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Original Article

Ten Years of Resident Canada Goose Damage Management in a New Jersey Tidal Freshwater Wetland

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ABSTRACT Intensive grazing by Atlantic Flyway Resident Population Canada geese (*Branta canadensis*) has been shown to dramatically reduce wild rice (*Zizania aquatica*) abundance in tidal freshwater marshes in the Mid-Atlantic Region of the United States. From 2001 to 2010, I implemented an integrated damage management program (IDMP) during spring to abate Canada goose herbivory to wild rice in tidal freshwater marshes of the Maurice River, New Jersey, USA. The IDMP consisted of shooting, rendering goose nests unhatchable, and euthanizing molting geese. With implementation of an IDMP, the number of nests on the study area declined 70% over 10 years and the number of geese declined over time. Consequently, the amount of IDMP effort needed to sustain rice was reduced. Because the study area was a key nesting site for ospreys (*Pandion haliaetus*), which are state-threatened species, there was concern that disturbance from IDMP activities could have a negative impact on osprey nesting or recruitment. The mean annual number of nesting ospreys doubled and the mean number of young fledged/nest was similar between years prior to and during implementation of the IDMP, suggesting that the IDMP did not have a negative impact on ospreys. Wetland managers should consider damage from excessive herbivory caused by non-native, breeding waterfowl, such as resident Canada geese or mute swans (*Cygnus olor*), in their suite of wetland mitigation strategies. © 2013 The Wildlife Society.

KEY WORDS *Branta canadensis*, Canada geese, integrated damage management program, New Jersey, wild rice.

Historically, wild rice (*Zizania aquatica*) was an abundant, emergent annual plant in tidal freshwater marshes of the Maurice River, New Jersey, USA (Ferren 1976) and elsewhere along the mid-Atlantic coast (Cowardin et al. 1979). Wild rice (rice) seed is valuable for many wildlife species (Martin and Uhler 1939, Moyle and Hotchkiss 1945, Webster 1964), and dense rice stems are important as cover for many birds, particularly soras (*Porzana carolina*) and other marsh birds (Melvin and Gibbs 1994). The Maurice River estuary is an important site for wintering waterfowl and raptors (Sutton and Kerlinger 1997, Sutton et al. 1998). Excessive herbivory by Atlantic Flyway Resident Population Canada geese (*Branta canadensis*) has been responsible for dramatic declines of rice within marshes of the Patuxent River, Maryland, USA (Haramis and Kearns 2007) and Maurice River study site (Nichols 2014). However, in both studies, management programs abated grazing impacts by resident geese.

Clark (2004) indicated that Maurice River marshes annually support 10–15% of the state's 330–400 nesting pairs of osprey (*Pandion haliaetus*), which is a state-threatened species (New Jersey Division of Fish and Wildlife 2011). Breeding ospreys have been shown to be sensitive to disturbance (Swenson 1979, Levenson and Koplin 1984). Given the aggressive nature of the integrated damage management program (IDMP) implemented for Canada geese on this study area (Nichols 2014), which involved shooting and boats operating outside of the main river channel during the spring breeding season, managers had a legitimate concern regarding potential impacts to ospreys. My goal was to restore the vegetation characteristics of this freshwater tidal marsh by reducing the number of geese over time while minimizing negative impacts to breeding ospreys. The objectives of this study were to 1) evaluate the effectiveness of the long-term IDMP on Canada goose abundance and 2) assess the impact of the IDMP on breeding ospreys.

