PERFORMANCE REPORT

STATE: New Jersey **PROJECT NUMBER**: E-1-26

PROJECT TYPE: Research and/or Management

PROJECT TITLE: Endangered and Threatened Wildlife Conservation

STUDY NUMBER AND TITLE: IV - Vertebrate Wildlife Conservation

JOB NUMBER AND TITLE: 2-C Piping Plover Threat Assessment and Management

PERIOD COVERED: September 1, 2001 to August 31, 2002

JOB OBJECTIVES: To determine the nature and level of threats to piping plover populations and reproductive success and to reduce threats through management.

SUMMARY:

Through nest checks conducted an average of 4 times per week, nest outcome and cause of nest failure was determined for 68 piping plover pairs nesting on 17 sites monitored and managed by NJ Division of Fish and Wildlife (NJDFW) – Endangered and Nongame Species Program (ENSP). All nesting areas were managed to reduce human disturbance to nests and broods and to reduce predation of nests. All known nests were protected with fencing and signs. All major nesting areas were patrolled on weekends and holidays and many received weekday patrolling. Predator exclosures were used at 9 selected sites to reduce predation risk to nests.

NJDFW was able to determine nest outcome for all of the 102 nesting attempts. Of the 102 known nest attempts, 52 (51.0%) failed, while 50 (49.0%) hatched. The likely cause of nest failure was determined for 44 of the 52 (84.6%) failed nests. Flooding was the most important cause of nest failure, destroying 22 nests (21.6% of nesting attempts, 42.3% of failures) followed by predation (11 nest failures -- 10.8% of attempts, 21.2% of failures) and nest abandonment (9 nests -- 8.8% of attempts, 17.3% of failures). The cause of failure could not be determined for 8 nests (7.8% of attempts, 15.4% of failures). A comparison of the relative contribution of factors involved in nest failure over the past five years shows that flooding caused a notably greater percentage of nest failures in 2001 and 2002 than in any of the previous three years.

Predator exclosures were used for 32 nesting attempts (31.4% of all nesting attempts). Twenty-three (23) exclosed nests hatched (71.9% of exclosed nests), fledging 45 young (1.96 fledglings per successful nesting pair). Of the 9 exclosed nests that failed, 6 were abandoned and 3 were flooded.

Observations of chick mortality were very rare. Flooding was probably a significant cause of chick mortality at Stone Harbor Point, North Brigantine Natural Area and Ocean City – North.

Comprehensive management to reduce human disturbance, including intensive monitoring, on-site patrolling, and improved municipal cooperation coupled with carefully monitored use of predator exclosures will continue as the primary methods for increasing nesting success and chick survival and will hopefully continue to achieve the relatively high average productivity experienced over the past five years. Achieving reproductive success similar to the years 1998-2001 will be necessary to mitigate the affects of years such as 2002 when factors unresponsive to management efforts, i.e, weather, diminished reproductive success.

STATUS: On schedule.

SIGNIFICANT DEVIATIONS: None.

RECOMMENDATIONS:

Maintain current nest monitoring frequency to ascertain causes of nest failure and brood loss. Continue use of predator exclosures where they have reasonable chance of effectively reducing predation. Use electric fencing in conjunction with predator exclosures, where feasible, to prevent predation by “smart predators.” Continue to develop and test modifications to predator exclosures. Continue to monitor the nest abandonment problem with regard to predator exclosures. Explore the feasibility of night-time monitoring at selective sites to help better pinpoint which species are predator threats at specific sites. Employ predator removal measures where exclosures are failing to reduce nest losses and chick losses to predators. Continue management to reduce detrimental human activities near nesting birds.

COST: $6,666.50 ($6,000.00 federal share; $666.50 state share)

BACKGROUND:

The Atlantic Coast Piping Plover Recovery Plan (USFWS 1996) lists habitat loss and degradation, disturbance by humans and domestic animals, and increased predation as significant factors in the decline of the piping plover population. Several studies have documented predation as an important cause of piping plover nest and chick losses (see USFWS, 1996 for summary). Ultimately, nesting productivity (fledglings per nesting pair) is a function of hatching success and chick survival. Hatching success is, in turn, primarily a function of whole-nest failure with loss of individual eggs from viable nests (clutch reduction) and egg inviability playing a much lesser role. Together, predation, flooding and abandonment account for virtually all identifiable nest failures. Chick survival (brood reduction) also contributes significantly to productivity, however, causes of brood reduction are more difficult to ascertain. Predation, often exacerbated by human disturbance, is suspected to be a primary cause of chick mortality. Flooding is also probably a significant factor at some sites.

NJDFW has been actively managing beach nesting birds in the state for nearly 17 years using the techniques described below. Throughout this time, we have intensified the management at each site, including extended patrolling, increased information and education efforts, and greater coordination with municipalities. Federal listing of the piping plover in 1986 also increased the management efforts for nests located on federal properties, notably Sandy Hook (Gateway National Recreation Area – Sandy Hook Unit), Holgate, Little Beach (both part of Forsythe National Wildlife Refuge), 2-Mile Beach (part of Cape May National Wildlife Refuge and the US Coast Guard – EECEN base) and the US Coast Guard TRACEN base.

PROCEDURES:

NJDFW monitored nest outcome and cause of nest failures at 17 of 28 nesting sites in New Jersey. The remaining 11 sites were monitored and managed by the National Park Service (7 sites), the U.S. Fish and Wildlife Service (3 sites) and The Nature Conservancy (1 site).

Nest checks Through regular (3-5 times per week) nest checks, NJDFW attempted to examine the relationship between potentially adverse factors and nest outcome (i.e. nest success and fledging rates). Observers attempted to determine the cause of all nest

failures and recorded evidence of extended human presence and any predation attempt on chicks or adults that they witnessed.

