Mortality of Migratory Waterbirds in Mid-Atlantic Coastal Anchored Gillnets During March and April 1998

By

Douglas J. Forsell

Fish and Wildlife Biologist

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U.S. Fish and Wildlife Service
Chesapeake Bay Field Office
177 Admiral Cochrane Dr.
Annapolis, MD, 21401
Doug_Forsell@fws.gov

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Executive Summary

The U.S. Fish and Wildlife Service has completed a study to assess bird mortality in nearshore anchored gillnets in the ocean off New Jersey, Delaware, Maryland, and Virginia. The goals were to assess the extent of the fishery, the amount of associated bird mortality, the avian species most susceptible, and the distribution and abundance of birds along the coast. The study consisted of four components: 1) observation of dead birds in net retrievals; 2) surveys of dead birds along beaches; 3) surveys of live birds out to 400 meters offshore from the beach, and 4) aerial surveys for birds and nets.

1) Observation of dead birds in net retrievals

Twenty-five dead birds were observed being removed from 161 net retrievals in New Jersey, Delaware, and Virginia. This equates to a minimum mortality of 0.16 birds per 300 foot net per 24-hour fishing period. Observers identified 13 red-throated loons, 4 common loons, and 2 double-crested cormorants. The mortality was likely underestimated, because several observers believed some fishers concealed netted birds, and some observations were limited by distance and poor weather conditions. Based on approximately 14,900 net sets either reported by fishers to the states or from our observations for states where effort is not reported, I estimated that a minimum of 2,387 diving birds were killed in the study area from February through April 1998.

2) Beach surveys of dead birds

Beach surveys for dead diving birds were conducted repeatedly at 20 locations within the 565 km of coastal shoreline extending from New Jersey through Virginia. Two hundred and ten (210) dead diving birds were found on 1,732 km of surveyed beach or 0.12 birds/km/day. Beach surveys were classified into two groups: 1) beaches with gillnets deployed within 2 km laterally up or down the coast and 2) beaches without gillnets within 2 km. On 851 km of surveys conducted on beaches with no nets set within 2 km, 20 dead diving birds were found, or 0.02 birds/km/day. On 881 km of surveys conducted on beaches with nets within 2 km, 190 dead diving birds were found, or 0.22 birds/km/day. Thus, approximately ten times more dead diving birds/km were found on beaches associated with at least one gillnet than on beaches without a net nearby.

I estimated the length of shore with gillnets deployed within 2 km to be about 115 km, based on shore and aerial observations. Using the value of 0.22 dead diving birds/km/day times an estimated 115 km of shore with gillnets set for a 50-day season (approximate length of fishing season at any one location), I estimated a mortality of 1,265 birds in February through April 1998. This estimate is likely to be low because offshore winds reduce the number of birds that wash ashore, scavenging by gulls reduces the residence time of birds on the beaches, and some fishers were observed keeping dead birds (3 of 25).

3) Surveys of live birds out to 400 meters offshore from the beach

In New Jersey, Delaware, Maryland, and Virginia, surveys of live birds were conducted to 400 m offshore on 590 km of shore with nets deployed within 1 km laterally up or down the coast, and 953 km of shore with no nets deployed within 1 km. I hypothesized that if birds were being killed in gillnets, populations should be lower in areas with nets deployed than in areas where no nets were deployed. For all diving birds, 10.3 birds/km were counted in nearshore waters without nets and 4.6 birds/km were counted in areas with nets. Thus, more than twice as many diving birds were observed in areas without nets as in areas with nets supporting my hypothesis. Rough estimates of the average number of diving birds at any one time during migration within 400 m along the 565 km of shore in March and April 1998 is about 4,600 birds. The most abundant diving birds estimated to be present at any one time were: 465 red-throated loons, 276 common loons, 60 horned and red-necked grebes, 1,050 double-crested cormorants, 1,051 red-breasted mergansers, 593 oldsquaw, and 586 scoters.