STUDY AREA

The tidal freshwater marshes of the Maurice River were located between Millville and Port Elizabeth in Cumberland County, New Jersey, USA (Fig. 1). This section of river was about 9 km in length and included 2 major eastern tributaries, Menantico Creek (3 km) and Manumuskin River (5 km). Maurice River marshes were bounded upstream by the Union Lake dam in Millville; and downstream, the marshes took on oligohaline characteristics before ultimately draining into Delaware Bay. The area consisted of about 420 ha of freshwater tidal marsh dominated by the coastal form of southern wild rice (*Zizania aquatica* var. *aquatica*; Oelke et al. 2000). Ferren (1976)

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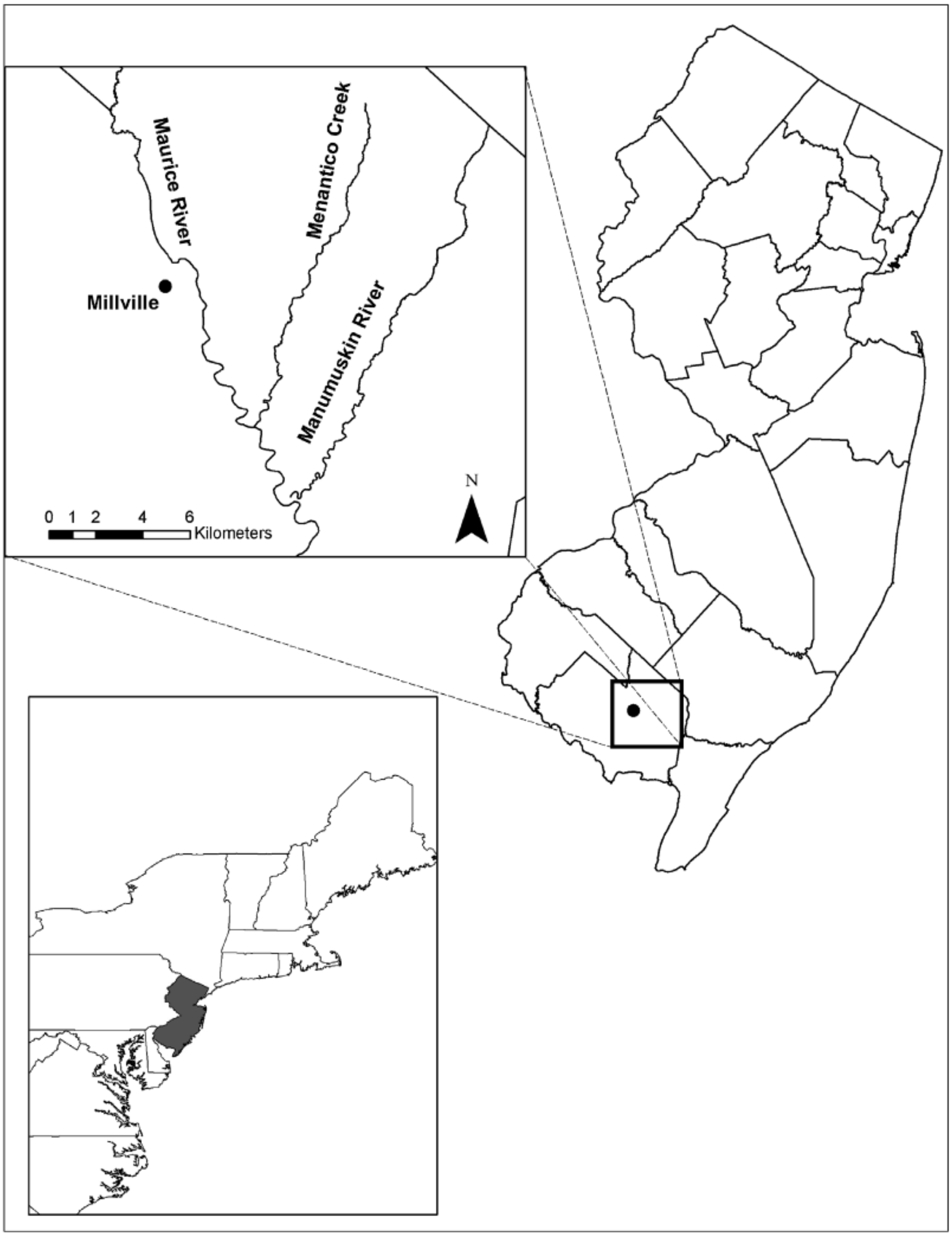

Figure 1. Location of Maurice River study area, showing major tributaries, New Jersey, USA.

