasted between 3 and 5 hours. Arrival time and departure time varied across and within sites because initially crows were not being observed so times were staggered in order to determine when crows were most likely to occur. At each site the goal was to attract crows to the feeding location using a mixture of Cheetos, unshelled peanuts, and dog food as bait. Because of their highly social nature, a device that played normal crow calls accompanied the bait. At Sites 1 and 2 a cellphone was used as an audio lure while at Site 3 a small bluetooth speaker was utilized.

The following sections describe the Study Area, Methods, and Results for Sites 1, 2, and 3. Sites 1 and 2 proved to be uncondusive locations for carrying out research; the crows were not responsive in terms of consistent attraction to and approaching the bait. In addition, continuous interference by gulls at Site 1 proved to be a complicating factor. Site 3 had more success attracting crows to the bait as is described later in this section. However, Site 3 also failed to continuously attract crows to the bait which did not allow for the hypothesis to be tested. See Appendix I for a more detailed review of observations.

Site 1 Study Area: Garrett Family Preserve, Cape May, NJ

Site 1 is located on The Nature Conservancy's (TNC) Garrett Family Preserve (Figure 1).

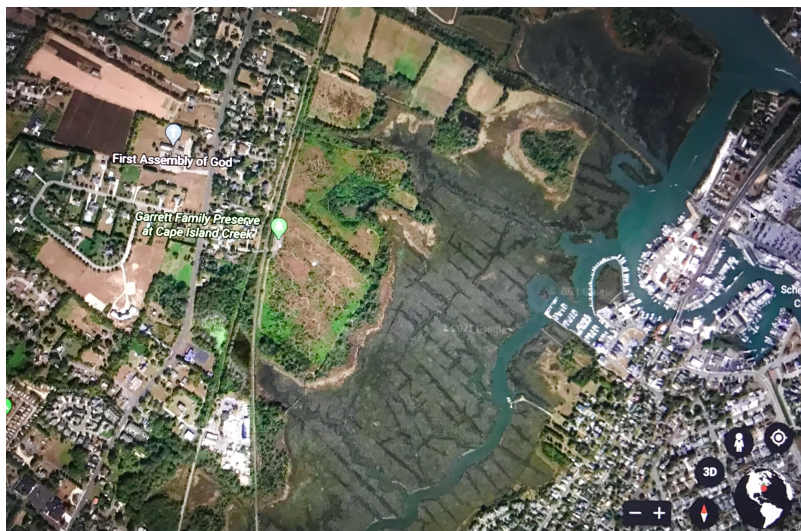


Figure 1. *Aerial view of Garrett Family Preserve, Cape May, New Jersey. Source: GoogleEarth.*

The preserve within TNC's boundary is approximately 180 acres of wildflower meadows, upland forests, and successional fields which were previously used for agriculture (Figure 2).



Figure 2. *This area at Garrett Family Preserve was formerly used for agriculture and now hosts a wildflower meadow. Source: Kelly Clinton.*

The preserve is open to the public, but the trail entrance to the area where this study took place is roped off with a sign provided by TNC (Figure 3).



Figure 3. *The trail entrance to Sites 1&2 was closed off to the public to avoid any disturbances from visitors. Source: Kelly Clinton.*

This site does not harbor shorebirds. It is located about half a mile (850m) from the nearest wetland habitat and 1.5 miles (2538m) from the nearest coastline. This site was chosen because the supervisor at TNC frequently observed crows in this area. The assumption was that

crows inhabited the nearby woods and would be able to easily observe and respond to the bait plots.

Site 1 Methods

Methods for Site 1 included building a 6.5-foot tall wooden platform on which the bait was placed (Figure 4).



Figure 4. *This wooden platform was used to hold the bait at Site 1. Source: Kelly Clinton.*

The bait used at Site 1 included Cheetos, unshelled peanuts, and dog food as well as a Pop-Tart wrapped in its original shiny foil which presumably would assist in the attraction of crows to the bait because of their anecdotal curiosity and affinity for shiny objects (Figure 5).



Figure 5. *Cheetos, unshelled peanuts, dog food, and a Pop-Tart were used as bait at Site 1. Source: Kelly Clinton.*

Binoculars were used for observations and took place about 10 meters from the platform behind woody vegetation. Methods for Site 1 were consistent except for the researcher's time of

arrival which varied from 7:00AM to 5:00PM. Duration of trials lasted from 3 hours to 5 hours each day. The large range of time is a result of trial and error; different times were chosen to see if a certain time of day was more likely to result in crow sightings than others.