Nests were considered lost to predation when there was evidence of a predator at a destroyed nest. Evidence usually consisted of tracks leading to the nest, but occasionally could include egg fragments or punctured eggs found in or near the nests in the absence of tracks. Whenever possible the specific type of predator was determined by examination and identification of tracks or other physical evidence. If a nest was destroyed with no discernable evidence of a predator at or near the nest, we did not assign a cause (nest failed -- unknown cause). When the identity of a predator could not be established, or when there was evidence of more the one type of predator we assigned the cause of failure as nest predated – unknown predator.

Brood monitoring included assessing factors that might be involved in chick mortality, but only very rarely included direct observations of chick mortality. Any dead chicks found were salvaged, and when warranted and possible, a necropsy was performed.

Management techniques The techniques NJDFW applied to protect nesting piping plovers and increase breeding success have been described in detail in several other reports (Jenkins 1989, Jenkins & Steidl 1986). In summary, they include restricting access to nesting areas and closure of some nesting areas; patrolling; working with municipal and state agencies to limit detrimental activities on their nesting beaches; law enforcement; and information and education. NJDFW used predator exclosures (as described by Melvin et. al., 1992) on selected beaches to reduce predation of nests by large avian and mammalian predators.

At North Brigantine Natural Area and Corson's Inlet State Park where predator exclosures alone were not an effective means of deterring mammalian predation, they were augmented with electric fencing. We encircled the predator exclosure with a single strand of wire placed 8 to 10 inches above the ground at a distance of roughly 1 foot from the exclosure. A copper-coated grounding rod was wired to the capacitor, which was mounted on a 3’ vertical piece of plywood.

FINDINGS:

The fledge rate of 1.00 fledglings per pair for beaches monitored by NJDFW was a notable drop from the relatively high productivity recorded the previous four years, but was similar to the average fledge rate for 1987-2001 (Jenkins et. al. 2002). The decline in productivity compared with previous years was due both to lower pair-nest success and lower chick survival. Weather, which contributed to both nest failure and chick mortality, was a major factor in the diminished fledge rate. Persistent repeated storms through the course of the nesting season that included strong winds, heavy rains, hail, and/or tidal flooding were the main problem. Four particularly bad storms that resulted in significant nest or chick loss occurred on April 28, June 6, June 13-14 and July 24-25. Other long periods of unusually hot weather may have also played a role in nest failure and chick morality.

Pair-nest success (0.71), which measures the rate at which nesting pairs successfully hatch nests, was lower than in 2001 (0.77), but essentially equivalent to the average for the period 1987-2002 (0.70). The successful-pair fledge rate (1.42 chicks per successful pair), a function of chick survival, was markedly lower compared to 2001 (1.77), but slightly above average for the period 1987-2002 (1.36). The following examination of reproductive potential illustrates the contribution of pair success and chick survival to the fledging rates recorded this year. Given that each piping plover pair could produce a maximum of 3.8 fledglings (average clutch size of 3.8 eggs, single brood per season), the 1.00 chicks fledged per nesting pair equates to nesting plovers attaining 26.4% of their maximum reproductive potential. The loss of 73.6% of reproductive potential breaks down as follows (Table 1): failure of pairs to hatch any eggs (pair-nest failure) accounted for 29.5%; disappearance or non-viability of individual eggs from ultimately successful nests accounted for 8.1%; brood reduction accounted for 36.0% of the loss. Over the past several years no consistent pattern in the contribution of either nest loss or brood reduction to overall productivity has been seen. However, the last two years have been similar in that the greatest loss of productivity was attributed to brood reduction.

Causes of nest failures Of 102 known nesting attempts, 52 (51.0%) failed (did not produce any chicks) and 50 (49.0%) hatched. Flooding was the most frequently identified cause of nest failure for nests where the cause of failure could be determined

(22 failures -- 42.3% of failures, 21.6% of nesting attempts) (Table 2, Fig. 1). Nineteen (19) of the 22 (86%) nests lost to flooding occurred at just 3 sites; Stone Harbor Point, Ocean City - North, and North Brigantine Natural Area (7, 7 and 5 nest failures, respectively). Predation accounted for 11 nest failures (21.2% of failures, 10.8% of nesting attempts). Of these, avian predation accounted for 4 failed nests and mammalian predation accounted for 3 nest losses, with the remaining being lost to undetermined predators. Abandonment accounted for 9 nest failures (17.3% of failures, 8.8% of attempts). One (1) nest was lost to human disturbance (1.9% of failures, 1.0% of attempts) and 1 nest was a non-viable clutch (1.9% of failures, 1.0% of attempts). There were 8 nest failures where the exact cause of failure could not be determined (15.4% of failures, 7.8% of attempts).

A comparison of the relative contribution of factors involved in nest failure over the past 5 years (Table 2) shows that flooding caused a slightly greater percentage of nest failures in 2002 than in 2001, but in both of these years flooding nest losses were considerably higher than 1998-2000 when predation was typically the most prevalent cause of nest failure. Nest failures due to abandonment were nearly the same from 2000-2002 with all 3 years being markedly lower than the high abandonment rate in 1998.

The percentage of nests lost to predation rose in 2002 as compared to 2001. However, in 2001 it was noted that most, if not all, nest failures categorized as undetermined probably failed due to predation (Jenkins et. al. 2001). Although no direct evidence of predation (tracks, eggshell remains, predator observations) was found when the nests were discovered to have been destroyed, no flooding/storms had occurred and there was no evidence to suggest human disturbance as a cause. This led NJDFW to ascertain that predation was the most likely cause. This scenario was not the case in 2002 when more than one factor was possible for most of the nests classified as lost due to "undetermined" causes. For example, in several cases it could not be definitively determined if flooding/severe storms or predation was the cause of nest lost. In several other instances, human disturbance was possibly a cause (or at least a factor) in the nest loss, but again no direct link could be made. Even if some of these nests lost to undetermined causes were, in fact, due to predation, the percentage of nests lost to predation this year was the lowest in the past 5 years.

