2004 PLYMOUTH BEACH SUMMARY REPORT

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October 6, 2004

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Introduction:

Plymouth Long Beach (PLB) is a 3.2 mile long barrier beach extending in a general northwest heading beyond the mouth of the Eel River, in Plymouth, MA. Access to the beach is possible by means of Ryder Way, a 1.6 mile unpaved road that runs along the axis of PLB, and cuts through the dunes at only one point to allow off-road vehicles access to the front beach. Vehicle access to both Ryder Way and the front beach is rigorously controlled by Town of Plymouth staff in accordance with the beach management plan and the final order of conditions. Copies of the management plan and the final order of conditions can be obtained from Plymouth Town Hall.

Four species of coastal waterbirds attempted to breed on PLB in 2004. Piping Plovers (*Charadrius melodus, PIPL)* had a moderately successful year, with 16 breeding pairs fledging 22 chicks. Least Terns (*Sterna antillarum, LETE)* failed to hatch a single chick, while Common Terns (*Sterna hirundo, COTE)* deserted this traditional colony site before hatching could occur. Arctic Terns (*Sterna paradisaea, ARTE)* were the most successful nesting tern on PLB with 4 pairs of ARTE fledging 3 chicks. Further detail about the breeding attempts of these birds, and the habitat they bred in, is presented in the next several pages of the report.

Habitats Used By Breeding Shorebirds on Plymouth Beach

To the east, or seaward side, PLB is bordered by Warren Cove, a small bay within Cape Cod Bay. To the west and landward side, the beach is bordered by Plymouth Harbor and the mouth of the Eel River. The harbor side of the beach contains mostly rock and cobble shoreline, several small areas of saltmarsh (dominated by *Spartina alterniflora*), and, at low tide, extensive rocky, sandy, and muddy tidal flats. Habitat on the ocean side is composed of sandy beach and extensive intertidal sand flats.

Geographically, PLB is divided into sections by several obvious markers (see Appendix A). Moving north from Manters Point, traveling on the harborside of Plymouth Beach, one sees fairly consistent habitat until reaching the end of Ryder Way, the first reference point on the beach. The next landmark is near the northern terminus of the beach where the Day Marker (a jetty with a navigational marker) demarks a strong transition from harbor waters. The next geographical marker is the 790 line, which is to the east and south of the day marker. The beach between the day marker and the 790 line is the transition from the short harbor beach to the extensive sandy beach bordering Warren's Cove. Moving south on the ocean side, the next geographical divider is a prominent sand retention marker known as the adjustable groin. Finally, the southern extent of breeding bird habitat on PLB is the vehicle crossover, which is present at the northern terminus of a rock dike that prohibits coastal waterbird (CWB) breeding. See appendix A for a map of these various sections of beach.

Nesting habitat used by coastal waterbirds on PLB is dispersed throughout the beach. Roughly speaking, the habitats used by CWB can be subdivided into four main types:

1.) **Cobble and granite washover areas:**

These are areas of rough rock and cobble that run perpendicular to the axis of the beach and stretch from the reconstructed dike to the high tide line of the bay side. They are devoid of significant vegetation, and form distinct breaks in the dune structure of the inner beach. This habitat is only present on the southernmost mile of the beach.

2.) **Sand Dune/Beach Border**:

This habitat is present where a frontal dune slopes gently and merges with open sandy beach. It is defined as stretching from the high tide line to a line approximately 15 feet from the vegetated dune edge. This habitat is present throughout the northernmost 1.3 miles of Plymouth Beach, extending north from the crossover on Warren Cove, around the point, and several hundred yards into Plymouth Harbor shoreline.

3.) **Dune Blowouts**

These are isolated areas imbedded within the dune structure of the beach where erosive processes have created unvegetated, sandy/gravel depressions. It is characteristic for this habitat to be located no less than 20 and as many as 200 m from the nearest salt water. This habitat is only present in the extensive dune system north of the crossover.

4.) **Vegetated Dune**

This habitat includes all areas of sandy dune covered mostly by American beachgrass (*Ammophilia breviligulata*). Grass density and height varies greatly depending on the specific area in question. Although this habitat is present on the beach from Manter's Point to the northern terminus of the beach, it is only used by nesting coastal waterbirds in the northernmost quarter mile of the beach.

Habitat types 1-4 were all used to varying degrees by 4 species of nesting coastal waterbirds. Below follows a detailed summary of the breeding attempts of the Piping Plover, Least Tern, Common Tern, and Arctic Tern on PLB in 2004.

Piping Plover Breeding Success

Nesting Piping Plovers were monitored daily throughout the breeding season by a combination of Town of Plymouth beach staff and a Massachusetts Audubon Society intern. Early in the season, all potential nesting habitat was searched for adult pairs of Piping Plovers, and likely areas were thoroughly searched for new nests. Throughout the nesting season, every known pair of PIPL was checked daily as the first priority in the morning. Once vehicle access to any part of the front beach was allowed, PIPL nests were checked before any vehicles were allowed onto the beach (by 9 am). On daily nest checks, all nests with eggs were inspected for freshness of scrape, presence or absence of adult plovers, and presence and condition of all eggs. PIPL nests with chicks were checked daily for all plover chicks (number noted daily) and for presence of active adults. Active clutches of chicks near popular spots on the beach were often watched for longer periods of time to determine their feeding schedule and daily movements. Additional spot checks were conducted through the day on nests of interest (near hatching date, high tides, possible abandonments, etc) to ascertain their precise status.

At the end of the season, the daily plover data was tabulated to determine potential trends and to calculate productivity of the whole population through the season. One such table detailing the fate of each PIPL breeding attempt can be found in Appendix B. From a table such as that in Appendix B subsets of data could be studied and analyzed. The results of such analyses are presented below.

In the summer of 2004, sixteen adult pairs of PIPL fledged 22 juveniles in 23 total nesting attempts. Thus 1.375 chicks were fledged per pair of adult plovers, which exceeds the number of fledges needed to support a sustainable population. Of nests that were exclosed, 23 chicks were fledged from 18 nesting attempts; however, 5 unexclosed nests were predated and

yielded no chicks. Early in the season, many Piping Plover nests were left unprotected in the hope that Red Foxes would not be able to key in on exclosures (as they had in previous years), reducing predation on and harassment of adult plovers. However, by May 11, 2004, it was clear that all unexclosed nests would be predated before hatching.

Due to the statistical difficulties presented by the complete failure of unexclosed nests, from this point in the report onward, the statistical analysis of breeding success will include only those nests that were exclosed. For the time being, it is assumed that in the future all nests will be exclosed as soon as possible, and as a result it is assumed that data from unexclosed nests will be irrelevant to future management efforts on PLB. Specific data on all plover nesting attempts can be found in Appendix B. Charts broadly displaying the success of PIPL breeding through the summer can be found in Appendix C.

Breeding Success by Habitat Used and Region of Beach

For each PIPL nesting attempt found on PLB in the summer of 2004, a precise location and description of habitat was recorded. Location on the beach was noted based on the beach's existing dune signage. On PLB, there is a line of short telephone poles in the middle of the frontal dune, from the Crossover to the 790 line. These poles have been numbered by the beach staff, and are a basis for comparing breeding attempts of PIPL from year to year. Additionally, recording the location and habitat type of each nest allows for comparison of breeding success in different regions and habitats.

Piping Plover breeding was restricted to habitat types 2 and 3. Thus, the distribution of plovers on PLB closely followed the distribution of these habitat types. In comparing the breeding success of dune nesting plovers (habitat 3) versus beach front nesting plovers (habitat 2), little differential breeding success can be noted. Dune plovers were more likely to hatch their eggs (approximately 2.5 chicks/attempt) than beach front plovers (approximately 1.8), but both dune and beach plovers were nearly equally likely to fledge chicks (dune= 1.25 chicks fledged per attempt, beach front= 1.20).

A regional analysis of plover nesting attempts showed some interesting trends as well. Plovers nesting between the adjustable groin and the 790 line yielded 1.86 fledglings per nesting attempt (not per pair), while no other section of beach fledged more than 1.25 chicks/attempt. Also, birds nesting in the groin-790 line zone hatched 3.14 chicks for every nesting attempt, while the average number of chicks hatched in the other 3 zones was only 1.44. The complete data set and calculations that are responsible for these values can be found in Appendix C. It is also worth noting that of the 22 chicks fledged on Plymouth Beach, 13 were produced from nests in the zone from the adjustable groin to the 790 line, and of the 38 chicks hatched on Plymouth Beach, 22 came from this most productive section of the beach (for a graphical representation of this data, please see Figures 1-3 in Appendix C).

For the differences in habitat productivity, the most intriguing trend is the difference between chicks hatched in the two habitats (2.5 to 1.8) and also the *lack* of difference between the number of chicks fledged from nests in the two habitats. It is possible that beach front plovers are less likely to hatch out of the egg due to disturbance while incubating (more people). It is also possible that dune plovers are less likely to fledge their larger number of hatched chicks due to the problems associated with moving the chicks out of the dunes, and the predation risks therein. Research over several years of breeding would be needed to see if there is a real trend in the differences that can be associated with breeding habitat. Differential breeding success between the four regions of the beach is even less clear. Perhaps most importantly, the distances of the 4 zones would need to be calculated to calibrate breeding success as a product of distance

or density. Further analysis of the trends in regional breeding success across a span of several years is needed to lend credibility to the differences noted above, and to perhaps arrive at a causation for any noted differences.