Upon arrival at the site, bait was placed on the platform and a cellphone was situated on a branch next to the platform which broadcasted 10 minutes of audio crow calls. These calls were obtained via YouTube and assumed to be vocalizations used by crows when they found a food source. Calls were repeated every 5 minutes.

This site utilized a trail camera which was installed on the trunk of a Callery pear (*Pyrus calleryana*) and aimed directly at the platform (Figure 6).



Figure 6. *This view is from the trunk of a Callery pear tree where the wildlife camera was fixed and pointed directly at the platform to record observations. Source: Kelly Clinton.*

This camera was triggered to begin recording 6-second videos when motion was detected on the platform. The camera caught footage of crows as well as other avian species that landed on the platform when the researcher was not physically there to record activity.

Site 1 Results

Site 1 consisted of 21 trials between July 2 and August 11, 2020. Crows were occasionally seen and heard firsthand by the researcher in the vicinity of the platform. Crows were only seen on the platform on two separate days via the trail camera (Figure 7).



Figure 7. *This image of a crow perched on the baiting platform was taken via the trail camera. It was only 1 of 2 times that a crow was observed on the platform at Site 1. Source: Kelly Clinton.*

Laughing gulls (*Leucophaeus atricilla*) proved to be a problematic issue during daily trials. Although crows were consistently seen and heard in the vicinity of the platform, gulls approached the platform and ate the bait either immediately or were recorded on camera eating the bait on 17 occasions (Figure 8).



Figure 8. *Three laughing gulls swarmed the bait platform at Site 1. Image via the trail camera. Source: Kelly Clinton.*

There were no signs that the gulls were aggressive towards the crows. But the gulls' pursuit of the bait was incessant; the gulls would eat the entirety of the bait as soon as the researcher placed it on the platform.

During daily observations at Site 1, a group of 5-9 crows were routinely seen congregating in an area which eventually became the location for Site 2. The research area was moved to another location based on the unanticipated circumstances surrounding the inability to observe any single crow eating bait from the platform for a consistent amount of time and repeated interruptions by gulls.

Site 2 Study Area: Border of Garrett Family Preserve and Private Farm, Cape May, NJ

Site 2 is located at the border between TNC's Garrett Family Preserve and an adjacent privately owned farm (Figure 9).



Figure 9. *Crows were frequently observed at this private farm which bordered Site 1. Source: Kelly Clinton.*

The small private crop farm was chosen as Site 2 because a group of crows had consistently been observed feeding and congregating in the trees here as there was a predictable food source (Figure 10).



Figure 10. *Nine crows are pictured atop these trees on the adjacent farm. Source: Kelly Clinton.*

This farm can be easily observed from the side that is owned by TNC; the two sides are separated only by a dirt trail. The owner of the farm was aware of the study and had been cooperative with the research team. The private farm is about 2 acres of grassy open space bordered by pine and oak trees on all sides.

The platform was lowered 1 foot from 6.5 feet to 5.5 feet and placed in an area that had vegetation directly above the platform and this site presumably was more accessible to the crows and less accessible to the gulls.

Site 2 Methods

Methods for site 2 mimicked those for Site 1, the main difference being the location of the platform and the times of arrival and departure which varied from 6:35AM to 6:30PM. The wildlife camera and audio lure were also utilized at this site.

Site 2 Results

Site 2 lasted for 9 trials from August 11 to September 2. Throughout these trials, only 1 crow was observed on the platform via the trail camera (Figure 11).



Figure 11. *An image of one crow at the baiting platform at Site 2 was captured via the trail camera. This video showed this particular crow making rattling noises on the platform. Source: Kelly Clinton.*

During observations with binoculars, crows were seen in the bordering trees on 3 occasions, but never directly observed on the platform by the researcher. This absence of crows utilizing the platform prompted a change to a more suitable location.

Site 3 Study Area: South Cape May Meadows Preserve, Cape May, NJ

Site 3 is located at The Nature Conservancy's (TNC) South Cape May Meadows Preserve located directly off of Sunset Blvd in Cape May, New Jersey (Figure 12).