Chick Mortality Observations of chick mortality were very rare. NJDFW staff found 2 dead chicks this year, including 1 at Stone Harbor Point and 1 at North Wildwood – Hereford Inlet. In the case of Stone Harbor Point, when the nest was checked on its predicted hatch date, the 4 egg nest had been reduced to 1 egg and 1 dead chick. Both adults were in the area, and 1 was incubating/brooding the egg and dead chick. A severe storm with high tides occurred the night before, most likely flooding the other two eggs (or newly hatched young). The dead chick was removed and placed in freezer storage at ENSP's Tuckahoe Field Office. The unhatched egg was left in the nest bowl and although the adults resumed incubating, they abandoned the egg a few days later. A second dead chick was found at North Wildwood – Hereford Inlet several days after it had disappeared, presumably from an extremely high tide that flooded the nesting area. The chick was recovered after a juvenile black-backed gull was observed flying out of the fenced nesting area with a plover chick in its bill. NJDFW staff retrieved the chick, which was saturated with water and slightly decomposed, suggesting that it had been dead prior to being picked up by the gull. This chick was also placed in freezer storage at ENSP's Tuckahoe Field Office.

Flooding and excessive storms, which accounted for a large number of nest losses, was also probably the most significant cause of chick mortality at Stone Harbor Point, North Brigantine Natural Area and Ocean City – North, and was believed to have played a role, although a lesser one, in brood loss at Monmouth Beach North and North Wildwood – Hereford Inlet. Determining the exact cause of chick loss is difficult. However, in these cases, flooding was the likely cause since the chicks disappeared the day after either a major storm or excessive high tides. In several instances, the entire nesting site was submerged or washed over by floodwaters.

Management summary Funding provided through the B. T. Nautilus oil spill natural resource damage settlement from 1995 - 2000, and, more recently, funding provided by the U.S. Army Corps of Engineers for beaches in Monmouth and Cape May counties, has resulted in increased monitoring and management intensity throughout the state since 1995. In addition, two intern projects put into place in 2001, including one with Monmouth University and another involving a National Science Foundation grant partnership with The Richard Stockton College of New Jersey, The Nature Conservancy

and The Wetlands Institute, have provided up to eight students to assist NJDFW with their stewardship and management program.

In general, some of the enhanced management efforts put into place over the past several years include: increased monitoring and patrolling at NJDFW sites; improved municipal communication and involvement in the management process, including the issuing of weekly management updates to municipalities/agencies hosting nesting birds and the initiation and implementation of formal management agreements in some communities; the establishment of a seasonal vehicle closure at North Brigantine Natural Area; increased use of pre-fencing as a habitat and nest protection measure; creation of fenced and/or posted "feeding corridors" on beaches with high levels of human activity; use of electric fence in conjunction with predator exclosures at selected sites; and mammalian predator removal at sites where persistent problems existed.

Table 3 provides a summary of site management activities in 2002. More detailed site-by-site management information, including recommendations for next year, is reported in *2002 New Jersey Piping Plover Nesting Site Summaries - Current and Recommended Management*, which is available upon request from NJDFW – ENSP (Jenkins et. al. 2002).

Predator exclosures Predator exclosures continued to be the primary technique used to reduce nest predation. Tables 4 & 5 present, respectively, the site-specific use and overall reproductive success of exclosed nests. Figures 2a and 2b summarize, respectively, the fate of exclosed nests and non-exclosed nests at NJDFW-monitored sites. Twenty-three (23) of 32 (71.9%) exclosed nests hatched and 9 (28.1%) failed. A total of 45 chicks fledged from exclosed nests. In comparison, 27 of 70 (38.6%) non-exclosed nests hatched, while 43 (61.4%) failed. Twenty-three (23) chicks fledged from non-exclosed nests. Pairs that had at least one of their nesting attempts exclosed fledged an average of 1.61 chicks per nesting pair and 2.05 chicks per successful pair (hatching ≥ 1 egg) compared to 0.58 fledglings per pair and 0.88 fledglings per successful pair for pairs that had no nests exclosed.

Nearly the same number of exclosures were erected by NJDFW in both 2001 and 2002 (31 and 32, respectively), however, as a percentage of total nesting attempts, the use of predator exclosures decreased from 39% in 2001 to 31% in 2002. As a percentage of

nesting pairs (pairs for which at least one nesting attempt was protected by predator exclosure), the use of predator exclosures on ENSP sites decreased from 51% in 2001 to 41% in 2002. This shift does not represent any change in NJDFW policy regarding predator exclosures, rather is a function of an increase in nesting attempts in 2002, particularly at sites or in situations where exclosures are not typically used. NJDFW continues to use predator exclosures only at those sites where there is a history of predation problems, not in a broad pre-emptive manner. In part, this policy is due to concern regarding the higher level of abandonment and other risks associated with using exclosures.

The primary cause of exclosed nest failure in 2002 was abandonment, which accounted for 6 of 9 nest failures (66.7% of failures). In contrast, abandonment only caused 3 non-exclosed nest failures (7.0% of failures). Flooding caused losses of 3 exclosed nests (33.3% of failures), while it was the primary cause of non-exclosed nest failure, causing 19 failures (44.2% of failures). No exclosed nests were lost to predation. Eleven (11) non-exclosed nests were lost to predation (25.6% of failures). NJDFW was able to determine the cause of failure for all exclosed nests. On the other hand, the specific cause of nest failure could not be ascertained for 8 non-exclosed nesting attempts (18.6% of failures).

All predator exclosures used at North Brigantine Natural Area this year were supplemented by electric fencing, as described under "Procedures." Fourteen (14) of 23 nesting attempts at this site were exclosed, of which 7 hatched, fledging a total of 16 young. Electric fence was also used in conjunction with a predator exclosure at Corson's Inlet State Park. One (1) pair nested at that site, hatching 4 young, of which 3 survived to fledging.

