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Brown Pelican (*Pelecanus occidentalis*) Colony Initiation Attempts: Translocations and Decoys

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Abstract.—Within the context of a limited number of Brown Pelican (*Pelecanus occidentalis*) breeding sites, promoting new colonies can mitigate localized threats to regional populations. To assess the efficacy of short-distance (~5 km) translocations and use of decoys to establish new colonies, and thereby increase statewide population viability, research was conducted within the Isles Dernieres archipelago, Louisiana. Translocations of 323 Brown Pelican chicks to an un-colonized island were performed from 2007 to 2009, and from 2008 to 2010, 108 Brown Pelican decoys were deployed on a separate island void of nesting. From 2008 to 2010 band re-sighting surveys detected only one transplanted Brown Pelican chick that returned to the release site. Further, < 1% of translocated individuals were observed throughout the archipelago, compared to 5% and 9% of banded individuals encountered that fledged from nearby islands. Low detection of translocated Brown Pelicans may be due to translocation stress that can result in disorientation and social disorganization, which may promote increased roaming. At sites with decoys, no loafing or nesting Brown Pelicans were observed. Further, behavioral surveys suggest there was no difference in interest of passing Brown Pelicans to decoys compared to paired control survey areas without decoys. Despite past successes of translocations and decoys for establishing new colonies of Brown Pelicans and other waterbird species, Brown Pelican conservation may be best promoted via restoration and protection of current colony sites. Received 6 April 2012, accepted 17 October 2012.

Key words.—bands, Brown Pelican, colony, decoys, Louisiana, movement, *Pelecanus occidentalis*, population viability, translocations.

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Wildlife populations have become increasingly threatened by habitat degradation and environmental contamination in recent decades (Piatt *et al.* 1990; Georgiou *et al.* 2005; Belanger *et al.* 2010). These threats are particularly relevant to avian species that nest on barrier islands. In addition to chronic erosion on some islands (Penland *et al.* 2005), hurricanes may cause extensive habitat loss over a short period of time. For instance, the Chandeleur archipelago in Louisiana was reduced in size by 82% during Hurricane Katrina in 2005 (Sallenger *et al.* 2009). Because hurricanes may be increasing in intensity and frequency due to climate change (Webster *et al.* 2005; Sallenger *et al.* 2006; Bender *et al.* 2010), they pose an increasing risk to avifauna that nest on barrier

islands. Beyond storm threats, crude oil extraction and transport in coastal waters has resulted in spills that have killed large numbers of marine birds (e.g., the 1989 Exxon Valdez spill, Piatt *et al.* 1990). Sub-lethal contamination by petroleum hydrocarbons can also result in long-term physiological, behavioral, and reproductive disorders (Peakall *et al.* 1981; Spies *et al.* 1996; Balseiro *et al.* 2005).

When individuals are concentrated, an environmental catastrophe can have a large effect on a substantial proportion of a population (Piatt *et al.* 1990; Sallenger *et al.* 2009). Therefore, waterbird conservation efforts sometimes attempt to augment the number of breeding colonies in order to diminish the magnitude of a localized threat to a re-

gional population. Two common techniques to initiate breeding colonies are translocations and the use of decoys to attract reproductive adults (Parnell *et al.* 1988; Fisher and Lindenmayer 2000; Crozier and Gawlik 2003).

Translocations that entail moving individuals to un-populated sites within their historical range serve to reinforce metapopulations and promote long-term population viability (Wolf *et al.* 1996; Fisher and Lindenmayer 2000). Wildlife translocation techniques have been used for over a century (Parnell *et al.* 1988), and have been implemented in mammal and bird conservation programs nearly 700 times per year in North America in recent decades (Griffith *et al.* 1989; Wolf *et al.* 1996). Translocations involving birds often release individuals prior to fledging, on the premise that translocated individuals will return to the release site to breed.

Decoys have also been used to initiate avian breeding colonies (Crozier and Gawlik 2003). Some colonial waterbird species may be attracted to decoys that simulate a nesting colony, and breed in the region due to their gregarious nesting behavior (Burger 1988; Shields 2002). Various studies have successfully used decoys to attract several species of terns, skimmers, and herons to potential nesting sites (Parnell *et al.* 1988; Pius and Leberg 2002), and to elicit foraging responses in other waterbird species (Anderson 1991; Green and Leberg 2005).

