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Autumn migration of Northern Saw-whet Owls on the lower Delmarva Peninsula; Fifteen year summary and year 2008 project report

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Cover photo of N. Saw-whet Owl by Shannon Ehlers

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Eastern Shore of Virginia National Wildlife Refuge

The Center for Conservation Biology at the College of William and Mary

The Center for Conservation Biology is an organization dedicated to discovering innovative solutions to environmental problems that are both scientifically sound and practical within todays social context. Our philosophy has been to use a general systems approach to locate critical information needs and to plot a deliberate course of action to reach what we believe are essential information endpoints.

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EXECUTIVE SUMMARY

The Northern Saw-whet Owl breeds in southern Canada and the northern United States. During the late fall months this species migrates south to the mid-latitudes of North America. Prior to the increase in the number of banding operations during the late 1990's, little was known about the Saw-whet Owl's migration ecology and winter distribution because of its secretive habits. During the fall of 1994, The Center for Conservation Biology began a study of migrant Northern Saw-whet Owls along the lower Delmarva Peninsula. This study has been the first to document large numbers of migrants south of Maryland. During the 15-year study, more than 3,300 owls have been banded and more than 100 foreign recaptures and returns have been recorded. We have also recorded over 500 same year recaptures.

The owl migration project is conducted each year between the third week of October and the middle of December. Three trap sites (Eastern Shore of Virginia National Wildlife Refuge (ESVNWR), Gatr Tract/Mockhorn Island Wildlife Management Area (GATR), and Kiptopeke State Park) consisting of 6 mist nets and a continuous-loop audio-lure are opened nightly from dusk to dawn. The primary objectives of these annual surveys are to 1) determine the annual variation in the magnitude and timing of Northern Saw-whet Owl migration through the lower Delmarva Peninsula, 2) determine the spatial pattern of habitat use near the tip of the Delmarva Peninsula, 3) determine the relative timing of passage for different age classes of Northern Saw-whet Owls, and 4) determine the rate of movement of Northern Saw-whet Owls moving down the Atlantic Flyway.

During the fall of 2008, 72 owls consisting of 64 newly banded birds, 6 foreign banded birds, and two owls banded in 2007 were captured and processed during 44 nights and 7,228 hours of operation. Capture rate was 1.6 owls/night or 1.0 owls/100 net-h. Age ratio was 12.5% (9 birds) hatching-year (HY) birds compared to 87.5% (63 birds) after-hatching-year (AHY). In addition to the Northern Saw-whet Owls captured during the season, 10 Eastern Screech Owls were also caught.

BACKGROUND

Each fall, millions of passerines, shorebirds, and raptors travel along the eastern seaboard of North America to over-winter in areas further south. Included with these migrants are populations of Northern Saw-whet Owls (*Aegolius acadicus*). Northern Saw-whet Owls breed throughout the boreal and hardwood forest of southern Canada and northern United States, with some populations scattered in the higher elevations of the Appalachians and Rocky Mountains (Rasmussen et al., 2008). Although Northern Saw-whet owls are resident year-round throughout much of their breeding range, some populations that breed in higher latitudes migrate to lower latitudes for the winter months (Mueller and Berger, 1967; Holroyd and Woods, 1975; Weir, et al., 1980). The Atlantic shoreline is one of the routes Saw-whet owls use on their way to their wintering grounds (Rasmussen et al., 2008; Brinker et al., 1997; Whalen et al, 1997). The winter range of most northeastern populations is believed to be in the east-central United States, but the limits of this range are uncertain (Rasmussen et al., 2008). Sporadic winter records of this species exist for all southeastern states including Florida (Holroyd and Woods, 1975; Miller and Loftin, 1984; Smith et al., 1988). Prior to 1994, there were very few fall or winter records of this species in Virginia (Kain, 1987), and an incredibly small number of records on the Delmarva Peninsula (Anonymous, 2004). In the last twenty years the winter range and the migration route of the Northern Saw-whet Owl is becoming clearer as more trapping and banding of Saw-whet Owls occurs throughout the east.

