

2011

## Osprey Nest Abundance, Distribution, and Productivity in Casco Bay

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2011

## OSPREY NEST ABUNDANCE, DISTRIBUTION, AND PRODUCTIVITY IN CASCO BAY



**OSPREY NEST ABUNDANCE, DISTRIBUTION, AND PRODUCTIVITY IN CASCO BAY, 2011**

*SUBMITTED TO:*



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*SUBMITTED ON:*

*February 6, 2013*

The BioDiversity Research Institute (BRI) is a 501(c)(3) non-profit organization located in Gorham, Maine. Founded in 1998, BRI is dedicated to supporting global health through collaborative ecological research, assessment of ecosystem health, improving environmental awareness, and informing science based decision making.

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**FRONT PHOTO CAPTION:** An Osprey nestling in the Fore River, Photo credit: C. DeSorbo; Maine shoreline photographed during an Osprey survey, Photo credit: C. DeSorbo.

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## 1.0 EXECUTIVE SUMMARY

Ospreys are one of the most well-established ecological bioindicator species because their nest distribution and productivity reflect patterns and changes in the foodweb that supports them. Osprey tissues (eggs, blood, feathers) reflect contaminants in aquatic ecosystems and as a result, they are regularly sampled throughout their range to monitor geographic and temporal contaminant patterns.

We conducted surveys of the Osprey population residing in Casco Bay to gather information on population abundance, distribution, and reproductive success. All mainland and island shorelines were surveyed from the Fore River (westernmost boundary) to the New Meadows River (easternmost boundary). Surveys were primarily conducted using fixed-wing aircraft, with the exception of the Fore River, which was surveyed by boat.

We checked the status of 124 current and traditional nest sites. Of the 124 nests, 107 were intact, and breeding pairs were confirmed at 86 sites. Of all sites, 98 had potential to contain resident pairs.

Ospreys were successful in producing young at 53 nest sites. Eighty fledglings were produced, yielding mean reproductive measures of 0.82 young per potential resident pair (breeders + presumed non-breeders or failed breeders), 0.93 young per active nest (breeding pair). The mean brood size was 1.5 young per successful nest.

The reproductive level considered required to maintain population stability lies between 0.80 – 0.90 young per active nest. Therefore, it appears based on this single-year evaluation, that the Casco Bay Osprey population surveyed in 2011 is stable. We discuss factors known to affect Osprey nest distribution and reproduction elsewhere and provide recommendations for further study.

## 2.0 INTRODUCTION

Osprey nest distribution and productivity (the number of chicks surviving per nest) are highly responsive to changes and patterns in the local foodweb. This characteristic in combination with others relating to their natural history (i.e., a strict fish diet, high annual fidelity to nesting territories, and a long lifespan) make ospreys one of the most valued bioindicators of aquatic ecosystem health. As a result, Osprey populations are commonly monitored and sampled throughout their range, and this information helps inform decisions related to managing and monitoring aquatic resources (Poole et al. 2002, Grove et al. 2009).

Few efforts have been undertaken to survey Osprey populations in Maine enabling present or future assessments of population status. We conducted surveys of marine-based Ospreys in Casco Bay during 2011 to gather information on population abundance, nest distribution, and reproduction. The portion of Maine's Osprey population residing in Casco Bay was an appropriate subpopulation to survey in 2011 because: (1) concurrent surveys conducted in other Maine regions (Penobscot Bay, the Penobscot River corridor, and the Kennebec River corridor) provided a unique opportunity to make same-year comparisons for other portions of Maine's Osprey population, (2) past investigations found high levels of emerging contaminants in some Ospreys sampled in this area (Goodale 2010), yet no recent efforts have assessed population abundance or reproductive status, and (3) continued survey efforts over the period 2011-2013 enable an evaluation of changes exhibited by the Osprey population over a roughly 30-year period (1981 – 1983, unpublished data; Maine Department of Inland Fisheries and Wildlife; MDIFW).

## 3.0 STUDY AREA

Our study area contains the majority of the region formally recognized as Casco Bay in southern Maine. Specifically, our study area includes all mainland and island shorelines from Danforth Cove (South Portland) to Bald Head (Phippsburg). Casco Bay islands and shorelines vary widely in their extent of municipal development. Several freshwater rivers input into Casco Bay, and these rivers vary widely in character and use. The Fore River is undoubtedly the most industrialized portion of the study area, with a significant amount of commercial activity and industrial development. The Fore River marks the westernmost periphery of our survey area. The New Meadows River, the easternmost tributary of Casco Bay, marks the eastern periphery of our study area. This region is characterized by mixed and coniferous forests and contains minimal to moderate levels of shoreline development.