The current abundance of Brown Pelicans (*Pelecanus occidentalis*) in Louisiana is in large part due to translocations (Holm *et al.* 2003). Exposure to water-borne pesticides (e.g., DDT and DDE; Nesbitt *et al.* 1978; McNease *et al.* 1992) during the 1950s and 1960s resulted in the reduction of the Louisiana population from over 50,000 individuals in the early 1900s to zero by 1963 (James 1963). To re-establish the population, approximately 100 Brown Pelican chicks were moved per year from Florida to Louisiana from 1968 to 1980 (Nesbitt *et al.* 1978; McNease *et al.* 1984). The first-translocated individuals were observed nesting 3 years following release, which led to the establishment of

two nesting colonies in Louisiana (McNease *et al.* 1984). These sites then provided the source of chicks for within-state translocations from 1984 to 1986, which resulted in the colonization of Raccoon Island (Fig. 1; McNease *et al.* 1992). Despite the Brown Pelican's re-establishment in Louisiana, the species remains particularly susceptible to habitat degradation and environmental contamination. Hurricanes Katrina, Gustav, and Ike degraded colony sites in the past decade and oil spills, such as the Deepwater Horizon event (Crone and Tolstoy 2010; Chen and Denison 2011), threaten breeding and foraging grounds along the Louisiana coast.

Over the past decade an average of 80% of Louisiana's Brown Pelican population nested on only three islands (T. Hess, unpubl. data). Consequently, the loss of one of these colony sites, or individuals from these colonies, would have a substantial effect on the statewide population. Although Brown Pelican translocations have been successful at initiating new colonies at distances greater than 100 km to areas lacking the species (McNease *et al.* 1984), their efficacy to initiate a new colony has not been tested when active nesting sites are nearby. Short-distance translocations may be of particular value to shift a nesting population with low nest success away from an undesirable site (e.g., one with rapidly eroding habitat) to a location with higher quality nesting conditions. Further, although Brown Pelicans typically nest on islands without mammalian predators, some locations with predators have supported large nesting colonies (e.g., Baptiste Collette Island, T. Hess, unpubl. data). Given the scarcity of suitable colony sites in Louisiana (Visser and Peterson 1994), managers may have to consider islands with mammalian predators as potential nesting sites if the number and distribution of nesting colonies is to be increased.

To assess techniques for establishing a new Brown Pelican nesting colony, we performed translocations and used decoys on separate un-colonized islands in the Isles Dernieres archipelago, Louisiana, from 2007 to 2010. We monitored the translocation and decoy sites for signs of nesting