A total of 44 nesting attempts were exclosed at sites that were not monitored by NJDFW staff. Of these nests, 40 hatched, fledging 71 young. The National Park Service (pers. com., Jeanne McArthur, Gateway National Recreation Area -- Sandy Hook Unit, September 2002) reported using 34 exclosures at Sandy Hook. Thirty-two (32) exclosed nests hatched, fledging a total of 57 chicks. Only 1 exclosed nest failure was the result of abandonment, a notable decrease from last year's 6 abandonments of exclosed nests. The U.S. Fish and Wildlife Service (pers. com., Vinnie Turner, U.S. Fish and Wildlife Service

-- Edwin B. Forsythe National Wildlife Refuge, September 2002) reported using 9 exclosures at Holgate. Of the 9 nests exclosed at Holgate, 7 hatched, fledging 13 chicks. Predator exclosures were not used at Little Beach in 2002. Only 2 unexclosed nests were lost to predators (1 mammalian and 1 unknown) at Little Beach this year. The Nature Conservancy (pers. com., Les Frie, The Nature Conservancy -- Delaware Bayshores Office, September 2002) reported using 1 exclosure at Cape May Meadows. That nest successfully hatched and fledged 1 chick.

As was done last year, nest abandonment was closely examined because of concern over the higher rate of abandonment experienced by exclosed vs. unexclosed nests. Statewide, 7 of 12 (58%) of all piping plover nests abandoned in 2002 were exclosed. This represents a marked drop in the number of exclosed nests that were abandoned in 2001 (93% of all abandoned nests were exclosed). Still this situation warrants attention, and as such NJDFW reviewed data from all abandoned nests statewide to look for any patterns that existed to provide insight into the cause(s) of abandonment (Appendix A).

NJDFW has been examining the timing of abandonments relative to the erection of exclosures to determine if there is a connection. In 2002 there was only 1 instance where abandonment occurred shortly after the exclosure was erected. This occurred at Sandy Hook when the abandonment took place only 4 days after the placement of the exclosure. Notably, in that time period a park ranger witnessed children shaking the exclosure, the likely cause of the abandonment.

In the other 6 abandoned nests, both members of the nesting pair had “accepted” the exclosure (as determined by sustained incubation well after the exclosure was erected). Abandonment of these 6 nests occurred more than a week after the exclosure was erected, and therefore did not appear to be a direct response to the exclosure assembly process and/or the presence of the exclosure itself. We suspect the following causes of abandonment: 3 were likely caused by mammalian predator harassment (although in those cases, there was no direct evidence linking predators to the abandonment, but high levels of predator activity were noted at or in the vicinity of the nest throughout the incubation period); 2 may have been caused by avian harassment; and 1 was likely due to flooding (water surrounded the nest for an extended period, which in combination with

the placement of a predator exclosure and electric fence around the nest, prevented the adults from being able to access the nest for incubation).

It is noteworthy that the abandonment of 5 exclosed nests took place at one site - the main overwash at North Brigantine Natural Area. Three (3) of those abandonments appeared to have occurred at roughly the same time among nests located no more than 20 yards apart, leading us to conclude that a single disruptive event was responsible. Circumstantial evidence suggests that predator activity was the most likely cause. No severe weather events occurred at this time and no human disturbance was noted. In general, an increase of red fox activity, including observation of tracks up to exclosed nests and foxes observed resting in the overwash nesting area was noted at this site this year.

Another factor considered in this triple abandonment is the usage of a new model of electric fence charger on those nests. Due to the bulk of the charger unit and the electric configuration required, it was mounted on a wooden “2X4”, whereas previous chargers have been mounted on a thin insulating rod. This may have provided a perch for avian predators, as evidenced by an accumulation of bird droppings found on and beneath one charger and ”2X4” mount. In this case, the mount for the charger was slightly higher than the predator exclosure because the sand was highly compacted and a deep enough hole could not be dug to sink the mount lower. In the future, all charger units should be mounted as low to the ground as possible. Anti-perch devices (i.e. spikes) may also be useful. However, since the new electric charger system was successfully used with other nests at North Brigantine Natural Area and at another site, it is unlikely that this is a widespread problem. In general, the new units seemed more durable and less prone to corrosion damage from the salt air and flooding.

It is also noteworthy that 2 of the abandonments at the overwash (including 1 of the triple abandonment nests discussed above) involved the same pair nesting in nearly the exact same spot (both initial nest and renest). Overall, the abandonment rate at this site is worrisome and warrants further attention, however, it appears to be a site-specific rather than a pervasive problem.

DISCUSSION and CONCLUSIONS:

NJDFW believes that the success of our management efforts is at least partially responsible for the recent increase in New Jersey's piping plover population. Management of nests and nesting areas has effectively diminished the effects of human disturbance on pair-nest success. Over the past 10 years and especially since 1995, management designed to moderate the effects of human disturbance has increased. Symbolic fencing, erected at virtually every nest site, is designed to prevent direct human harm to nests and to significantly reduce the threat of human disturbance interfering with incubation.

Judicious use of predator exclosures continues to be a very effective means of reducing losses of nests to predation. The use of electric fencing with exclosures continued to prove effective at North Brigantine Natural Area where we have previously experienced problems with so-called "smart predators" (foxes that learned that exclosures marked nests and that subsequently gained entry to cause abandonment of those nests). However, as already discussed, the effectiveness of electric fence at this site diminished this year due to the high abandonment rate among nests exclosed and outfitted with electric fence. These abandonments (as well as flooding losses) markedly diminished pair success and ultimately productivity at this site this year compared with recent past nesting seasons. Further, because this site has recorded some of the highest fledge rates in the state in recent years when the statewide fledge rate has been at its highest, and its nesting pairs now represent over 10 percent of the statewide population, those abandonments played an consequential role in the lower overall fledge rate this year. None of the pairs from the five abandoned nests noted above, ultimately hatched or fledged any young.