In this report, we summarize Osprey survey data within three subregions of Casco Bay: (1) mainland and island shorelines in Casco Bay (the Casco Bay subregion hereafter), (2) the Fore River subregion, and (3) the New Meadows River subregion. We refer to the entire study area surveyed as "Casco Bay" throughout this report. While there may be a hydrological basis for making comparisons between populations in the Fore River and the New Meadows River, these delineations are relatively arbitrary. The population emphasized in this study is that within all of



Casco Bay, and caution is advised in making comparisons among subregions that consider them different populations. Subregions may be useful in future efforts attempting to monitor portions of the population surveyed during this study.

## 4.0 METHODS

### 4.1 Surveys

We inventoried nesting ospreys in the Casco Bay region using a combination of low level aerial surveys and boat-based surveys. All of the study area was surveyed by aerial surveys with the exception of the Fore River and mainland shorelines immediately to the south and north of the mouth of the Fore River due to Class-C airspace limitations within 5 miles of the Portland Jetport. All flights were conducted in a Cessna 172 Skyhawk piloted by contractor Ray Fogg, d.b.a. Aerial Photo Service of Maine. Chris DeSorbo, Rick Gray, and Ian Johnson (Biodiversity Research Institute) alternately co-observed with Charlie Todd (MDIFW) as the primary observer. Survey speeds were generally 80 – 100 miles per hour at altitudes 300 – 700 feet above the surface. Flight tracks and reference locations were recorded on a portable GPS unit. Nest locations were refined by visual plots on aerial photos during the July flight. Observers recorded nest condition, nest substrate type (not quantified in this report), osprey residency, breeding activity, nest success, and number of fledglings on a portable recorder and a flight log.

We conducted surveys during two phases of the osprey breeding cycle in 2011. We timed surveys based on past knowledge of Osprey phenology, further refined by clues on seasonal timing gathered opportunistically from other surveys conducted throughout the state. Weather patterns (i.e., fog, rain) and pilot availability also influenced survey timing. The first survey was conducted on May 28 and June 4, 2011 to document the condition of nests, Osprey pair residency, and nesting activity (nesting survey hereafter). The second survey was conducted on July 28 at intact nests to evaluate continued pair occupancy and determine the number of fledglings surviving (productivity survey hereafter). Productivity surveys were conducted at all but one active site in the Casco Bay subregion, and all but two active nest sites in the New Meadows River subregion. Given the reasonably large sample size of active nests noted during our survey and used in calculations of nest success and productivity, missing data for these three nests had a minimal influence on nest success and productivity estimates for the overall Casco Bay study area population. Reproductive statistics are presented both including and excluding these nests.

Surveys were additionally conducted in Penobscot Bay during 2011 in collaboration with Charlie Todd, (MDIFW), and Erynn Call and Mac Hunter (Univ. of Maine Orono), with funding from the Maine Outdoor Heritage Fund and Biodiversity Research Institute. While not comprehensively summarized in this report, we include preliminary data summaries from this parallel survey effort to provide context for the Casco Bay study area. Additional surveys were conducted in the Kennebec River corridor and the Penobscot River corridor in 2011; we aim to incorporate these statistics in future summaries.

## 4.2 Definition of Terms

We evaluated the condition of newly found and previously known Osprey nest sites during surveys. Osprey nests (the majority of which are on natural sites in our study area) that are not maintained tend to fall into disrepair or fall to the ground entirely following the winter. Other clues, such as weed growth in the nest bowl, are often evident at unoccupied nests. While these characteristics do not necessarily characterize all unoccupied sites, they significantly aid in distinguishing occupied from unoccupied nests. We categorized nests as either **intact** (nest integrity and evidence of activity suggested it could be used by Ospreys) or **not intact** (nest structure in disrepair, evidence did not suggest occupancy by ospreys). Nests deemed intact during the nesting survey were visited during the productivity survey. We define a **nesting territory** as an area that was observed or presumed to contain a nest within the home range of a mated pair (Steenhof and Newton 2007).

We categorized Ospreys associated with nest sites as either **confirmed breeding pairs** or **possible resident pairs**. We define **confirmed breeding pairs** as those in which surveys revealed breeding activity, as indicated by the presence of incubating adults, eggs, or young. These pairs are traditionally referred in published literature as “active pairs” (Postupalsky 1974, Poole 1989). Osprey pairs were considered **possible resident pairs** when surveys revealed one or two adults attending intact nests in good condition, but no evidence of breeding was apparent during nesting or productivity surveys. Because we only conducted a single nesting survey, the status of these pairs cannot be further confirmed. Nest sites determined to contain possible resident pairs might be: (a) pairs that attempted breeding and failed without detection, (b) non-breeding pairs, or (c) individuals that were incorrectly assumed to be associated with a nest site based on their behavior patterns during the survey. The sum of confirmed breeding pairs and possible resident pairs represents an estimate of the total number of **potential resident pairs** detected during the survey.