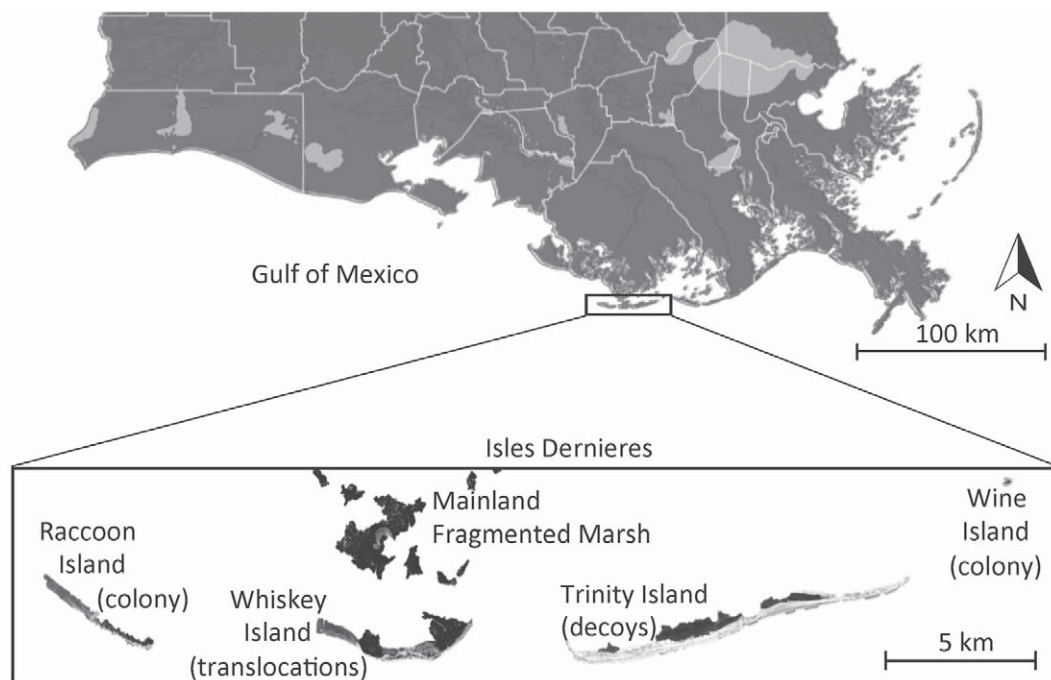


Figure 1. Coastline of Louisiana, USA, islands within the Isles Dernieres Refuge, and adjacent mainland marsh. Islands with Brown Pelican colonies or that served as translocation or decoy sites are noted. Surveys for Brown Pelicans occurred across all islands from 2008 to 2010.

pelicans, and also evaluated Brown Pelican behavior at paired decoy and control survey areas. To assess possible effects of translocation stress on pelican behavior and survival, we compared re-sighting proportions of our banded translocated birds to encounters of marked pelicans from two nearby nesting colonies. Our results should help contribute to the conservation of the species that is of interest within the context of habitat degradation, environmental contamination, and its recent removal from the Federal List of Endangered and Threatened Wildlife (U.S. Fish and Wildlife Service 2009).

METHODS

Study Area

We conducted our research across the four islands that make up the Isles Dernieres Refuge in Louisiana (Fig. 1) from 2007 to 2010. These islands are composed of a sandy substrate, are low in elevation (< 1 m; Visser *et al.* 2005), and are on average 5 km from mainland marsh. All islands support a variety of grass and forb species, and the shrubs black mangrove (*Avicennia*

germinans) and marsh elder (*Iva frutescens*). See Hester *et al.* (2005) for a review of vegetation assemblages common to Louisiana barrier islands. Within the Isles Dernieres, Raccoon (29° 3' 0.863" N, -90° 55' 4.691" W) and Wine (29° 5' 48.264" N, -90° 36' 41.255" W) Islands supported Brown Pelican and other waterbird nesting colonies during our study, and did not hold mammalian predators. Conversely, Whiskey (29° 3' 17.496" N, -90° 51' 59.112" W) and Trinity (29° 3' 56.879" N, -90° 39' 29.160" W) Islands were only used as loafing sites for Brown Pelicans, although other coastal avifauna occasionally nested on sandy spits. Further, small numbers of raccoons (*Procyon lotor*) and coyotes (*Canis latrans*) inhabited Whiskey and Trinity Islands. All islands are separated from the next nearest island by 4 to 5 km (Fig. 1).

Translocations

The Louisiana Department of Wildlife and Fisheries, U.S. Fish and Wildlife Service, and University of Louisiana developed a plan to establish a new colony on Whiskey Island, which had habitat similar to Raccoon Island located 5 km to the west. The objective was to expand the number of islands used by the Brown Pelicans for nesting in response to loss of several colony sites due to damage from Hurricane Katrina. We translocated 323 chicks from Raccoon Island to Whiskey Island from 2007 to 2009. Following methods used during translocations from Florida to Louisiana