Overall, exclosed nests not only experienced higher pair-nest success, but also pairs with exclosed nests achieved higher successful-pair fledging rates, indicating that chicks from exclosed nests experience higher survival rates (Table 5). This has been true in all of the previous 5 years as well. As predator exclosures are used on beaches where predation pressures are high, this outcome, is, on the surface, counter-intuitive. Detailed examination of the factors that might be involved is beyond the scope of this report other

than to note that the use of exclosures on beaches that receive very high levels of human use is generally avoided.

The markedly higher pair-nest success and fledging rates achieved by exclosed nests seems to suggest that exclosures should be used on the vast majority of nests. However, high levels of human activity and/or beach topography prevent us from using exclosures at some nesting beaches that have experienced high losses to predation. “Smart” predator problems – predators that have learned to identify and exploit exclosures further limits use of exclosures on some beaches.

Looking ahead, the issue of high rates of abandonment among exclosed nests suggests that intensive monitoring of exclosed nests is warranted. For example, where feasible all exclosed nests should be checked each evening and morning to determine if most abandonments are occurring during the day or night. Directed studies using night-capable video equipment or human monitoring using night vision scopes would be helpful, but costly.

Except where there is evidence of high levels of chick loss to predators occurring independent of human activity, NJDFW believes that limiting human disturbance and managing beach management activities, such as beach raking and other activities involving operation of municipal vehicles on the beach, comprise the most important measures for improving chick survival. NJDFW is optimistic that, despite a drop in productivity in 2002, the increase in chick survival on average over the past 5 years and the large increase in nesting pairs the past 4 years is at least partially due to success at reducing harmful activities through increased communication and cooperation with municipal managers. More widespread adoption of formal beach nesting bird management plans by municipalities, in particular those towns receiving federal funded beachfills, should reinforce and strengthen this effort.

Flooding and other weather related factors appear to have negatively affected productivity in 2002 more than any factor that management efforts seek to address. We can speculate that age and inexperience of breeding pairs may have played a role in increasing losses to flooding and other causes, as recent population increases within the state have likely resulted primarily from the recruitment of young adults into the breeding population. Younger birds often experience lower reproductive success than more

experienced birds and this phenomenon has been documented in piping plovers (Haig et. al. 1988).

In any case, the outcome of the 2002 nesting season illustrates that it is critical to balance years when weather or other unpredictable or uncontrollable factors reduce nesting success with years of higher productivity, like those recorded the previous 4 years. Persistent application of intensive management to reduce human disturbance, including intensive monitoring, on-site patrolling, and improved municipal cooperation coupled with carefully monitored use of predator exclosures will continue as the primary methods for increasing nesting success and chick survival. NJDFW is hopeful that these management efforts will continue advancing New Jersey's piping plover populations toward population and productivity recovery goals.

FAIRS ACTIVITY CODES: 1450, 1460.

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Table 1. Fate of reproductive potential at NJDFW monitored sites: 1998 – 2002.

Fate	1998	1999	2000	2001	2002
Lost to nest failure	30.6%	19.6%	32.9%	22.6%	29.5%
Lost to clutch reduction	8.0%	5.3%	6.5%	4.1%	8.1%
Lost to brood reduction	23.0%	35.2%	18.8%	37.4%	36.0%
Fledglings	38.4%	39.9%	41.8%	35.9%	26.4%

Table 2. Fate of lost nests at NJDFW monitored sites: 1998 – 2002.

Cause of Destruction	1998		1999		2000		2001		2002	
	% of attempts	*% of failures*	*% of attempts*	*% of failures*	*% of attempts*	*% of failures*	*% of attempts*	*% of failures*	*% of attempts*	*% of failures*
Flooding	7.0	18.7	3.6	10.0	11.8	25.8	15.2	38.7	21.6	42.3
Predation	9.3	25.0	14.5	40.0	14.7	32.3	5.1	12.9	10.8	21.2
Abandonment	16.3	43.8	3.6	10.0	7.4	16.1	6.3	16.1	8.8	17.3
Human Disturbance	0	0	0	0	0	0	0	0	1.0	1.9
Non-viable clutch	0	0	3.6	10.0	0	0	0	0	1.0	1.9
Other[1]	0	0	0	0	1.5	3.2	0	0	0	0
Undetermined	4.7	12.5	10.9	30.0	10.3	22.6	12.7	32.3	7.8	15.4

[1] In 2000, one nest was accidentally destroyed while placing a predator exclosure.

Table 3. Summary of piping plover nest site management in New Jersey: 2002.

Site	# of Nesting Pairs	Monit.	Signed	String & Post	Partial Snow Fence	Wire Fence	Weekend Patrol	Full-time Patrol	Pred. Excl.	Notes
S. Hook Coast Guard	7	X	X	X	X		V,P	V,P	7	1
S. Hook North Beach	9	X	X	X	X	X	V,P	V,P	8	1,4
S. Hook N. Gunnison	4	X	X	X	X	X	V,P	V,P	4	1,4
S. Hook S. Gunnison	1	X	X	X	X		V,P	V,P	1	1,4
S. Hook Critical Zone	2	X	X	X	X	X	V,P	V,P	2	4
S. Hook Hidden Beach	5	X	X	X	X	X	V,P	V,P	7	1,4
S. Hook Fee Beach	7	X	X	X	X	X	V,P	V,P	5	1,4
Sea Bright North	5	X	X	X	X		I,P	I,P	3	1
Monmouth Beach North	3	X	X	X	X		I,P	I,P	3	1
Monmouth Beach South	1	X	X	X			I,P	I,P	1	1
Sea Girt - NGTC	1	X	X	X			P	I,P	0	1
Island Beach S.P.- Inlet Spit	0	X	X		X	X				3
Barnegat Light	3	X	X	X		X	P	P	1	1
Holgate	14	X	X				V,P	P	9	5
Little Beach	17	X	X						0	6
North Brigantine NA	15	X	X	X	X		P	P	*14	1,7
Brigantine Beach	0	X								
Brigantine Inlet (Cove)	1	X	X	X			P	P	0	
Longport Sodbanks	0	X								
Ocean City - North	8	X	X	X		X	P	I,P	0	2
Ocean City - Center	8	X	X	X	X		P	I,P	0	
Corson's Inlet State Park	1	X	X	X			P	P	*1	1
Strathmere NA	0	X								
Whale Beach	1	X							0	10
Sea Isle City	0	X								
Townsend's Inlet	1	X	X	X	X		P	P	1	1
Avalon - North	0	X	X	X	X				0	1
Avalon - Dunes	7	X	X	X	X		I,P	I,P	5	1
Stone Harbor Point	6	X	X	X			I,P	I,P	0	
N Wildwood - Hereford Inlet	3	X	X	X			P	P	0	
N Wildwood - Oceanfront	0	X								
Coast Guard - EECEN	2	X	X	X			P	P	0	8
Coast Guard - TRACEN	3	X	X	X			P	P	3	9
Cape May City	1	X	X	X	X		P	P	0	
Cape May Meadows	2	X	X	X			P	P	1	1