Following traditional aerial survey methodology, we counted the number of live young in nests during productivity surveys to calculate nest success and productivity measures. We defined **nest success** as the proportion of pairs that successfully produced  $\geq 1$  young. All successful nests contained young aged approximately 80% of fledging age (approximately 42d based on fledging at 53d; (Poole et al. 2002) during the productivity survey. We defined **productivity** as the number of young produced per pair (further defined below).

Due to the uncertainty associated with possible resident pairs, Osprey researchers generally consider Osprey reproduction measures based upon confirmed breeding pairs the most reliable for evaluating population status or making comparisons (Spitzer et al. 1983, Poole 1989). However, numerous studies also report reproductive measures relative to the number of “occupied nests.” In this study, we report Osprey nest success and productivity measures relative to both confirmed and potential breeding pairs. The pairing of these two measures produces a range, with measures based upon potential resident pairs reflecting the potential influence of non-breeders (assuming our assessments of residency for possible resident pairs is correct), and measures based upon confirmed breeders representing only the detected

breeding portion of the population. Finally, we also report **mean brood size**, the mean number of young produced by successful pairs (Poole 1989, Steenhof and Newton 2007).

## 5.0 RESULTS

### 5.1 Nest Distribution and Abundance

*Overall:* We checked the status of 124 current and traditional (i.e, previously/traditionally known) Osprey nests in Casco Bay during 2011 (Figure 1, Table 1). Of all nest sites checked, 107 were considered intact and 17 nests were not found and were presumed fallen. Nine nest sites were considered unoccupied and unlikely to contain residents. Breeding activity was confirmed at 86 of intact nests checked, and possible resident pairs (breeding activity not confirmed) were confirmed at 12 sites. In total, 98 nest sites were considered to contain potential breeding pairs.

*Subregion Comparisons:* As might be expected due to a greater area, the Casco Bay subregion harbored the majority of intact Osprey nests in the Casco Bay study area (Figure 1, Table 1). The Casco Bay subregion contained the highest proportion of confirmed breeding pairs (73%) and potential resident pairs (74%) compared to other subregions. Eighty-three percent of the possible resident pairs – the unconfirmed breeders – were located in the Casco Bay subregion. Twenty percent of all confirmed breeding pairs and 19% of all potential resident pairs were located in the New Meadows River subregion. The Fore River contained the lowest proportion of confirmed breeding pairs (7%) and potential resident pairs (6%) of all subregions.

Table 1. Number of Osprey nests, and pairs deemed possible resident and confirmed breeding pairs during surveys of Casco Bay, 2011.

Study Area	No. nests		Possible Resident Pr.	Confirmed Breeding Pr.	Potential Resident Pr.
	Checked	Intact			
Casco Bay	93	78	10	63	73
Fore River	6	6	0	6	6
New Meadows	25	23	2	17	19
<b>ALL</b>	<b>124</b>	<b>107</b>	<b>12</b>	<b>86</b>	<b>98</b>

\* See methods for term definitions.

### 5.2 Number of Fledglings and Successful Nests

*Overall:* A total of 53 Osprey nests were confirmed to be successful in producing  $\geq 1$  young in the Casco Bay study area (Table 2). A total of 80 fledglings were produced from these nests.

