



Preventing Extinctions

Results of January 2011 Gull Hazing Trial on the Farallon National Wildlife Refuge



***Report to U.S. Fish and Wildlife Service
Farallon National Wildlife Refuge
San Francisco Bay Refuge Complex***

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Gull Hazing Trial on the Farallon National Wildlife Refuge: January 2011

EXECUTIVE SUMMARY

A gull hazing trial was conducted on Southeast Farallon Island (SEFI) from January 21-26, 2011 in order to assist in the development of a gull hazing protocol to accompany a proposed eradication of invasive House mice (*Mus musculus*) from the Farallon National Wildlife Refuge being considered by the U.S. Fish and Wildlife Service. The field trial team consisted of Island Conservation personnel and two hazing experts: Winston Vickers of the Office of Spill Prevention and Response (California Department of Fish and Game) and Derek Milsaps of APHIS USDA Wildlife Services.

The goal of the trial was to determine which hazing techniques might be most effective in minimizing the number of gulls and other potential non-target birds from roosting on the islands during a fall mouse eradication effort. Eradication alternatives being considered involve using cereal-based pellets with rodenticide that Western gulls (*Larus occidentalis*) and other gull species are known to be able to consume, therefore hazing will be necessary to reduce both the number of non-target bird mortalities to gulls, as well as to ensure the delivered bait pellets are available to all mice. Hazing was generally restricted to SEFI, but attempts were also made to haze gulls on West End Island (WEI) and offshore islets from SEFI. Hazing techniques tested during the trial were conducted in limited study areas on the islands, and were implemented so as to avoid disturbance to marine mammals in the area.

Diurnal hazing techniques tested included Mylar tape, effigies, *Airsoft* guns, and the broadcasting of predator calls. Dawn and dusk hazing methods included spotlights, lasers, and pyrotechnics, and nocturnal hazing consisted of lasers and predator calls. Attempts were made to assess the numbers of gulls present in treated areas before and after the initiation of hazing efforts and to determine how long the effects of hazing lasted.

Results indicated that intensive use of pyrotechnics at dawn and dusk proved to be highly effective at moving gulls from the island and discouraging them from alighting on the island. Lasers used in the hours before dawn were also very effective at discouraging gulls from landing on the island. The daytime use of effigies, especially in conjunction with predator calls was effective at dissuading gulls from roosting on the island throughout the course of the day. Observations of gulls indicated that the majority of gulls retreated to WEI (Maintop and Shell Beach) and Saddle Rock when hazed off the island.

It was concluded that SEFI could be effectively hazed with as few as five personnel at dawn and dusk, but that one person permanently patrolling the island during the day and night for gulls would be useful in further limiting the number of gulls attempting to reestablish and land on the island. The gulls appeared to move from one island to another, but did not leave the island group entirely. It is unknown as yet how long the hazing techniques would be effective, as habituation could set in over time. For this reason, it is suggested that a wide array of hazing techniques be available for use during the mouse eradication operation. Recommendations were made to inform the operational plan. Furthermore, future studies are recommended to test the efficacy of the hazing techniques over a longer period of time and for the potential of gull habituation. Recommendations were made describing a potential secondary hazing trial. A number of other hazing techniques were also suggested that were not tested during the preliminary trial but are known to be effective in hazing birds including: lethal removal, kites, trained dogs and falcons, and radio-controlled aircraft.

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Objectives:

- Establish which techniques are most effective and how they can be used to successfully haze gulls
- Estimate the personnel, equipment, and materials needed to effectively haze gulls
- Determine the effective distances of various techniques
- Observe gulls and ascertain where they retreat to when hazed off SEFI

BACKGROUND INFORMATION

The vast majority of information available on gull hazing methods comes from those individuals and groups attempting to haze gulls from airfields, agriculture, aquaculture and landfill facilities, and chemical hazard sites. There are a wide range of techniques available, including lethal and nonlethal methods, those requiring substantial manpower and those requiring relatively little. For succinct descriptions of advantages and disadvantages of these techniques, see: Gorenzel & Salmon 2008 and Harris & Davis 1998.

There are many cases where the greatest efficacy in hazing gulls is achieved through integrating a number of methods into the hazing program. Harris and Davis (1998), in their report to the Canadian Government, list pyrotechnics, falconry, distress and alarm calls, and shooting (lethal removal) as key components of any effective hazing program, citing the use of effigies as a possible supplementary technique. The use of multiple audible and non/lethal techniques were more effective than multiple visual deterrents such as mylar & balloons (Cook et al. 2008). On-demand systems or those systems responsive to changes in animal behavior, as opposed to continuous or randomly activated systems, were also found to be most effective in dispersing problem birds (Ronconi and St. Clair 2006).

Lasers & lights

Lasers are concentrated light beams used in low lighting conditions to disperse or deter roosting & feeding birds. They remain one of the most effective tools for dispersing birds at night, when most other techniques are ineffective. Lasers emit either green or red light and are highly portable (Gorenzel and Salmon 2008). Lasers are not effective on all bird species, but there is considerable evidence that lasers can be used to effectively deter gulls (Blackwell et al. 2002, Baxter 2007). All-night control of gulls at a reservoir found that lasers could be used to disperse a population of 5,000 gulls, with no individuals remaining at daybreak. Researchers also observed an additive effect, whereby fewer and fewer gulls attempted to return to roost once hazing had begun. No habituation to the laser was seen for the duration of the 26-day trial and gull response to the laser was always immediate (Baxter 2007).

A study conducted on geese reduced use of the treated area by 34-93%, but prior use of the laser did not deter geese from using the treated area during the daytime. Researchers suggested that geese which were most responsive (populations which saw greatest reductions) were those exposed to little human disturbance and accustomed to very little ambient light during the night (Sherman and Barras 2004). There has been some use of moving spotlights or beacons to disperse or deter birds. In one

instance, the intermittent use of a spotlight to deter waterfowl from contaminated bodies of water cut the number of birds using ponds by 90% and reduced bird mortality to less than one-third of that recorded the previous year. During the second year of operation, the beacon further reduced bird mortality to one-sixth of that seen during the first year (Read 1999). Gorenzel & Salmon (2008) also recommend the use of spotlights or strobes, though they suggest that efficacy is variable and other methods may need to be used to supplement spotlight use.

Biosonics

Biosonics, or bioacoustics, as a hazing method, involves using animal alarm or distress calls to alter the behavior or behavioral patterns of target species, typically causing them to vacate or avoid an area. The vocalizations used are usually those emitted by a predator of the target species or the alarm or distress call of the target species (or a closely related species). Vocalizations are typically broadcast from commercially available units or can be assembled from their component parts. (Gorenzel and Salmon 2008). Biosonics have often been used to haze a variety of seabirds at locations such as: landfills, in association with airfields, at aquaculture facilities, and contaminated ponds (Gosler et al. 1995, Mott and Boyd 1995, Stevens et al. 2000, Cook et al. 2008).

The efficacy of biosonics has been found to be highly variable from one situation to the next. In studies specifically concerned with gulls, the numbers of gulls are typically reduced significantly within the first few weeks (Gosler et al. 1995, Baxter et al. 1999, Baxter 2000). Stout et al. (1975) found that distress calls were more effective at dispersing gulls than alarm, mew, trumpet, or choke type calls. In one study at a UK landfill where distress calls were the only method used, the numbers of gulls observed was reduced by 66-83% (Baxter 2000). Gosler (1995) observed that distress calls can be effective at dispersing and deterring gulls from returning, if there are alternate sites available to these individuals. Habituation to this method has been observed in a number of gull species and starts within one to four weeks of initiating hazing by this method (Baxter 2000, 2001, Soldatini et al. 2008).

When using distress calls, Gorenzel & Salmon (2008) recommend using distress calls from the target species, preferably from individuals inhabiting the same region as target individuals. Montoney & Boggs (1995) found that Laughing Gulls (*Leucophaeus atricilla*) are responsive to the distress calls of other species, although Baxter (1999) found conspecific bird calls to be significantly more effective than congeneric calls in dispersing birds. Interviews conducted by Harris & Davis (1998) indicated that distress calls enhanced by the use of pyrotechnics were more effective than calls alone. There has been only limited research into the effect of predator calls on target species. Harris & Davis (1998) reported that Gunn (1973) found gulls to be responsive to Peregrine Falcon calls.

Effigies

Typically, human effigies or models (scarecrows) or predator models are recommended as a bird hazing technique (Curtis et al. 1996, Gorenzel and Salmon 2008). However, the use of dead bird effigies (gulls and vultures) has been shown to be effective in scaring birds (Stout et al. 1975, Seamans 2004). Stout et al. (1975) conducted a comprehensive study which found that effigies positioned on their sides (with wings folded) or effigies with wings outstretched elicited the greatest response from gulls. Taxidermy gulls were more effective at dispersing gulls than other imitation (fiberglass molded & partial taxidermy mounts) models, but these specimens often deteriorated in wet weather. They also showed that the greatest effect was seen in groups of gulls exposed to both effigies and distress calls, with no

habituation in individuals. In the presence of food, however, gulls resisted dispersal. The combination of distress calls and effigies was the most effective method when food was available, yet still not successful in completely dispersing birds. Stout & Schwab (1979) found that by using very life-like models of Ring-billed Gulls (*Larus delawarensis*), Herring Gulls (*Larus argentatus*), and Laughing Gulls, that they were able to reduce the number of loafing gulls by 80% in a popular loafing area. In another study, effigies placed in loafing areas achieved similar results (gulls retreated to alternative sites), whereas effigies placed in areas of nesting or food sources had little effect (Seamans et al. 2007). Habituation to this technique was seen after as little as four weeks and as long as eight months after deploying effigies (Stout and Schwab 1979, Seamans et al. 2007).

Mylar tape

Mylar flags or tape have frequently been prescribed as a stimulus used to deter birds from cropland or contaminated areas (Littauer 1990, Gorenzel and Salmon 2008). Mylar is a reflective plastic ribbon with one side colored either red or yellow. It is often tied to poles or suspended from overhanging lines, where its motion in the wind creates a humming or crackling sound and it reflects sunlight. It has been shown to be of variable efficacy in preventing passerines from feeding on food crops (Gillsdorf et al. 2002). Belant & Ickes (1997) conducted an experiment on Herring Gulls and showed that mylar was 50% effective in reducing the number of gulls using loafing areas, but was totally ineffective in deterring populations of nesting birds.