described the vegetation characteristics and Nichols (2014) further described the study area. Typical tidal amplitudes ranged from 1.3 m to 1.8 m. As a result of previous agricultural practices, the study area contained about 7.3 km of linear dike remnants of various lengths, many of which now occur as islands and provide nesting sites for geese (Fig. 2). Muskrats (*Ondatra zibethicus*) were common on the study area and their houses also served as goose nesting sites because of their elevation above the high-tide level. Ospreys nested throughout the study area, predominantly on manmade wooden nesting structures. Ospreys also used snags on dike remnants as well as the tops of permanent duck-hunting blinds. The riverbanks were predominantly forested, with much of the marsh and adjacent uplands in public or non-government conservation organization ownership; however, several sections of low-density housing were present on the study area.

METHODS

Integrated Damage Management Program

From 2001 to 2010, I implemented an aggressive IDMP on the study area. Geese were shot during April–May with 12-gauge shotguns loaded with nontoxic, fine-shot ammunition. All geese that presented safe targets and were within effective shotgun range ($\leq$40 m) were shot. Eggs in nests of

Figure 2. Late-June 2003 aerial photo taken in Maurice River marshes, New Jersey, USA, during mid-tide; it shows dike remnants from previous agricultural activities. Many of these dike remnants now occur as islands, which were preferred nesting sites for Canada geese. The vivid green in the marsh is predominantly mid-growing-season wild rice.

incubating females that could not be shot were rendered unhatchable by puncturing with a strong, thin wire (Smith et al. 1999). To facilitate access to remote sections of marsh, work began 2–3 hr prior to high tide and continued through high tide to 2–3 hr of ebbing tide. Geese that could not be approached within shotgun range, usually because of shallow water that would not allow access by boat, were harassed with pyrotechnics fired from a 15-mm pistol-launcher or 12-gauge shotgun (Smith et al. 1999). Because IDMP activities coincided with osprey nesting, only geese >100 m from osprey nest sites were shot. Geese molting in nearby (approx. 1 km) lakes were captured using panel nets (Costanzo et al. 1995) and euthanized with CO_2 gas during late June in 2002 and 2003.

During 2001–2003, the IDMP was most intensive; it began in early April and continued through mid-May. From 2004 to 2007, the IDMP was begun in mid-April and concluded in early May. During 2008–2010, the IDMP was only conducted during mid-April during the peak of Canada goose nesting. From 2001 to 2004, geese were shot from 4-m fiberglass boats powered with 25-horsepower outboard engines; after 2004, geese were shot from a 5-m aluminum boat powered by a 23-horsepower air-cooled, mud-motor engine (Go Devil, Inc., Baton Rouge, LA). During some years, geese were also shot from 3.5-m fiberglass kayaks and from shore.

In an effort to minimize contentious encounters with the public, I only conducted the IDMP on Monday through Thursday, because these weekdays had lower use by fishermen and recreational boaters. To further avoid public encounters, I conducted the IDMP on cool, overcast days, or days with light precipitation whenever possible because fewer people were present during inclement weather. In most cases, I conducted work during mid-day (i.e., 0900–1500 hours) when many river-bank homeowners were away at work. The mid-day period also typically coincided with higher wind speed, which helped to dissipate noise from gunshots. Carcasses were put into opaque, plastic bags when transported in boats and vehicles. Several secure, discrete locations were identified where carcasses could be unloaded from boats and temporarily stored for later pickup by vehicle. I also contacted local law enforcement agencies by telephone just prior to IDMP activities each day.