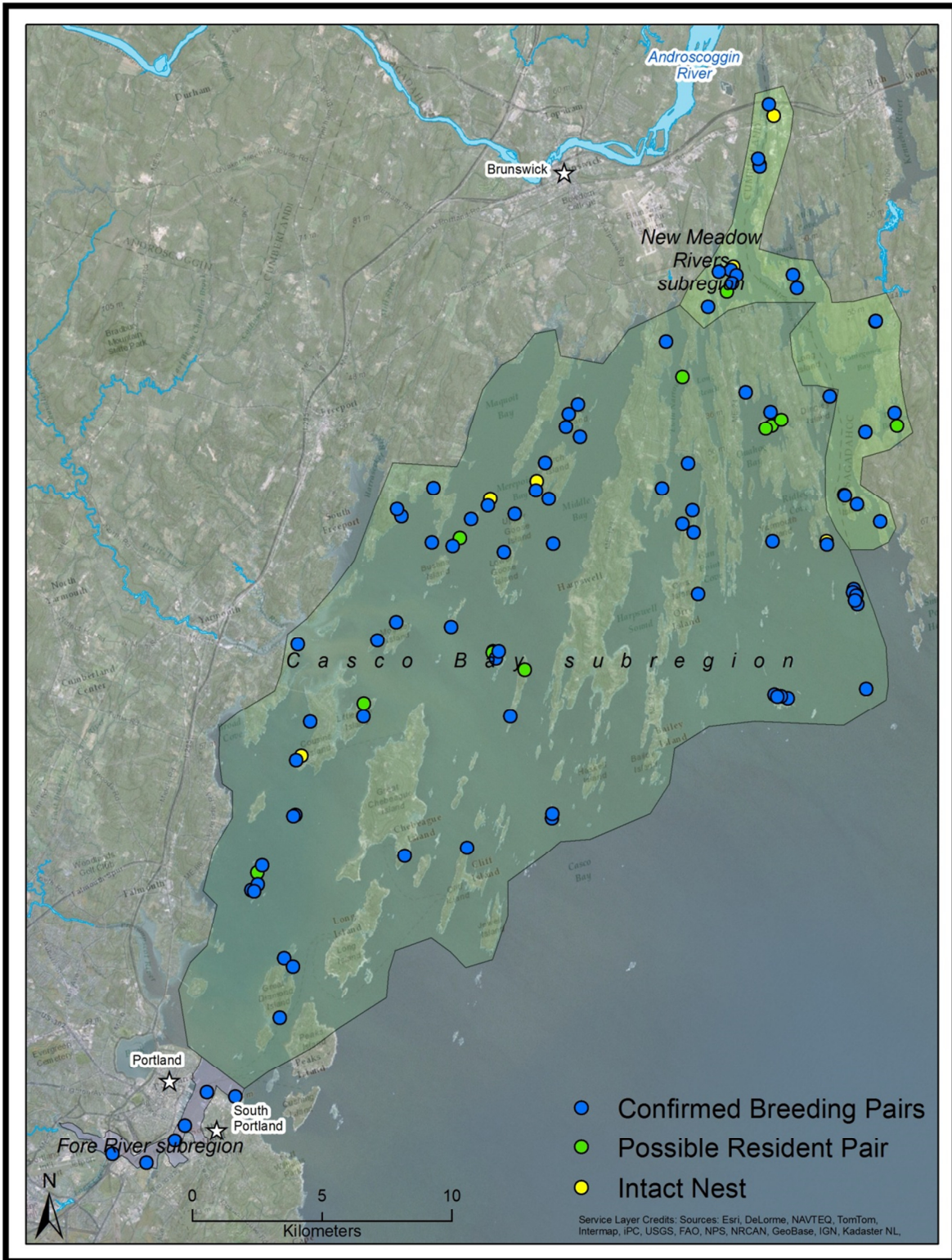


Figure 1. Confirmed breeding and possible resident Osprey pairs detected during population surveys in Casco Bay, 2011.



Table 2. Number of successful nests, fledglings, and brood size for Ospreys in three subregions of the Casco Bay study area surveyed in 2011.

<b>Subregion</b>	<b>Successful Nests (n)</b>	<b>Fledglings (n)</b>
Casco Bay	37	54
Fore River	6	12
New Meadows	10	14
<b>ALL</b>	<b>53</b>	<b>80</b>

\* See methods for term definitions.

*Subregion Comparisons:* The number of successful nests in the overall study area reflected differences in proportions of nests in each subregion. Seventy percent of the successful nests were located in the Casco Bay subregion, 18.9% were in the New Meadows River subregion, and 11.3% were in the Fore River subregion. Of the 80 fledglings produced in the overall study area, 67.5% were produced in the Casco Bay subregion, 17.5% were produced in the New Meadows subregion, and 15% were produced in the Fore River subregion.

### 5.3 Nest Success and Productivity

Estimates of nest success for confirmed breeding pairs in the Osprey population in the overall Casco Bay study area was 62% (Table 3). If we consider all potential breeding pairs, the figure drops to 54%. Productivity based upon confirmed breeding pairs was 0.93 young per breeding pair. Productivity based upon potential breeding pairs was 0.82 young per pair. Mean brood size (fledglings / successful nests) was 1.5 young per successful nest.

Table 3. Nest Success and productivity estimates for Ospreys in three subregions of the Casco Bay study area surveyed in 2011.