Pyrotechnics

Pyrotechnics describe a wide variety of tools which can be used to non-lethally haze birds. Pyrotechnics are primarily an auditory stimulus, creating a loud bang or report, but many charges also produce bright flashes or spiralling light. Pyrotechnic charges are fired from a handheld pistol-style or shotgun-style launcher (Gorenzel and Salmon 2008). Pyrotechnics are used by a majority of airport control programs throughout North America (Harris and Davis 1998). When trialed individually against other techniques (taste deterrents sprayed on refuse) at a landfill, pyrotechnics were effective at reducing the number of foraging gulls from 2,000-2,500 gulls to between 40-50 gulls (Curtis et al. 1995). A study at another landfill in Denver, CO reflected similar findings of 90-95% reduction in gulls—sometimes 100% (Barnes et al. 1999). Habituation to this method can occur, if pyrotechnics are not used sparingly to disperse groups of gulls (Harris and Davis 1998). Some of the frequently cited advantages to this method are: relatively low cost, highly portable, and simple to execute (Curtis et al. 1995, Harris and Davis 1998, Gorenzel and Salmon 2008).

Methods not tested during this trial, but discussed in the recommendations for a future trial are:

- Lethal Removal
- Kites/Balloons
- Trained Dogs
- Trained Raptors
- Propane Cannon
- Radio-controlled Aircraft

Methods Used in 2011 Trial

The following gull hazing techniques were tested during the trial: lasers, spotlight, pyrotechnics, effigies and predator calls, Mylar tape, and an Airsoft gun. A map showing where techniques were implemented can be found in Figure 1 of Appendix B.

1. Lasers

Two different handheld lasers were used during the course of the trial: one red Avian Dissuader[®] (50mW) and one handheld green laser pointer (no brand name—5mW). These lasers were used from the lighthouse during pre-dawn hours (5h30-7h00) to haze gulls already settled on the island. Once gulls were no longer spending the night on the island, the lasers were used from both the lighthouse and the marine terrace to fend off gulls attempting to land on the island just prior to sunrise. Lasers were also used in the evenings (16h30-18h00) from the lighthouse and the marine terrace to enhance the use of pyrotechnics and reach areas that were not readily accessible or could not be hazed with pyrotechnics (often due to the presence of marine mammals). Two short nighttime (20h00-21h00) sweeps were also attempted with the laser, in order to haze any gulls that might have settled back on the island during the course of the evening. The effective range for this method was estimated by using a *Leica[®] 1200 Rangemaster* to determine the distance to the closest gull. Photographs of the two laser tools can be found in Appendix C.

2. Spotlight

A million candlepower spotlight was used from the lighthouse during pre-dawn hours (5h30-7h00) to haze gulls already settled on the island. Once gulls were no longer spending the night on the island and their presence was restricted to marine ledges, the spotlight was also tested from the marine terrace to haze gulls intermittently settling on the ledges. Two short nighttime (20h00-21h00) sweeps were also attempted with the laser (with the spotlight), in order to haze any gulls that might have settled back on the island during the course of the evening. The effective range for this method was estimated by using a *Leica[®] 1200 Rangemaster* to determine the distance to the closest gull.

3. Pyrotechnics

Pyrotechnics were initially tested for their effects upon marine mammals using the island. A series of pyrotechnics, increasing in loudness, was shot off from a location near the powerhouse. Observers were stationed at Mussel Flats and Garbage Gulch to monitor responses from California and Steller's sea lions. Another series of pyrotechnics, increasing in loudness, was shot off from a location on the marine terrace, near Pointy Cliff. An observer was stationed in the E. Seal Blind to observe the responses of the Elephant Seals to the pyrotechnics. Whenever pyrotechnics were used, hazers watched marine mammals after firing to evaluate their response and ensure no disturbances or harassment ensued.

Pyrotechnics were initially implemented from the lighthouse only, but could not effectively haze certain portions of the island. As the trial proceeded, an intensive hazing campaign evolved, which involved firing pyrotechnics from two additional locations on the marine terrace during the pre-dawn (5h30-7h00) and dusk (16h30-18h00) hours.

4. Effigies and predator calls

Upon arriving on the island and during the course of the trial, personnel were on the lookout for any seabird carcasses which were mostly intact. These carcasses were suspended from old mist-net poles by the feet or the neck and placed in or near areas heavily used by both roosting and territorial gulls, often making use of ridges and high topographical features of the island.

The first effigy was deployed in the middle of the marine terrace, directly opposite the Coast Guard house. The Bird Gard® SUPER PRO (powered by 110 volt AC) was placed on the ground on the marine terrace and 4 speakers (in a single enclosure) were deployed approximately two meters away from the effigy. The calls of two predator species—Red-tailed Hawk and Peregrine Falcon—were broadcast at random intervals, ranging from five to ten minutes. One call of each species (lasting approximately two to three seconds) was broadcast in a random order, twice. The volume was turned up to the highest setting. The following day, the interval between calls was increased to range from 10-30 minutes. The Bird Gard® was moved two days later to the top of the eastern cistern to increase its range and the accompanying effigy was moved to a location overlooking the ledges at Mussel Flats and a second effigy was erected at a distance of 65 meters.

The effective range for this method was estimated by using a *Leica® 1200 Rangemaster* to determine the distance to the closest gull. A total of nine effigies were deployed on the island at any one time. Some of the effigies were moved or added in order to target certain gull problem areas. A map showing the locations of effigy placement can be found in Figure 2 of Appendix B and a photograph of an effigy in action can be seen in Figure 2 of Appendix A. A photograph of the Bird Gard® system used in this trial can be found in Appendix C. To test the efficacy of effigies despite the presence of a food source, non-toxic placebo bait was hand broadcast on the helipad and Shubrick at a density of ~ 18 kg/ha.

5. Mylar tape

The catchment pad located at Shubrick was used to test the effectiveness of mylar. Bamboo poles measuring approximately six feet had 1-meter lengths of 1" mylar tied to the tops of them. These poles ringed the catchment pad, as well as two nearby promontories popularly used by gulls. Half of the catchment pad also had mylar suspended overhead. Strips of mylar measuring 1-1.5 meters were tied to two pieces of monofilament strung between bamboo poles on opposite sides of the catchment pad. The distance between the monofilaments was approximately four meters. To test the efficacy of mylar tape despite the presence of a food source, non-toxic placebo bait was hand broadcast on the catchment pad at a density of approximately 18 kg/ha. See Figure 1 in Appendix A for a photograph of this method in deployment.

6. Airsoft Gun

A Crosman® Pulse R76 AEG airsoft gun was used with white Soft Air 6mm 0.20 gram biodegradable non-toxic pellets. The gun was initially tested on willing personnel to ensure that pellets would not harm or injure gulls. In no wind conditions, at 30 meters, the pellets could be felt, but did not cause pain or bruising. The airsoft gun was used along the perimeter of the island to haze gulls that could not be hazed through other methods, due to their proximity to marine mammals. The effective range of this method was also tested using a *Leica® 1200 Rangemaster*. See Appendix C for a photograph of this tool.

Results

For a map of areas successfully hazed, refer to Figure 5 of Appendix B.

1. Lasers

There was no detectable difference in the response of gulls to the green versus the red laser. The only difference lay in the fact that the Avian Dissuader is a much more powerful instrument which is able to create a strong beam reaching islets and areas that were further away. The Avian Dissuader, for instance, was able produce a concentrated, easily visible beam that could haze gulls off Sugarloaf islet, approximately 500 meters distant from the lighthouse. The green laser, could, in comparison, produce a weak beam able to reach from the marine terrace to Saddle Rock, a distance of approximately 400 meters. This could only be achieved through the use of binoculars to help guide the beam as it could not be readily detected by the human eye.

Both lasers were very effective at moving large groups of gulls from roosting and territorial locations. Whole groups of gulls could be “herded” around the island and, with some practice, made to go in a specific direction. Once the island had been clear of gulls overnight, the lasers were extremely useful at fending off gulls circling the perimeter of the island and attempting to land just prior to sunrise. The laser could be shined at a flock of airborne gulls and moved over them until they respond (almost immediately). Gulls would typically wheel away from the laser beam, dispersing in different directions.

Lasers could also be used to target specific individuals not flushed through the use of pyrotechnics. The use of lasers was limited to hours of darkness, starting about 30 minutes after sunset until about 15 minutes before sunrise. Lasers were not as effective at discouraging gulls from landing on the island once they had become established, particularly territorial birds. The laser had to be used continuously to prevent gulls dispersed from a location from landing back on their roosts or their territories.

Once intensive hazing with pyrotechnics was initiated, very few gulls remained on the island overnight. Two attempts were made to haze gulls on the island during hours of full darkness. There were, however, no gulls found on the island to haze.

2. Spotlight

The use of the spotlight was similar to the use of the lasers. It was effective at moving groups of gulls already settled on the island. Its effective range, however, was only about 150 meters, the distance from the lighthouse to the houses. The spotlight was not an effective method at keeping gulls off the island, as many birds (about 2/3) returned to territories within as little as four minutes. The spotlight had to be used continuously to prevent dispersed gulls from landing back on their roosts or their territories. The use of the spotlight was also restricted to the hours of relative darkness

Once intensive hazing with pyrotechnics was initiated, very few gulls remained on the island overnight. Two attempts were made to haze gulls on the island during hours of full darkness. However, no gulls were found on the island.

3. Pyrotechnics

Pyrotechnics were by far the most effective tool used to move gulls from their roosts and territories and dissuade them from returning to these locations. Sea lion species were found to be sensitive to bangers at a distance of 125 meters and the use of this type of pyrotechnic was discontinued. Caps, screamers, and flaming-whistlers, however, could often be used within 100 meters of sea lions without causing a disturbance. The response—or lack thereof—of sea lions was variable day to day and it is hard to categorically state how close one can use pyrotechnics without causing a disturbance. One shotgun charge was used from the lighthouse (in the direction of Sugarloaf) and failed to elicit a response from sea lions at a distance of about 300 meters. Elephant seals were distinctly unaffected by the use of pyrotechnics, which could be fired within 30 meters of the colonies without disturbing these animals.