Canada Goose Use of Study Area

Aerial surveys were conducted at periodic intervals (approx. every 20 days) from about 5 April to 20 June, 2001–2005. The survey period occurred after the migrant population (i.e., Atlantic Population) Canada geese had departed on spring migration and encompassed the nesting, brood-rearing, and remige-molting period of Atlantic Flyway Resident Population Canada geese. The survey period coincided with rice germination, and continued until about mid-growing season. Aerial surveys were conducted from a fixed-wing airplane (Cessna 182) at an altitude of 50–70 m and a speed of 160 km/hr. I served as the only observer and sat in the right front seat next to the pilot. Because geese, particularly nonbreeding-adults (hereafter, subad), used the marshes most readily when rice was exposed for grazing during the low-tide cycle, I conducted surveys within a 4-hr window from 2 hr prior to (ebbing) low tide to 2 hr following (rising) low tide. All wetlands and grassy uplands within 200 m of the marsh were systematically covered and I assumed that all geese present were observed. During the nesting season (survey onset to 10 May), single geese were presumed to represent a nesting pair (Malecki et al. 1981) and, therefore, accounted for 2 birds. Observed goslings were also included in totals of goose use.

Impact of Integrated Damage Management Plan on Osprey Nesting

To document population changes to ospreys during implementation of IDMP in the study area, I obtained nest occupancy and fledgling production data for 1998–2010 (data were not collected prior to 1998) from the New Jersey Division of Fish and Wildlife, Endangered and Nongame Species Program. This time series included 3 years prior to IDMP activities (1998–2000) and the 10 years concurrent with the IDMP.

Statistical Analyses

I used linear regression to determine the trend of the number of goose nests found on the study area through the 10-year duration of the IDMP and mean number of geese observed on aerial surveys in the study area. I compared the mean number of young ospreys fledged/active nest between years prior to and during the IDMP using a Student's t-test. All analyses were done using SigmaStat 3.11, Systat Software, Inc. (Chicago, IL).

RESULTS

For the duration (2001–2010) of the IDMP, 950 geese were removed through shooting ($n = 651$) and culls ($n = 299$) and 291 nests were destroyed or rendered unhatchable. During the first 3 (2001–2003) intensive years of the IDMP, a mean of 209 (SE = 14) geese were killed and a mean 53 (SE = 6) nests were treated annually (Fig. 3). As the IDMP effort was scaled back (2004–2010), a mean of 33 (SE = 6) geese were shot and 19 (SE = 2) nests treated annually (Fig. 3). The number of nests in the study area declined ($r^2 = 0.81$, $F_{1,9} = 31.67$, $P < 0.001$) over the duration of the IDMP. During the first 3 intensive years (2001–2003) a mean 53 nests were treated. During 2004–2006, nesting effort ($\bar{x}$ = 24 nests) declined 55% from 2001 to 2003 and ultimately stabilized during 2007–2010 ($\bar{x}$ = 16 nests) at a level 70% below the nesting effort observed at the onset of the IDMP. For all years, 13–50% ($\bar{x}$ = 28%, SE = 4%) of incubating females were shot (and their nests destroyed), while the remaining nests of incubating females were rendered unhatchable. The number of geese that were hazed from the study area was not quantified because I was frequently unable to discern whether hazed birds left or simply moved to a different section of marsh within the study area. In addition, nearby geese (e.g., within 400-m distance) were frequently hazed by the sound of gunshots when geese were shot.

As the number of geese using the study area declined over time, I reduced the effort (person-hour) expended on the IDMP (Fig. 4). During 2001–2003, 200 hr/year (SE = 0) were expended; whereas, a mean of 57 hr/year (SE = 9) were expended during 2004–2007. Effort was reduced further ($\bar{x}$ = 16 hr/year, SE = 2) during 2008–2010. The mean number of geese shot/hr doubled from 0.5 shot/hr (SE = 0.1) during 2001–2004 to 1.0 shot/hr (SE = 0.1) during 2005–2010. Generally, the mean number of nests treated/hour increased through the study period.