<b>Subregion</b>	<b>Nest Success (%)<sup>a</sup></b>		<b>Young Produced /<sup>b</sup></b>		
	<b>Potential Residents</b>	<b>Confirmed Breeders</b>	<b>Potential Residents</b>	<b>Confirmed Breeders</b>	<b>Successful Nests</b>
Casco Bay <sup>c</sup>	51	59	0.74	0.86	1.5
Fore River	100	100	2.00	2.00	2.0
New Meadows <sup>d</sup>	53	59	0.74	0.82	1.4
<b>ALL<sup>e</sup></b>	<b>54</b>	<b>62</b>	<b>0.82</b>	<b>0.93</b>	<b>1.5</b>

<sup>a</sup> Nest Success defined in methods.

<sup>b</sup> Productivity defined in methods.

<sup>c</sup> Figures after removing one active nest not checked during productivity survey from calculations: Nest success (%), SNP/PR (51), SNP/CR (60); Productivity, CF/PR (0.75), CF/CR (0.87).

<sup>d</sup> Figures after removing two active nests not checked during productivity survey from calculations: Nest success (%), SNP/PR (59), SNP/CR (67); Productivity, CF/PR (0.82), CF/CR (0.93).

<sup>e</sup> Figures after removing three active nests not checked during productivity survey from calculations: Nest success (%), SNP/PR (56), SNP/CR (64); Productivity, CF/PR (0.84), CF/CR (0.96).

*Subregion Comparisons:* Measures of nest success based upon confirmed breeding pairs and potential breeding pairs were similar between the Casco Bay subregion and the New Meadows River subregion (Table 3). All six nests in the Fore River subregion were successful in producing young, and thus nest success for this subregion was 100% (Table 3). Productivity measures based upon confirmed breeding pairs, potential breeding pairs, and successful nesting pairs were similar for Ospreys in the Casco Bay subregion and the New Meadows River subregion. The six nests in the Fore River had notably higher productivity measures compared to the other two subregions (Table 3, Figure 2). Productivity for the six nests in the Fore River was inflated due to the 100% nest success and relatively high chick production.