Pyrotechnics were most effective when a laser or a cap was used to get gulls airborne and a screamer or a flaming whistler was fired almost immediately after, into the swarm of swirling gulls. This had the effect of dispersing these gulls and discouraging them from returning. Screamers and flaming whistlers were predominantly used to haze gulls, though their range was at times, limited. For instance, a pyrotechnic shot from the lighthouse was not effective at hazing gulls at Sea Pigeon Point (about 380 meters away) or the ledges at Sand Beach (about 400 meters away). This was remedied by moving personnel closer to these locations and having them fire pyrotechnics at a closer range. During a single hazing period, between 35 & 60 pyrotechnics were collectively used by all three hazers. A single shotgun charge was fired in the direction of Sugarloaf and succeeded in scaring birds off this islet.

Once hazed with pyrotechnics, gulls were cleared off almost the entirety of the island, either retreating to the water or to surrounding islets. Birds formed rafts on the water in Mirounga Bay, off Shubrick, and in Maintop Bay. In the early morning hours, gulls could not be found on land, but could be heard on the water. Initially, gulls retreated to the ledges ringing the island. As hazing became more aggressive, they retreated to offshore islets and sought refuge on Weather Service Peninsula, behind Falcon's Roost (out of sight of the laser), and on the northeastern corner of Murre Blind Hill (also out of sight of the laser). A very large portion of birds which fled SEFI retreated to WEI. Thousands of birds were seen on Shell Beach and Maintop on January 24th and 25th. Anywhere from 100-800 gulls used Saddle Rock as a refuge, with a further 1,000-2,000 swirling in the air above on these dates. For a map of refuges and retreats used by gulls, see Figure 1.

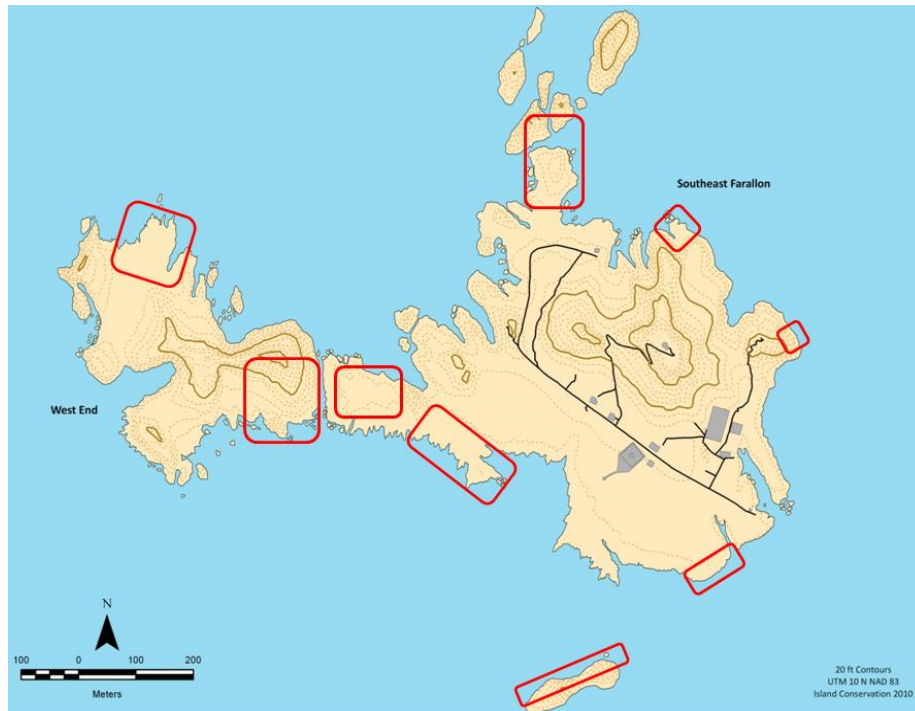


Figure 1. Areas ringed in red indicate roosts used by gulls retreating from aggressive hazing operations on SEFI. These zones might require more intensive monitoring and hazing.

4. Effigies and predator calls

Effigies were extremely effective at clearing an area and keeping that area clear of birds during daytime hours and even into dusk and early morning hours. The first effigy, erected opposite the CG house (along with the Bird Gard®), had the immediate effect of completely clearing the surrounding area of gulls—approximately 200 gulls were flushed off the terrace and did not return. The Red-tailed Hawk call seemed to be the more alarming of the two calls and elicited a greater response from gulls. The presence of this effigy and the persistent broadcasting of the predator call managed to keep a portion of the marine terrace cleared for the duration of the trial. The effective range of this combination of methods in this location had a mean of 60 meters to the nearest gull. See Figures 1 & 2 in Appendix A for photographs depicting the effect of these deterrence methods on gulls. At this location, however, the gulls remaining on the ledges could not be effectively hazed (See Figure 3, Appendix B). This effigy was moved to just above the ledges on Mussel Flats and the Bird Gard® was elevated upon a cistern, resulting in almost complete and continuous clearance of this area, with nearest gulls between 100 and 200 meters away.

The remaining effigies elicited similar responses. Simply walking around the island with carcasses suspended from poles managed to distress gulls, causing them to leave their territories, retreating to ridges and high points, or fleeing the island altogether, sometimes even prompting them to defecate on hazers. The effigies erected on and around Shubrick managed to clear and maintain clearance on similar problem areas, shown in Figures 3 & 4 in Appendix A.

No gulls were seen foraging on bait broadcast over either the helipad or Shubrick point. Nor were either of these locations occupied by gulls for the remainder of the trial once bait was broadcast.

5. Mylar tape

The effect of mylar tape on gulls was unclear. The morning immediately following its installation, not a single gull was seen on the catchment pad or on the grassy areas which had been dappled with mylar tape. However, once the use of pyrotechnics began that morning, gulls became distressed and began moving into these areas again. Yet, gulls only occupied the portion of the catchment pad which was ringed with mylar, not the portion which had mylar suspended overhead. On the day of departure, prior to the removal of mylar and without the use of pyrotechnics, these areas continued to be unoccupied, though this may reflect the effect of the effigies more than the effect of the mylar. It should be noted that mylar is effective both as a visual and audio deterrent and could possibly be used in foggy conditions. The bamboo poles did not always withstand the wind and in some instances the mylar tape was also shredded by the wind. No gulls were seen foraging on bait applied over the catchment pad, nor were any gulls seen occupying this space once nearby effigies were installed.

6. Airsoft Gun

The airsoft gun proved to be useful at targeting individuals or groups of birds that persisted on the island, despite the use of pyrotechnics during daylight hours. Birds often retreated to ledges which were occupied by or in proximity to pinniped colonies, particularly at Sea Pigeon Point, Mirounga Beach, and Sand Beach. Normally, the laser is quite effective at targeting these individuals, but its effectiveness is dependent on low ambient light and cannot be used throughout the course of the day. The airsoft gun, however, allowed one to haze these gulls at a distance (from 30 to 40 meters away). After several days of hazing, gulls were generally more sensitive to hazing, becoming “jumpy.” The airsoft gun was thus advantageous, because a single gull could be targeted with the gun, raising the alarm in the roost and causing the whole roost to flush. A light wind can affect the trajectory of the pellets, but this error can be accounted for in adjusting the aim of the gun.

DISCUSSION

Based on the results of this short trial, it appears that the most effective tools for hazing gulls include pyrotechnics, effigies, distress calls, and lasers. Systematic and careful use of pyrotechnics at dawn and dusk, when the greatest influxes of gulls were observed, will likely deter the majority of territorial and a portion of loafing/roosting gulls. Pyrotechnics can be enhanced through the use of lasers during low light conditions. Lasers will be especially useful for targeting gulls in areas where they seem unaffected by pyrotechnics. The combination of those two techniques should dissuade the majority of gulls from alighting and roosting on the interior of the island, particularly during the daytime.

Inaccessible areas and popular roosting spots will require greater attention during both the daytime and dawn/dusk operations. These areas should be subject to persistent hazing through the use of effigies and regular patrols. The Bird Gard® broadcast system, emitting the call of the Red-tailed Hawk, was extremely effective at clearing the marine terrace and could be effectively used to haze inaccessible areas from SEFI, such as Aulon Peninsula, and the eastern end of WEI. The airsoft gun might prove useful during an eradication operation, but if lethal removal is a possibility, it might be best to reinforce other hazing methods with live ammunition as opposed to plastic BB's. Given that other methods can be extremely useful at hazing gulls, mylar is not recommended as a primary hazing technique, but it could be used as an ancillary method should foul weather or habituate to other methods require it.

Recommendations for the Hazing Program During Project Implementation

Barring the possibility of carrying out a full-scale hazing trial prior to project implementation, an aggressive hazing program should be implemented during the course of the house mouse eradication according to the recommendations presented below. We recommend certain methods based on our experiences on the island, but that does not mean that we would discourage the use of additional methods during the actual eradication, particularly if challenging weather conditions arise. The more tools and methods available to the hazing team during the eradication, the more robust and effective the hazing program will be.

It is recommended that an aggressive gull hazing program be implemented *before* rodenticide is applied to the island. Observations of gulls at Sand Beach, in the presence of food (Elephant seal carcasses and afterbirth), showed that once they have discovered an attractive food source, even constant hazing with pyrotechnics will not prevent them from landing and foraging on the food source. Preventing gulls from ever learning of the existence of active bait or dead mice on the island is absolutely crucial to allowing mice greater access to the bait and reducing the risk of non-target mortality in gulls.

Hazing must continue for the duration of the eradication. A cumulative effect was seen in the response to intensive pyrotechnic use, but as soon as hazing efforts diminished (especially in the mornings), gulls returned in large numbers, resuming their roosts and their territories. Hazing techniques and efforts must remain in effect while a large quantity of bait remains in the environment. The hazing program must remain dynamic, adapting to changes in the weather, habituation in gulls or changes in their behavior.

As an alternative to hazing gulls from the ledges and areas bordering the intertidal zone which are habitual refuge and roosting areas, well-secured, gull-proof bait stations could be used in place of aerial bait broadcast. If these areas cannot be completely and successfully hazed, then it would be better to further limit the risk of gulls consuming bait, by making bait unavailable to them. There will be a certain degree of difficulty in placing and positioning these bait stations so that gulls may not access them and marine mammals will not accidentally crush them.