Breeding Success vs. Date of Clutch Completion

In the summer of 2004, Piping Plover breeding success on PLB showed remarkable correlation with date of clutch completion. This correlation was uncovered by comparing the number of PIPL chicks hatched and fledged to the date of their clutch completion. The dates of clutch completion for PIPL nests were grouped into 4 intervals: May 1-10, May 11-20, May 21-31, and June 1 onward, and the mean hatching and fledging rates for all clutches completed within a given range of dates were calculated.

As can be seen in figure 4 in Appendix C, the hatching and fledging productivity of PIPL nesting attempts decreased linearly with each 10 day period in the nesting season. Very high rates of hatching and fledging are observed for nests completed in early May (exclosed nests only are included in this analysis), while extremely low hatching and fledging rates are observed later in the season (0 chicks fledged from nests completed after June 1).

Qualitatively, it was noted that as the breeding season wore on into late June and early July, adult PIPL put less energy into nest defense and other parental duties. Early nests were defended with vigor through mid June. Adults were strident and anxious when their nests were approached for daily nest checks. By July 15, broken wing displays by parent plovers were rarely recorded, and general nest protection was minimal. This increase in plover disinterest may have been related to the fact that by August 9th only 5 PIPL were recorded on PLB (similar numbers continued through Aug. 15). This qualitative data suggests that the decline in productivity through the breeding season is due to a policy of migration-related disinterest adopted by adult PIPL late in the breeding season. More research across a span of many years is required to even verify that this decrease in breeding success rates does exist, and furthermore to examine the cause of that decrease.

It is also worth noting that habitat use by nesting PIPL changed dramatically as the nesting season progressed. All nests in early May were on beachfront habitat, but by June 5, the majority of active egg clutches was in dune habitat (see Appendix C, figure 5). It does appear that beachfront habitat was preferred by PIPL, and furthermore that dune nesting was mostly an alternate strategy. Nonetheless, plovers experienced higher rates of breeding success in the dunes than on the beach (figure 3) despite losing 11 of 11 eggs laid after May 31. The patterns of dune/beachfront nesting would need to be watched by future beach management officials to determine any significant trends or causation

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Predation and Abandonment

A total of 86 eggs were laid on PLB by PIPL in the summer of 2004. From those eggs, 40 PIPL chicks were hatched, and 22 of those chicks were fledged. Including the failed, unexclosed nesting attempts, there were 23 total predation events and abandonments on PLB which resulted in the loss of 64 eggs and chicks. Of the 64 plover embryos that did not fledge, 36 (57%) failed to do so as a result of Red Fox predation or a related abandonment. Factoring out the unexclosed nests that were predated early in the season, 15 of 48 PIPL embryo failures were due to Red Fox activity (31.3% of exclosed embryo failure). Additionally, the remains of a single adult plover were found outside of PIPL nest #17 on 6/8/2004, the presence of fox tracks around the exclosure at that time suggests that this bird's mortality was a result of predatory Red Fox behavior. Fox tracks were routinely noted up to many exclosures on daily surveys, and in many

cases (see Appendix B) the daily presence of these fox tracks was sited as evidence for a fox-related abandonment.

Birds (crows and gulls) were likely responsible for 2 predation events costing 6 plover embryos (9.4% of all lost PIPL embryos). Tidal washovers were responsible for 7 plover embryo failures (10.9%), and unknown or unclear reasons are cited for 14 unfledged plover deaths.

Predation of PIPL eggs by Red Fox was a major problem for PIPL before nests were exclosed. After being exclosed, no PIPL eggs were predated, although several abandonments did occur. Of exclosed eggs (70 total), 40 survived to hatching. Of the 30 exclosed unhatched eggs, 19 were abandoned, 3 were left behind in the scrape, and 6 were washed into the ocean. 2 did not hatch for unknown reasons. Of 19 eggs abandoned in 5 nests, the loss of 15 eggs in 4 nests was attributed to fox harassment. Of 40 hatched plover chicks, 22 fledged while 18 did not survive. Of those 18, 6 were killed by predatory birds, 5 were killed by Red Fox, 5 were lost to unknown causes, and 1 each was lost to high tides and plover territorial activity.

Least Tern Breeding Success

LETE nesting attempts were surveyed by the Massachusetts Audubon Society intern and the Town of Plymouth Natural Resource Officers, or their appointed technicians. Counts were generally conducted every other day of the breeding season, and were actual egg counts. For each day, every nest was noted, as was its location, and the number of eggs present in the nest. This complete data set is in the possession of David Gould, who may be contacted through the Plymouth Town Hall. A broad summary of LETE nesting attempts is noted below, and further data can be found in appendix C, figures 11-13.

Least Tern productivity on PLB in the summer of 2004 may have been the lowest for this beach since records were first kept. Early breeding season adult counts of ~70 adult LETE suggested that at least 30 pairs of LETE would nest on Plymouth Beach. However, in the course of the season, no more than 15 nests were ever recorded on PLB; heavy fox predation prevented even 50% of LETE from actually putting eggs down on the beach. At the end of the season (the last LETE egg was seen on July 11), no LETE had hatched on PLB, and none would fledge. Overall productivity of LETE on PLB was 0 chicks produced by an estimate of 30 pairs of adult LETE. (this number decreased through the summer). No more than 5 LETE could be found on PLB on any given day.

An interesting pattern is apparent when one compares the breeding data for LETE on PLB with the data for LETE at Ellisville Harbor, in South Plymouth. On June 18-19, 2004, a major predation event occurred in which LETE nests were reduced to just a few from 13. On June 24, 2004, the number of LETE nests at Ellisville Harbor went from just 1 (on June 9, 2004) to 13. Later in the summer, a second large predation event dropped the number of active LETE nests from 15 on July 6 to 0 on July 12. In that same period, the number of active nests at Ellisville Harbor jumped from 16 on July 6th to 28 on July 11th. By July 20, 32 pairs of LETE were actively nesting at Ellisville Harbor. Simple addition and subtraction vaguely suggests that the PLB LETE may have moved to Ellisville Harbor. However, without the aid of banding studies this suggestion is merely speculation and cannot be confirmed.

Back on PLB, LETE nested in 4 habitat types. Primarily, they used front beach habitat (type #2) where most nests were found on open sand or on mixed sand/cobble sections of shoreline, within view of the water. Additionally, many LETE used habitat type 3 later in the

season, nesting in sandy and cobbled blowouts, often out of sight of water. Most of the nests for habitats 2 and 3 were between the crossover and the 790 line. Several pairs of LETE attempted to nest on limited beach north of the 790 line, and one pair attempted to nest in the defunct Common Tern colony (habitat 4). Finally, a small colony (up to 10 pairs) of LETE attempted to nest in habitat type 1, south of the crossover. This colony was pared down to 2-3 pairs by the third week of June, and 1 pair continued territorial behavior in this area until the end of the nesting season. None of these areas hatched LETE chicks, and fledging productivity for each was 0.

In the past several summers, predation of LETE nests by predators like foxes, skunks, and gulls has been a major problem for this species on PLB. Based on the tracks that can often be found leading up to LETE nests, it is estimated that a minimum of 90% of all LETE nest predation events can be directly attributed to Red Fox activity. Striped Skunks and tide were the two other main causes of LETE nest failure. Through the breeding season, patterns of LETE predation are evident, in that periods of maximum LETE nest abundance generally precede or coincide with periods of heavy predation. In a lull period from June 18 to July 6, no LETE predation was recorded and nesting totals maxed out at 15 nests (June 30) and 20 total eggs (July 6). However, on July 9, 11 predated LETE nests were noted, and by July 12 there were no nesting pairs of LETE on PLB. This pattern of heavy overnight predation of tern colonies is consistent with that of mammalian, *Canid* predators. A partial summary of the LETE breeding season on PLB can be found in Appendix C, figures 11, 12, and 13.

Arctic Tern Breeding Success

Arctic Tern (ARTE) nests on PLB in 2004 were surveyed nearly daily, depending on weather and other factors. The ARTE nests were spread out in separate dune blowouts (all in habitat type 3), and were checked in conjunction with daily PIPL monitoring efforts. Historically, Arctic Terns have nested on PLB in association with a colony of Common Terns (COTE). This summer, the COTE colony disappeared by June 1, and the only "medium-sized" terns on Plymouth Beach after that date were 8 Arctic Terns. By June 16, 4 pairs of Arctic Terns were nesting on PLB. 2 pairs were successful, fledging, in total, 3 juvenile ARTE. This fledging of 3 chicks was the highest productivity for ARTE at any one site in Massachusetts in 2004. All 3 fledged chicks appeared extremely fat and healthy at fledging, and were seen catching fish for themselves in mid-August.