The Northern Saw-whet Owl is a small, secretive owl that inhabits areas where the vegetation is dense, making visual observations of the owl difficult. Night surveys that have been useful in detecting the movements of larger owls have not been as successful for detecting Saw-whet Owl movements (Russell et al., 1991). In this respect, the expansion of banding stations that concentrate on the capture and banding of Saw-whet Owls have been indispensable for determining Saw-whet Owl fall movement patterns. In the twenty years that some of the banding stations have been operating, capture records and foreign recaptures have indicated that the Atlantic Coastal Plain serves as a Saw-whet Owl migration route that extends from Nova Scotia to the Southeast (Holroyd and Woods, 1975). For instance, Duffy and Kerlinger (1992) demonstrated that substantial numbers of Northern Saw-whet Owls migrate at least as far south as Cape May, New Jersey every year. Northern Saw-whet Owls have also been banded each fall at several locations in Maryland, including Assateague Island National Seashore (Brinker et al., 1997). Finally, banding stations on the lower Delmarva Peninsula regularly capture owls originally banded in Cape May or Assateague Island National Seashore, indicating an exchange of Saw-whet Owls in the fall. Collaboration between Northern Saw-whet Owl banding operations have provided insight into the magnitude and direction of Saw-whet Owl fall migration.

In 1994 three banding stations were established on the tip of the Lower Delmarva Peninsula to investigate the migration ecology of the Northern Saw-whet Owl. This study has been the first to document large numbers of migrants south of Maryland. During the 15-year study, more than 3,300 owls have been banded and more than 100 foreign recaptures and returns have been recorded. We have also recorded over 500 same year recaptures.

The objectives of this ongoing study are to: 1) determine the magnitude of the autumn migration of Northern Saw-whet Owls on the lower Delmarva Peninsula, 2) analyze the spatial dynamics of migration on the lower Delmarva Peninsula, 3) determine the seasonal timing of migration, and 4) investigate age-specific differences in migration ecology.

This long-term study has most recently documented mass variation in Northern Saw-whet Owls and the implication for the much used sexing criteria (Paxton and Watts, 2008). It has also documented passage times (Whalen, et al., 1997), influence of audio-lure use on capture pattern (Whalen and Watts, 1999), diet (Whalen et al., 2000), and some aspects of stopover ecology of Northern Saw-whet Owls migration through the mid-Atlantic coastal plain (Whalen and Watts, 2000).

METHODS

Study Area

This study was conducted on the tip of the lower Delmarva Peninsula that defines the mouth of the Chesapeake Bay to the north (Figure 1). Owls were trapped at three stations located within a 10 km^2 area, and each station was approximately 3-5 km from the other. Stations were located on the Eastern Shore of Virginia National Wildlife Refuge (ESVNWR), Gatr Tract/ Mockhorn Island Wildlife Management Area (GATR), and Kiptopeke State Park. In 2006, the Eastern Shore of Virginia NWR station was moved to an area slightly north; after many trees and shrubs were lost after Hurricane Isabel. Each of the stations are found in forest patches composed of a mixture of Loblolly Pine (*Pinus taeda*), Eastern red cedar (*Juniperus virginiana*), and various hardwoods (*Quercus* spp., *Carya* spp., *Acer rubrum, Prunus serotina*). The understory is moderately dense with green brier (*Smilax* spp.), poison ivy (*Toxicodendron radicans*), American Holly (*Ilex opaca*), and various tree saplings.