(McNease *et al.* 1984), each year we hand captured > 100, 7 to 9-week-old chicks that had already naturally abandoned their nests to form pre-flight crèches. Before transfer to Whiskey Island, each chick received a nine-digit U.S. Geological Survey metal band, and also a corresponding three-digit alphanumeric plastic color band to allow post-release monitoring. Further, we collected a small blood sample from each individual to determine sex using laboratory genetic procedures (Fridolfsson and Ellegren 1999). Each chick was then placed in a ventilated cardboard box for transport by boat to Whiskey Island (Fig. 1) where they were released within 3 hr of capture. We deposited chicks in the central region of the island along the northern shoreline where black mangrove and beach habitat resembled nesting conditions on Raccoon Island. Because Brown Pelican adults feed their chicks until they are able to forage independently (Shields 2002), we provisioned the crèche of translocated chicks with 90 kg of Gulf menhaden (*Brevoortia patronus*) per day. Gulf menhaden is the Brown Pelican's dominant prey in the northern Gulf of Mexico (Shields 2002), and this quantity was more than sufficient to nourish the chicks based on daily consumption rates (Shields 2002). Fish were purchased frozen and thawed before throwing them to the chicks from 20 m away. Feedings lasted until all translocated chicks were capable of flight, and following daily provisioning we searched the vicinity for dead chicks and signs of mammalian predators.

In an attempt to prevent potential mortality to translocated chicks on Whiskey Island, we trapped raccoons and coyotes before (0 to 8 days) and after (9 to 15 days) the day of translocation. Tomahawk box traps and leg-hold traps were deployed and baited with sardines between 12 June and 16 July, 2007 to 2009, for a total of 456 trap nights. During each release effort, we trapped until all chicks fledged from Whiskey Island, or we determined that all residential mammalian predators had likely been captured due to absence of predation or new tracks. Leg-hold traps were set at sites away from pelicans to avoid catching chicks.

Band Re-Sighting Surveys

We banded, but did not translocate, an additional 575 chicks on Raccoon Island and 539 chicks on Wine Island (Fig. 1) from 2007 to 2009 (S. Walter, unpubl. data). In this study we compare their re-sighting proportions to those of our translocated individuals.

We surveyed the translocation site on Whiskey Island from 26 March to 11 July in 2008 to 2010 to search for banded translocated birds ($n = 80$ total surveys). In addition to these surveys at the vegetated interior portion of Whiskey Island, we also performed separate band re-sighting surveys at all areas where pelicans commonly loaf across all islands in the Isles Dernieres (Fig. 1). These surveys were conducted from 26 March to 22 July during 2008 to 2010 and numbers of surveys per island were: Raccoon = 50, Whiskey = 46, Trinity = 51 and Wine = 53. Further, in 2010 we performed 15 band re-sighting surveys at Orange Island (29° 8' 5.135" N,

-90° 40' 43.788" W), located 8 km northwest of Wine Island. All surveys entailed scanning for Brown Pelicans and potential bands with Swarovski® 20 × 60 power spotting scopes, and were conducted at random times between 07:00 and 17:00. For each band observation, we recorded island location, date, and auxiliary band number and color. Ages were later determined from our banding database. Finally, we made requests to the local birding community and wildlife agency personnel that they submit incidental observations of our banded Brown Pelicans.

To estimate and compare apparent survival probabilities for Brown Pelicans that were from Raccoon and Wine Islands, or translocated to Whiskey Island, we used program MARK (White and Burnham 1999). However, due to extremely sparse sightings of translocated individuals, our data were insufficient to produce estimates. Consequently, to compare encounters of individuals from the three islands we used a Chi-Square Contingency Table analysis to determine if re-sighting proportions of banded birds were independent of where they were tagged (PROC FREQ; SAS Institute, Inc. 2008). Due to low sample sizes, we pooled sightings across all survey locations and years for this assessment. Because roughly the same proportions of banded birds fledged from Raccoon, Wine and Whiskey Islands each of the 3 years, we do not believe this pooling biased our results to the point of obscuring or creating the large apparent differences in band recovery that we observed.