Personnel Requirements

- The whole of SEFI could feasibly be hazed with a small team of five people.
- Aggressive hazing should take place from 06h00-8h30 and 16h30-18h00 and would predominantly involve the use of pyrotechnics, as well as lasers and spotlights, as necessary.
- A coordinator would need to be based at the lighthouse, directing concerted use of pyrotechnics by four other people.
- One of these people would also be based at the lighthouse, mainly hazing the northern side of the island (Fertilizer Flat, Tower Hill, Murre Blind Hill), as well as northern offshore islets.
- A second hazer could be based on the Marine Terrace, near Pointy Cliff, but moving around so as to better target problem gull roosts on Sand Beach, Mirounga Beach, Weather Service Peninsula, and Falcon's Roost.
- A third hazer could be stationed on the eastern half of the Marine Terrace, patrolling roosts at Sea Pigeon Point, East Landing, Shubrick, and Murre Blind Hill.
- A fourth hazer could be stationed near North Landing, patrolling Aulon Peninsula, Sea Lion Cove, Corm Blind Hill, and the hillside above the Eggers' House.

- These additional hazers should be able to cover areas which either a) cannot be effectively hazed from the lighthouse or b) are not able to be seen from the lighthouse.

During the daytime, gull numbers dropped substantially and were restricted to coastal ledges and roosts. It is thus recommended that there be constant hazing efforts during the daytime to flush any gulls persisting on the island. This task could be performed by a single person (or a number of people on rotation), simply walking the island, carrying an effigy and armed with an airsoft gun for use against gulls.

Although no gulls were seen on the island at night during the period of aggressive hazing, it is recommended that a nighttime patrol nevertheless be instituted. A single person armed with a laser or spotlight could walk the accessible perimeter of the island and up to the lighthouse, flushing any lingering gulls or gulls which might have returned during the course of the evening. This should be conducted some hours after dark (20h00-23h00) and should last anywhere from 30-60 minutes, or the time required to cover the island. One patrol a night is recommended, unless large numbers of gulls are caught on the island, in which case the number of patrols should be increased as needed.

Equipment and Material Requirements

- All hazers should be equipped with a selection of pyrotechnics as well as lasers. It was estimated that 15-20 charges (plus 20-30 caps) per person would be sufficient for any one round of hazing, though this number is a conservative overestimate.
- The person at the lighthouse should also be equipped with a few cracker shells charges and a 12-gauge shotgun.
- Cracker shells charges might also be useful for breaking up rafts of birds on the water, by shooting into the water. One should keep in mind that there is a certain amount of (paper) trash which is generated through extensive use of pyrotechnics, some of which may not be retrievable if it falls into wilderness areas or the ocean.
- Hazers should be equipped with either red or green lasers. Both were shown to be effective. The small laser-pointer was, of course, more economical, but less powerful.
- It might be practical for hazers targeting more distant groups of gulls to be equipped with the Avian Dissuader, while other hazers rely on the use of green laser-pointers. Lasers are especially useful in selectively hazing gulls, whereas pyrotechnics are indiscriminate and can flush gulls off of islets and back onto main islands accidentally.
- The use of spotlights is also recommended, especially for nighttime patrols. While the light from the spotlight does dissipate readily and is not effective at a great distance, it would allow hazers to detect groups of gulls roosting in the darkness. The hazer could then target these groups with the laser, effectively flushing them from their roosts. It is also worth considering a stronger spotlight (10 million candlepower, for instance), which might be more effective in all respects.
- Effigies were also very effective at discouraging gulls from roosting or taking up territories in areas surrounding the suspended carcasses. Effigies could effectively be used to haze some of the problem roost areas and might even be useful in discouraging gulls from using less accessible areas, such as WEI. It is recommended that effigies be installed all around the perimeter of the island, on promontories and prominent features, including: Weather Service Peninsula, Sea Pigeon Point, Shubrick, Murre Blind Hill, North Landing, Mussel Flat, Sand Beach, behind Pointy Cliff. It is estimated that 20-25 effigies could be sufficient to haze the majority of gulls.

- It is recommended that a few more Bird Gard® broadcast systems (as many as 5) also be employed, either in conjunction with effigies or not. This is especially true as effigies will be of little use if the island is shrouded in heavy fog. The Bird Gard® is another method which could be used to haze less accessible areas, including wilderness areas or WEI, as they can be powered by 12 volt batteries (which can in turn be fed by small solar panels) and left unattended. It is recommended that a selection of audio chips—including gull distress calls and predator calls—be made available, to prevent gulls from habituating to any one call.
- Mylar tape may have its place in the armory of hazing tools, but it should by no means be relied upon as a primary hazing method. It could possibly be used to enhance other methods already in place or be used as a secondary method if habituation to other methods is observed. It is possible that it would be useful in foggy weather as it produces a crackling sound that might be as much as a deterrent as the visual aspect of the mylar. Moreover, the installation of mylar would be labor-intensive and it is uncertain where this method could be most effectively used.
- Airsoft guns also stand to enhance ongoing aggressive hazing methods, though their use is somewhat restricted. The main limitation of the airsoft gun, of course, is the distance at which it is effective, and the accuracy of the gun. Having a few (2-3) on hand for targeting problem gulls would be advised, though the lethal removal of problem gulls might be a more practical and effective method of hazing.

Proposed Future Hazing Studies

We believe we have tested the efficacy of these gull hazing techniques and a great deal was learned during the 2011 trial. However, the efficacy remains to be tested over an extended period of time. The potential for habituation of gulls to hazing strategies needs to be addressed and additional hazing technologies exist that have yet to be tested. Time and funding permitting, it is recommended that a full hazing trial of both islands be undertaken to further inform a hazing program for the eventual eradication.

The proposed trial should attempt to address the following questions:

1. How effective are these techniques at harassing the gull populations expected during the eradication window?
2. How effective are these techniques in the presence of a readily and widely available food source (i.e. a grain-based pellet)?
3. How quickly do gulls habituate to both individual hazing techniques and the full complement of techniques?
4. How can WEI be hazed of gulls while still maintaining SEFI clear of gulls?
5. Is it possible to haze WEI from a boat?
6. How well do hazing techniques work in adverse weather conditions, especially high winds and fog?
7. What is the estimated number (or percentage?) of gulls that might come into contact and consume a lethal dose of bait pellets?
8. How effectively do the following techniques work?
 - Lethal removal
 - Zon gun (propane cannon)
 - Kites
 - Falcons
 - Radio-controlled aircraft
 - Dogs

Timing

It is recommended that further hazing trials are conducted during the timeframe slated for the actual eradication: late November to December-January when the potential number of gulls on island can reach higher numbers. When attempting to assess habituation to techniques, it is especially relevant to trial techniques on a population of gulls during the same point in their annual cycle as that which might be encountered during the eradication.

A full-scale hazing trial would last a minimum of three weeks, ideally, four to six weeks. A review of literature indicates that many techniques, if they do not cease to deter gulls in the first 10 days, will become ineffective after four weeks of hazing. It is thus recommended that hazing techniques remain in place long enough to gauge at which point habituation occurs.

Personnel

A minimum of three people should be engaged in hazing gulls on the island SEFI. With a significantly larger population of gulls in January, three people were able to haze most of SEFI, but there remained pockets of gulls that could not be effectively hazed with the limited staff. It is possible that three people would be effective in hazing lower numbers of gulls during the eradication window. However, in order to fully cover SEFI and concurrently haze WEI, it is likely that more personnel would be needed. A hazing team of five personnel is recommended to adequately cover SEFI and WEI. It is possible that not all five personnel would be needed to engage in hazing activities at all times, but only in the mornings and evenings, when hazing is most crucial.

It is recommended that a hazing expert accompany the hazing team for a full-scale trial, in order to teach and advise the team. An expert might prove especially helpful in choosing appropriate vantage points for hazing on WEI. It would be difficult, however, to ask a hazing expert to contribute more than a few days to the trial.

Aside from those actively hazing gulls, it is highly recommended that additional personnel/volunteers assist in counting gulls and estimating the numbers of birds resisting hazing. It is likely that gull counts would need to be suspended for the duration of the trial, but PRBO staff could possibly help in documenting and quantifying the success of hazing activities.

Equipment

Equipment and resources should be brought in sufficient amounts for all hazing personnel to be equipped to participate in hazing activities.

- 1 double-barreled record launcher per person
- 45-60 screamers, flaming-whistlers per hazing session
- 70-80 caps per session
- 1 12-gauge pyrotechnic launcher
- 10-15 cracker shells
- 1 laser (red or green) per person
- 1-3 1M/10M candlepower spotlights
- 20-25 gull effigies (carcasses can be collected opportunistically and kept frozen until the trial)
- 5-10 predator kites (such as Bald or Golden Eagle) or a Helikite
- 3-4 Bird Gard® SUPER PRO or other distress call broadcast systems (one to two requiring an autonomous power supply) & supply of electronic chips
- 1-2 airsoft guns with a minimum of 5,000 pellets
- 1 propane cannon

Proposed Scope

A full-scale hazing trial should treat the entirety of SEFI and WEI for the duration of the trial and aim at maintaining the islands completely free of gulls. WEI should be subjected to hazing for as long as is allowed by the refuge manager or until it can be ascertained if this island can be effectively hazed and by what means, so as to ensure no unnecessary disturbances to marine mammals beyond that which is required to ensure that lethal exposure to gulls will be avoided to the maximum extent practicable.

Proposed Methods

The goal of the trial is not to evaluate which methods are or are not effective in hazing gulls, but to determine what combination of methods is effective at hazing gulls from the island(s) completely for an extended period of time.

Southeast Farallon Island

For SEFI, it is advised that a rigorous hazing program involving the regular use of pyrotechnics and lasers (and spotlights, where applicable) during the dawn and dusk periods be implemented to clear the island of as many individuals as possible. The intensity of pyrotechnic use should adapt to the conditions on the ground and the behavior of gulls, to minimize the possibility of habituation and the hazing program could/should involve the following strategies:

- Four to five personnel deployed as hazers on SEFI during these dawn and dusk periods.
- A coordinator stationed at the lighthouse, using radios to direct the use of pyrotechnics by three to four other people.
- The coordinator could document the effect of hazing, although it is recommended that they be allowed to focus on hazing coordination and not multi-task.
- One hazer based at the lighthouse, mainly hazing the northern side of the island (Fertilizer Flat, Tower Hill, Murre Blind Hill), as well as northern offshore islets.
- A second hazer based on the Marine Terrace, near Pointy Cliff, moving as necessary, in order to target problem gull roosts on Sand Beach, Mirounga Beach, Weather Service Peninsula, and Falcon's Roost.
- A third hazer stationed on the eastern half of the Marine Terrace, patrolling roosts at Sea Pigeon Point, East Landing, Shubrick, and Murre Blind Hill.
- A fourth hazer stationed near North Landing, patrolling Aulon Peninsula, Sea Lion Cove, Corm Blind Hill, and the hillside above the Eggers' House.