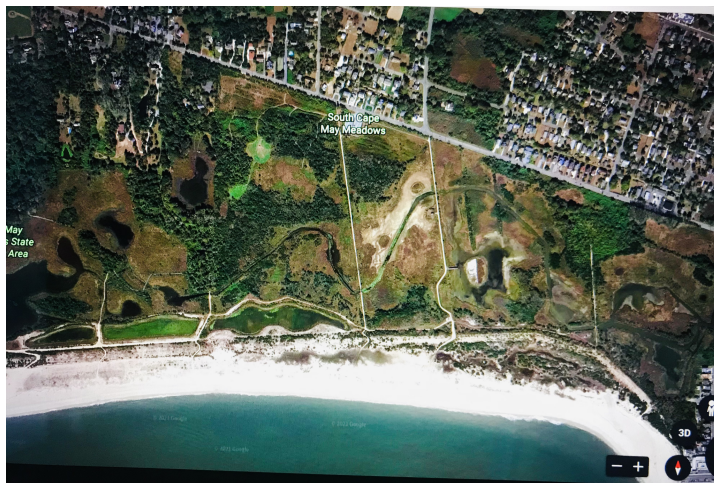


Figure 12. *An aerial view of TNC's South Cape May Meadows Preserve, Cape May, New Jersey. Source: GoogleEarth.*

The preserve within TNC's boundary is approximately 218 acres of dunes, freshwater wetlands, meadows, ponds, and a full mile of protected beach (Figure 13).



Figure 13. *This preserve contains wetlands, uplands, and ponds that host a variety of wildlife.*

Source: Kelly Clinton.

The preserve is open to the public for passive recreation such as hiking, bird-watching, and photography; pets are not allowed on the premises. This site is located half a mile from shorebird nesting habitat on the aforementioned protected beach. Site 3 consisted of 15 trials between September 6 and October 4, 2020. These dates do not fall within shorebird nesting season, but research continued in order to test the effectiveness of using effigies to prevent crows from occurring in the location.

The specific data collection took place in the preserve's gravel parking lot which also serves as the entrance off of Sunset Blvd across from a row of residential houses (Figure 14).



Figure 14. *The bait spot for Site 3 was located in a gravel parking lot across from residential houses on Sunset Blvd in Cape May, New Jersey. Source: Kelly Clinton.*

A spot located at the entrance of the parking lot was chosen as the location for the bait because it is out of the way of visitors and could be easily observed from within the researcher's parked car. It can be assumed that the researcher's presence did not disturb or influence the crow's behavior, as there are cars and people traveling in and out of this area from sunrise until dusk each day.

This site is abounding with wildlife, particularly bird species which makes this area a world renowned birding area. Crows are also known to frequent this space and are able to be heard and observed throughout the year.

Site 3 Methods

Trials for Site 3 began on Sunday, September 6, 2020 at 7:00AM. The methods were consistent at this Site except for the time of arrival and departure; arrival times varied between 7:00AM and 4:00PM. Observation duration lasted between 3 and 5 hours each day. The bait consisted of Cheetos, unsalted peanuts, and dry dog food. This bait was placed in the corner of the parking lot, out of the pathway of cars and pedestrians, but able to be spotted by crows and other birds. A small, black bluetooth speaker was hidden in the grass 1 meter from the bait and used as an audio lure. There were other cars in the parking lot at the time of the trials, in addition

to joggers and walkers that filtered in and out throughout the day. The trail camera was not used at Site 3. Observations took place from a parked car about 5 meters from the bait with an unobstructed view.

Site 3 Results

Site 3 consisted of 21 trials over the course of 4 weeks from September 6 to October 5, 2020. It is possible that the crows were aware of the bait since Trial 11 on September 11 (see Appendix 1 for more detailed review of observations). However, there were only 3 occasions where crows were observed eating the bait. During the first occasion on September 14th, a total of 21 crows and 1 gull came to feed on the bait (Figure 15).



Figure 15. *A total of 21 crows descended on the bait on September 14th, 2020 at Site 3. Source: Kelly Clinton.*

This large group of crows remained in the vicinity of the bait plot for about 1.5 hours until they eventually flew off in small groups.

The second occasion crows were observed by the researcher taking the bait was 3 days later on September 17th. Only 2 crows approached and ate the bait on this occasion. The researcher observed 2 crows making vocalizations back and forth for 50 minutes prior to their

approaching the bait. Both crows displayed neophobic behavior by cautiously approaching and then jumping back from the bait. These “jumping jacks” were performed 4 times by 1 of the crows (Figure 16).