On PLB in 2004, each ARTE nest was defended exclusively by the individual pair of birds on the nearest nest, and colonial defense of nesting areas was not noted until other nests had failed in mid to late July. It is likely that the lack of other colonial nesting waterbirds on PLB in 2004 increased the stress load on parent ARTE and may have diminished their success in breeding. Additionally, the presence of Red Fox was another stress factor on adult ARTE nesting on the beach. Of the 8 eggs laid on PLB by ARTE in 2004, 3 were healthily fledged, 2 were eaten by a Red Fox as eggs, 1 was eaten by a Red Fox as a chick, 1 did not hatch due to parental stress, and 1 did not hatch for unknown reasons. For complete nest summaries, see Appendix C, figure 14, and for more information on management efforts with ARTE and COTE on PLB see the note below.

Common Tern Breeding Success

PLB hosts a historical colony of COTE dating back to the middle of the 20th century. At its peak it held over 5,000 pairs of breeding COTE. In other years it was completely deserted. In 2003, several hundred pairs of COTE returned to PLB, but had no breeding success (due to Red

Fox and gull predation). It was hoped that a similar number of COTE would return in 2004 and be helped along by beach management efforts. About 40 adult COTE returned to PLB in late May, and by May 25 were laying eggs in Habitat Type 4, at the tip of PLB. However, around May 28, 2004, the colony disappeared overnight. After that point, Common Terns were rarely sighted on Plymouth Beach until mid-July, when colonies in other parts of the state started dissipating. As a result, a maximum of 20 pairs of COTE considered nesting on PLB, and 5 pairs actually initiated nesting attempts (egg laying) before all abandoned their nests before June 1. No later nesting attempts were recorded, although several pairs of COTE were seen in the historical COTE colony area in late June.

Notes on the Management of COTE, ROST, and ARTE Colony on Plymouth Beach

In the summer of 2003, the town of Plymouth purchased and installed electric fencing in an attempt to combat a Red Fox predation problem. In 2003, fencing was used over very small areas (200-300 m circumference circles) of open dune to protect nesting LETE. This effort saw little success in 2003, for while unhatched eggs were well protected by the charged fence, young LETE left the exclosed area and were predated.

In 2004, it was hoped that electrical fencing could be used to protect nesting COTE on PLB. Prior to the arrival of COTE in 2004, the historical nesting area for COTE was fenced off using this electric fence. The absence of fox tracks in the exclosed area suggested that Red Fox were not entering the fenced area. This fencing allowed for 20 pairs of COTE to return to PLB in late May and commence nesting activities (courtship, egg-laying). However, by June 1, with no recorded predation events, all COTE left PLB and abandoned several active nests. Throughout this time period, no Red Fox tracks were noted in the electrically fenced area. COTE nests in this area remained intact until at least June 20, when blowing sand began to obscure them.

On June 6, 2004, the battery pack used to power the COTE colony electric fence was shifted to a new set of fence panels erected around an ARTE nest in an unvegetated dune blow out. By June 16, 2004, there were 5 separate electrical fencing areas on PLB. Four of these areas were made with only one electrical fence section, and were therefore only 200 ft in circumference. The fifth area was the historical COTE colony, where the circumference of the electric fence was at least 800ft. Only one of these areas was powered with electricity, but predation of ARTE nests did not occur in areas that were exclosed with any type of electric fencing (with or without charge). In fact, one ARTE nest that was exclosed by uncharged electric fencing survived for over 40 days, while LETE nests just outside of the fenced area were predated 3 times in that 40 day period. When the electric fencing was removed on July 26 (the eggs, at 40 days old, 18 days past the average incubation period of ARTE, were deemed unviable), the nest was depredated within 24 hours. In only one case in 2004 did a *Canid* go over any sort of electric fencing to depredate a bird nest. In this case, in mid-July, a Red Fox jumped over the electric fence in the historical COTE colony area to depredate a LETE nest.

Electric fencing is a great resource for the management of Plymouth Beach, where *Canid* predation has been a major limiting factor for PIPL, LETE, and COTE breeding success. Significant effort should be devoted in 2005 for the preparation and maintenance of electric fencing on PLB. Depending on which species of tern return to the beach, efforts should be made to place electric fencing in sensitive areas before nesting birds arrive. LETE would greatly benefit from having an area of front beach protected from foraging *Canids*. PLB has the ability to sustain a fairly large breeding population of LETE, as it has in the past (well over 100 pairs);

however, success of a LETE colony on PLB would require either intensive electric fencing of nesting areas or equally intensive predator removal. That being said, the reward in terms of potential LETE success could be great.

Currently, the COTE colony on PLB is defunct. Given the transitory nature of COTE colonies in Massachusetts Bay, it would not be unlikely for COTE to recolonize the habitat on PLB at some later date. Some effort could be made to encourage COTE to return to PLB by using decoys and broadcasting calls. Upon returning to PLB, Common Terns would likely benefit from having a more extensive region of the tip of the beach exclosed from fox activity, as fox harassment could discourage nesting terns. Thus, increased effort towards fencing in the tip of the beach would likely be necessary in reestablishing the COTE colony on PLB. Furthermore, an established COTE colony of over 100 pairs would likely attract many predatory land mammals to the tip of the beach, and active predator removal may be required for the establishment of a successful, active COTE colony.

Maintenance of the PLB COTE (and LETE) colony will be, from this point forth, an active and intensive management task. The location of the colony on a peninsula allows mammals to gain easy access to the colony from mainland Plymouth, and if the colony ever does attain a healthy size (>100 pairs) it will be a magnet for these predators. Active management of mammal populations on the beach through exclosure and predator removal would be required, in the months prior to and even during the summer months. Additionally, as noted by Steve Liptay in his 2003 summer report on PLB, gull predation could be a major problem at this site, which occasionally hosts evening roosts of over 1000 individual gulls. A situation similar to one that played out on Crane's Beach, in Ipswich, MA, this summer could be a major problem for beach managers. That site invested several thousand dollars into an electric fencing initiative, and had tremendous success protecting LETE and PIPL from coyotes. However, this past summer (2004)bird predation there became a major problem (especially for nesting LETE) and breeding success for that species was minimal.

The presence of a tern colony on PLB in future years is far from a certain thing, and will most certainly require intensive efforts in tern attraction and predator deterrence in the earliest phases. Those with interests involved in Plymouth Beach, as well as COTE and ROST populations as a whole, should meet to discuss the management of this once significant tern colony. The long-term prospects of COTE breeding success on PLB should be discussed, and the allotment of money and resources to protecting this colony should be scrutinized. Maintenance of a large tern colony on PLB should be part of a statewide strategic plan for state nesting coastal waterbirds, and not an automatic response to the disappearance of a once productive site. Long-term costs of predator maintenance should be weighed against the costs of other options for nesting COTE in Massachusetts Bay, before reintroduction and protection are attempted.

General Notes on PLB Management Plan

In 2004, the PLB management plan was in full effect for the first time. This management plan puts strong restrictions on vehicle access on Plymouth Beach, and regulates a few other recreational activities including dog walking and kite flying. The management plan also stipulates that certain staffing minimums be met at all times that the beach is open to the public and vehicle traffic.

To the great credit of all of the beach staff, beach supervisors, and even recreational beach users, the management plan was carried out very successfully during the summer of 2004. The combined efforts of natural resource officers, natural resource technicians, and natural resource assistant technicians allowed for all breeding coastal waterbirds to be thoroughly monitored and duly protected from human and non-human interference. Especially impressive was the work undertaken by several members of the Town of Plymouth Beach Staff to make contact with and educate all people using PLB—not just those people breaking the regulations of the management plan.

Before PLB was opened to vehicle traffic, the town beach staff worked to measure out and erect a specified travel corridor above the mean high tide line from the crossover to the 790 line. They also worked through the summer to adjust and maintain symbolic fencing demarking plover and tern nesting habitat, and to erect and maintain PIPL nesting exclosures. Nesting exclosures were made with predator wings which were used to prevent foxes from circling and harassing plovers in exclosures. As is noted above, early season nests were not exclosed in the hope that foxes would not be able to find the unexclosed nests; however, after May 11 (when many nests were found depredated), all nests were exclosed as soon as possible by beach staff. On a daily basis, beach technicians or Natural Resource Officers worked with the MAS intern to collect data on PIPL, ARTE, and LETE nesting attempts. Town beach staff was also responsible for erecting and maintaining electrical fencing through the summer.

Once the beach was opened to vehicle traffic, town beach staff were responsible for ensuring the appropriate use of the beach by vehicles. Staff was responsible for greeting vehicle drivers as they came on the beach (and checking them in), and checking them out when they left. This arrangement allowed for beach staff to take a moment and inform beach users about the regulations on the beach and any temporary vehicle restrictions for that day. For much of the summer, beach staff was responsible for ascertaining the position and enforcing the location of the vehicle restriction. This restriction moved with the movements of unfledged plover chicks, and kept vehicles several hundred yards from where unfledged plover chicks would be in danger of passing cars.

Throughout the season, the beach staff were responsible for patrolling the length of the beach, working along the way to educate people on the beach about nesting activities and management plan policies. Additionally, patrols would work to enforce the regulations of the management plan by confronting violators. Most frequently, this duty meant enforcing the Plymouth Leash Laws, which for the second year in a row were the most frequent violation of the PLB management plan.