These additional hazers should be able to cover areas which either a) cannot be effectively hazed from the lighthouse or b) are not able to be seen from the lighthouse.

Daytime harassment should involve the sustained deployment of effigies, predator kites, and Bird Gard® systems: (It might be worth introducing each of the methods one-by-one into the environment, in response to habituation in gulls or inefficacy of the method)

- Effigies placed along or on promontories above problem areas, e.g.: Sea Pigeon Point, Mussel Flats, Mirounga and Sand Beaches, Weather Service Peninsula, Falcon's Roost, behind Pointy Cliff, North Landing, Shubrick Peninsula, Murre Blind Hill (possibly at the blind). Twenty to 25 effigies should be sufficient to cover these areas. See Figure 2 in Appendix B for suggested locations.
- Where effigies are not used or if these are in short supply, kites could be tried (weather permitting). A number of kites are available, including traditional kites (relying upon wind to lift) in the form of predators, 3-D predator shaped kites, and Helium-powered kites (requiring no wind). Most kites can be used to haze gulls at a short distance. For instance, kites could be flown from the Murre Blind and used to haze gulls resisting the use of pyrotechnics and avoiding lasers on this hill. See Figure 2 in Appendix B for recommended locations.

- Ideally, 2-3 Bird Gard® SUPER PRO systems should be used to cover problem areas on SEFI. A number of electronic chips with both gull distress and predator calls should be made available to retain an aspect of unpredictability. The ideal placement for these systems would be 1) Mussel Flats, 2) North Landing, and 3) Weather Service Peninsula. Hazing could possibly be achieved with fewer systems, if the systems are moved around to target pockets of problem gulls. It is recommended that these systems be moved every 2-3 days, depending on gull behavior. See Figure 2 in Appendix B for possible locations.

These stationary methods should be periodically moved around the island, in accordance with gull movements and roosting sites. A daytime patrol, consisting of one person armed with an airsoft gun and carrying a gull effigy on a pole, should also be implemented to deter gulls persisting on the island. During the day, hourly or two-hourly gull counts should be undertaken from both the lighthouse and the ground, covering as much of the islands as possible, guiding daytime harassment efforts.

Nighttime sweeps with the spotlight and lasers should also be used to harass any gulls which have returned to the island since dusk:

- As few as one sweep per night (between 20h00 and 23h00) might be sufficient to discourage gulls from overnighting on the island.
- Hazers should be prepared to adapt to gull behavior during the trial.
- Sweeps should include the southern perimeter of SEFI, taking in North Landing, Mirounga Bay, Mussel Flats, Sea Pigeon Point, Shubrick, and the Marine terrace. Lighthouse hill (northeast and southwest faces).
- Lasers can also be used to sweep Maintop and eastern extremes of WEI, which might be valuable if this island cannot be readily accessed.

West End Island

For WEI, it is recommended that the island be intensively hazed for a minimum of at least four to seven consecutive mornings and nights. Given the difficulty in accessing the island/restricted access to the island, it might be hard to carry out even such a short period of hazing, but it is worth subjecting these gulls to comprehensive hazing efforts, if possible. Logistically, hazing this island is a challenge, as there are no facilities allowing hazers to overnight and the terrain makes it challenging to navigate the island during the pre-dawn and post-dusk hours.

- A minimum of two persons would be needed to effectively haze WEI.
- Possible hazing locations include the saddle above the trail to Indian Head Beach and another vantage point further along the trail to Indian Head Beach, overlooking Shell Beach.
- Ideally, intensive hazing would take the shape of intensive hazing occurring on SEFI, involving pyrotechnics and lasers, though the density and proximity of marine mammals may limit the use of pyrotechnics.
- If marine mammals & access prove to be an impediment to the use of the most effective tools (lasers & pyrotechnics), other long-term, unmanned hazing methods should be attempted: effigies, kites, Bird Gard®, and possibly, the Zon gun (only in areas where marine mammals are absent).
- Further evaluation would be needed to determine which locations would be most effective for using the aforementioned techniques. It is unlikely that daytime hazing (other than unmanned hazing) would be feasible on WEI.

- If overnight stays are conducted on WEI, then nighttime sweeps are recommended, if at all possible. Otherwise, nighttime sweeps of this island may have to be conducted in a limited fashion from SEFI.
It is recommended that hazing on WEI and SEFI be initiated at the same time, in order to observe how gulls react and where they retreat to or attempt to retreat to when an island-wide, maximum of effort is invested in hazing.

Metrics of Success

It will be difficult to quantify the success of a hazing program, but it is recommended that personnel or volunteers be assigned the task of documenting and/or quantifying the effects of hazing on gulls. Given that a) intensive hazing takes place during low light conditions and b) gulls are generally on the wing during hazing sessions (making it nearly impossible to count them), it will certainly be a challenge to record or assess the effect of hazing on gulls. One possibility is to videotape the hazing sessions, taking in gull roosting/congregation patterns before hazing and recording gull behavior once hazing begins. Once light levels drop below the visible recording threshold of the camera, the observer could verbally record their observations on the camera. Thus, a visual & audio record of how gulls behave would be created, allowing for these data to be referenced days and weeks later.

One of the principle difficulties in achieving a count of gulls before hazing takes place is that counting gulls requires some time, but if a video snapshot could be taken of gulls before hazing begins, the video could be viewed later and gull numbers assessed at that time. These data could be invaluable to future contractors employed in developing & executing the final hazing program. Use of the Academy of Sciences Webcam should be investigated, and the potential to capture and store images (offline).

Additional (Untested) Methods

Depending on access to equipment and resources, other untested methods could be introduced either at the initiation of the trial, or once habituation to other methods occurs. Below is a discussion of lethal removal (requiring permits from US FWS), trained dogs, trained raptors, kites/balloons, radio-controlled aircraft and propane cannons, including background information and how they could be employed on Farallon NWR to haze seagulls.

Lethal Removal

A number of experienced bird hazers have found that lethally removing a small number of gulls from a population of problem gulls can have a substantial effect on their behavior and their persistence in using certain areas. Lethal removal through the use of live ammunition is frequently employed at airports where birds pose a real threat to air traffic (Anderson and Otter 2007). Lethal removal is often used to reinforce pyrotechnics (Cook et al. 2008). In one case, bird numbers were reduced by 98% (from 5700 to 47) through a combination lethal removal & pyrotechnics regime maintained from dawn to dusk. A mere 2% of the initial population was removed and noted that it is especially important to target individuals persisting in treated areas despite the use of other methods (Baxter 2008). Use of this method is usually dependent upon obtaining the necessary permits required by state, local, or federal agencies (Harris and Davis 1998).

Relatively few individuals would need to be removed in order for gulls to begin associating their presence in a location with the risk of removal. Gulls which exhibit problem behavior—such as consuming bait—should be lethally removed, so as to reinforce that not only their presence, but also their foraging habits are risky. Any gulls lethally removed should also be displayed as effigies in the area where they were removed from, in order to maximize the impact of the removal.

Trained dogs

Trained dogs—typically border collies—are commonly used to haze or “run off” problem birds (including gulls and geese) from urban areas such as golf courses often achieving 100% hazing success in treated areas (Castelli and Sleggs 2000, Holevinski et al. 2007). Outside of the urban environment, border collies have been used to a limited degree at air force installations. At airfields (with mixed bird species, including some gulls), clearance rates ranged from 40% to 99.9% within a 2 kilometer radius (Carter 1999, Patterson 2000). In another instance, a 57% reduction in birdstrikes was observed at an airfield (Froneman and van Rooyen 2003). It was noted, however, that as soon as dogs were removed from a treated area, birds returned, even over the course of just a weekend (Carter 1999). The success of border collie programs are largely dependent upon skilled handlers and properly trained dogs (Froneman and van Rooyen 2003). Carter (1999) suggests that a single dog and handler can maintain an area of 50 square kilometers (usually runways, and thus flat ground) free of unwanted animals. Collies are not bred or trained to harm wildlife and can be used to safely disperse birds or mammals.

The greatest use of trained dogs on the Farallones would likely be during daytime hours, when a person would be patrolling the island for any remaining gulls. A dog can more quickly haze or reach these groups of roosting gulls than a person can. This method could possibly be used during a hazing campaign, though there are a number of important considerations. Firstly, dogs would need to be extremely well-trained, in order to prevent them from consuming either bait or dead and moribund mice. Any consumption of bait could, however, be mitigated by administering prophylactic doses of Vitamin K, the antidote to the proposed rodenticide. Dogs would have to be accompanied by experienced dog handlers and dogs would have to be well-disciplined enough to not risk disturbing or interfering with marine mammals. Dogs would also need to be properly vaccinated and quarantined prior to arriving on the island, to prevent the exchange of communicable diseases between dogs and marine mammals. A holding facility or kennel would also be required for the duration of their stay on the island. The use of dogs would mainly be restricted to low-lying areas of Southeast Farallon Island, as a large portion of WEI is occupied by large pinniped colonies.

Trained Raptors

Trained raptors can be used to disperse or pursue problem birds and have been used at commercial and military airfields, landfills, and agriculture facilities in North America and in Europe with some success (Erickson et al. 1990, Larson et al. 1994). At an airfield in Scotland, where gulls had grown accustomed to and were undeterred by shotgun patrols, visual deterrents, and distress calls, peregrine falcons were used for two years, substantially reducing the number of birdstrikes (after Heighway 1969 in Erickson et al. 1990). Baxter and Allan (2007) found that falcons were more effective than hawks at dispersing birds, but were only useful against corvids and small gulls. Falcons did not reliably alter the behavior of large gulls (Herring Gulls) and were ineffective at preventing gulls from scavenging. As with most dispersal techniques, falconry alone generally does not disperse all individuals and must be complemented by other techniques (especially pyrotechnics) (Erickson et al. 1990). Habituation to falcons has been seen to occur in as little as one week with Yellow-legged gulls (Soldatini et al. 2008). A number of considerations must be accounted for when initiating a campaign: acquiring raptors and

training them on the target species, housing raptors, and identifying competent falconers (Erickson et al. 1990). Some additional limitations to the use of falcons include: birds cannot be flown in rain and fog or during periods of molt, birds can become lost, injured, or overworked if other raptors are not on hand to cycle through hazing duties (Solman 1966, Erickson et al. 1990). In many cases where falcons had been integrated into hazing programs, falconry was limited or terminated because of the high costs of falconry programs (Erickson et al. 1990).