Figure 16. *This is a still frame from a video at Site 3 depicting what one researcher called “jumping jack maneuvers” in which the crow cautiously approached the bait and jumped back with its wings spread multiple times. Source: Kelly Clinton.*

Within 6 minutes of their initial approach, both of the crows had taken a single piece of bait up to a nearby utility pole. After 1 hour, the crows flew off and did not return, leaving bait on the plot.

The third and final occasion crows were seen by the researcher eating the bait was on September 22nd. On this occasion, only 2 crows approached and ate the bait. One gull was also feeding on the bait. The crows’ approach was very similar to that of the second occasion: cautious and leery while 1 crow performed the “jumping jack” method. Both crows made vocalizations before they took their final pieces of bait up to a utility pole and eventually flew away, again leaving bait.

The researcher determined that not enough evidence was provided to determine if the effigies would have a statistical effect on crow behavior. In other words, the conditioning period was not successful enough to test the effigy hypothesis; the effigies were never placed.

Results and Discussion:

Although crows were observed to be in the area of Sites 1, 2, and 3 during initial observations and during trials, research efforts were not able to condition crows with bait to the

desired location. Several factors may have contributed to the inability to test this hypothesis. The location, disturbances from gulls, availability of other food sources, and neophobia appear to be the most significant factors affecting conditioning crows to the bait.

At Site 1, crows were initially attracted to the bait (*see Appendix I*), but interference from gulls proved too large of a disturbance to continue trials. Gulls would wait for the researcher to bait the platform and then consistently outcompete crows for the bait. Peterson (2013) cited bait consumption by gulls during trials, but it did not deter crows from visiting baited plots. Crows at Site 1 did not challenge gulls for the bait, possibly because of the availability of other food sources (this site was located adjacent to an old farm field, wetlands, and meadows).

Another issue could be the use of the platform. Crows are historically neophobic so the platform could have been too novel of a structure, causing the crows to feel apprehensive to approach. Additionally, crows typically forage on the ground or in trees (Kilham 1989) so the introduction of this unfamiliar manmade structure may have made crows more wary to approach.

Site 2 was located in an area where a group of crows were known to frequent as the border of tall trees surrounding an old farm field provided suitable crow habitat. However, the crows may have had an availability of other food sources in this area which led them to avoid the bait.

Neophobia could again be the reason for avoidance at Site 2. Since Cheetos and peanuts have been proven to be successful as bait, neophobia could explain why the crows avoided the novel structure which held the bait.

Site 3 proved to have the most success with conditioning crows to the bait location (this is described in more detail in the Appendix). On September 14th a total of 21 crows were observed eating the bait. However, this success was short-lived; only 4 crows ate the bait on 2 other occasions followed by complete unresponsiveness. It is possible that their behavior was affected by the large presence of humans, although this is unlikely because humans frequent this space throughout the day almost daily.

Alternative food sources may also be a factor here; the Cape May Meadows is situated within meadow, pond, forest edge, wetland, and beach habitat. Additionally, crows are cooperative foragers and they are not known to fight over food (Kilham 1989) so perhaps the bait was not enough for the group at large.

On the second and third occasions when crows ate the bait, their behavior was representative of neophobia. Their temperament was wary; they would observe the bait plot for a period of time before approaching and then they would take a piece and jump back several times or take a piece up to a nearby utility pole. This behavior was described by Bernd Heinrich (1988) as “jumping jack maneuvers” . The behavior he described decades ago is able to be observed today because corvids still hold intense reservations about novel food sources which may have served them well from a survival standpoint.

This explanation makes accounting for the 21 crows eating the bait difficult to explain. It is possible that due to their highly defined social structure, the crows felt safer in a larger group. It appears that once one of these lower-standing crows investigated the bait and saw it was not immediately dangerous, the rest of the group felt secure enough to approach and feed. However, judging by the suspicious and leery approach by the few crows taking the bait on September 17th and 22nd, neophobia appears to be the largest influence as to why all 3 bait stations failed.

Recommendations for replicating this study:

Due to the inability to consistently attract the crows to the bait, the hypothesis that effigies will deter crows from an area was not able to be tested. However, some key findings were made about how to perform this research with the desired results of conditioning crows to bait plots in the future.