Observers categorized the distance that diving birds were observed from shore into 100 meter zones. More than 30 percent of black scoters, gannets, red-throated loons, and cormorants occurred in the 300 to 400 m zone, while red-breasted mergansers, oldsquaw, and common loons occurred in disproportionately higher numbers in the 0 to 100 m zone. The difference in the distributions of these birds affects their vulnerability to being caught in gillnets, because fewer than 4 percent of the nets were deployed between 0 to 200 meters offshore and 14 percent of the nets were deployed between 200 and 400 meters offshore.

4) Aerial surveys

The overall distribution of nets along the coast was determined from aerial surveys. Some areas along the coast where diving birds concentrate were identified. Three aerial surveys indicated very large flocks of scoters and mergansers along the southern Virginia and northern North Carolina coasts. More diving birds would likely be caught if gillnets were deployed in areas where birds concentrate. The distributions of diving birds determined from the aerial surveys helped define the timing of their migration and the time they would be exposed to gillnets.

A vulnerability index was developed based on the bird’s foraging behavior, distance observed from shore, and time in the fished area during migration. Red-throated and common loons were predicted to be most vulnerable to gillnets, were the most often observed caught in nets, and were the bird most often found dead on beaches.

Introduction

Each February through April migratory waterbirds drown in anchored gillnets in the nearshore waters of the mid-Atlantic coast primarily in the American shad (*Alosa sapidissima*) coastal intercept fishery. Preliminary estimates, based on limited field observations in 1997 and bird kills reported to the Madison Wildlife Health Laboratory, indicated that, annually, substantial numbers of diving birds may be killed by anchored gillnets.

In 1998, the U.S. Fish and Wildlife Service initiated a study to estimate the mortality of migratory waterbirds in gillnets anchored in nearshore waters and to estimate populations of waterbirds in the nearshore waters from Barnegat Bay, New Jersey to the Virginia-North Carolina border. The objectives were:

1. To determine the number, distribution, and distance from shore of anchored gillnets along the coast from Barnegat Bay, N.J. to Cape Lookout, N.C., from aerial surveys.

2. To estimate bird mortality in the anchored gillnets by observing fishers as they retrieved their nets.

3. To determine the distribution and abundance of birds in nearshore waters in areas with and without gillnets.

4: To determine the number and species of dead birds washed up on beaches in areas with and without gillnets.

Methods of data collection included aerial surveys and shoreline observations. Observers on beaches counted all waterbirds in the nearshore waters and on beaches, conducted surveys for dead birds on the beaches, and observed fishers pick their nets. The study was designed to provide flexibility so some observers could do all three components of the beach-based work at the same time, while other observers could do any of the three components as time, weather, tides, bird identification ability, and equipment permitted. Numerous volunteers conducted surveys along the beaches, but only U.S. Fish and Wildlife Service employees observed fishers. Aerial surveys were flown to determine the location of nets and the distribution and abundance of birds.

Results

The Gillnet Fishery

Nearshore anchored gillnets were deployed in the study area from late February through April 1998. Most nets were deployed to catch American shad, but in some areas Atlantic croaker (*Micropogonias undulatus*), striped bass (*Morone saxatilis*), bluefish (*Pomatomus saltatrix*), or weakfish (*Cynoscion regalis*) made up a large percentage of the catch. Nets were usually permanently deployed. Also, some gillnets were deployed as drift nets, but observers were unable to differentiate between the fisheries, because they only observed retrievals. Weather permitting, fishers would pick the nets daily, usually in the early morning. A gillnet set was defined as one 300 foot net anchored for 24 hours or a single retrieval if deployed as a drift net.

Two types of boats deployed gillnets in the study area. In Delaware coastal areas and southern New Jersey fishers used open boats < 25 feet in length. Nets were checked by pulling the boat along the net and emptying the fish as the net passed over the boat's rails. In Maryland, Virginia, and northern New Jersey most fishing was conducted from larger boats with hydraulic net reels located near the stern of the vessel. Most gillnets were single-strand monofilament with a 6 to 6.5 inch stretched mesh.