Four to six aerial surveys were conducted each year from early April to late June 2001–2005 (Fig. 5). The annual mean

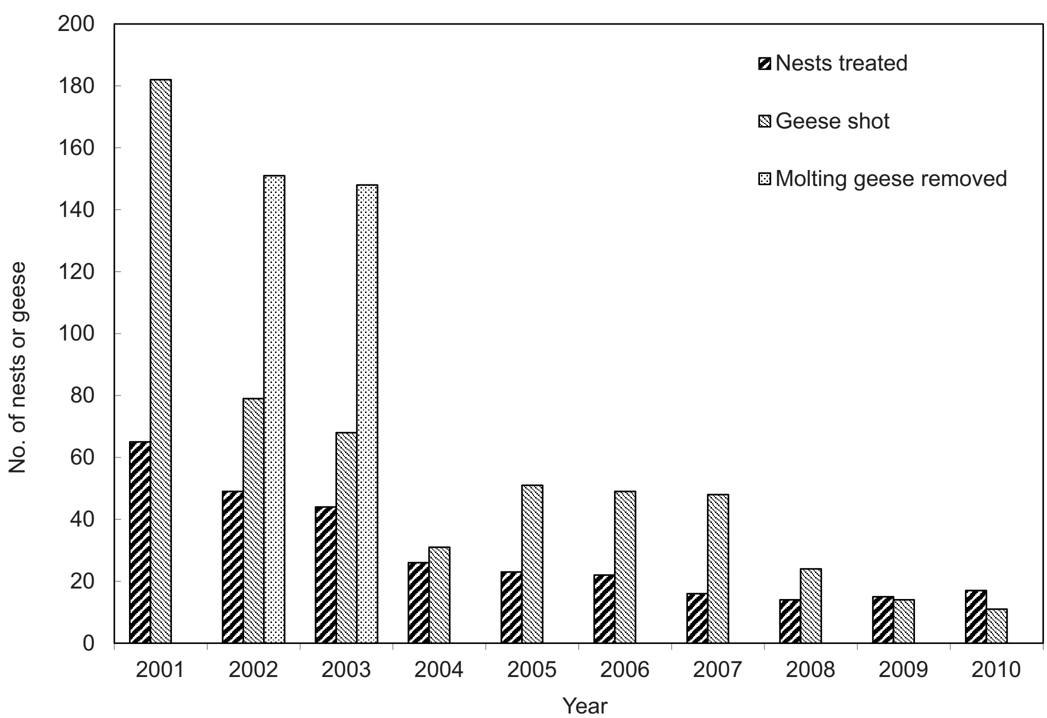

Figure 3. Summary of Canada geese shot, number of molting geese removed, and number of nests treated, by year during Integrated Damage Management Programs in Maurice River marshes, New Jersey, USA, 2001–2010.