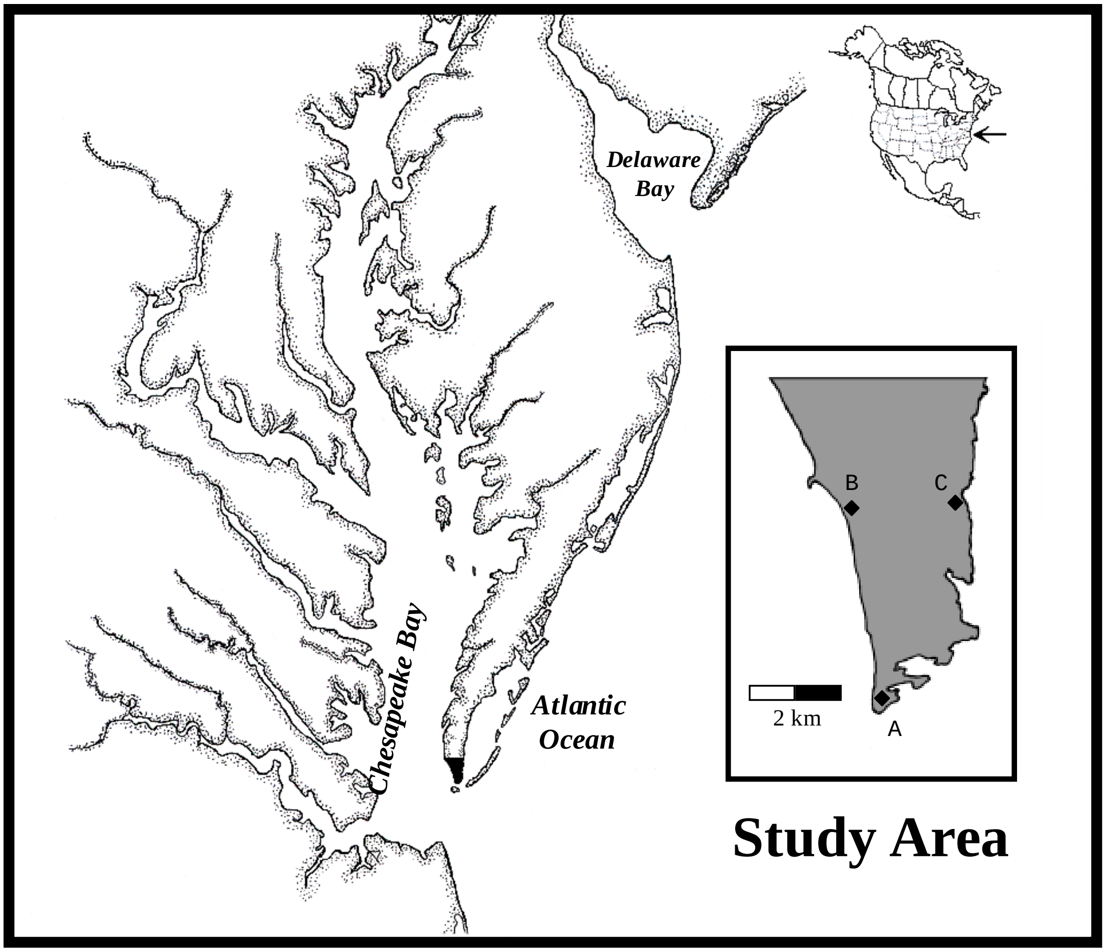

Figure 1. Map of study area on lower Delmarva Peninsula. Inset map shows location of trap sites within A) Eastern Shore of Virginia National Wildlife Refuge, B) Kiptopeke State Park, and C) GATR Tract Wildlife Management Area.

Trapping

A continuous line of six mist-nets was erected along an east-west axis at each trapping station. The mist-nets were 12m long by 2m tall and were made of 60mm black nylon mesh. An audio-lure was situated at the center of each net lane to attract migrating owls. Audio-lures consisted of a portable compact disk player, an amplifier, a 12 V deep cycle marine battery, and a loud-speaker (Figure 2). A continuous-loop broadcast of a Northern Saw-whet Owl "advertisement call" (Rasmussen et al., 2008) was played from the audio-lure. The effectiveness of the audio-lure has been demonstrated by increasing capture rates 5-10 fold in the United States (Erdman and Brinker, 1997; Duffy and Matheny, 1997; Evans, 1997). It should be noted that this technique may exaggerate sex ratios (Whalen and Watts, 1999).

Figure 2. Photos of audio lure components. Photo on left shows components inside plastic container including battery, CD player, amplifier, and bell speaker and connectors. Photo on right shows audio lure in operation with external bell speaker. Photos by Fletcher Smith, CCB.

This year, banding began on 25 October 2008 and continued nightly, weather permitting, until 15 December 2008. Nets were opened at a half hour after dusk and closed at a half hour before dawn. Net checks were conducted every three hours thereafter. A net check consisted of driving to all of the stations in the order in which they were opened and checking the nets for captured owls. All owls were placed in a holding box until processed (Figure 3). Until 2006, owls were processed at the College of William and Mary field house, located on the Eastern Shore of Virginia NWR. Since 2006, owls have been processed in the area of the trapping station and released near the point of capture.