Sites in **bold italics** *monitored and managed by agencies other than NJDFW.*

Notes

1. Nesting areas fenced prior to season using string and post symbolic fencing.
2. Nesting areas fenced prior to season using wire pasture fence.
3. Nesting area "permanently" fenced with snow fence and wire fence by NJ Division of Parks and Forestry.
4. No public access of intertidal zone during period of chick rearing.
5. Beach closed to public.
6. Beach only accessible by boat; closed to public.
7. Beach closed to ORV traffic during period of chick rearing; northern portions also closed during egg laying/incubation period.
8. Beach closed to public; base security personnel patrols beach; also monitored by USFWS.
9. Beach closed to public; base security personnel patrols beach; also monitored by Coast Guard personnel.
10. No fencing – nest found after destroyed by vehicle.

I - Intern
P- Paid
V- Volunteer
I- Intern
* Electric fence used w/ exclosure

Table 4. Results of piping plover nest predator exclosure use in New Jersey: 2002.

NESTING SITE	# attempts exclosed	# pairs exclosed	# nests hatched	# pairs fledging chicks	# chicks fledged
Sites monitored by NJDFW					
Sea Bright North	3	3	2	2	5
Monmouth Beach North	3	2	2	1	2
Monmouth Beach South	1	1	1	1	4
Barnegat Light	1	1	1	1	4
North Brigantine Natural Area	14	12	7	7	16
Corson's Inlet State Park	1	1	1	1	3
Townsend's Inlet	1	1	1	1	2
Avalon Dunes	5	4	5	3	6
US Coast Guard - TRACEN	3	3	3	2	3
Subtotal	*32*	*28*	*23*	*19*	*45*
Sites monitored by other agencies					
Sandy Hook (all sites)	34	32	32	31	57
Holgate	9	9	7	7	13
Cape May Meadows	1	1	1	1	1
Subtotal	*44*	*42*	*40*	*39*	*71*
TOTAL ALL SITES	**76**	**70**	**63**	**58**	**116**

Table 5. Reproductive success of exclosed vs. non-exclosed nests at NJDFW sites: 2002.

Reproductive Parameter	Exclosed Nests	Non-Exclosed Nests
Nest success	0.72 nests hatch	0.39 nests hatch
Pair-nest success	0.79 pairs hatch[1]	0.65 pairs hatch[2]
Fledging rate	1.61 chicks/pair[1]	0.58 chicks/pair[2]
Successful pair fledging rate	2.05 chicks/successful pair[1]	0.88 chicks/successful pair[2]

[1] Includes pairs that had at least one nesting attempt exclosed.
[2] Only includes pairs that had no nesting attempts exclosed.

Figure 1. Flow chart of piping plover nest fate at NJDFW sites: 2002.