Decoys and Behavioral Surveys

In an attempt to initiate a new Brown Pelican nesting colony on Trinity Island, we deployed 108 pelican decoys on the island from 2008 to 2010. To construct decoys we modified Canada Goose (*Branta canadensis*) plastic decoys (Flambeau®) that are similar in size and shape to Brown Pelicans. We used upright 'sentry' heads and necks to best match the stature of pelicans, and also added a plastic pipe for a bill, duct tape for a gular pouch, and painted the decoys in breeding plumage colors (Sibley 2000; Shields 2002). For decoy placement each year, we selected three sites based on availability of black mangroves, the Brown Pelicans' preferred nesting substrate in coastal Louisiana (Visser *et al.* 2005). Within each site we selected two plots (roughly circular in shape and approximately 25 m in diameter) separated by at least 250 m, and then randomly designated one plot to receive decoys while the other served as a paired control. In each of the three decoy plots, located 1.6 to 5.7 km from each other across the island, we affixed 36 decoys near the tops of 1- to 2-m tall black mangroves using plastic zip ties. Within plots we spaced decoys 1 to 3 m apart from each other to mimic the spatial distribution of nesting pelicans at Raccoon and Wine Islands. In Louisiana, Brown Pelicans typically initiate nesting at the end of March. Therefore, we placed decoys in the field from 5 to 19 March in attempt to attract prospecting adults, and then collected the decoys from 24 June to 6 July at the cessation of the majority of each season's nesting efforts. Different plot locations on Trinity Island were used each year to increase independence of

plot surveys. We conducted no removal of mammalian predators on Trinity Island.

To survey for signs of nesting, we visited each plot every 4 to 6 days, for 67 total visits across years. Using binoculars, we searched for signs of nesting from a boat ≥ 150 m from plots to avoid disturbance. During each survey we recorded the number and behavior (i.e., loafing, foraging, swimming) of Brown Pelicans within a circular survey area with an approximate diameter of 225 m around decoy or control plot centers. We conducted surveys from 07:00 to 17:00, and visited survey areas in random order over days.

We also performed behavioral surveys at paired decoy and control survey areas to evaluate potential interest of passing Brown Pelicans to decoys. From 26 March to 6 June 2009, we performed 90 surveys that each lasted 1 hr (i.e., 45 hr each at decoy and control survey areas), from a boat anchored ≥ 150 m away to avoid disturbance. After arriving at observation locations we waited 5 min for natural activity to resume before we simultaneously monitored paired survey areas. Decoy and control survey areas were circular with an approximate diameter of 225 m around plot centers. If a Brown Pelican passed over the survey area with decoys, we assumed it would likely have the ability to notice the decoys. For each survey area, we recorded the number of Brown Pelicans per group that passed, and noted if the same group passed over both survey areas. For every Brown Pelican entering the survey areas, we classified their behaviors. Actions that signaled interest included 'looking down, circling overhead, or landing within the survey area', and behaviors that did not appear to express interest were 'flying over, foraging, or swimming by' with no detectable recognition of the survey region. We conducted surveys from 08:30 to 16:30, and visited plots in random order across days.

To evaluate associations between 'interest' and 'no interest' by Brown Pelicans to decoy and control areas we used a Chi-Square Contingency Table analysis with 10,000 Monte Carlo re-samplings to determine p-values. To maintain statistical independence, the behavior expressed by multiple individuals within a group was counted as a single data point for that group. Also for groups or individuals that passed through paired decoy and control survey areas, we only used a single, randomly selected observation from one of the two areas for analysis.

RESULTS

Translocations

Of the 323 chicks translocated to Whiskey Island, 19 individuals perished before they could fly. Based on tracks and appearance of carcasses, we found evidence of possible predation by raccoons on 12 chicks and a coyote on one chick.

During 3 years of trapping (465 trap nights) we captured five raccoons (2007 = 2, 2008 = 1, 2009 = 2) and no coyotes. We captured all raccoons in box traps after translocations had occurred, and released them 25 km away on the mainland.

Banded Brown Pelican Re-Sightings

Of the 304 translocated Brown Pelicans that we assume survived until first flight (based on our encounter of 19 dead chicks), only a single 2-year-old male was observed loafing on Whiskey Island, near the release site, during our 215 band re-sighting surveys from 2008 to 2010. Two additional translocated individuals, females aged 1 and 2 years old, were observed. Both of these were found loafing on Raccoon Island. Further, an additional 1-year-old translocated bird of unknown sex was observed on 5 October 2010 at Holly Beach, Louisiana, 260 km from the translocation site. Incidentally, of a subset of translocated chicks for which we determined sex, we found a ratio of nearly one to one (45 females and 46 males).