Recommendations

Two main problems plagued the management of PLB in 2004, both were related to canids. Dog walkers who refused to keep their dogs on the leash were one part of the problem, and Red Fox predation and harassment of PIPL, LETE, COTE, and ARTE was another problem. Potential solutions to both problems do exist.

Due to the large size of the beach and the refusal of many dog walkers to obey the authority of beach staff, enforcement of leash laws was an ongoing and frustrating problem throughout the summer of 2004. In the future, aggressive enforcement of this law by NRO's (who have the authority to ticket violators) may be able to curtail unleashed dog use on PLB. In many cases, simply requesting that dogs be kept on a leash will suffice. Yet a minority of leash law offenders are repeat offenders, and their persistent refusal to keep their dogs on leash takes up the resources of the beach staff. A possible solution to this problem would be to have escalating consequences of violation. The first violation would warrant a warning, the second a ticket, and the third a revoking of beach sticker rights for the season. This solution would not only give the beach staff more authority and leverage over problem cases, but would also lessen the strain on beach staffing caused by dog violators.

The second canine problem was related to the Red Fox that hunted and lived on PLB. Based on the data from the PIPL and LETE breeding attempts, Red Foxes were a major problem for coastal waterbirds nesting on PLB. Electric fencing could be used in important front beach habitats early in the season to encourage nesting in that area, and prevent or reduce harassment of nesting PIPL by Red Foxes. By protecting a very large swath of potential PIPL habitat, beach staff would also be protecting a large amount of LETE habitat that could yield some positive results with that species as well. A more controversial approach would involve getting the necessary permits and physically reducing the Red Fox presence on PLB. Either approach would likely increase the breeding success of both PIPL and LETE on PLB.

Educational Opportunities

The educational opportunities on PLB are at once expansive and limited. It is felt by both the Town of Plymouth and The Massachusetts Audubon Society that it is important for there to be educational opportunities on PLB. The natural and human histories of the beach offer a deep well of fascinating information upon which educational programs could draw. In all four seasons, PLB offers the potential for programs on the current natural history of the beach, and the many historical uses of Plymouth Long Beach and the land surrounding it.

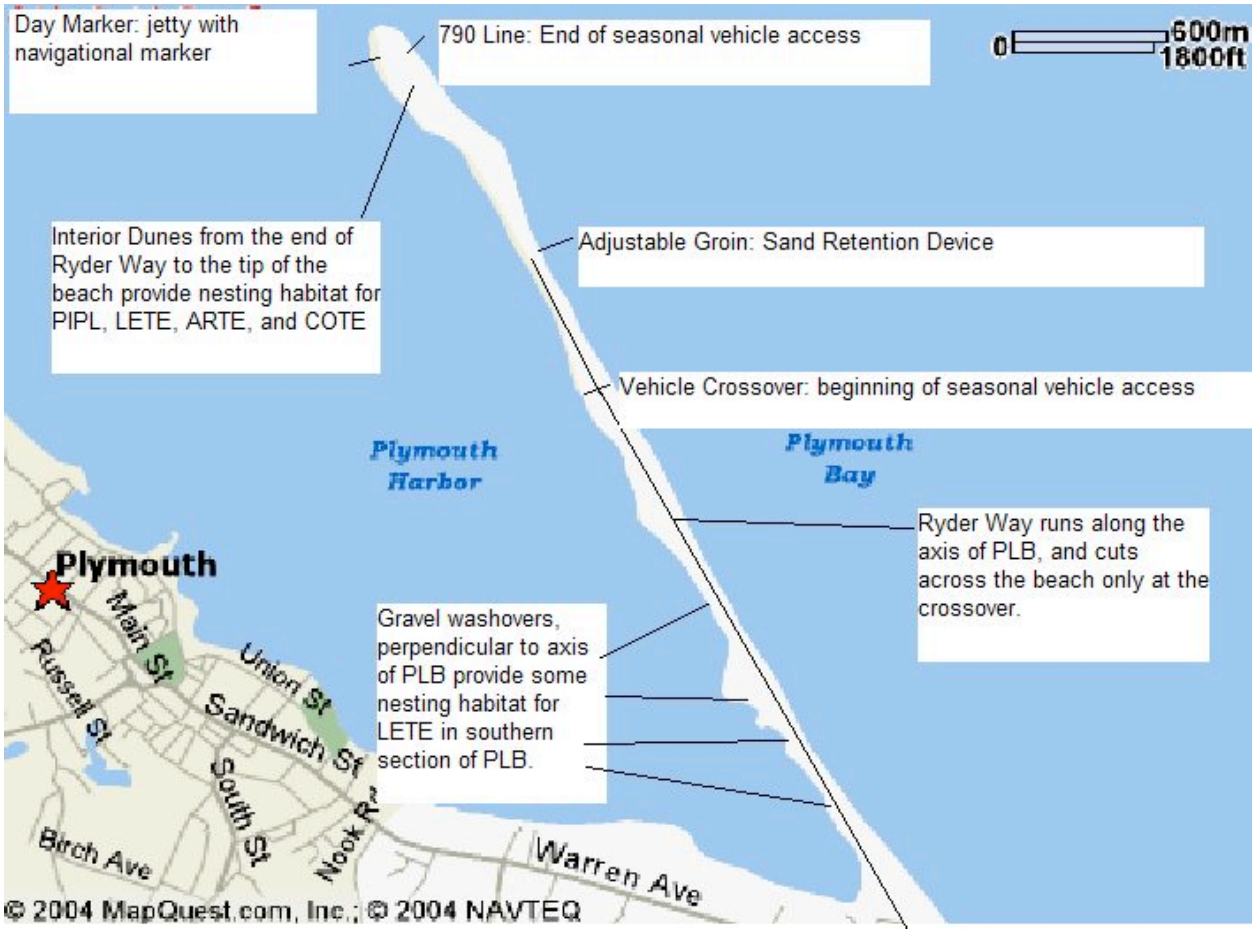
Currently, educational opportunities on PLB are somewhat limited by access problems. In the summer months, day time access (9am-5pm) to Plymouth Beach is allowed only with a Plymouth Beach sticker or a $10-15 per car admission charge. These restrictions restrict potential participants from partaking in even free nature programs. Additionally, at high tides, walking access to the beach is only possible by means of the stone revetment on the east side of the beach, or by walking along the beach road (which can be quite narrow and busy in summer).

Despite these access restrictions, many programs could still be run from PLB in both the summer months and in other seasons as well. In the summer, evening programs that run after the 5 pm end of charged admission allow for an unrestricted participant pool. Additionally, these programs present PLB in a quieter evening time of day, when the beach is at its most beautiful. Early morning walks are possible, provided that they end before 9 am. These walks would be best conducted at low tide, or using some sort of transportation to allow access to the furthest stretches of PLB, where vehicle traffic is reduced.

Finally, working within the beach access restrictions, it is possible for programs to be run with those people who are already at the beach. Walks could be conducted from both the crossover and the main beach parking lot at Manter's Point. These programs are especially appealing because they present the opportunity of educating those people who are using PLB on a daily, recreational basis. Such summer programs could be run by MAS interns in the summer, or by town staff if such programs were granted priority and funding. Additional programs could

be run throughout the year, with even fewer restrictions (no admission fee and less beach traffic). Whatever the situation, it is important that educational programs be attempted at PLB to educate citizens about the beach's ecological and historical importance. Education, in concert with other management strategies, is the best way to ensure the preservation of this natural gem.

Appendix A: Schematic Diagram of PLB



Appendix B: Summary of all 23 Piping Plover nesting attempts on PLB

Nest #	Date Found	# eggs when found	exclosed? when?	Date Clutch Complete	Final # of Eggs	Date Hatched	# Chicks	Date Fledged	# fledged
1	5/3/2004	4	no	unknown	4	n/a[i]			
2	5/5/2004	3	Yes, 5/12	5/7	4	6/4/2004	4	~7/12	2[ii]
3	5/5/2004	4	no	unknown	4	n/a[iii]			
4	5/5/2004	2	no	n/a	3[iv]				
5	5/5/2004	1	yes, 5/11	5/10	4	6/7/2004	3	~7/13	2[v]
6	5/5/2004	4	no	unknown	4	n/a[vi]			
7	5/6/2004	1	yes, 5/11	5/12	4	n/a[vii]			
8	5/5/2004	1	yes, 5/12	5/13	4	6/11/2004	2[viii]	~7/13	2
9	5/6/2004	4	yes 5/10	unknown	4	6/2/2004	3[ix]	6/29	3
10	5/7/2004	1	no	n/a[x]	1				
11	5/11/2004	1	yes, 5/11	5/17	4	6/15/2004	4	~7/19	3[xi]
12	5/12/2004	1	yes, 5/12	5/18	3	6/13/2004	3	7/18	2[xii]
13	5/17/2004	3	yes, 5/19	5/19	4	6/13/2004	3	~7/18	1[xiii]
14	5/17/2004	4	yes, 5/18	unknown	4	6/16/2004	4	~7/21	4
15	5/17/2004	1	yes, 5/19	5/23	4	n/a[xiv]			
16	5/19/2004	1	yes ?	5/24/2004	4	n/a[xv]			
17	5/20/2004	2	yes, 5/21	5/24/2004	4	n/a[xvi]			
18	5/20/2004	2	yes, 5/20	5/23/2004	4	6/24/2004	4	7/25	3[xvii]
19	5/20/2004	1	yes, 5/21	5/24/2004	4	6/24/2004	4	n/a[xviii]	
20	5/31/2004	1	yes, 6/4	6/4/2004	3	n/a[xix]			
21	6/12/2004	1	yes, 6/12	6/18/2004	4	7/14/2004	4	n/a[xx]	
22	6/12/2004	3	yes, 6/12	6/14/2004	4	n/a[xxi]			
23	6/16/2004	3	yes, 6/17	6/17/2004	4	7/11/2004	2	n/a[xxii]	