Location

Selecting a site location that is suitable for crows is an important first step. Proper areas for perching such as tall trees with scarce vegetation on top or utility poles would be preferred. Food sources, either natural or anthropogenic, are also important for site selection. Site 3 presumably had the most success because crows forage in this area. Furthermore, there was only a slight disturbance from gulls, but not enough to deter crows from the bait. Since crows are expected to again occur in this area, this would be a suitable location to host the experiment again.

Time of Year

For the purpose of strictly testing crow responses to effigies, fall or winter would be the most appropriate time to revisit this experiment because it would not interfere with the crow, plover, or tern breeding season which could affect crow behavior.

If the intent is to study the effect of effigies specifically for the purpose of shorebird conservation, this should be studied in April or May, at the onset of the breeding season. This will allow for the most accurate observations because the breeding season is when the predation is taking place. Timing this study during breeding season is very sensitive. In one study by Forsys et al. (2015) researchers maintain that effigies might be a successful deterrent if used *before* the onset of the plover breeding season. They explain that once the crows have experienced successful foraging prior to the erection of effigies, they are not likely to be deterred by effigies in the middle of the season (Forsys et al. 2015).

Bait

Because crows expressed neophobic behavior, giving them time to adjust to the bait source will be required. Placing the bait at the same time and location each day for 3-5 hours will facilitate familiarity and presumably alleviate any skepticism or fear surrounding the bait. Based on the duration of trials for Site 3, it may take several weeks before the crows become comfortable enough to consistently visit bait plots.

Cheetos, peanuts, and dog food are an empirically successful form of bait which should be used again for future trials. Since eggs are favored food sources by crows, using chicken eggs (L. Kiziuk, personal communication, October 1, 2020) or quail eggs (D. Brinker, personal communication, March 15, 2021), which are close in size and coloration to plover eggs, could also be effective.

Audio Lure

The speaker that broadcasted crow calls should continue to be used as an audio lure. During normal baiting trials, normal crow calls should be played. During trials when the effigy is presented, crow distress calls should be played.

Conclusion

Avian predation has a significant negative impact on the breeding success of ground nesting shorebirds, and thus poses severe challenges for shorebird conservation managers. Corvids present a particularly difficult issue because they are intelligent, aggressive predators who easily adapt and flourish in human dominated habitats which have been altered and adversely impact shorebirds. The complexity of this issue is evidenced by how difficult it was to even test this study's hypothesis. In addition to continuous disruptions from gulls, the primary issue was the inability to consistently attract crows to the bait plots. The literature review shed more light on reasons why this hypothesis was not able to be tested, including crow neophobia and availability of additional and more trusted food sources. Replicating this study in the future would require different approaches such as including quail eggs as bait and giving the crows more time to become acclimated to the bait source in order to accommodate for their neophobic inclinations.

Coastal conservation organizations throughout the country have encountered avian predation on shorebirds with little solutions. Lethal removal, habitat modification, and behavioral modifications have all been utilized to some extent, but no methods are fool proof. The Nature Conservancy's Cape May Meadows Management Plan briefly mentions fish crows as a significant shorebird predator. However, the plan did not provide any methods or strategies for remedying this important issue. Based on the observations from this research project and findings from the literature, an addendum to their management plan was created and attached as Appendix II to this paper.

The Nature Conservancy's Cape May Meadows should use a combination of ingenuity and persistence by employing several techniques outlined in the addendum to combat avian predation on endangered and threatened shorebirds at their preserve. These include restricting beach access during breeding months and enforcing this with effective signage and volunteer docents as well as providing suitable habitat for breeding terns and plovers by keeping vegetation minimal or nonexistent, maintaining fencing to keep mammals out, and clearing the beach of litter which attracts undesirable predators such as gulls, crows and mammal species. Based on the research that suggests the effectiveness effigies have at keeping crows away from target locations, presenting 2 or more effigies nearby the breeding habitat could potentially have the desired effect of scaring crows away from nests.

Threatened and endangered shorebirds such as terns and plovers have a great deal to combat in order to maintain their existence including human disturbances and natural predators. However, these birds are persevering and with the help of conservation managers, local communities, and everyday citizens we can learn to coexist with these magnificent birds so they are able to rebound and return to robust and thriving populations.