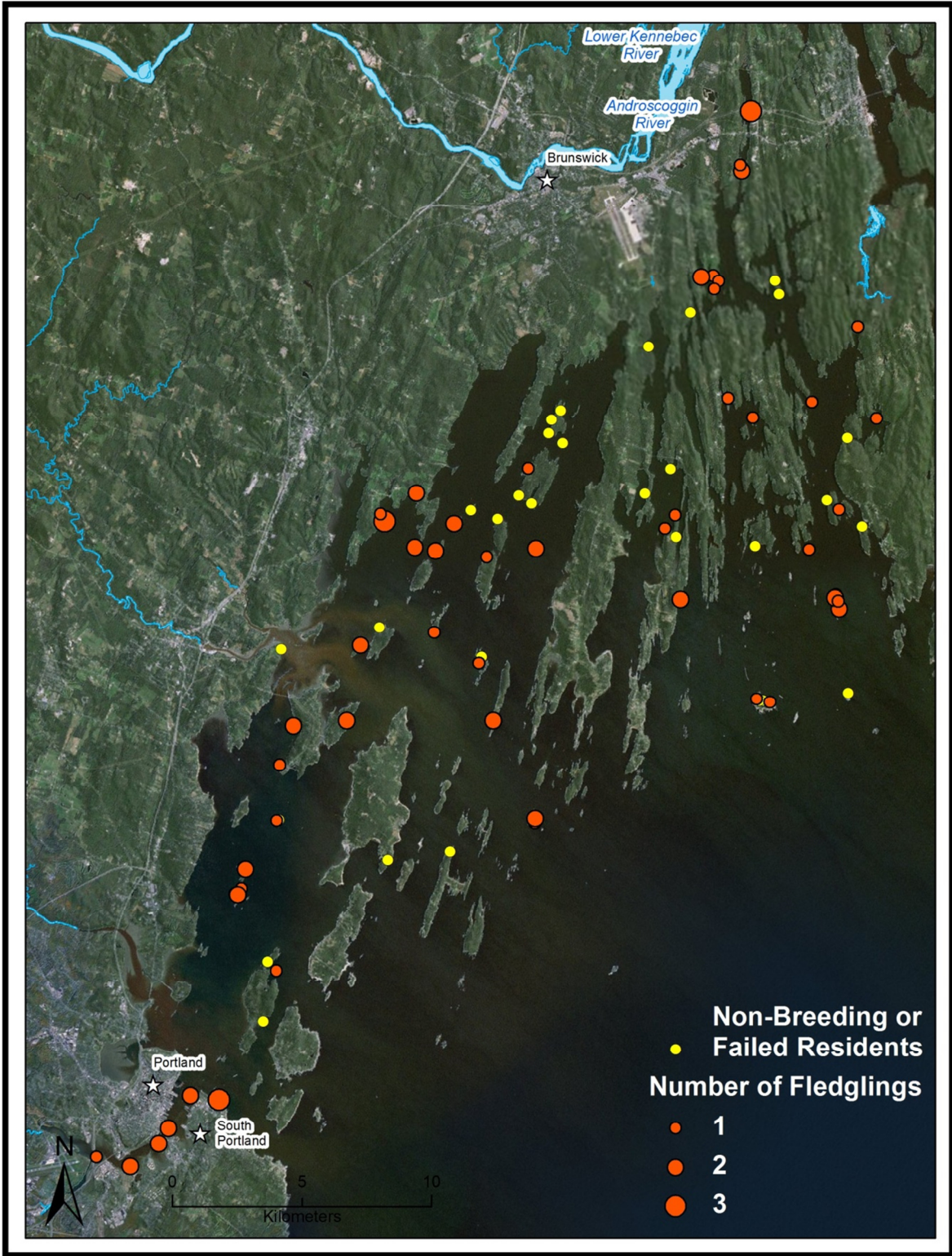


Figure 2. Distribution of non-breeding, failed resident and successfully nesting Ospreys in the Casco Bay study area surveyed in 2011.

## 6.0 DISCUSSION

In this study, we conducted an inventory of the Casco Bay Osprey population and evaluated their reproductive success. Similar efforts targeting Maine Ospreys are rare. The only comparable effort to systematically survey Ospreys in Casco Bay was conducted for a sample of the Casco Bay population three decades ago (1981 – 1983) by the Maine Department of Inland Fisheries and Wildlife. While we summarize data for surveys conducted in a single year (2011) here, further efforts are underway to compile survey findings from 2012 and conduct 2013 surveys. These combined datasets will enable a 3-year assessment of the current Casco Bay Osprey population and an opportunity to evaluate long-term changes in the population between survey periods.

### 6.1 Why is monitoring Ospreys important?

Ospreys are among the most well-established bioindicator species. Natural history traits such as a long lifespan, high site fidelity, and an exclusive fish diet make Ospreys particularly effective monitors of contaminant patterns in the aquatic systems in which they reside (Henny et al. 2004, Grove et al. 2009). Ospreys are also valuable ecological indicators as their nest distribution and productivity are highly responsive to changes and patterns in the local foodweb (Poole 1989, Watts et al. 2004a). Thus, efforts to measure Osprey population parameters and collect biological samples from them may be among the most valued and cost-effective means of detecting broad-scale ecological changes or spatial and temporal changes in contaminant patterns in aquatic systems.

Surveys in this study have established a single-year measure of abundance, nest distribution, and reproduction statistics for the Casco Bay Osprey population. This dataset provides a valuable benchmark to which past and future population monitoring data collected in Casco Bay and elsewhere can be compared. Additionally, information collected on nest location and status during this study provides the foundation required for other efforts requiring information on nest status or location, such as toxicological assessments, habitat use analyses, and a variety of management applications.

### 6.2 Status of the Casco Bay Osprey Population

We detected 107 intact Osprey nests in Casco Bay during 2011 surveys. Osprey pairs were confirmed to breed at 86 nest sites, while another 12 pairs were considered to contain possible resident pairs. Thus, a total of 98 nest sites are considered to be attended by potential resident pairs (breeders + non-breeders; see methods). While these measures of abundance are valuable, the primary measures used to assess Osprey population stability and overall trends are those related to reproduction.

Nest success of confirmed breeding Osprey pairs in Casco Bay was 62%. Conversely, 38% of breeders failed to successfully raise at least one young to near the age of fledging. Productivity



based upon confirmed breeders was 0.93 young per breeding pair, and productivity based on all potential resident pairs was 0.82 young per resident pair.

A considerable amount of research emphasis has been dedicated to population regulation in Ospreys because breeding populations were heavily monitored throughout their range to quantify the impacts of DDT on populations and chart their recovery. Intensive studies on both New England and Michigan Osprey populations during this period estimated that 0.80 – 0.90 young per active nest (confirmed breeders in this study) is the productivity level required to maintain population stability (Spitzer et al. 1983, Poole 1989, Postupalsky 1989, Poole et al. 2002). Based on this level, it would appear that the Casco Bay Osprey population we surveyed in 2011 is stable.