[i] Nest found on 5/4/2004, not refound on 5/10/2004 (last checked 5/7/2004). Fox tracks seen up to the scrape
[ii] 2 chicks lost to unknown causes: 6/8/2004 and 6/11/2004. Fox tracks in the area, but no evidence of predation
[iii] Nest not refound on 5/10/2004, last visited 5/7/2004. No cause sited for depredation.
[iv] Nest not refound on 5/10/2004 when fox tracks were noted in the area. Last previous visit had been 5/7/2004.
[v] 1 chick lost in territorial battle with adults from nest 22. See further notes on plovers for more information.
[vi] Nest not refound on 5/10/2004, last previous visit was 5/7/2004. Fox tracks noted in the area.
[vii] Abandoned on 6/4/2004. Fox tracks had been noted around the exclosure daily since it was exclosed on 5/11/2004
[viii] On the night of 6/3/2004, the nest was washed by a high tide, scattering 3 eggs and claiming the fourth. Three eggs were recovered into the nest and incubated on 6/4. The exclosure was refit to this new nest on 6/5/2004
[ix] 3 chicks hatched on the night of a high tide, their nest was washed and it is unclear whether the 4th chick hatched or would have had it not been washed in the night tide
[x] nest not refound on 5/10/2004, previous visit to site was 5/7/2004.
[xi] 1 chick lost, last seen July 4. No sign of predation but fox tracks had been in the area. Also high tides and holiday
[xii] 1 chick disappeared, last seen on 6/21/2004. No evidence present on beach as to cause.
[xiii] 2 chicks eaten by smart crow on 6/13/2004.
[xiv] Nest abandoned around 5/30/2004, fox tracks recorded daily up to and around the exclosure
[xv] nest washed out at high tide on night of 6/2/2004
[xvi] nest abandoned on 6/8/2004. Fox tracks present in the area throughout the period.
[xvii] 1 chick lost on day of hatching (6/24/2004), fox tracks were recorded throughout the area.
[xviii] 1 chick found dead inside of exclosure, no visible wounds. 2 chicks never seen again, 1 other chick was present on the harbor side of the beach until 7/1/2004 when it was lost on a night of very high tides.
[xix] Nest abandoned on 7/2/2004. Fox tracks seen daily near the nest during incubation.
[xx] Chicks disappeared 7/19, 7/21, 7/22, and 7/26. Gulls were a problem. No direct evidence of predation.
[xxi] Abandoned by 7/11/2004. No evidence of cause noted.
[xxii] 2 chicks hatched on 7/11/2004, but were never found. A mix of plover and fox tracks were present in the area. 2 other eggs were incubated until 7/15 when nest was abandoned.

Appendix C: Graphs and Charts from PIPL and LETE Data

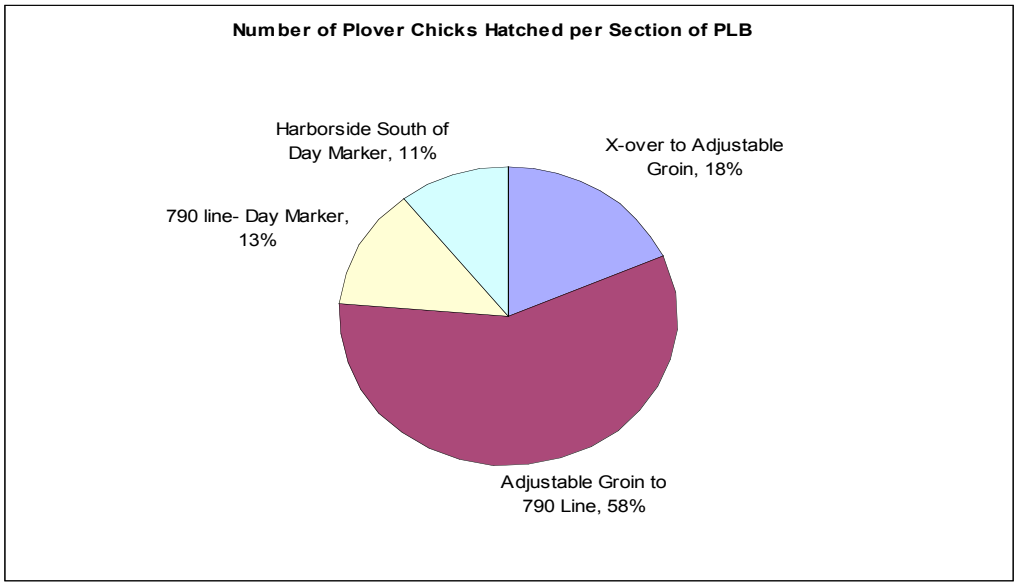


Figure 1: Number of PIPL chicks hatched in each of 4 sections of PLB, summer 2004

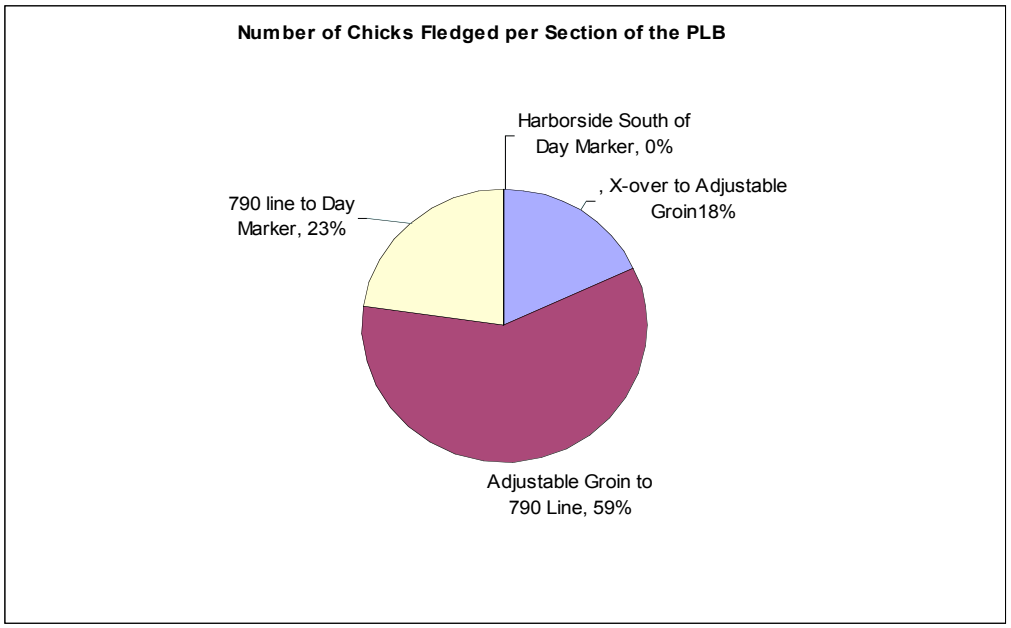


Figure 2: Number of PIPL Chicks Fledged per section of PLB, summer 2004

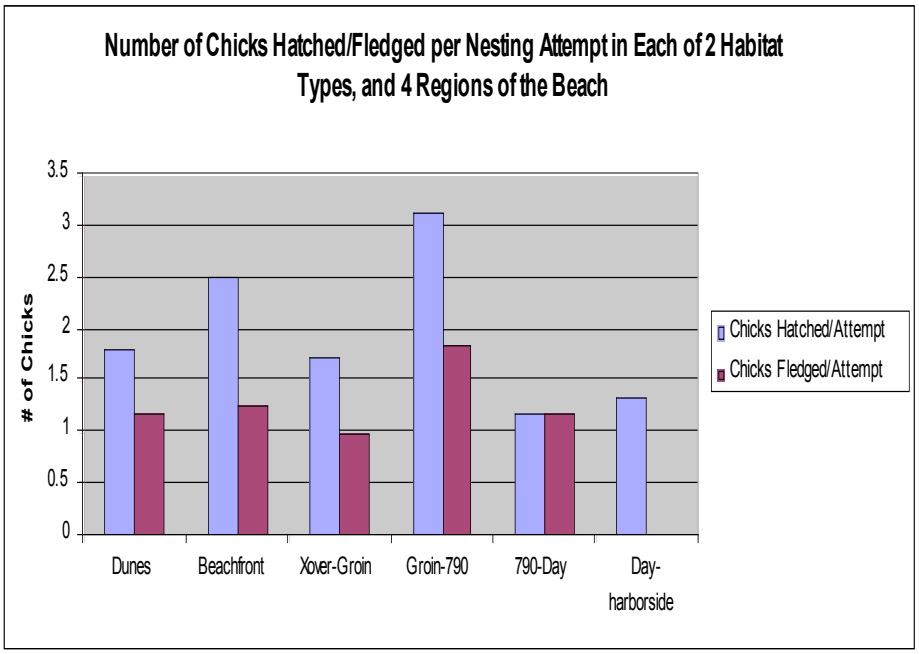


Figure 3: Number of Chicks Hatched (blue) and Fledged (red) in each of two habitat types and 4 sections of PLB, summer 2004