Figure 3. Photo of holding boxes used for transportingowls for processing. Photo by Brian Watts, CCB.

Owls were banded with federal aluminum tarsal bands. A standard leg gauge was used to determine proper band size. Natural (unflattened) wing cord measurements were recorded to the nearest millimeter and mass was recorded to the nearest tenth of a gram using an electronic balance. Wings were inspected for evidence of molt to determine age (Evans and Rosenfield, 1987; Pyle, 1997)(Figure 4). Saw-whet Owls were aged as hatching-year (HY) if all primary and secondary remiges and coverts appeared uniform in color. They were aged as after-hatching-year (AHY) if primary and secondary remiges were not uniform in color, indicating the presence of more than one generation of feathers. Owls that show only two generations of feather were further aged as second-year owls (SY). Additionally, birds with three or more generations of feathers were aged as after-second year (ASY)(Pyle, 1997).

Figure 4. Bird (top left) showing typical hatching year plumage pattern with single generation of light brown feathers. Bird (top right) showing one of the plumage patterns of a second-year bird with two generations of feathers. Bird (bottom left) showing one of the plumage patterns of an after-second year bird with more than two generations of feathers. Photos by Jethro Runco.

RESULTS

In 2008, 72 Northern Saw-whet Owls and 10 new Eastern Screech owls were netted over a period of 44 days (Table 1). Of the 72 Saw-whet Owls, 64 were new captures, 6 saw-whet owls were from foreign stations, and 2 were owls banded in 2007. Additionally, 28 saw-whet owls and four screech owls were recaptured during the season, which included a screech owl that was originally banded in 2001. The stations operated for a total of 7,228 net hours which was less than the previous year (Table 1). Multiple nights of inclement weather and incidents with depredation at ESVNWR resulted in partial or total net closures 25 nights this season. The capture rate was 1.6 owls per trap night or 1.0 owls per 100 net hours. The capture rate was within the average capture rate for non-invasion years although it was 5 times lower than the previous year.

Table 1. Effort, capture totals, and capture rates for Saw-whet Owl trapping on the lower Delmarva Peninsula, 21 October-15 December, 1994-2008.

Year	Trap-Nights	Net-Hours	Owl Captures	Owls/Trap-Night	Owls/100 Net-Hours	Invasion Year?
1994	32	6,903	52	1.6	0.8	No
1995	44	9,481	1,007	22.9	10.6	Yes
1996	42	8,817	106	2.5	1.2	No
1997	40	8,212	101	2.5	1.2	No
1998	22	4,499	22	1	0.5	No
1999	48	9,633	695	14.5	7.2	Yes
2000	46	9,477	101	2.2	1.1	No
2001	48	9,804	273	5.7	2.8	Yes
2002	37	7,287	137	3.7	1.9	No
2003	43	8,279	119	2.8	1.4	No
2004	46	8,559	144	3.1	1.6	No
2005	48	7,421	73	1.5	1.0	No
2006	41	7,704	21	0.5	0.3	No
2007	45	8,577	460	10.2	5.4	Yes
2008	44	7,228	72	1.6	1.0	No
Invasion Year Average	46.3	9,374	608.8	13.1	6.5	
Non-Invasion Year Average	41	7,811	144	3.4	1.7	

The trapping station at Kiptopeke State Park caught 62.5% (n=45) of the saw-whet owls in 2008, which is above average for non-invasion years (Table 2). In non-invasion years, the stations at Kiptopeke State Park and Gatr/Mockhorn Island Wildlife Conservation Area each capture approximately 42% of the owls. In 2008, the captures at Gatr/Mockhorn Island only constituted 23.6% (n= 17) of the owls netted. Both stations were operated for the approximately the same amount of net hours (Kiptopeke= 2,697; Gatr= 2,647), therefore other unmeasured factors must account for the capture percentage difference. The caputure rate at Eastern Shore of Virginia NWR is frequently the lowest of the three trapping sites, and this year proved no different. A meager 13.9% (n=10) owls were captured at the station this year. However this station also operated for fewer net hours (1,883) than the other stations due to hunting season restrictions, exposure to wind, and depredation incidents.