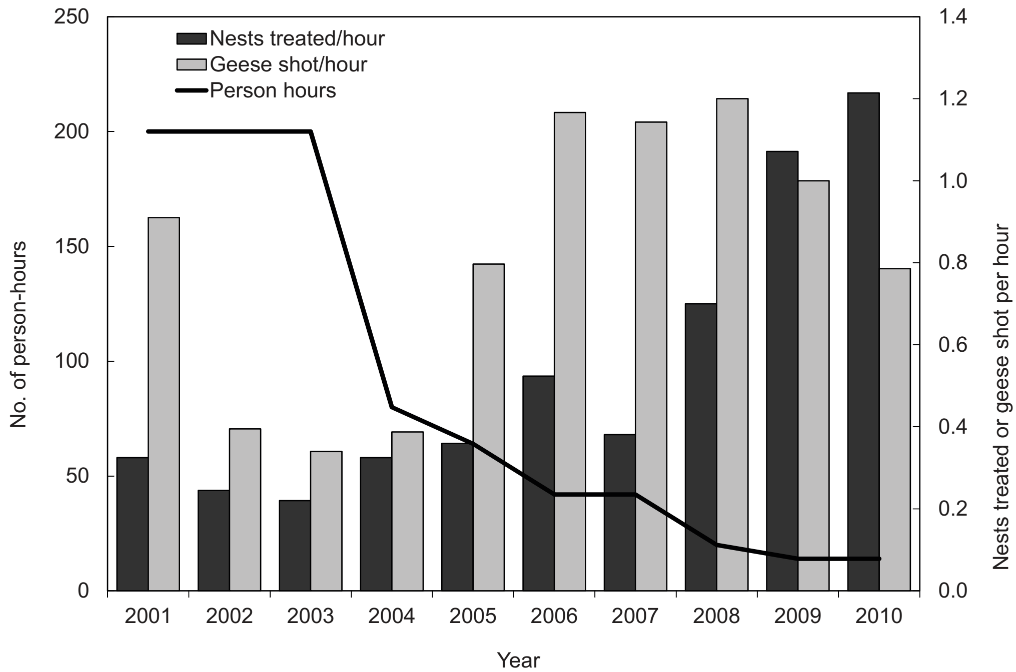

Figure 4. Effort (person-hour) expended, number of Canada geese shot, and nests treated per person-hour expended, by year during Integrated Damage Management Programs in Maurice River marshes, New Jersey, USA, 2001–2010.

number of geese observed in aerial surveys declined ($r^2 = 0.80$, $F_{1,4} = 12.18$, $P = 0.04$) through the IDMP. Each year, the number of geese declined about 30% from the previous year. During the first 3 years (2001–2003) of the IDMP, the number of geese initially declined from early April to early May but then peaked in late May–early June; however, during 2004 and 2005, the number of geese declined continuously throughout the survey period (Fig. 5). During all years of the IDMP, the number of geese reached its lowest point in late June during the Canada goose remige molt. Further, the mean number of geese present during the molt was 15-times greater ($t = 3.316$, $P = 0.045$) during the

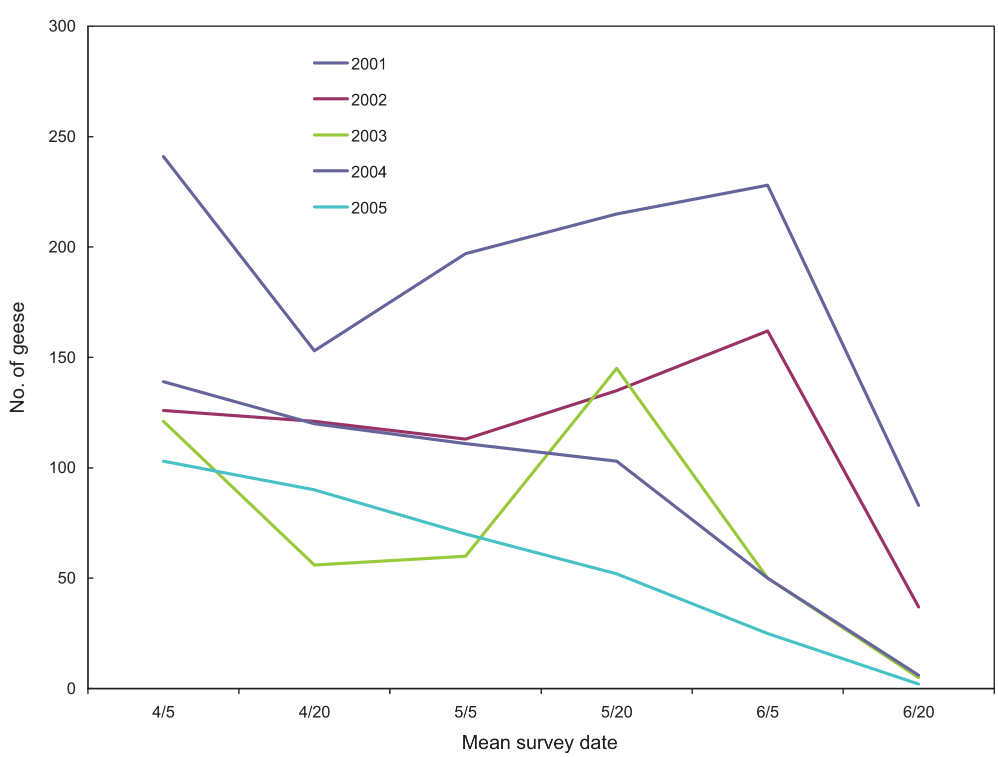

Figure 5. Number of Canada geese observed during early April to mid-June aerial surveys in Maurice River marshes, New Jersey, USA, 2001–2005.

first 2 years of the IDMP (2001–2002; $\bar{x} = 61$ geese, SE = 23) than during the latter 3 years of the IDMP (2003–2005; $\bar{x} = 4$ geese, SE = 1). The maximum number of goslings observed each year ranged from 0 to 17 goslings in 0–4 broods. All maximum observations of goslings occurred during late May. The expense incurred from aerial surveys was not warranted after 2005 because the vegetation characteristics of the marsh had recovered.