### 6.3 Subregions and Geographic Patterns in Casco Bay

In general, Osprey nests appeared to be widely distributed throughout Casco Bay (Figure 2). Clusters of nests appeared in some regions including: (a) the Fore River, (b) areas east and west of Merepoint Bay, (c) the Woodward cove vicinity in the upper New Meadows River, and (d) outer islands such as Flag and Ragged Islands. Nests were noticeably few or absent from areas such as: (a) east and west shorelines along the Harpswell Peninsula, (b) Maquoit Bay, (c) mainland shorelines from the Fore River to Cumberland (to Broad Cove), and (d) several large islands in southern Casco Bay including Peaks, Long, and Chebeague Islands. Preliminary evaluations did not indicate notable differences in nest success and productivity among our Casco Bay subregions with the exception of the six highly productive nests within the Fore River. Continued surveys of this subpopulation will help us determine the extent to which higher observed productivity in the Fore River reflects differences in survey technique (boat vs. aerial) and a small sample size compared to other regions. High productivity for Fore River nests may reflect access to an abundant food supply, use of artificial nest substrates, or other factors.

### 6.4 Comparisons with Penobscot Bay

During the 2011 breeding season, BRI and MDIFW also conducted Osprey surveys in Penobscot Bay using duplicate methodology. The area surveyed generally fell within two HUC-10 watersheds – Penobscot Bay, and Stonington Coastal Drainages. In this area, we checked 161 nest sites and found 140 of them to be intact. Breeding pairs were confirmed at 108 sites, and pairs were considered potential residents at 125 sites. Seventy-two confirmed breeders were successful in producing a total of 100 fledglings.

Nest success for the Penobscot Bay population was 58% when based upon all potential resident pairs (vs. 54% in Casco Bay), and 66% when only considering confirmed breeders (vs. 62% in Casco Bay). Productivity based upon all potential resident pairs was 0.80 young per resident pair (vs. 0.82 in Casco Bay), and productivity based upon confirmed breeders was 0.92 young per confirmed breeding pair (vs. 0.93 in Casco Bay). Brood size was 1.4 young per successful nest in the Penobscot Bay region (vs. 1.5 in Casco Bay).

We documented more confirmed breeding pairs, successful nesting pairs, and chicks fledged in Penobscot Bay compared to Casco Bay. Nest success was slightly higher in Penobscot Bay compared to Casco Bay, but mean productivity measures were similar between the two regions. These figures should be considered preliminary as we continue to verify and analyze Penobscot Bay data.

### 6.5 Factors Affecting Osprey Reproduction and Comparability among Populations

A wide variety of factors affect Ospreys' ability to successfully fledge young (Poole 1989, Poole et al. 2002), and many of the most important factors vary significantly among populations. Many of the most well-studied Osprey populations were monitored as they recovered, sometimes exponentially, following the ban on DDT.

Food availability has a strong influence on reproduction measures in birds, particularly raptors (Newton 1979). Ospreys typically lay more eggs and are able to raise more young to fledging age during years and regions associated with higher food availability (Bowman et al. 1989, Steidl et al. 1991, Poole et al. 2002). In years where food is limited, young commonly starve and sibling rivalry increases. While this fact enables the practice of using Ospreys to monitor ecosystem patterns and change, it seriously limits our ability to use Osprey populations studied in some regions as benchmarks for Maine's population. For example, while much data exists on the Osprey population in Chesapeake Bay, this population resides in one of the largest and most productive estuaries in the world (Watts et al. 2004b, Watts and Paxton 2007), with a remarkably different ecology compared to coastal Maine.

Several studies have found Ospreys nesting on artificial structures (i.e., duck blinds, nest platforms, channel markers) produce more young compared to natural nests typically built in trees (Poole et al. 2002). Poole (1989) summarized Osprey productivity by nest substrate reported in various studies (MI, FL, MD, NY, ID). Productivity of Ospreys nesting on artificial sites ranged from 1.04 to 2.2 young per active nest, while those using natural sites ranged from 0.6 – 1.3 young per active nest. Exceptions to this pattern have been reported in the Canadian Great Lakes region, where natural sites typically comprised nests on stumps with equal or greater stability as artificial sites (Ewins 1996, Martin et al. 2005). While exceptions exist throughout our study area (i.e., the Fore River), the majority of Osprey nests in Casco Bay are built on natural sites. Maine's Osprey population may be unique compared to many other populations along the Atlantic in the high proportion of nests built on natural sites. The nest site choice favoring natural sites by Ospreys in Casco Bay may naturally limit the productivity of this population.