Table 2. Summary of capture locations for Saw-whet Owls on the lower Delmarva Peninsula, 21 October-15 December, 1994-2008.

	Station 1 ESVANWR		Station 2 Gatr/Mockhorn		Station 3 Kiptopeke		
Year	**#**	**%**	**#**	**%**	**#**	**%**	**Totals**
1994	17	32.7	21	40.4	14	26.9	52
1995	237	23.5	323	32.1	446	44.4	1007
1996	29	27.4	40	37.7	37	34.9	106
1997	19	18.8	35	34.7	47	46.5	101
1998	3	13.6	8	36.4	11	50	22
1999	117	16.8	272	39.1	306	44	695
2000	13	12.9	56	55.4	32	31.7	101
2001	61	22.3	57	20.9	155	56.8	273
2002	20	14.6	55	40.1	62	45.3	137
2003	5	4.2	46	38.7	68	57.1	119
2004	19	13.2	65	45.1	60	41.7	144
2005	11	15.1	27	37	35	47.9	73
2006	3	14.2	13	62	5	23.8	21
2007	105	22.8	97	22.1	258	56.1	460
2008	10	13.9	17	23.6	45	62.5	72
Invasion Year AVG	130	21.4	187.3	30.8	291.3	47.8	608.8
Non-Invasion Year Average	14	15.7	35	40.4	38	43.9	86

The age ratio of hatching-year (HY) birds to after hatching-year (AHY) birds was inverted between the 2007 and 2008 banding seasons (Table 3, Figure 5). In 2007, hatching-year owls constituted a greater proportion of the captures (81.5%, n=374), which is indicative of an irruption year. However in 2008, hatching-year birds only constituted 12.5% (n=9) of the total owl captures which is four times lower than the average non-invasion year for HY captures. Frequently the year after an invasion year, there are proportionally more after-hatching-year owls captured. Then in the following years, the difference in the capture rates between HY and AHY owls reduce. In 2008, after hatching-year owls constituted 87.5% (n=63) of the total captures. Further investigation shows that of the 63 after-hatching year birds captured, 51 of these birds were aged as second-year birds (SY), two birds were aged as after-second year birds (ASY), and 10 remained as AHY.

Table 3. Patterns in age ratios of Saw-whet Owls captured 21 October-15 December, 1995-2008.

	Hatching-year Birds		After Hatching-year Birds	
Year	**Number**	**%**	**Number**	**%**
1995	836	83	171	17
1996	15	14	91	86
1997	59	58	42	42
1998	11	50	11	50
1999	559	80	136	20
2000	18	18	83	82
2001	215	79	58	21
2002	58	42	79	58
2003	71	60	48	40
2004	75	52	69	48
2005	57	78.1	16	21.9
2006	8	38	13	62
2007	374	81.3	85	18.5
2008	9	12.5	63	87.5
Invasion Year Avg.	496	81.5	112.5	18.5
Non-Invasion Year Average	38	42.3	52	57.7