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Appendix I: Observation Notes

Observation Notes from Site 1: Garrett Family Preserve, Cape May, New Jersey

There were a total of 21 trials for Site 1 from July 14 to August 7. On July 14, at 10:30AM a wildlife camera was installed in a tree directly facing the top of the platform. At 1:00PM after testing the camera, the bait consisting of dog kibble, cheetos, peanuts, and a silver pop tart wrapper was placed atop the platform. Crow calls were played from the researcher's smartphone which was placed inconspicuously in the nearby tree in the hopes that this would attract crows to the platform.

No crows were seen or heard in the area and observations concluded at 3:00PM. The bait remained on the platform overnight.

On July 15 the researcher arrived at 12:00PM and noted that the bait was gone from the platform. Video from the previous day showed 1 crow perched on the platform at 6:45PM and it remained there for at least 1 minute. The camera recorded a total of 5 videos of this crow on the platform. The crow did not eat all of the bait.

The next footage seen on the wildlife camera was a catbird (*Dumetella carolinensis*) at 6:59PM which appeared to have eaten a small amount of the bait. At 7:04PM 2 catbirds were seen on the platform.

At 7:17PM video shows 1 laughing gull (*Leucophaeus atricilla*) standing atop the platform while 2 other laughing gulls circled the platform from above. The 1 gull on the platform seemed to be combative and defensive of the bait. Researcher assumes that this gull ate most of the bait on the platform.

During observations on July 15, 1 crow was seen flying near the platform, with 2 other crows present in the trees nearby. Observations included crow vocalizations and flying nearby the platform as well as gulls landing on the platform and finishing the bait. It can be concluded that due to the crows' presence on the platform and their occurrence in the area, the platform had the attention of the crows.

On July 16 the researcher arrived at 11:48AM and checked the video from the previous day. Video showed 1 catbird on the platform at 4:04PM. The video did not show any crows or gulls.

Bait was placed on platform and observations began at 12:03PM. Immediately, 1 crow was observed in the trees across from the platform. This crow remained in the trees for 2 minutes. Cawing was then heard and 1 crow was observed from a telephone pole behind the researcher at 12:10PM, but it quickly flew off.

At 12:50PM 1 catbird landed on the platform and remained only for a few moments. At 1:12PM 3 crows were seen and heard flying low towards the meadow and passed close by the platform; it is not clear where they landed.

Bait was left on the platform and observations ended at 3:00PM.

On July 17 upon arrival, the researcher noted that the previous bait was gone from the platform. New bait was placed on the platform and observations began at 11:30AM. Video from

July 16 showed about 7 gulls either on the platform or swarming just above it. This occurred at 3:39PM, just 39 minutes after observations ended on July 16th.. It is assumed that the gulls ate all of the bait.

At 12:20PM the researcher was checking the memory card for footage from the previous day. When the researcher went to put the memory card back, the bait was gone. There were no observations of what may have taken this bait. The platform was quickly re-baited and observations reconvened. During this time, 4 crows were seen flying near the platform while making vocalizations. It is likely that either crows or gulls ate this bait.

Bait was left on the platform and observations ended at 2:30PM.

On July 18 upon arrival at 6:15PM, it was noted that the bait was gone from the platform. Video footage from July 17 showed that gulls got to the bait at 2:45PM, approximately 15 minutes after observations ended. Video showed 1 crow on the platform at 5:45PM for 4 minutes.

Observations from July 18 concluded that crows were aware of the bait on the platform but the gulls were more aggressive and dominant when it came to securing and eating the bait. The crows were not interested in challenging the gulls for the bait on the platform.

For the next 2 weeks from July 19 to August 7, observations were more or less the same: platform was baited, gulls lingered until the researcher left and then finished the bait. Crows were still present in the area, but were not approaching the bait in a timely manner, nor were they seen on the platform. The gulls became a huge issue and continuously beat the crows to the bait.

During observations, it was noted that a group of crows were consistently seen on the other side of the research location on a former agriculture field. The area contained more vegetative cover and thus the platform could be made more inconspicuous to the gulls. In addition, crows had been observed in this space on several occasions and it was inferred that it was part of the crows' territory. The researcher decided that it would be better to move the platform to this area and continue the research.

Observation Notes from Site 2: Garrett Family Preserve, Cape May, New Jersey (Opposite end of Site 1)

Site 2 consisted of 9 trials from August 11 to September 2. On August 11, observations began at 12:15PM and ended at 3:40PM. The bait consisted of unshelled peanuts, cheetos and dog food. Bait was placed on the platform and observations began. There were no crows observed on the video footage or seen in the vicinity on August 25th.