Trained falcons could similarly be used to target specific problem gulls or groups of gulls on SEFI, especially those persisting on ridges, rocky precipices, or even outlying islets. Trained raptors could pick off persistent problem birds, reaching inaccessible areas including wilderness areas, Murre Blind Hill, Aulon Peninsula, Chocolate Drop, Great Arch, and Sugarloaf. They might also be useful in hazing WEI. Falcons would need to be accompanied by experienced falconers and require a housing facility while on the island. Falcons do not pose a risk of disturbing or distressing marine mammals. There might be a slight risk of falcons consuming dead or moribund mice, but well-fed and well-trained falcons should not be at risk of secondary poisoning while on the island. The use of falcons, however, is restricted to days of clear weather.

Kites/balloons

Kites in the shape of predators or painted with predators have been used in the past to deter birds from feeding at aquaculture and agriculture facilities. These stimuli typically take the form of a traditional kite or consist of a kite held aloft by a Helium-filled balloon—a Helikite® (Harris and Davis 1998). The unpredictable movement of a kite in the wind serves to slow the habituation of gulls to this method, while not disturbing marine mammals. There has been limited research conducted to fully evaluate this technique, but one study indicated that the use of Helikites® had no effect on gulls persisting at a landfill site (Baxter 2001). A report to Transport Canada indicated that the usefulness of kites “is limited by habituation [and] are recommended only for situations where short-term and local control is sufficient” (Harris and Davis 1998).

Kites were not trialed as it was thought that high winds would preclude the use of this method. Most kites are only rated for use in 15-20 mph winds, while maximum wind speeds on FNWR during the fall and winter months range from 27-38 mph. This trial showed the high variability of weather on the Farallones and it is recommended that a number of kites be made available for use during the hazing operation. It is thought that kites might be useful for targeting certain specific problem areas, such as Murre Blind Hill, which cannot be effectively hazed from most places on the island. A kite on a long enough tether could be sent out to haze gulls at a distance from the hazer.

Radio-controlled Aircraft

Radio-controlled or ultralite aircraft—often painted with or in the form of a raptor—can also be used to haze birds (Harris and Davis 1998, Gorenzel and Salmon 2008). In one study conducted on geese, 25% of geese were dispersed on the first day, with each day seeing fewer and fewer animals. By the fifth day, 100% of geese had been dispersed. Geese remained absent for ten days, at which point goose numbers returned to pretreatment levels (Fairaizl 1992). In studies involving gulls, Carter (2000) found radio-controlled aircraft to be “highly effective” against loafing gulls and “partially effective” at deterring gulls from feeding on earthworms on the runways of an airfield. In tests against soaring raptors, a balsa wood aircraft with a 6-foot wingspan, weighing 5 pounds, could travel at speeds of 75-100 miles per hour and target specific problem birds (Loud 2000). Littauer (1990) suggested that one operator and one plane could effectively cover 200 to 300 acres.

On Farallon NWR radio-controlled aircraft would perform the same function as trained falcons, targeting hard to reach places, hazing specific gulls or groups of gulls. Radio-controlled aircraft are difficult for untrained personnel to fly well, without losing or damaging the aircraft. Experienced RC pilots would be required to effectively use RC aircraft as a hazing method. The prevalence of windy conditions on Farallon NWR might also prevent the implementation of this method as few models are designed to withstand really high winds. The use of aircraft might also be restricted to clear days, as foggy conditions would make it difficult to follow the aircraft.

Propane cannon “Zon Gun”

Propane cannons, also called gas exploders, produce a loud, directional blast similar to that emitted by a 12-gauge shotgun (D. Milsaps, pers. Comm.). They are easily and readily moved, can be automated and used with a timer, firing either regularly or randomly. Some models can also be placed on a stand and programmed to rotate after each blast (Gorenzel and Salmon 2008). Unless cannons are moved frequently and blasts randomly fired, gulls readily habituate to this method, often within a few days (Harris and Davis 1998). Hazing with propane cannons has been found to have an effect, but a study by Washburn et al. (2006) indicated that propane cannons did not significantly alter gull behavior at an airport, even when reinforced with lethal control methods.

The Zon Gun was not tested initially on Farallon NWR, as hazing experts decided that it would be impractical or not especially useful on the island. It emits a very loud blast of sound which they likened to the sound emitted by the shotgun pyrotechnic, thus restricting its use to areas removed from marine mammal haul-outs. There was also a concern that the Zon Gun would not withstand more than 2 weeks on an island without succumbing to the salt air. One of the primary advantages of this tool is that the Zon Gun can be connected to an automated timer, so that the unit can function without any need for attending personnel. Such a function might make it useful for hazing gulls in areas which can only be infrequently accessed, though the presence of marine mammals would remain a concern. Sugarloaf, portions of WEI, and the southeastern side of Saddle Rock are locations which might benefit from the use of the Zon Gun.

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Appendix A: Photographs



Figure 1. A photograph showing how mylar tape was suspended from bamboo poles staked around the perimeter of the catchment pad.



Figure 2. A photograph of a gull effigy placed at North Landing (*Dead gull was found on island and placed on tether*).



Figures 3 & 4. Photos of gull densities before (top) and after (bottom) the deployment of an effigy and the Bird Gard®, taken 2 days apart (between 7.15 and 7.45 AM). No pyrotechnics were used during either of these morning observation periods. In the bottom photograph, a problematic roosting spot is indicated by the red rectangle while the blue rectangle denotes the location of the effigy and the Bird Gard®.



Figures 5 & 6. The top photograph shows the density of roosting gulls at Shubrick. The bottom photograph shows the change in gull densities two days later, after the placement of two effigies at the locations indicated by the orange circles. No pyrotechnics were used during either of these morning observation periods and photos were taken between 7.10 and 7.20 AM.



Figure 7. A daytime photograph showing the Marine Terrace completely devoid of gulls, except for those restricted to Sand Beach.



Figure 8. A photograph of Aulon Peninsula, Chocolate Drop and the Great Arch, showing how gulls are using these islets for roosting.

Appendix B: Maps

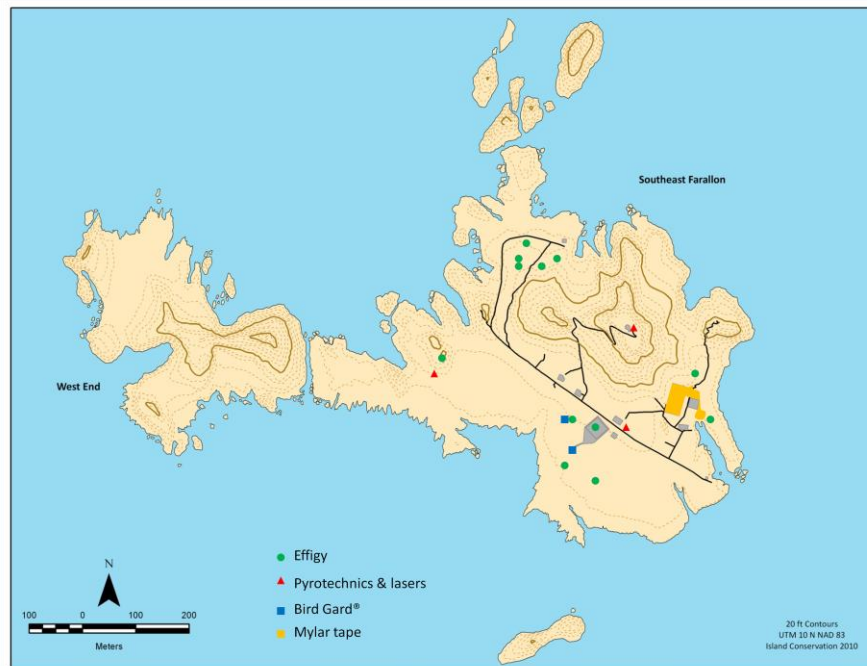


Figure 1. A map of where hazing techniques were trialed on SEFI during the January 2011 trial.

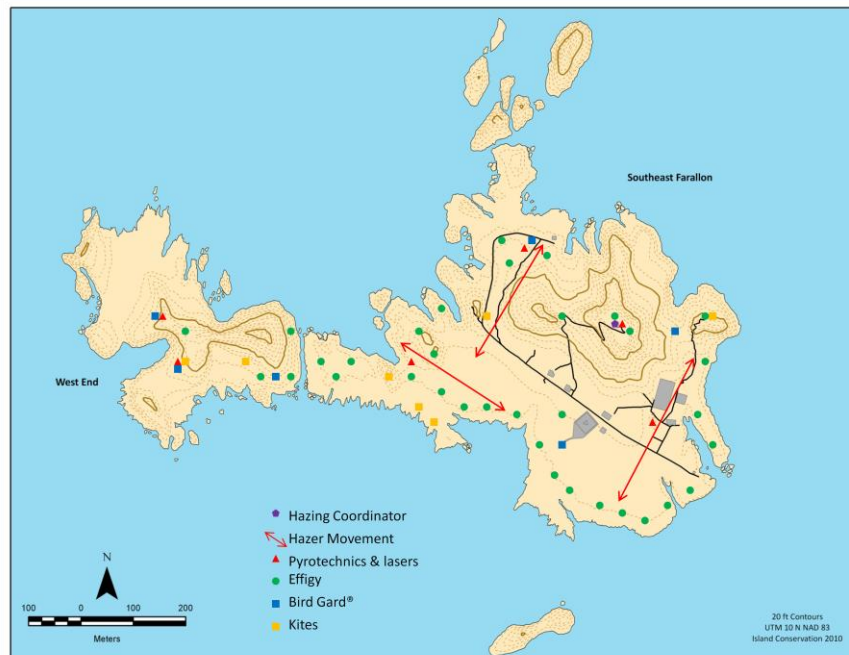


Figure 2. A map of suggested locations for future hazing trials or the hazing component of the eradication.