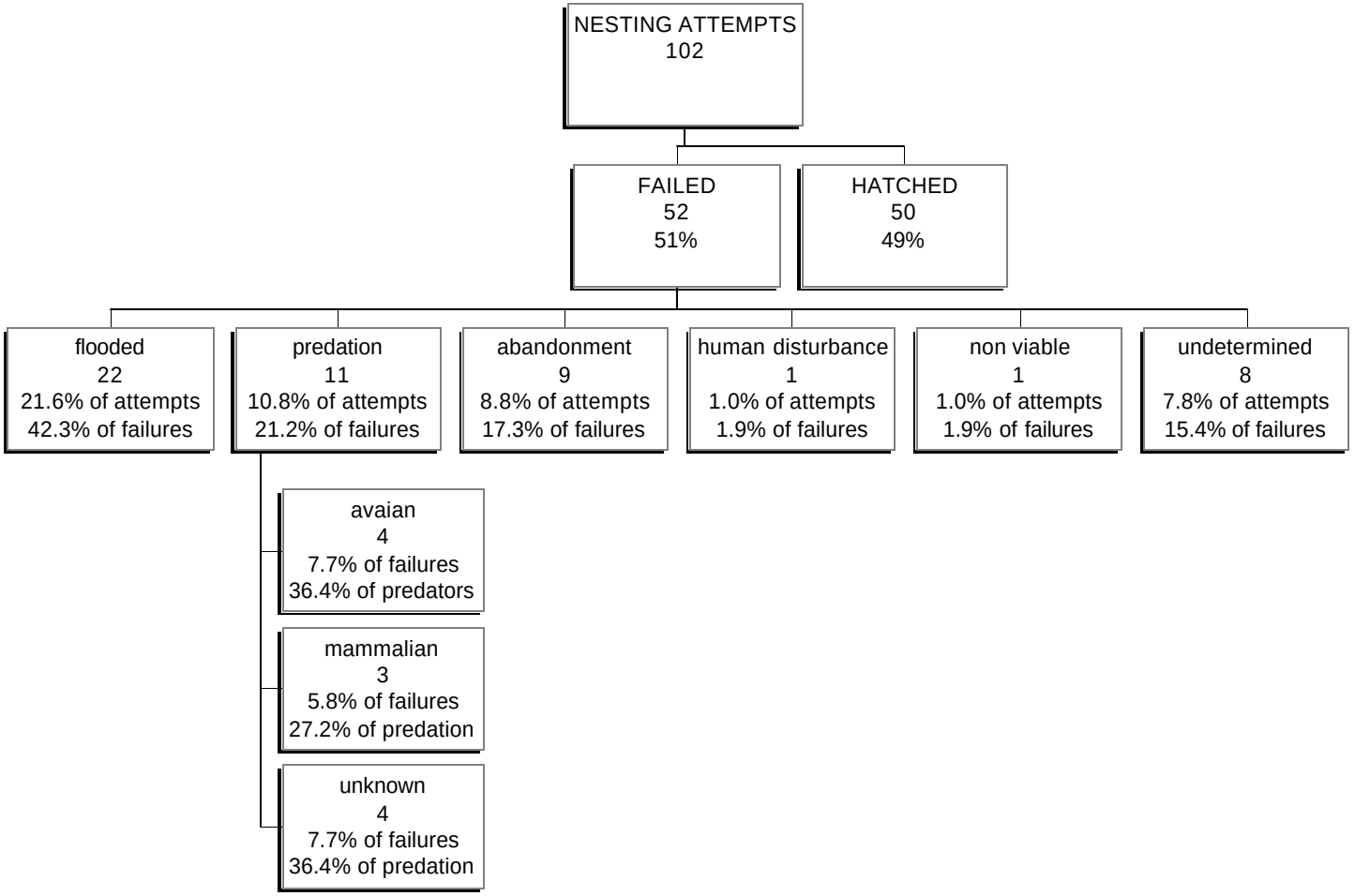


Figure 2a. Flow chart of piping plover exclosed nest fate at NJDFW sites: 2002.

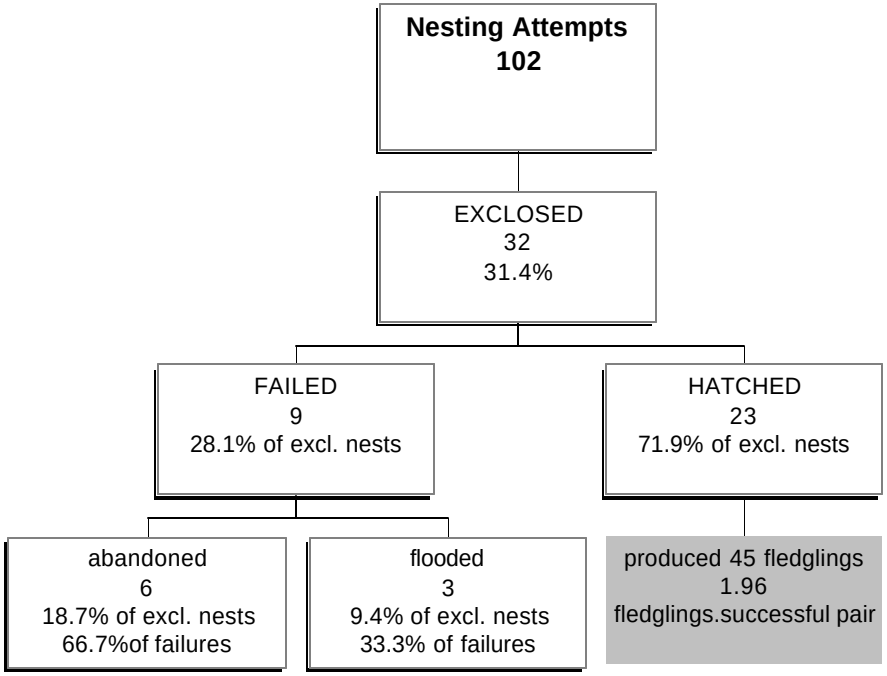
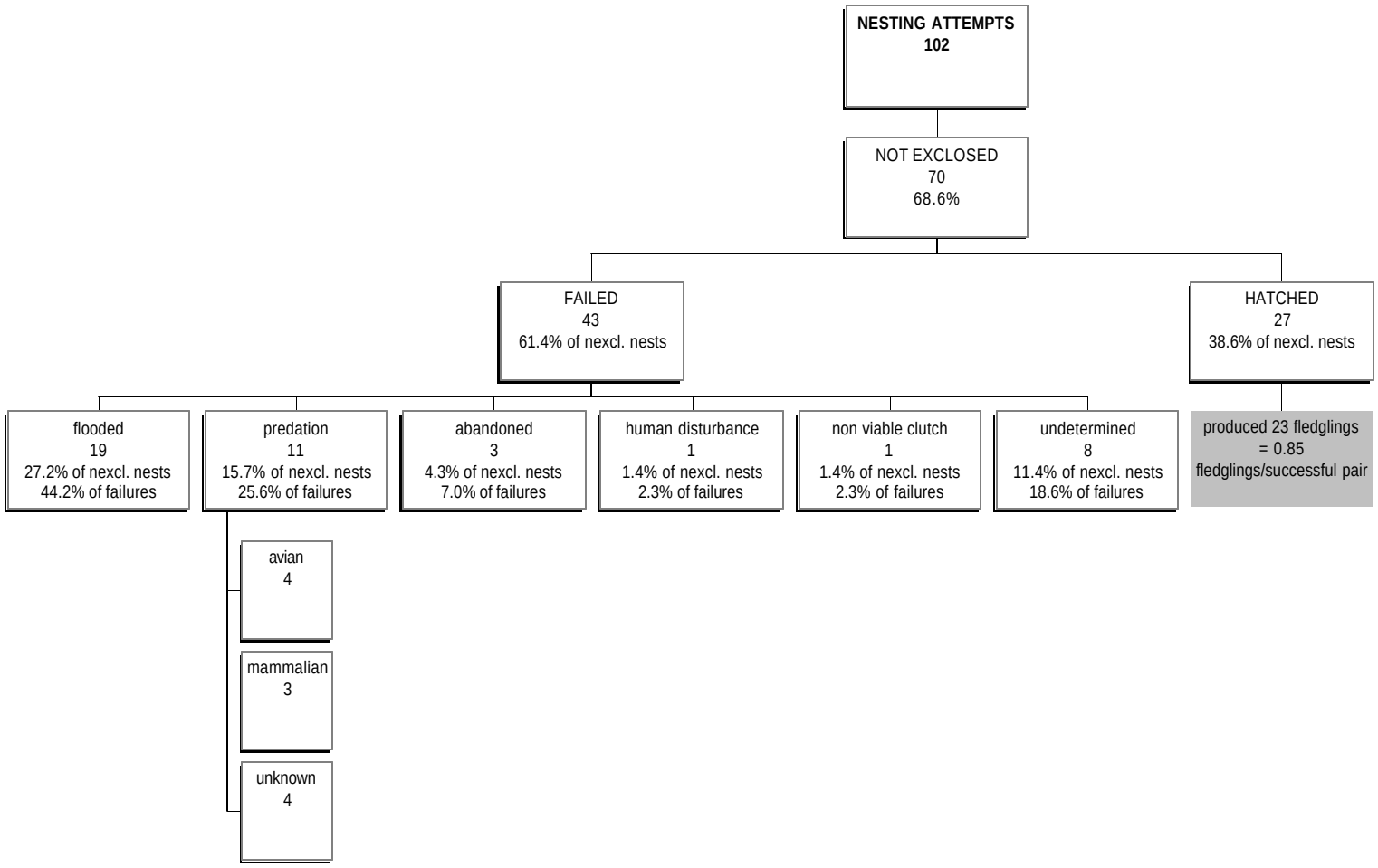