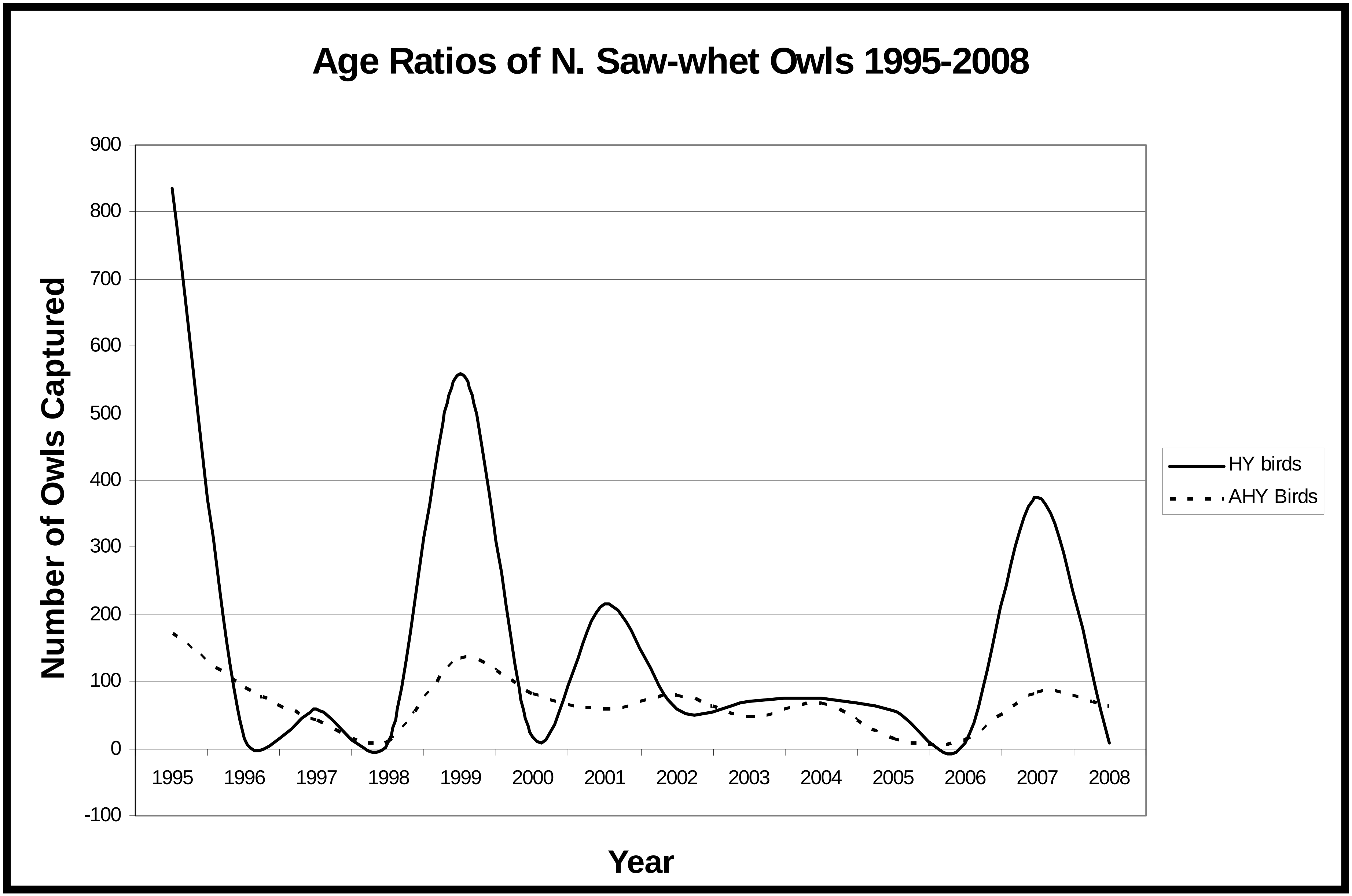

Figure 5. Graph depicting the annual variation in age of Northern Saw-whet Owls captured between 1995 and 2008. Note the spike in hatch-year (HY) birds during the irruptive years of 1995, 1999, 2001, and 2007.

DISCUSSION

Although Northern Saw-whet Owls occur regularly on the Atlantic Coast each autumn, the magnitude of the migration is irruptive in nature. The number of Northern Saw-whet Owls trapped at Cape May, NJ during 1980-1988 ranged from a low of 8 owls in 1984 to a high of 115 owls in 1980 (Duffy and Kerlinger 1992). Our data demonstrate that considerable year to year variation exists in the number of owls migrating through the lower Delmarva Peninsula. In 1995, the owl capture rate on the Delmarva was almost 46 times higher than in 2006, 10 times higher than in 1996, and 21 times higher than in 1998. The 2007 capture rate, while lower than that of 1995, was 20 times higher than 2006, 4.5 times higher than in 1996 and 1997, 3.4 times higher than in 1994 and 11 times higher than in 1998. It has been suggested that annual variation in the number of Saw-whet Owls is almost entirely due to variations in breeding success (Weir et al. 1980). However, huge variation in the magnitude of migration is likely to be caused by a number of additional factors. Newton (1979) suggests that the most important cause of annual fluctuations in the number of migrating raptors is variation in the amount of available prey. In years with particularly harsh weather, such as unusually cold temperatures and early snow cover, prey availability may decrease drastically. Predators may be forced to migrate to lower latitudes in search of a sufficient prey base. As a result, the magnitude of the raptor migration may be larger than normal.