The mean annual number of nesting ospreys (Fig. 6) doubled when comparing years prior to (1998–2000; $\bar{x} = 20$, SE = 6) and concurrent with (2001–2010; $\bar{x} = 42$, SE = 3) the IDMP. The mean number of young ospreys fledged/nest was similar ($t_{482} = 0.624$, $P = 0.53$) between years prior to ($\bar{x} = 2.15$, SE = 0.28) and during ($\bar{x} = 1.82$, SE = 0.20) implementation of the IDMP (Fig. 6).

DISCUSSION

Nichols (2014) noted that without an IDMP, the number of geese peaked on the study area in late June during the goose remige molt. This was caused by gosling recruitment and the apparent immigration of additional adult geese to molt in the denuded, lawn-like landscape preferred by flightless, molting geese (Smith et al. 1999). In contrast, geese left the marsh in early June just prior to the molt during all IDMP years, presumably because maturing rice plants were unfavorable as forage and created a visual barrier generally avoided by molting geese. With no IDMP, goose density reached 0.60 geese/ha of marsh during the remige molt in late June (Nichols 2014), while during IDMP years the density of molting geese declined 90% to 0.06 geese/ha. The mean number of nests declined 70% from 2001–2003 to 2007–2010. In addition, the total number of geese declined with each successive year, indicating that the IDMP reduced the number of geese over the long term.

Haramis and Kearns (2007) were able to abate goose damage to rice through egg addling and expansion of hunter access during September Canada goose-hunting seasons. September hunting seasons had been open in study area marshes since 1995 and hunter access to marshes was readily allowed. However, anecdotal observations suggested that few geese used huntable areas of the study area during September hunting seasons, rendering Haramis and Kearns' (2007) approach unviable for reducing adult goose survival in the study area. Although hunting is a cost-effective and preferred alternative for dealing with Canada goose overabundance (Coluccy et al. 2001), hunting can have limitations for reducing adult survival (Balkcom 2010). In modeling simulations, Coluccy et al. (2004) found that reducing adult survival, particularly survival of nesting females, was the most effective way to reduce Canada goose populations. In addition, modeling efforts for mute swans (*Cygnus olor*) by Ellis and Elphick (2007) suggested that an intensive period of adult culls at the onset of the management period was the most efficient option when considering biological effectiveness and economic cost. Given that Atlantic Flyway Resident Population Canada geese are similar to mute swans in being long-lived with high survival rates (U.S. Fish and Wildlife Service 2005), conclusions made by Ellis and Elphick (2007) were supported by my results.

Nichols (2014) noted the important role that goslings had on rice herbivory. Although locating goose nests can sometimes be difficult and limit the efficacy of goose control efforts (Smith et al. 1999), the large tidal amplitude (>1 m) on the study area limited nesting sites to the highest elevations, which made nest sites readily identifiable. Because the number of goose nests and total geese declined, I was able to reduce the amount of effort and costs expended on the IDMP over time.

After the onset of the IDMP each year, ospreys reacted to IDMP boats in a disturbed manner by exhibiting alarm calls and conspicuous posturing (i.e., erect stance, back feathers raised, neck extended, and wings partially opened, beating slowly) as described by Poole (1989). Notwithstanding, it appeared that beyond the initial response, any potential disturbance from the IDMP on breeding ospreys was minimal because the number of occupied osprey nest sites