On August 26 observations began at 6:35AM and ended at 9:45AM. The bait from the previous day was still on the platform. No crows were seen on the camera footage or in the area.

Upon arrival on August 27 at 6:30PM, it was noted that the bait had been reduced from a handful of cheetos, peanuts and dog food to only a few pieces of each. The camera did not reveal what took the bait. Since some bait remained, it was speculated that something other than a gull ate the bait (a gull surely would have eaten all of the bait).

Over the course of the next 6 trials from August 28 to September 2, crows were observed in the vicinity, but did not respond to the bait as expected. One crow was observed on the platform making rattling calls via the trail camera on September 5 at 11:42AM. But other than this one instance, no crows were observed on or near the platform. The lack of responsiveness from the crows prompted a change to a more suitable location.

Observation Notes from Site 3: Cape May Meadows Preserve, Cape May, New Jersey

September 6 was the first day of trials for Site 3. At 8:08AM the bait was presented and observations began. Two crows alighted on the 7th pole followed by 5 more crows flying overhead amongst gulls. Crow calls continued to be played from the speaker. This group of crows flew out of sight at 8:40 AM.

At 9:26 AM a group of 10 crows flew around the 7th pole again, 2 were engaged in a chase. This group again flew from sight at 9:29AM. Cars circulated in and out of the parking lot throughout the morning. At 10:30AM bait was collected and observation ended. These events happened more or less the same for the next 5 days from September 6 until September 10. On Friday, September 11 observations started at 8:30AM and the same bait (cheetos, peanuts and dog food) was set up. At 9:32AM 3 crows alighted on top of the 5th telephone pole while 3 more sat atop the 11th pole. Eventually by 10:04AM 1 crow was circling the bait with 3 others in tow, swooping down towards it, but never landing to eat it. This 1 crow sat atop the 1st pole while cawing frequently. Though the bait was not approached it had undoubtedly been noticed by this group of crows. At 11:30AM there were still no new advances towards the bait and the crows had flown off. Bait was collected and observation ended.

On Monday, September 14, observations began at 11:10AM and the bait station and accompanying speaker were set up. By 12:25PM 6 crows alighted on the 5th and 6th poles. At 12:39PM 1 gull approached the bait and began feeding on the bait. Immediately thereafter, 14 crows quietly descended upon the bait in a somewhat orderly fashion where most took just one piece of bait and flew off to a nearby utility pole. 5 more crows came to eat the bait. Only about 5 crows stayed at the bait to feed on more than 1 piece of bait and 5 crows came back around to feed for a second time. In total 21 crows were observed eating the bait.

These 21 crows remained alighted atop telephone poles and rooftops all within 16 meters of the bait until 2:12PM when they flew off in groups of about 5. At 2:30PM the bait was collected and observations ended.

On Tuesday, September 15, observations began at 9:50AM and bait was placed in the same spot in the parking lot with the speaker which broadcasted crow calls. The parking lot eventually filled up with cars (a total of 30 cars) due to a hiking group which met on this day at 11:30AM. No crows were observed in the vicinity of the bait or around the preserve from the researcher's viewpoint in the parking lot. One gull approached and ate some of the bait from 11:32 until 11:35AM. At 1:00PM bait was collected and observations ended.

On Wednesday, September 16 the bait was set up and observations began at 11:00AM. Throughout the next 4 hours, a total of 12 crows were observed within a quarter of a mile of the

bait. The only bird to approach and eat the bait was 1 gull at 12:53PM. During observations on this day, no crows ate the bait. At 3:00PM bait was collected and observations ended.

On Thursday, September 17, observations began at 12:30PM. One crow was already perched atop the 1st pole making short vocalizations. After the bait was placed, this crow continued to make vocalizations and was shortly accompanied by 1 more crow who sat on the 2nd pole preening itself. The second crow moved to another location on top of the TNC's green roof office. These 2 crows continuously made vocalizations back and forth from 12:39PM until 12:57PM. At 1:20PM both crows very cautiously approached the bait and took a few pieces up to the 1st pole to eat it. A moment after, 1 crow flew down to the bait again, took a piece of bait and jumped back while eating it. This leery approach was repeated 4 more times until it took a few pieces and rejoined the other crow who was still atop the pole. Three other crows were observed silently perched in the trees just beyond the pole. The 2 crows made vocalizations until 1:41PM when they and the 3 in the trees flew off. At 3:30PM bait was collected and observations ended.