Observations of banded individuals that fledged from Raccoon, Whiskey, and Wine Islands were found in unequal proportions ($\chi^2_1 = 1094.86$, $n = 1418$, $P < 0.001$; Fig. 2).

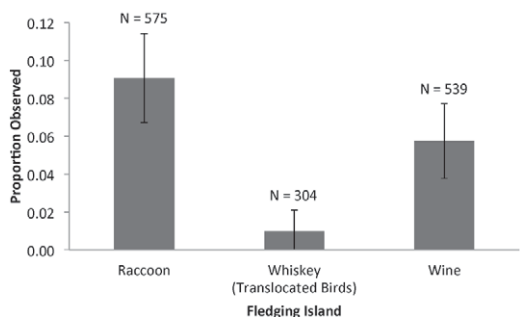


Figure 2. Proportions of observations of banded Brown Pelicans from Raccoon, Whiskey, and Wine Islands within the Isles Dernieres archipelago, Louisiana, USA. Individuals from Whiskey were translocated, and numbers of individuals that were presumed to fledge from each island are listed above bars. Observations are based on 215 band re-sighting surveys from 2008 to 2010 across all islands within the archipelago and on nearby Orange Island. Error bars are 95% confidence intervals for observed proportions.

The proportions of re-sighted pelicans was 9.2 and 5.8 times greater for birds that fledged from Raccoon and Wine Islands, respectively, compared to observations of translocated birds that were assumed to survive until first flight.

Decoys and Behavior

On 28 May 2008, 22 individuals of mixed ages were observed loafing 15 m away from decoys. Also, on 19 June 2008 two adults (≥ 3 years) and three sub-adults were swimming in the bay 25 m from decoys. No Brown Pelicans were observed within adjacent control survey areas.

Across 90 hr of behavioral survey hours at decoy and control areas, we observed 315 groups of Brown Pelicans, for a total of 786 individuals. Of these groups, 22% passed over both paired survey areas. An average of 3.6 (Range: 0-11) groups per hr passed by survey areas, with an average of 8.7 (Range: 1-51) Brown Pelicans per group.

Of Brown Pelicans passing decoy survey areas, three groups expressed interest in the decoys; a single individual and a group of eight circled, and a single pelican looked down at decoys while flying over. No Brown Pelicans flying over control survey areas circled or looked down, yet a single individual landed in a control area. Based on all observations of Brown Pelicans that did or did not express interest in decoy and control survey areas, there was no difference in behaviors ($\chi^2_1 = 1.65$, $n = 244$, $P = 0.33$).

DISCUSSION

Our attempt to establish a new Brown Pelican nesting colony on Whiskey Island was based on historically successful translocation protocols (McNease *et al.* 1992; Holm *et al.* 2003); however, our efforts have not resulted in a new colony. Typically, Brown Pelicans start nesting when 3 years old, although 1 and 2 year olds occasionally breed (McNease *et al.* 1984; Shields 2002). Therefore, we could have potentially detected nesting during all

three of our survey years, yet breeding would have been most likely in 2010. Since the end of this study, we have visited Whiskey Island on several occasions during the 2011 and 2012 breeding seasons and detected no evidence of Brown Pelican nesting. Although future years hold potential for nesting, the apparent differences in success of current and former translocation attempts might inform future attempts to establish new colonies.

Our translocations occurred within the vicinity of two active colonies (5 to 20 km away), as opposed to historical translocations where there were no active colonies within 100 km (James 1963). Consequently, translocated individuals from our study may have joined colonies on nearby Raccoon or Wine Islands. Further, although we selected young chicks to translocate in attempt to promote imprinting on Whiskey Island before first flight, natal site fidelity may have already been established at Raccoon Island. Imprinting in other seabirds likely takes place during early chick development (Serventy *et al.* 1989). However, fidelity to Raccoon or Wine Islands does not appear to explain our observations, as translocated individuals were largely absent from these islands during our study. We are unable to compare the degree to which our translocated chicks returned to release sites to patterns following older translocations, due to a lack of re-sighting data from the 1970s and 1980s. Yet, based on numbers of nesting attempts by individuals from translocations in 1968 (McNease *et al.* 1984), the proportion of our translocated individuals that remained within the region appears to be considerably lower than following earlier translocations.