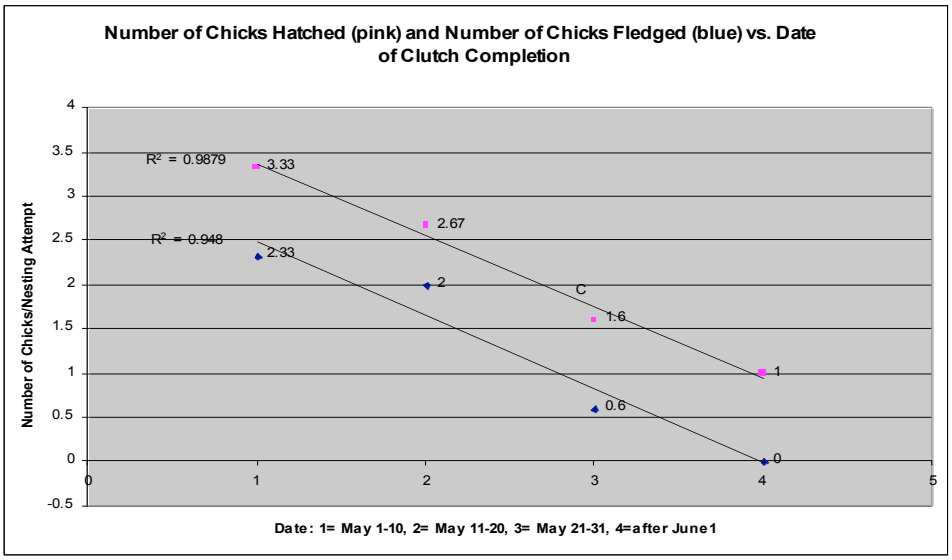


Figure 4: Number of PIPL chicks hatched (top) and fledged (bottom) on PLB, summer 2004

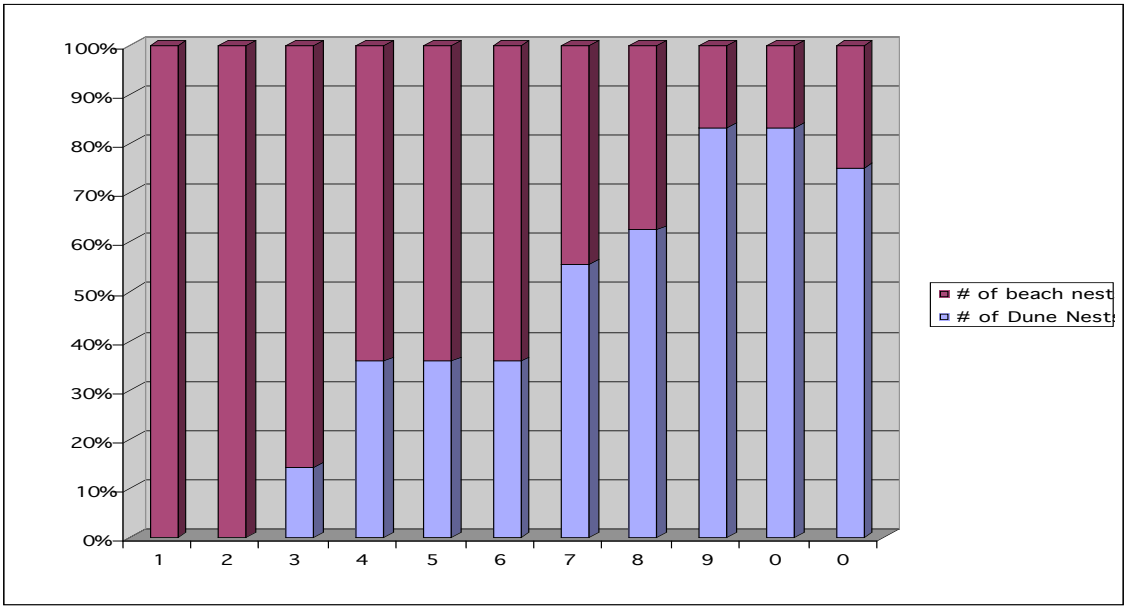


Figure 5: Percentage of total PIPL egg clutches in front beach (red) and dune (blue) habitat through summer 2004 season. Each number on the X-axis represents a 5 day period. Thus, 1=May 1-5, 2=May 6-10, 3=May 11-15, 4=May 16-20, 5=May 21-25, 6=May 26-30, 7=May31-June 4, 8=June 5-9, 9=June 10-14, 10=June 15-19, and 11=June 20-24.

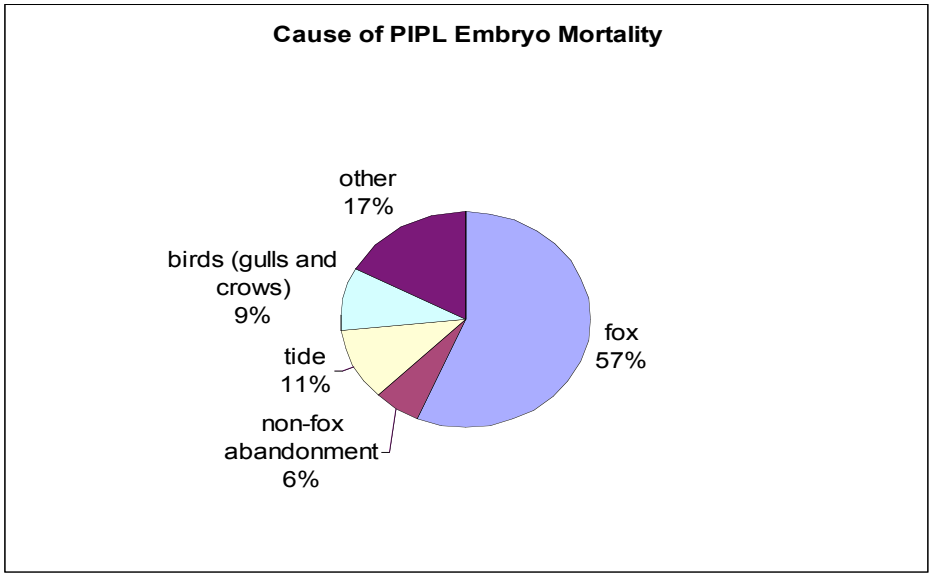


Figure 6: Causes of PIPL egg and chick predation (chicks and eggs together counted as PIPL embryos.