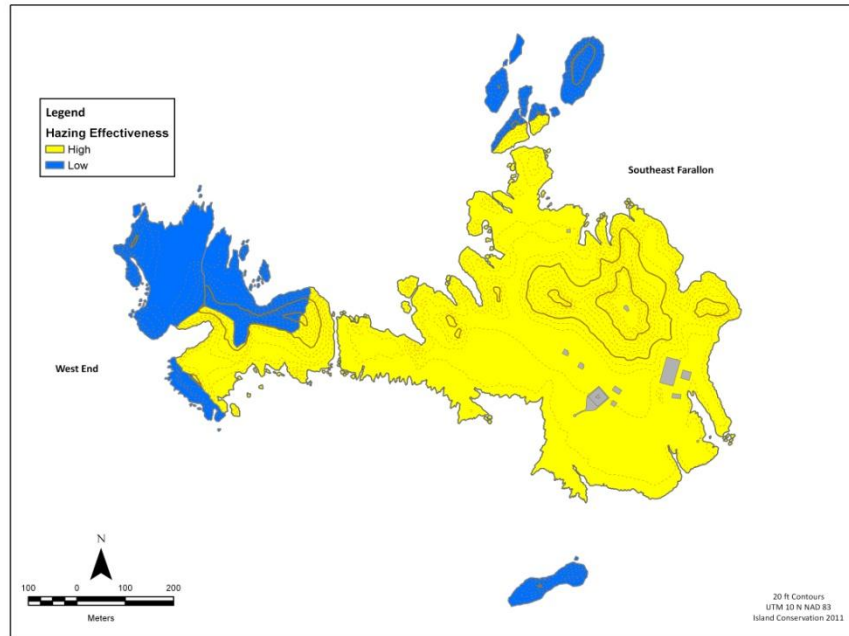


Figure 3. Map showing the estimated feasibility of hazing on foot, regardless of closures (“High”) and providing safe weather conditions. “Low” areas are not accessible by foot or land and would require a boat for hazing.

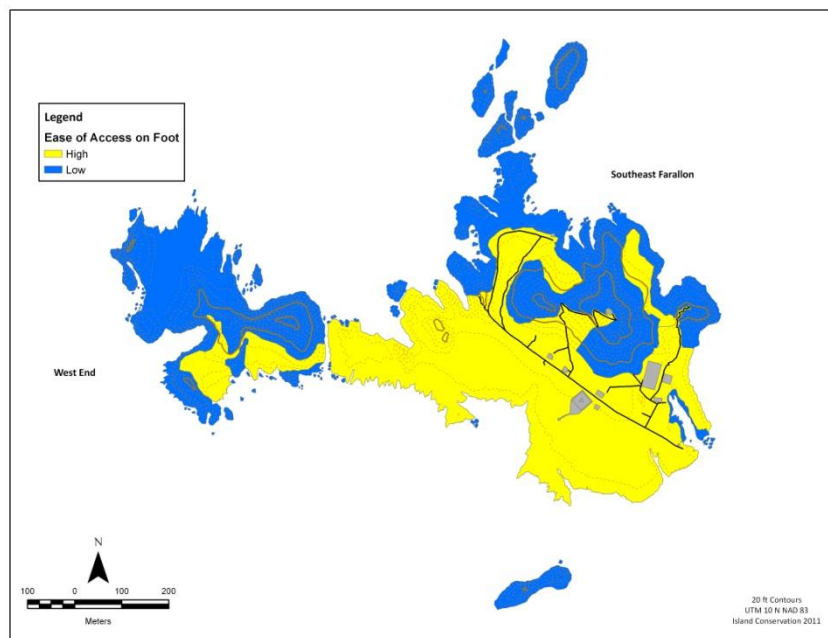


Figure 4. Map showing the estimated ease of foot access, assuming permission to access the whole island.

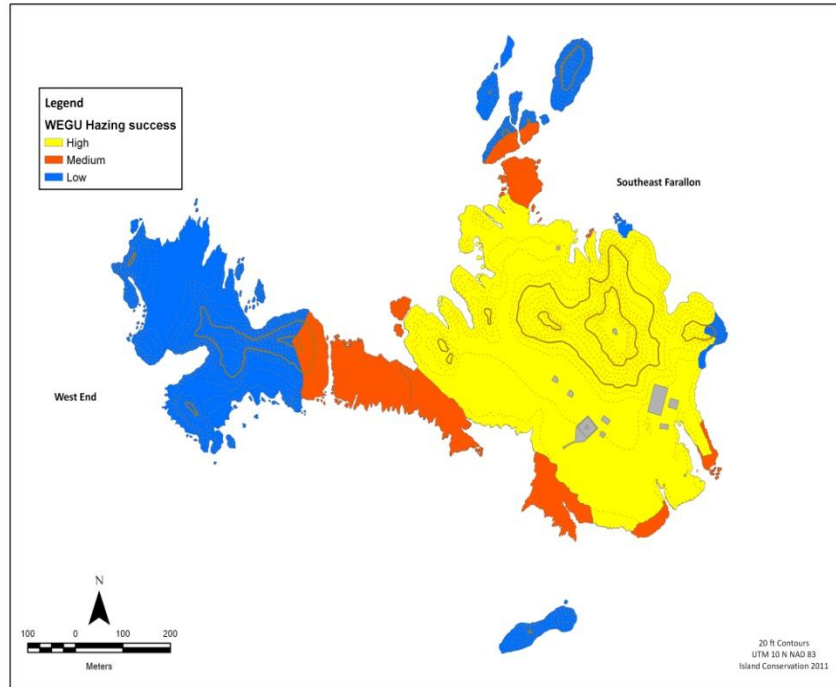


Figure 5. Map showing areas that were successfully hazed in January 2011 during dawn and dusk hours. **“High”** success is 90% or greater clearance (generally clear) **“Medium”** success is about 45-90% clear (can be cleared to 100% but requires persistent hazing), **“Low”** is 0-45% clearance (limited effect). Some areas, such as islets, could be hazed with lasers, but only once it was sufficiently dark.

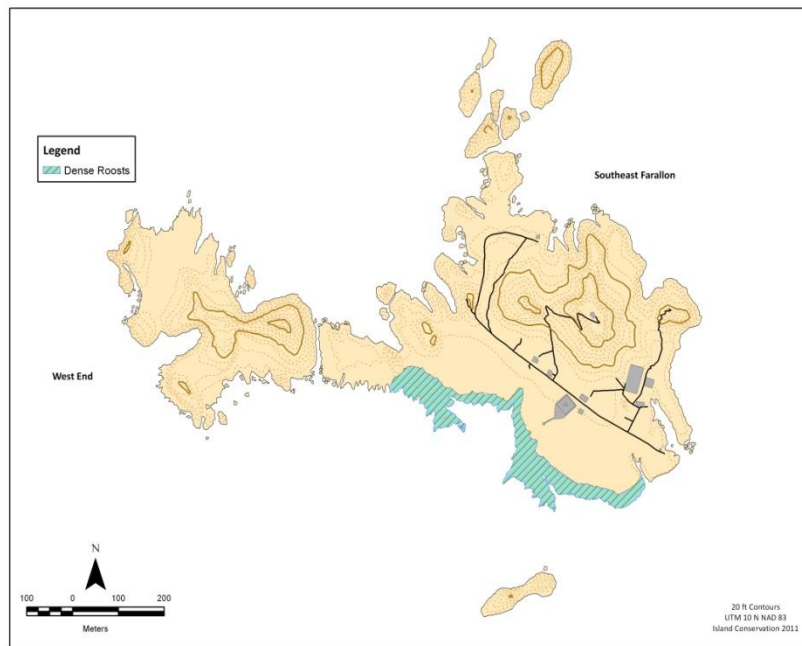


Figure 6. According to November 2010 observations, approximately 68% of gulls congregated on the Marine Terrace during dawn and dusk hours.

Appendix C: Equipment



Propane cannon. A Zon Gun mounted on a tripod

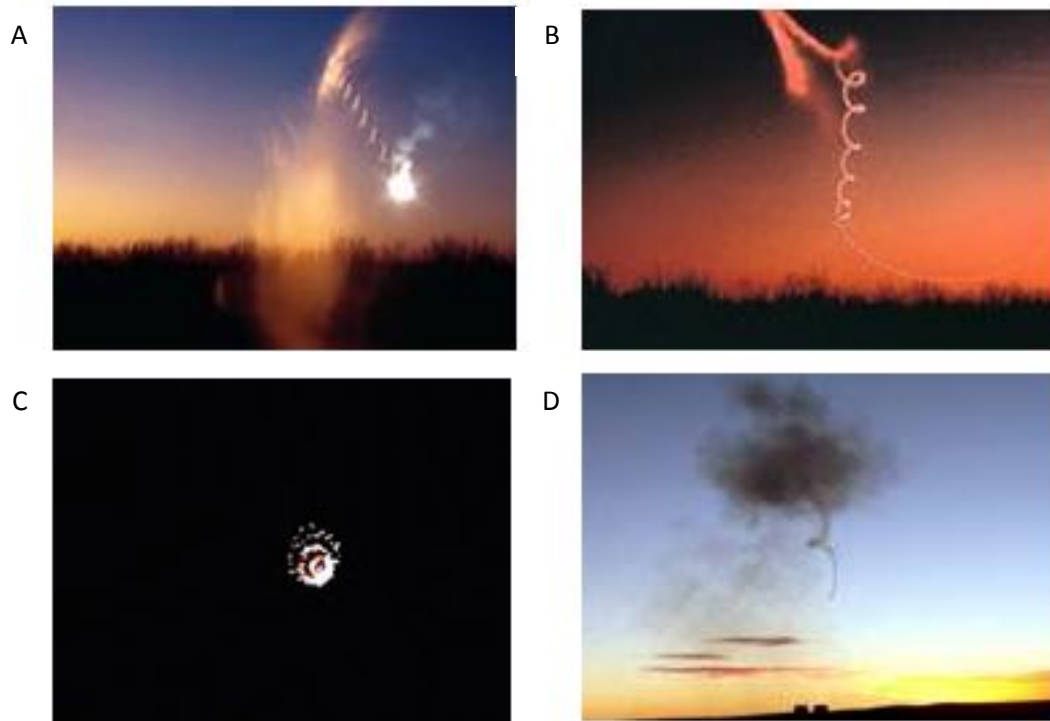
http://margosupplies.com/public/american1/scare/zon_gallery/zon_gallery_08.jpg



Record launchers. A single shot launcher (left) and a double shot launcher.