Populations that follow an irruptive pattern for migration are commonly dependent on food sources that are cyclic in their availability and therefore the population moves in accordance to food abundances (Newton, 2006). Northern Saw-whet Owls are an opportunistic feeder that frequently prey upon small mammals, such as Deer Mice (*Peromyscus* spp.), White-footed Mice (*Peromyscus leucopus*), and in boreal habitats, Red-backed Voles *(Myodes* spp.*)*(Rasmussen et al., 2008; Whalen et al, 2000). Although Red-back Voles do follow a cyclical pattern in productivity, Northern Saw-whet Owls are not entirely dependent on voles throughout their range. Their ability to feed on a variety of small mammals prevents them from being irrevocably linked to cyclical prey items (Cote, et al., 2007). Marks and Doremus (2000) propose that Northern Saw-whet Owls are the first example in North America to be irruptive without depending on a cyclical prey because of the low site fidelity they observed in nesting Saw-whet Owls. It is suggested that there is a continuum between species that are regular (obligate) migrants and those that are irruptive (facultative) migrants (Newton, 2006). Although Saw-whet Owls do not depend on a cyclical prey throughout their range, they do possess other characteristics of irruptive migrants.

Each year there was an irruption of Saw-whet Owls, the predominate age class captured were immature birds. In the invasion years of 1995, 1999, 2001, and 2007; immature birds composed 83%, 80.4%, 78.8%, and 81.5% respectively, of the total captures. Interestingly the year immediately following the irruptions; 1996, 2000, 2002, and 2008 recorded a complete inversion of the age ratios with 85.5%, 82.2%, 57.7% and 87.5%, respectively, of the total capture aged as adults. In 2008, 81% of the adult owls were further aged as second-year birds, which means they were hatched in the previous irruptive year, 2007. This suggests that irruptive years of Saw-whet Owls may have its roots in high productivity. It has been suggested that annual variation in the number of Saw-whet Owls is almost entirely due to variations in breeding success (Weir et al., 1980; Cote, et al., 2007). However there are several years that pass between invasion years where capture rates of Saw-whet Owls are low and the age ratio is constant. Therefore other factors must influence the magnitude of migration over the years.

Lack (1954) proposed that prey cycles may intensify the effect of food shortages because low prey years may often be preceded by years of abundant prey in which predator populations experience low mortality and high productivity. For example, studies in the boreal forest during the fall 2006 suggested a rare, synchronized bumper seed crop from both conifers and hardwood trees across eastern Canada and northern United States (Pittaway, 2006). It is presumed that this bumper seed crop produced an increase of productivity of small mammals, particularly Red-backed Voles (Pittaway, 2006). This banner seed crop year (and subsequent rise in prey population) likely increased the productivity of Northern Saw-whet Owls in 2007. However, studies in 2007 discovered that the seed crop for 2007 was greatly reduced which respectively caused, in addition to increased depredation pressure, a crash in vole populations (Pittaway, 2007). Just as productivity for Saw-whet Owls peaked, one of their main boreal food sources crashed causing many owls to move south for the 2007 winter season. Therefore, it is possible that irruptions of Saw-whet Owls are caused by both competition for food sources and high productivity.

Although Northern Saw-whet Owls breed almost exclusively in the northern forest of the United States and Canada, substantial numbers penetrate the Southeast each fall and winter. Prior to the start of owl banding efforts in 1994, there were only a scattering of fall and winter records of Northern Saw-whet Owls on Virginia's coastal plain. However, in 1995, more Northern Saw-whet Owls were captured on the Eastern Shore of Virginia than at any other owl-banding site in the eastern United States. This fifteen-year study has shown that previous descriptions of the Northern Saw-whet Owl as rare on the Coastal Plain were due to the secretive nature of the species, rather than to the relative abundance of the species.

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