Daily Number of PIPL Eggs on PLB, summer 2004

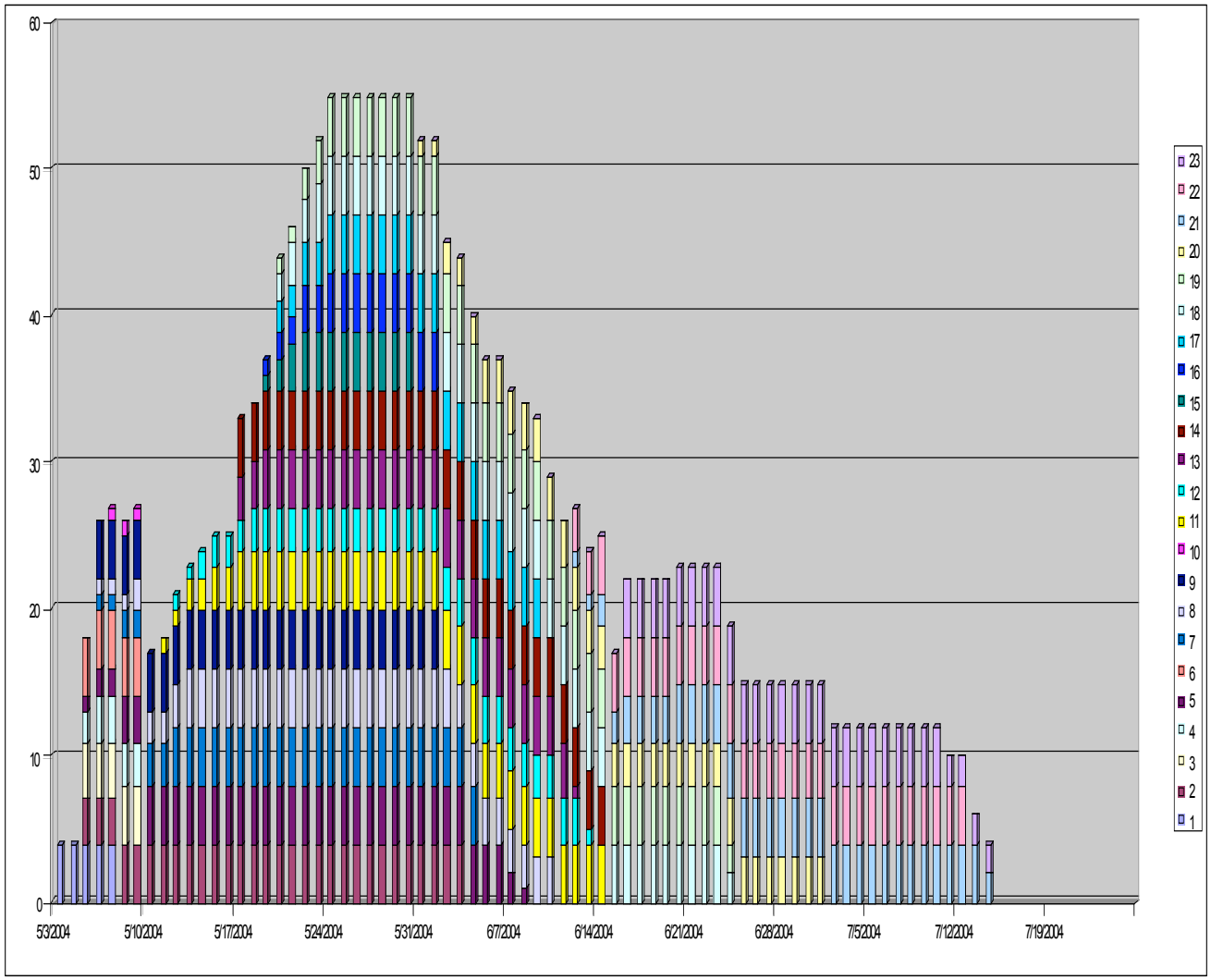


Figure 7: Daily Number of PIPL eggs on PLB in summer 2004. Total bar height represents the total number of PIPL eggs being incubated on any given date. Color bands within the total bar represent the contribution of each active nest to the total number of eggs.

Daily Number of PIPL chicks on PLB, summer 2004.

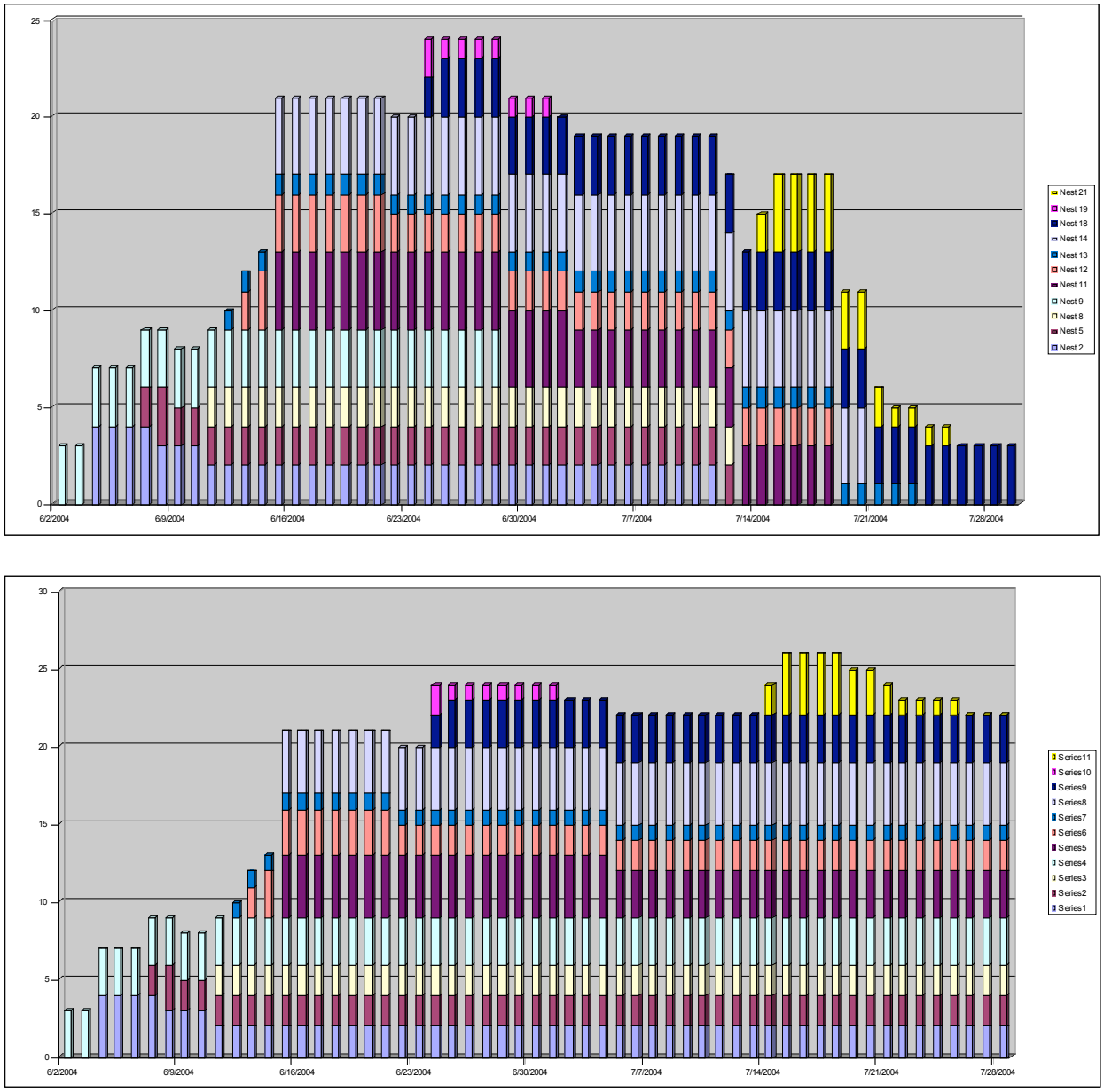


Figure 8: Daily number of PIPL chicks on PLB, summer 2004. Total bar height represents total number of PIPL chicks on the beach, each color band represents the chick contribution of each individual nest. Top graph removes PIPL nests as they fledge, bottom graph keeps PIPL fledged chicks on the graph until the end of the period.

Figure 9: PIPL breeding success by region of PLB. (used for figures 1, 2, 3)

Location	Nest Number	Plovers Hatched (c/a= chicks/attempt)	Plovers Fledged	mortality cause
front beach nest numbers (exclosed only)	2	4	2	fox?
	5	3	2	territorial
	7	0	0	fox
	8	2	2	tide
	9	3	3	tide
	12	3	2	unknown
	13	3	1	crow
	16	0	0	tide
	17	0	0	fox
	22	0	0	season
total from exclosed front beach nests:	10 attempts	18 1.8 (chicks/attempt)	12 1.2 chicks per attempt	30% fox 30% tide 10% crow
dune blowout nest numbers (exclosed only)	11	4	3	unknown
	14	4	4	none
	15	0	0	fox
	18	4	3	fox
	19	4	0	fox, tide
	20	0	0	fox
	21	4	0	gulls (?)
	23	0	0	fox
total from exclosed blowout nests	8 attempts	20 2.5 chicks per attempt	10 1.25 chicks per attempt	63% fox 37% other
nests X-over-adjustable groin (exclosed)	2	4	2	fox
	7	0	0	fox
	12	3	2	?
	17	0	0	fox
total:	4 attempts	7(1.75 c/a)	4 (1.00 c/a)	75% fox
nests adjustable groin-790 line	5	3	2	territorial
	11	4	3	?
	13	3	1	crow
	14	4	4	none
	15	0	0	fox
	18	4	3	fox
	21	4	0	gulls
total	7 attempts	22 (3.14 c/a)	13 (1.86 c/a)	29% fox
nests 790 line-day marker	8	2	2	tide
	9	3	3	tide
	16	0	0	tide
	22	0	0	season
total	4 nest attempts	5 (1.2 c/a)	5 (1.2 c/a)	75% tide
hsrbor side south of day marker	19	4	0	fox, tide
	20	0	0	fox
	23	0	0	fox
total	3 attempts	4	0	~ 75% fox

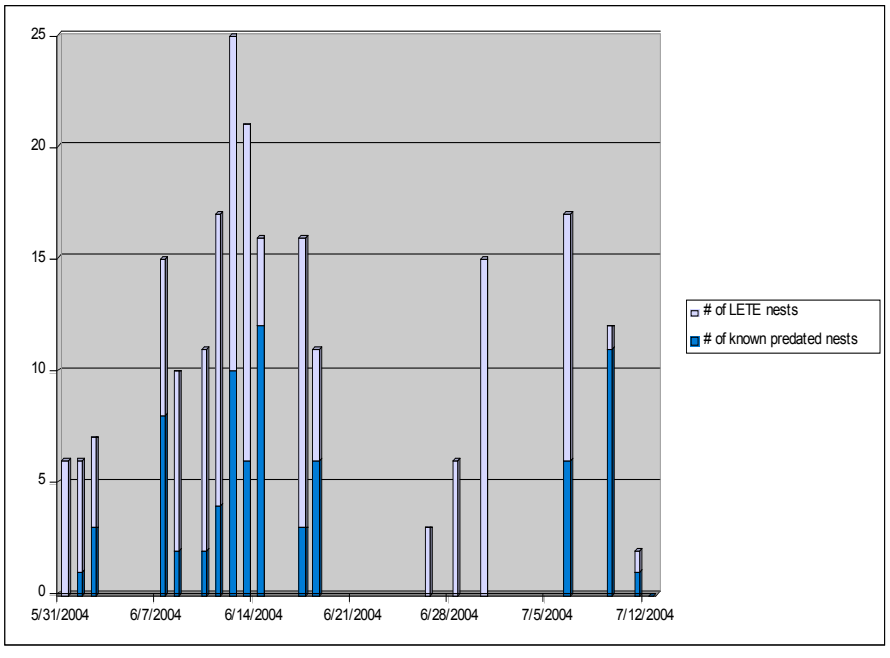
Figure 9b: summary of figure 9.