Figure 2b. Flow chart of piping plover non-exclosed nest fate at NJDFW sites: 2002.



Appendix A. Notes regarding individual abandoned piping plover nests.

Sandy Hook

North Beach: Abandoned on 5/20, 7 days after discovered with 1 egg. Storms and high winds believed to be cause of abandonment of this non-exclosed nest. The pair later renested and fledged 2 chicks.

Hidden Beach: Abandoned on 5/26, 4 days after the exclosure was put up. In that time period a park ranger observed children shaking the exclosure. Last seen incubating 5/24. In a separate incident, humans destroyed an exclosure at this site. It was pulled up and the exclosure legs were broken.

Sea Bright North: Abandoned on 5/11, 9 days after the exclosure was put up. On 5/11 a crow was observed perched on the exclosure and the nest was abandoned the following day. Nest was next to an access path that was closed, but there was evidence that people were still using it.

Little Beach: Abandoned on 6/26. Nest never exclosed, adults seen incubating full clutch 6 days prior. Turtle tracks near nest, but no other signs of predators or evidence for abandonment. Adults later renested but did not fledge any chicks.

North Brigantine Natural Area

Overwash: Abandoned on 4/30. Nest never exclosed since clutch was not complete at time of abandonment. Severe storm night of 4/28 probably responsible since 2 of the 3 eggs were displaced from nestbowl. No adults in the area but staff replaced the eggs in the nest anyway. On 5/6 the eggs were collected and a renest was discovered. That nest was predated, but on their third try the pair was able to fledge 2 chicks.

Abandoned 5/23, 17 days after the exclosure was put up. On 5/14 fox tracks were observed around the nest. Adult was still sitting on 5/20. On day nest was discovered abandoned a male was in courtship nearby. Notably, the next 2 abandonments listed were probably also abandoned on this same day (5/23) and were within 20 yards of one another. It is likely that the cause of this abandonment was also the cause of the following 2.

Abandoned on 5/23, 17 days after the exclosure was out up. On 5/20 adult was still sitting. On day nest was found abandoned,

North Brigantine Natural Area (Cont.)	scrapes were already located nearby. No predator tracks. Abandoned 5/23, 17 days after exclosure was put up. On 5/14 the electric was still working and fox tracks were seen nearby. On 5/20 an adult was still sitting. On the day of discovery, fox tracks were found between the electric fence and the exclosure. The adults were observed in courtship. Abandoned on 6/10, 27 days after the exclosure was put up and one day after the predicted hatch date. On 6/9 there were no adults near nest when first observed. There was a male in courtship and scrapes nearby. Shortly after an adult came and sat on the eggs. Human tracks that were not from the staff led right up to the nest. On 6/10 there was a hatch crack in 1 of the eggs, but no adults nearby. Instead, scrapes and courtship were witnessed in the area. The cause was most likely related to flooding around and up to the nest in the days prior to the abandonment. Abandoned on 7/11, 18 days after exclosure was put up. On 7/9 the electric fence was not working. No tracks of any kind were found but white wash from a bird was observed on the electric charger. In addition this nest was a renest of one of the pairs that was part of the triple abandonment on 5/23. This renest was located very close to the initial nest, so the cause of abandonment may have been related to the cause of the original abandonment.
Ocean City Center:	Abandoned on 6/15. The 1-egg nest was discovered on 6/10. However, no adults ever seen around it and egg was never in a maintained scrape but described as “always seen laying on top of sand”. This was a renest of a nest that was predated by fox. The pair was scraping after losing this nest but never laid a third clutch.
Cape May City:	Abandoned on 5/1. This renest (first nest predated) was never exclosed and birds never seen incubating the 3 eggs. The renest was approx. 10’ from original nest. The adults never displayed or called during staff nest checks. After 5/1 the adults were not seen in the area and there was no evidence for the cause of the abandonment (other than predation on the first nest).

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