Our translocation program largely adhered to methodologies that commonly increase the success of translocations (Wolf *et al.* 1996; Armstrong and Seddon 2007). Over repeated years, we moved regionally wild-captured individuals, compared to captive raised, to an area within their historical range that held preferred habitat conditions (Visser *et al.* 2005). Also, the numbers of birds we transplanted per year exceeded recommended group sizes (i.e., > 80 individuals; Griffith *et al.* 1989), and were similar

to the average number released per year in previous successful Louisiana translocations (McNease *et al.* 1984). The ages of birds we moved were also similar to those used during previous successful translocations (Nesbitt *et al.* 1978). Further, the relatively short time from capture to release likely helped reduce stress from confinement; only 5% of all our transplanted chicks perished before flight compared to the loss of 10% of chicks moved from Florida to Louisiana from 1968 to 1980 (McNease *et al.* 1984). Finally, chicks readily ate the fish we supplied on a daily basis until they were able to forage independently. Despite these efforts that favored the success of the translocation efforts, we detected few translocated individuals during re-sighting surveys.

Physiological and behavioral stress associated with translocation (Griffith *et al.* 1989; Dickens *et al.* 2009) may explain the absence of the majority of our translocated Brown Pelicans. Disregarding the chicks that perished shortly after translocation, we still observed 5.8 to 9.2 times more non-translocated pelicans banded at nearby colonies compared to transplanted individuals. In other avian species, introduction to a novel area, disruption of social organization, and disorientation can promote irregular behavior and increased roaming (Letty *et al.* 2007; Oro *et al.* 2010). With Brown Pelicans, Selman *et al.* (2012) recently documented the complete desertion of hatch- and after-hatch-year individuals from their translocation site in Louisiana during the year in which they were moved. The highly mobile and gregarious nature of Brown Pelicans may have resulted in our translocated individuals joining pelican groups outside our study area.

Although Brown Pelican translocations in Louisiana have been successful in the past (McNease *et al.* 1992; Visser and Peterson 1994), managers should consider the losses of individuals from the regional population. Regardless of whether mortality or emigration is responsible for the failure to re-sight hundreds of our translocated birds, a large portion of these individuals did not inhabit the Isles Dernieres archipelago following

fledging. If this absence continues, it equates to fewer reproductive adults to maintain active colonies within one of the most productive portions of the Louisiana coast (T. Hess, unpubl. data). Further research is needed to determine if potentially roaming translocated birds return, as Brown Pelicans may not return to their natal grounds for several years following fledging.

Given the successful use of decoys to attract various species of colonial waterbirds (Parnell *et al.* 1988; Crozier and Gawlik 2003), the gregarious nesting behavior of Brown Pelicans suggested that they might respond to decoys. Brown Pelicans regularly passed over our decoys, yet the attraction cue was apparently insufficient to elicit nesting despite deployment of decoys prior to the onset of nesting. Regular Brown Pelican nest initiation in the region typically occurs in March, although nest site selection occasionally begins as early as February in Louisiana. Because new nests are continually created as late as July in Louisiana, our decoys were available to attract prospecting adults during the majority of the breeding season. In addition to appropriate timing of decoy placement, decoys were situated among preferred nesting substrate. Further, we suspect our clusters of 36 decoys provided sufficient numbers to emulate a small colony. In other research, clusters of 28 to 33 Arctic Tern (*Sterna paradisaea*) decoys have initiated nesting (Kress 1983), as well as clusters of 32 Black Skimmer (*Rhynchops niger*) and Gull-billed Tern (*Sterna nilotica*) decoys (Pius and Leberg 2002). In Louisiana, naturally established colonies that now hold hundreds of nests have begun with as few as four nests during the initial year of colonization (e.g., Rabbit Island; T. Hess unpubl. data). Although some decoy programs to attract seabirds include recordings to simulate an active colony (Parnell *et al.* 1988), we did not feel auditory cues were warranted. Male Brown Pelicans attract mates by selecting nest sites and performing behavioral displays, and do not direct specific vocalizations to females (Shields 2002). Further, because Brown Pelicans are the first colonial species to nest on Louisiana barrier islands in the

spring, nest initiation occurs in the absence of tern and gull calls.