Location of Nest	Number of Nesting Attempts	Number of Chicks Hatched	Chicks hatched/ nesting attempt	Number of Chicks Fledged	Chicks Fledged/ Nesting Attempt	Leading Cause of Mortality
Xover to Adjustable Groin	4	7	1.75	4	1.00	75% fox
Adjustable Groin – 790 Line	7	22	3.14	13	1.86	29% fox
790 line-Day marker	4	5	1.25	5	1.25	75% tide
Harborside, South of Day Marker	3	4	1.33	0	0	75% fox
Nests on Beach front (habitat 2)	10	18	1.8 c/a	12	1.2 c/a	30% fox, 30% tide
Nests in Dune Blowouts (habitat 3)	8	20	2.5	10	1.25	63% fox

Figure 10: PIPL breeding success vs. Date of Clutch Completion

Date of Clutch Completion	Number of Nesting Attempts	Number of Chicks Hatched	Chicks Hatched/ nesting attempt	Number of Chicks Fledged	Chicks Fledged/ nesting attempt
May 1-10	3	10	3.33	7	2.33
May 11-20	6	16	2.67	12	2
May 21-31	5	8	1.60	3	0.6
After June 1	4	4	1.00	0	0

Figure 11: LETE breeding season on PLB, summer 2004. Light blue represents number of active LETE nests, dark blue represents the number of nests found predated on any given day.



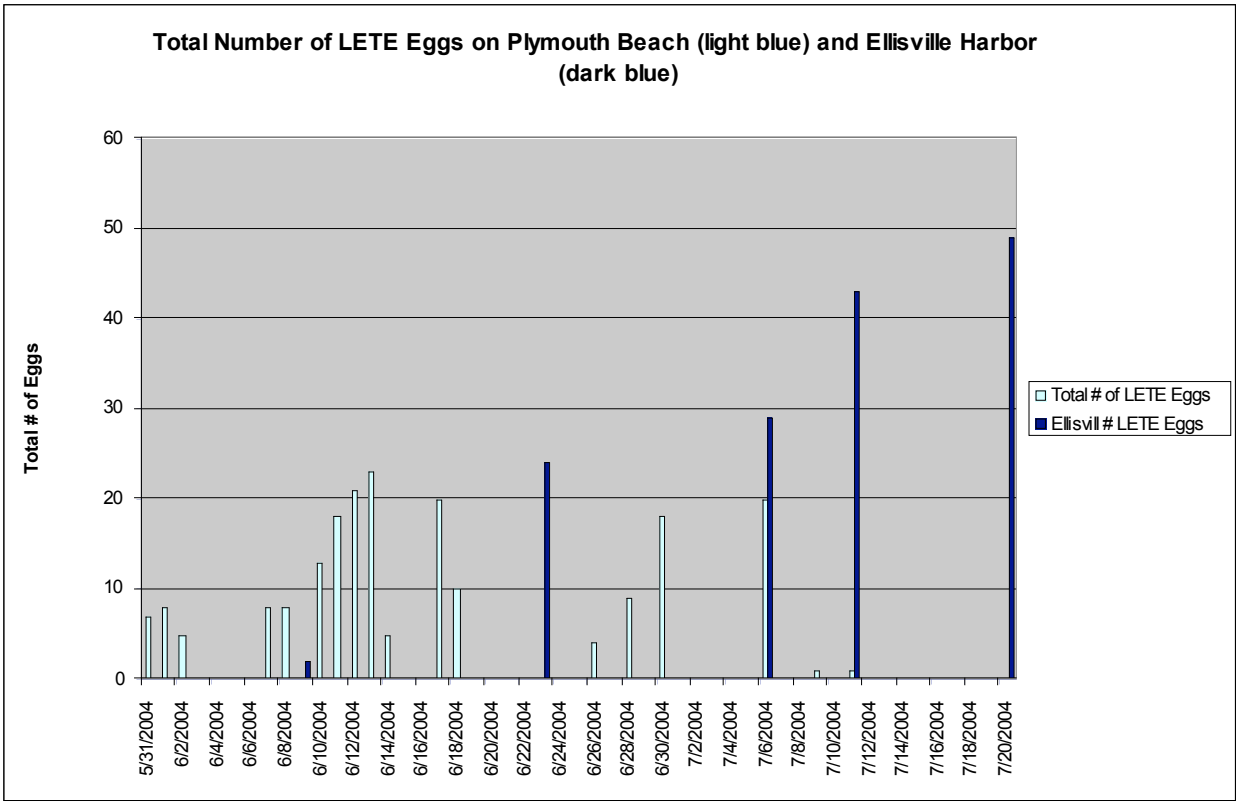


Figure 12: Total Number of LETE eggs on PLB (light blue) and Ellisville Harbor. Note that the number of LETE eggs at Ellisville Harbor jumps on 6/24/2004 (6 days after a PLB LETE crash) and again on 7/12/2004 (5 days after a PLB crash).

Date	# of LETE 1 Egg Nests	# of LETE 2 Egg Nests	# of LETE 3 Egg Nests	Total # of LETE Eggs	# of LETE Chicks	Total # of Potential LETE	# of known predated nests	# of LETE nests
31-May	5	1	0	7	0	7	0	6
1-Jun	2	3	0	8	0	8	1	5
2-Jun	3	1	0	5	0	5	3	4
7-Jun	6	1	0	8	0	8	8	7
8-Jun	8	0	0	8	0	8	2	8
10-Jun	5	4	0	13	0	13	2	9
11-Jun	8	5	0	18	0	18	4	13
12-Jun	9	6	0	21	0	21	10	15
13-Jun	7	8	0	23	0	23	6	15
14-Jun	3	1	0	5	0	5	12	4
17-Jun	7	5	1	20	0	20	3	13
18-Jun	2	1	2	10	0	10	6	5
26-Jun	2	1	0	4	0	4		3
28-Jun	3	3	0	9	0	9		6
30-Jun	12	3	0	18	0	18		15
6-Jul	2	9	0	20	0	20	6	11
9-Jul	1	0	0	1	0	1	11	1
11-Jul	1	0	0	1	0	1	1	1
12-Jul	0	0	0	0	0	0	0	

Figure 13: LETE breeding season, PLB summer 2004

Figure 14: ARTE breeding attempts, summer 2004 PLB

Nest 1:
Location: dune blowout near nest 23
egg Date:
1st egg: 8 June
2nd egg: 10 June
Hatch Date: July 6th, 2 chicks, 26 days of incubation
Both Chicks spend time near the dike, are found hiding in it (7/20/04) large size, feathers beginning to appear. Fence is moved to include 2 new chicks. On 7/25 one chick was seen in the dike, inside of the electric fence. Had well-developed feathers on tail and wing. Other chick was not seen but could be present. On July 30, one chick seen flying at north end of the blowout near nest 23. On August 2, the second chick was seen in flight as well and for the following week 2 chicks could often be seen perched on the rocks on the harbor side of the beach. 2 fledged.

Nest 2:
Location: dune blowout near nest 21
Egg dates
1st egg: 6/11
2nd egg: 6/14
Hatch Date:
1st chick: 7/12 28 days of incubation. 2nd chick never hatched.
present: 7/13, 7/14, 7/15 inside of electric fence. 7/16 just outside of electric fence. 7/16 fence extended to include most likely chick areas, electrified with new battery. Chick moves to

blowout of nest 21 itself (7/18), chick moves to "tree blowout." Chick is now present in the blowout near nest 14, and remains there (7/19-7/25). Chick remains near "tree blowout" after fledging in early August and is seen there daily (now flying) through Aug. 10.

Nest 3:
Location: edge of dunes near nest 5
Egg Dates:
1st egg: 6/12(?)
2nd egg: June 13
Depredated: June 14

Nest 4:
Location: dune blowout near nest 13
Egg Dates:
1st egg: June 14
Hatch Date: n/a
Note: frequent disturbance from flyover gulls moving from ocean to harbor side throughout incubation period. Parents are obsessive in defense of their nests. On July 24, after 40 days of incubation, electric fence is removed from nest which is still being incubated and defended vigorously. It is considered inviable. Predated by fox on 7/26.

Nest 5:
Dune blowout near nest 19
Egg dates:
1st Egg: June 16
Hatch Date:
July 10, 24 days of incubation
Depredated: Chick by fox on July 14, 2004, adults still present in nesting area 7/15, 7/16, but no chicks are noted.