### 6.6 Uncertainty Inherent in Aerial Surveys

Uncertainty in reproduction statistics is inherent when conducting aerial raptor surveys, particularly in populations that nest asynchronously (Ewins and Miller 1995, Steenhof and Newton 2007). While Poole (1989) suggested that five visits to nests were ideal to comprehensively survey Ospreys, this is seldom practical, thus many Osprey surveys rely on

information collected during one or two surveys to estimate population size and productivity (Henny et al. 1974, Postupalsky 1974, Watts et al. 2004b, Henny et al. 2008). Consequently, measurement error, typically associated with detection of nests or young, is an inherent component in aerial surveys. Rotor-winged aircraft are generally considered to have higher accuracy compared to fixed-wing aircraft; however, costs of rotor-winged are often limiting (Ewins and Miller 1995). Henny et al. (1974) found nest detection rates were lower in aerial surveys compared to ground surveys, and also that detection rates were lower for tree nests vs. artificial nests. The majority of our study area was surveyed by fixed-wing aircraft, and it is not possible to estimate the number of nests that may have gone undetected. As a result, breeding pairs that failed prior to the nesting survey, or those that initiated nesting and failed between surveys, may have gone undetected in our study.

Ewins and Miller (1995) evaluated the measurement error associated with Osprey productivity estimates in the Canadian Great Lakes region by comparing aerial survey findings to direct nest inspections. In a portion of their study area, high fledgling mortality subsequent to the productivity survey resulted in an overestimate of the number of young in nests for fixed-wing aircraft surveys, and consequently, an overestimate in Osprey productivity. High fledgling mortality in our study area could presumably result in a similar overestimation of productivity; however, such mortality cannot be confirmed.

Compared to direct nest inspection and helicopter surveys, Osprey surveys using fixed-wing aircraft have been found to underestimate mean productivity by 10-33% in some populations (Ewins and Miller 1995). In our study, a 10 – 33% increase in productivity to adjust for this potential underestimation would result in productivity ranging from 1.02 – 1.24 young per active nest (based on confirmed breeders).

Many fledglings observed during our productivity survey appeared to be advanced in age, upright, of a similar age most cases. At several nests, fledglings were observed making short flights within the territory, and the probability of detecting these young may be different from prefledged young, and could influence productivity estimates. We suspect that late fledgling mortality likely had a minimal effect on our overall productivity figures in 2011 because most fledglings were close to fledging. Because findings from our survey suggest the Casco Bay Osprey population may lie relatively close to the margin required for population stability, further efforts to consider the effects of potential measurement error in this and future surveys are warranted (Overton and Davis 1969, Fraser et al. 1984, Elith et al. 2006, Henny et al. 2008). The mean productivity maintenance threshold level is considered to be 0.80 young per active nest (Spitzer et al. 1983), and productivity estimated for the 2011 Casco Bay Osprey population was 0.93 young per active nest. Therefore, factors causing overestimates in productivity could have greater consequences to management decisions for this species compared to factors causing productivity estimates to be underestimated.

## 6.7 Summary

This study represents the only effort to comprehensively evaluate and document the abundance, distribution, and stability of the Casco Bay Osprey population. Using primarily aerial survey methods, we estimated the abundance of breeding and presumed resident Ospreys in Casco Bay. Abundance estimates supported the general notion that Ospreys are relatively common in the region. Osprey nests were located throughout Casco Bay, but nest densities varied spatially. Reproductive measures for the population suggest the population reproduces at or above the level required to maintain population stability. Osprey productivity was similar between the New Meadows subregion and the remainder of Casco Bay, but a small sample of nests in the highly industrialized Fore River exhibited relatively high productivity. Evaluations of the Casco Bay Osprey population that compile data from multiple years, such as the one currently underway, will help us interpret the general patterns observed during this first-year survey. This dataset represents a valuable resource that can be used toward a wide variety of management, conservation, and research purposes in the future.

## 6.8 Recommendations

1. As outlined in this report, Osprey populations can exhibit a high degree of annual variability in abundance and productivity. Population surveys were also conducted in 2012 and funding has been secured for the 2013 survey. We recommend conducting a complete 2013 survey that considers appropriate measures for addressing uncertainty related to measurement error.
2. We recommend making statistical comparisons between the 2011-2013 Osprey population surveyed in this study, and those surveyed in 1981-1983 (MDIFW; unpublished data; not a baywide survey). This analysis will provide a first-time evaluation of long-term trends for the Casco Bay population. Based on status assessments of the past and present Osprey populations residing Casco Bay, we will make further recommendations that consider the need for, and value of, continued monitoring of this population in the future.
3. Using the 2011-2013 dataset collected in part during this study, we recommend future analyses further consider the factors influencing the nest distribution and productivity measures in the Casco Bay Osprey population (i.e., nest availability and substrate, habitat selection, distance to Bald Eagles, and food abundance).
4. Previous studies documented high levels of emerging contaminants in Casco Bay Osprey eggs, and notable spatial variability in exposure (Goodale 2010). Studies evaluating the extent and sources of contaminant exposure to Maine Ospreys warrants further investigation. The information collected during this survey (nest locations, productivity) provides a foundation from which subsequent studies can be built.

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