Visser *et al.* (2005) suggest ideal locations are islands at least 7 km from the mainland, have at least 70% open foraging water within their vicinity, and are 10 to 70 ha in size. Our translocation and decoy sites exceeded this recommendation with regard to foraging habitat. However, Whiskey and Trinity Islands are closer to the mainland (2.0 and 6.8 km, respectively) and considerably larger (280 and 440 ha, respectively) than most extant colonies (Visser *et al.* 2005). Many waterbird species, including Brown Pelicans, select small and isolated islands for nesting because they are less likely to hold mammalian predators (Greer *et al.* 1988; Parnell *et al.* 1988). Raccoons and coyotes occur on Whiskey and Trinity Islands and these islands have not supported Brown Pelican colonies since surveys began in 1971 (Visser and Peterson 1994). However, as other sites of Brown Pelican colonies in Louisiana are relatively close to the mainland or islands with mammalian predator populations (e.g., Rabbit Island = 1.4 km, Queen Bess Island = 3.0 km), distance to predator sources does not completely determine what islands might serve as colony sites. Further, Brown Pelicans have successfully bred within the presence of some mammalian predators with only minimal predation on young chicks (Anderson *et al.* 1989). Although we are uncertain if raccoons or coyotes killed some of our translocated chicks, the threat of predation may have caused pelicans to avoid returning to the translocation site. Likewise, raccoons on Trinity Island may have dissuaded prospecting adults from nesting at our decoys. A Brown Pelican translocation or decoy attraction study on islands with preferred nesting habitat, yet devoid of mammalian predators, would help clarify the relationship between colony site conditions, predators, and nesting patterns.

The rapid loss of Brown Pelican colony sites in Louisiana (Sallenger *et al.* 2009) warrants the immediate implementation of conservation management to ensure Brown Pelican population viability. Although expanding the distribution and number of

nesting colonies could mitigate threats to the currently concentrated breeding population, short-distance (~5 km) translocations and decoys may not effectively promote additional colonies. Until future studies demonstrate the effectiveness of such practices, protection and restoration of current colony sites may best sustain viable populations.

Several techniques have been used to create and protect barrier island habitat. In Louisiana, breakwaters made of boulders have successfully protected islands used by pelicans for nesting. At Raccoon Island for instance, areas with breakwaters have apparently reduced habitat loss compared to nearby areas without the structures that mitigate wave-induced erosion (Broussard and Boustany 2005). Further, the boulder-reinforced perimeter of Queen Bess Island, Louisiana, has prevented shoreline retreat and consequently maintained stable habitat since Brown Pelican nesting began there in 1971 (Visser and Peterson 1994). Stable habitat conditions at Queen Bess Island are in contrast to degrading conditions at nearby colonized islands without shoreline fortification (e.g., Mangrove and Shallow Bayou Islands). However, boulders may not always work to preserve nesting habitat; a dike (< 1 m tall) constructed of boulders around Wine Island in 1991 has not prevented extensive land loss that led to the abandonment of the island by nesting Brown Pelicans. Habitat creation via dredge pumping, dune construction, and vegetative plantings offer additional alternatives for island restoration (Penland *et al.* 2005). Finally, the design and development of dredge spoil islands may offer additional nesting sites, as various spoil sites across the northern Gulf of Mexico coast support Brown Pelican colonies (Robinson and Dindo 2008).

Finally, predator control may provide a means to protect or initiate colonies (Parnell *et al.* 1988), as this practice has been successfully used to decrease acute predation following translocation or decoy attraction of other avian species (Kress 1983; Letty *et al.* 2007). However, continued predator monitoring and trapping is suggested, particularly at colonized islands close to predator

sources, to ensure long-lasting success of new colonies (Letty *et al.* 2007). Given declines in Brown Pelican nest success and reductions in colony size and number over the last decade (T. Hess, unpubl. data), we encourage the consideration of habitat protection and management practices to promote sustained viable populations at multiple sites along the northern Gulf coast. These restoration and protection measures will not only benefit Brown Pelicans, but also a suite of waterbird species that nest on barrier islands.

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