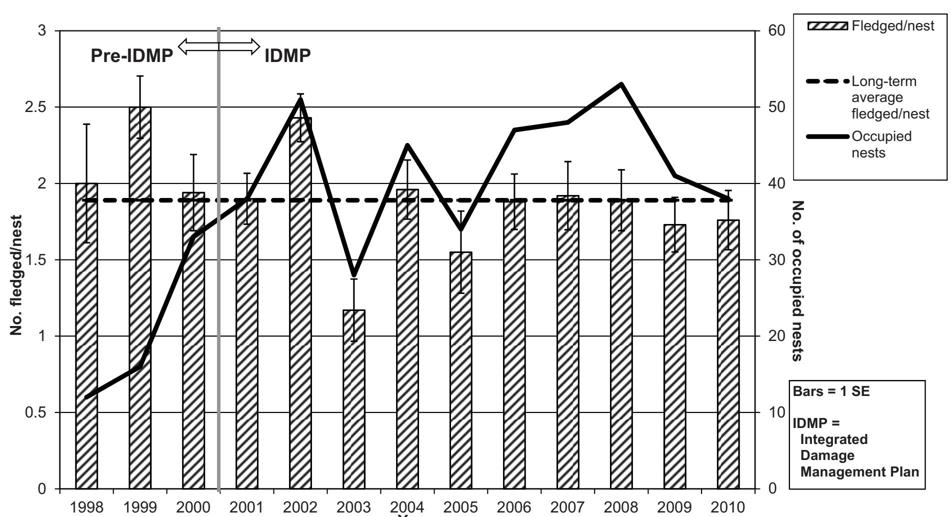

Figure 6. Number of occupied osprey nests and number of young fledged per nest for years before and after an Integrated Damage Management Program for Canada geese was implemented in Maurice River marshes, New Jersey, USA, 1998–2010.

increased during the study period and fledgling production was similar when comparing years before and after the IDMP was implemented.

The study area included a mosaic of landowners; therefore, success of the IDMP hinged on agreement and partnership among all affected parties. Following the dramatic impact that geese had on rice during 2000 (Nichols 2014), I met with several key stakeholders (including the president of an influential local nonprofit conservation group and managers from 3 non-government organizations who had large landholdings on the study site) to discuss options to mitigate goose damage. For 2001, I proposed an aggressive IDMP that would be done by state wildlife agency (NJ Division of Fish and Wildlife) personnel under the authority of federal (16 USC 703–712; 50 CFR Part 13) and state (NJSA 23:4–52) scientific collection permits. The IDMP would focus on goose population reduction during the spring when the critical herbivory damage was occurring on rice (Nichols 2014). All partners endorsed the IDMP for 2001, in effect giving them partial ownership of the program. This was particularly important because goose control programs are frequently controversial with the general public (Smith et al. 1999). Following the dramatic success of the IDMP during the first year (Nichols 2014), and the lack of contentious events involving goose removal, partners continued to endorse the IDMP for the long term. However, an operational funding mechanism was lacking.

In 2003, the City of Millville, New Jersey was required to mitigate for an U.S. Army Corps of Engineers (U.S. ACE) General Permit 14 that involved filling a small portion of wetland in the upper portion of the study area. Because Title 33 in the Code of Federal Regulations (33 CFR 330.1) allows for habitat enhancement for U.S. ACE permits, I developed a Memorandum of Agreement between a nonprofit organization and the City of Millville, whereby the mitigation monies were available to pay IDMP expenses over the long term. Expenses included an annual contract to pay for the work. These funds paid for the IDMP from 2003 to 2010 and include enough monies to pay for this work through 2015.

MANAGEMENT IMPLICATIONS

An IDMP in a tidal, freshwater marsh in New Jersey was successful in restoring the vegetation characteristics of the marsh and reducing the resident goose population over the long term. After several years of intensive management, the IDMP evolved into a less intensive endeavor where only 1–2 staff-days of management were necessary each spring. Wetland mitigation strategies are diverse and include (but are not limited to) acquisition, restoration, and invasive plant (i.e., common reed [*Phragmites australis*], purple loosestrife [*Lythrum salicaria*]) management. Wetland managers should consider damage from excessive herbivory caused by non-native, breeding waterfowl, including resident Canada geese and mute swans (Tatu et al. 2007, Stafford et al. 2012), in their suite of wetland mitigation strategies.

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