On Tuesday, September 22 the bait and speaker were placed in the parking lot and observations began at 3:40PM. At 3:45PM a group of 20 crows were observed flying near or perched on the 7th pole. After a few minutes of reshuffling among the group, 1 crow flew to the 2nd pole while others scattered out of view throughout the trees. At 4:08PM 2 crows cautiously approach the bait, taking 1 piece at a time and then quickly jumping back and retreating to the pole to make vocalizations. At 4:11PM both crows returned to the bait with slightly less caution; they were not as "jumpy". A few minutes later 1 crow made vocalizations while approaching the bait which it carried off to the first pole to eat. At 4:18PM both crows flew off and no more were seen in the vicinity. At 6:30PM bait was collected and observations ended.

On September 23 and 24, no crows were seen in the vicinity of the bait for the 3.5 hours in which it was presented in the parking lot.

On September 30, the bait and speaker were set up and observations began at 9:10AM. Crow calls were continuously played from the speaker. No crows were seen or heard in the vicinity. Observations concluded at 12:30PM.

On October 4, observations began at 11:00AM. A group of crows were seen out in the distance. Two crows alighted atop the 5th pole at 11:07AM. The speaker played crow distress calls. At 11:11AM the 2 crows took off over the meadows. The speaker was then switched to normal crow calls.

At 11:14AM 2 crows perched atop the 5th pole and 6th pole, respectively. Until 11:42AM these 2 crows remained in these spots, preening themselves. At 12:40PM crows flew off into the distance. At 2:00PM the bait and speaker were collected and observations ended.

Appendix II

Beach-Nesting Bird Management Plan for The Nature Conservancy

At The Nature Conservancy's Cape May Meadows Preserve, the least tern (*Sternula antillarum*) and piping plover (*Charadrius melodus*) eggs and chicks experience significant avian predation, notably by fish crows (*Corvus ossifragus*). Several methods could be implemented to reduce crow predation and increase shorebird reproduction success.

Adult plovers and terns are known to flush their nests when a potential predator or threat is sensed, leaving their eggs vulnerable to attacks. The Meadows is privately owned by TNC, but keeps their beaches open to the public for passive recreation. The two beach entrances leading to plover and tern breeding habitat should be closed from March until June. This would prevent people (and pet companions) from approaching the breeding grounds and potentially causing an adult to flush their nest, allowing an avian predator to pluck the eggs or chicks. The Meadows currently has informative signs placed on the symbolic fencing on the beach, but by this point visitors may already be too close to nests, causing incubating adults to flush. The entrances should be closed with signs that make it clear to visitors that their presence past this point is potentially deadly to plover and tern shorebirds. These birds are threatened and endangered and disobeying these signs is potentially punishable by law.

Based on the evidence maintaining that crow effigies elicit a danger response from corvids, hanging 2-4 effigies nearby the breeding colony could be effective at preventing the crows from entering into the beach-nesting area. The effigies should be moved periodically, about once every 6 days to evoke an active danger threat. So as not to interfere with incubating adults, effigies should not be placed too close to tern or plover nests. On or near the outside of the fencing would be a suitable location.

Crows have been able to thrive in human dominated regions, partly because of the abundance of food sources which includes refuse left behind by people. Though the preserve provides natural food sources that may keep crows around, all efforts to prevent littering and feeding of wildlife should be implemented.

Managing plover and tern habitat at the Meadows to keep it suitable for breeding is essential. Ensuring that vegetation does not grow too high and there is enough sand and shell cover between the shoreline and the dunes will be vital in providing habitat that breeding shorebirds will choose to nest in.

Maintenance of fencing that prevents mammalian predators from entering the breeding habitat should be repaired. Any necessary improvements should be made in a timely manner before mammals have the opportunity to prey on eggs and chicks.

TNC enlists the employment of 2 seasonal stewards. Because this is a popular preserve that attracts many visitors during the summer months, these stewards are already inundated with daily tasks and may not have the bandwidth to keep an eye on the beach habitat at all times. The addition of a volunteer docent program may be effective during the breeding season. This would ensure that visitors are not entering the breeding area, bringing pets onto the premises, littering, or violating any other prohibited activities that could negatively affect shorebirds.