Clip launchers. The top two models take a 6-shot clip. The bottom models take a 10-shot clip.



Pyrotechnic cartridges. Examples of the visual stimuli of pyrotechnics. **(A)** A banger which explodes with a loud report and travel 75-90 feet. **(B)** A screamer which produces a loud screaming sound, and in low light conditions, emits light. This cartridge has a range of 250 to 300 feet. **(C)** A whistler with silver comet produces a loud whistling sound and has a highly visible sparkling tail. Range is 250 to 300 feet. **(D)** A whistler has little visual effect, but emits a loud whistling sound and has a range of 250 to 300 feet (Margo supplies).



Laser. The Avian Dissuader™ is marketed specifically for hazing birds. Both red and green lasers are available. Shown here with a site
From:
<http://www.aviandissuader.com/>



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Laser pointer. The style of laser pointer (green) which was used in this trial.

http://www.xump.com/science/Green-Laser-Pointer-Silver.cfm?SID=12&gclid=CJSNkubfs6cCFQkSbAodbF9E_Q



Predator Kite. A Jackite Brand 3-dimensional kite of a Bald Eagle

<http://www.kiteandwind.com/ProductDetails.asp?ProductCode=ABEPASS&click=73>



Helikite®. A kite held aloft by a Helium-filled balloon.

<http://www.helikites.com/bird/index.html>



Bird Gard® Broadcast System. The distress system used in this trial employed the SUPER PRO model, pictured at left, using AC-power (middle left) and the 4-speaker unit pictured at right. Other optional equipment includes 4 separate speakers (center bottom) and battery clamps for use with a 12-volt battery.

<http://www.fingerlakestellissupply.com/products/bird-gard/repelling-systems/super-pro/>



Mylar tape. This reflective tape can be strung between poles or suspended from poles.



Airsoft Rifle. The Crosman® Pulse R76 was used during the course of this hazing trial.

Appendix D: Sources for Equipment

Product & specifications	Manufacturer	Supplier	Cost
Red laser ○ 650 nm, 50 mW ○ 805 m range ○ Pistol style	Avian Dissuader®	Reed Joseph http://www.reedjoseph.com/lasers.htm	\$1,095
	Avian Dissuader®	Avian Dissuader http://www.aviandissuader.com/products.htm	\$1,095
Green laser ○ 532 nm, 30 mW ○ 805 m range ○ Pistol style	Avian Dissuader®	Reed Joseph http://www.reedjoseph.com/lasers.htm	\$1,895
	Avian Dissuader®	Avian Dissuader http://www.aviandissuader.com/products.htm	\$1,895
Green laser pointer ○ 532 nm, 50-150mW ○ 300-8,000 m range ○ Pen style	Acheron	Laserto http://www.laserto.com/acheron-series-green-laser-pointer.html	\$59.50
Eagle (48" ws) or Golden Eagle kite (36" ws) 18 mph rating	Unknown	Sutton Agricultural Enterprises http://www.suttonag.com/VisualBirdControl.html	\$9.95 (Golden Eagle)-12.95 (Eagle)
Bald Eagle kite ○ 25 mph ○ 60" wingspan	Jackite	Margo Supplies Ltd. http://www.margosupplies.com/public/american1/scare/sight_motion.htm	\$66.00
*(may require line/fiberglass pole)	Jackite	http://www.biconet.com/birds/jackite.html	\$63.95
Helikite "Vigilante" ○ 200 ft tether ○ Max 20 mph rating ○ Can fly without or wind ○ Cover up to 25 acres ○ Sensitive to rain	Allsopp	Margo Supplies Ltd. http://margosupplies.com/public/american1/scare/sight_motion.htm (includes 5 replacement balloons & line, but no Helium)	\$299.00
	Allsopp	Bird Busters http://www.birdbusters.com/bird_deterrant_kite.html (includes 5 replacement balloons & line, but no Helium)	\$295.00
	Allsopp	Biocontrol Network http://www.biconet.com/birds/helikite.html	\$279.00
Broadcast System ○ SUPER PRO	Bird Gard®	Sutton Agricultural Enterprises http://www.suttonag.com/BirdGard.html	\$649.00 for unit

<ul style="list-style-type: none"> ○ 4 external speakers ○ 110-AC power adaptor ○ 12v battery clips ○ Optional solar panel & 4-speaker enclosure 		#	\$400.00 for 20W solar panel \$ 180.00 for 4-speaker unit
<ul style="list-style-type: none"> ○ SUPER PRO ○ 4-speaker enclosure or 4 external speakers ○ 110-AC power ○ 12v battery clips ○ Optional solar panel 	Bird Gard®	Goodlife http://www.birdcontrolpro.com/bird_control_products/bird_gard_super_pro.htm	\$659.95 for unit & speakers \$399.95 for 20W solar panel
<ul style="list-style-type: none"> ○ SUPER PRO ○ 4-speaker enclosure or 4 external speakers ○ 110-AC power ○ 12v battery clips ○ Optional solar panels: rigid or unbreakable 	Bird Gard®	Margo Supplies Ltd. http://margosupplies.com/public/american1/scare/bird_guard1.htm	\$660.00 for unit & speakers \$275.00 for unbreakable 20W solar panel \$239.00 for rigid 20W solar panel
Chip # 20 <ul style="list-style-type: none"> ○ Species including: LAGU, RBGU, HERG, GWGU, DCCO, NOHA 	Bird Gard®	Biocontrol Network http://www.biconet.com/birds/birdgardChips.html	\$50.00
Custom Chip # 98 <ul style="list-style-type: none"> ○ Species including: RTHA, AMKE 	Bird Gard®	Goodlife http://www.birdcontrolpro.com/manuals/birdgard_bird_chips_public.pdf	\$50.00
Custom Chip # 108 <ul style="list-style-type: none"> ○ Species including: HERG, PEFA 	Bird Gard®	Sutton Agricultural Enterprises http://www.suttonag.com/BirdGardChips.html	\$45.00
Custom Chip # 30 <ul style="list-style-type: none"> ○ Species including: LAGU, RBGU, HERG, PEFA, BAEA 	Bird Gard®	Goodlife http://www.birdcontrolpro.com/manuals/birdgard_bird_chips_public.pdf	\$50.00
Mylar tape <ul style="list-style-type: none"> ○ 1" x 500' ○ Available in silver/silver or red/Silver 	BirdBaffler™	Sutton Agricultural Enterprises Inc. http://www.suttonag.com/VisualBirdControl.html	\$3.95/silver-silver roll \$4.95/ red-silver roll
<ul style="list-style-type: none"> ○ Red/silver ○ 12mm x 90m or 30mm x 90m 	Bird Scare	Margo Supplies Ltd. http://margosupplies.com/public/american1/scare/sight_motion.htm	\$3.40/ 12 mm roll \$7.45/ 30mm roll
Record launcher <ul style="list-style-type: none"> ○ Single or double shot ○ Require 6mm caps 	Unknown	Margo Supplies Ltd. http://margosupplies.com/public/american1/scare/pyro_launchers/records.htm	\$34.00 single shot \$42.00 double shot

	Unknown	Reed Joseph http://www.reedjoseph.com/pyrotechnics.htm	\$34.00 single shot \$42.00 double shot
6-clip Record launcher ○ Uses 6mm caps ○ Possibly no longer available in US	Unknown	Margo Supplies Ltd. http://margosupplies.com/public/american1/scare/pyro_launchers/clip_launchers.htm	\$67.25 in blue finish \$123.50 in nickel finish
10-clip Record launcher ○ Uses 6mm caps ○ Possibly no longer available in US	Unknown	Margo Supplies Ltd. http://margosupplies.com/public/american1/scare/pyro_launchers/clip_launchers.htm	\$98.85 in blue finish \$130.00 in nickel finish
Cartridges ○ 15mm ○ Screammers, bangers, whistlers, whistlers with silver comet ○ Uses 6mm caps	Unknown	Margo Supplies Ltd. http://margosupplies.com/public/american1/scare/pyro_launchers/pyro.htm	\$21.00 per box of 50
Cartridges ○ 15 mm ○ Uses 6mm caps ○ Screamer sirens ○ Travel 250-300 feet	Unknown	Reed Joseph http://www.reedjoseph.com/pyrotechnics.htm	\$45.00 per 100 rounds
Caps ○ 6mm for use with handheld launchers	RWS	Margo Supplies Ltd. http://margosupplies.com/public/american1/scare/pyro_launchers/pyro.htm	\$9.00 per 100 rounds
Caps ○ 6mm for use with single launcher	Sellier & Bellot	Margo Supplies Ltd. http://margosupplies.com/public/american1/scare/pyro_launchers/pyro.htm	\$6.00 per 100 rounds
Caps ○ 6mm for use with handheld launchers	Unknown	Reed Joseph http://www.reedjoseph.com/pyrotechnics.htm	\$8.00 per 100 rounds
12-gauge Shell Crackers	Unknown	Margo Supplies Ltd. http://margosupplies.com/public/american1/scare/12_gauge_carts.htm	\$31.00 for box of 25
Propane Cannon ○ Zon Mark IV bird scare cannon ○ Detonation intervals from 40 sec to 30 min	Zon Gun	Margo Supplies Ltd. http://margosupplies.com/public/american1/scare/zon_mark_iv.htm	\$285.00 for cannon

<ul style="list-style-type: none"> ○ Weighs 8.4 kg ○ Optional multi-shot with timer controller (multiple shots at controlled intervals or random setting) 			\$225.00 for multi-shot controller with timer
<ul style="list-style-type: none"> ○ Zon Mark IV bird scare cannon ○ Detonation intervals from 30 sec to 30 min ○ Weighs 8.4 kg ○ Optional conversion kit with multi-shot with timer controller (multiple shots at controlled intervals or random setting) ○ Blast of 125-150 decibels ○ Available for rental 	Zon Gun	Sutton Agricultural Enterprises Inc. http://www.suttonag.com/ZonGun.html	\$275.00 for cannon purchase
			\$60/month cannon rental
			\$5/month propane rental
			\$225.50 for Zon 4MT08 conversion kit