Gillnets were located by aerial surveys along the mid-Atlantic coast (Fig. 1). Aerial surveys on 13 February and 5 March were flown before nets were deployed in northern states. A survey flown on 26 March had poor observation conditions, thus the overall distribution of nets could be determined, but an accurate enumeration of nets was not possible. For this report, I estimated the number of gillnet sets from state databases of fishing effort and supplemental observational data from aerial and shoreline observations. Data were collected differently in each state. The state databases are preliminary and represent those reported by fishers with no attempt at verification (Table 1). An estimated 14,900 sets were made based these data and our estimates of nets in states without data.

Table 1. Estimated fishing effort reported by states and estimated from observations in New Jersey, which did not collect effort data.

State	Number of Boats	Net Yards	Number of 300 ft. Sets
New Jersey[1]	5+	204,919	2,049
Maryland[2]	5+	162,000	1,620
Delaware	5	157,414	1,574
Virginia[2]	15-20	965,667	9,657
All States	30+	1,378,035	14,900

[1] Estimated from nets counted along the coast times a 50 day season.
[2] Data may include drift net fisheries when not differentiated.

Observation of Fishers by Service Personnel

Fishers were observed emptying their gillnets in New Jersey, Delaware, and Virginia. U.S. Fish and Wildlife Service employees used 20 to 80 power spotting scopes to observe fishers from hotels or vehicles on the beach. Some observations were of partial retrievals of nets because fishers may not have picked the entire net,

observation conditions changed, or the observer needed to move their position on the beach. We observed 95 complete net retrievals and 98 partial net retrievals (percentages observed equaled 66 retrievals) for a total of 161 retrievals or 1.08 percent of the estimated 14,900 nets set for a 24-hour period. Soak times of nets were not always known although most were for one day, but some may have been for two or more days due to poor weather hampering fishing activity.

The number of birds killed in nearshore nets was likely underestimated, because some fishers knew they were being observed. Some fishers on small boats appeared to remove birds below the gunwale of the boat, out of sight of observers. More than 20 percent of the birds seen being removed from nets in all areas were observed in the first day fishers were watched in Delaware, and no birds were observed during rest of the study, although birds dead birds washed ashore. It is not known whether this was an unusually high number of birds caught or whether subsequent observations were affected by the fishers hiding the bycatch from observers.

We observed 27 birds and 2 small turtles caught in 161 sets (Table 2). One red-throated loon (*Gavia stellata*) and 1 common loon (*Gavia immer*) were released alive and are not included in the calculations. Observers identified 13 red-throated loons, 4 common loons, and 2 double-crested cormorants (*Phalacrocorax auritus*) of the 25 dead birds observed in the nets. This equates to 0.16 birds killed per 300 foot gillnet per haul or day. This number may be underestimated, because birds were almost certainly missed when seas were rough and nets were more than 500 m from the beach. Conversely, the mortality could be overestimated, because a disproportionate number of nearshore sets were observed. Diving birds may be more abundant in nearshore waters than offshore waters, but no data exists on the distribution of birds beyond 400 meters. By multiplying the 0.16 birds killed per net per day by the estimated 14,900 gillnet sets, I estimate a minimum of 2,387 diving birds were killed in the study area from February through April 1998.

Table 2. Observer days, gillnet sets observed, and birds observed killed in gillnets during March and April 1998.

State	Observer Days	Sets Observed	Birds Observed Killed	Birds Killed per Set
New Jersey*	6	34	5	0.15
Delaware	43	79	11	0.14
Virginia	34	48	9	0.19
All States	83	161	25	0.16

* data includes one days' (10 sets) observation by a NMFS observer.

Beached Bird Surveys for Dead Birds

The beached bird surveys were conducted on 20 beaches (Figure 2) to determine if there were differences between the number of dead diving birds found on beaches in areas where gillnets were deployed and the number found on beaches where gillnets were not present. Beaches with gillnets were defined as those beaches within 2 km of nets.

Birds may drift a great distance from where they are discarded depending on wind and currents, thus, 2 km is probably a conservative estimate if winds are blowing parallel to the beach. This is illustrated by the following observation:

> On 13 March at 1350 hours I observed a red-throated loon floating on the surface about 150-200 m from shore off Fenwick Island State Park, Delaware, a beach with a north-south orientation. The wind was blowing from the southeast at about 10 knots. The bird was found on the shore two hours later, 715 m north of its original location. Since many of the nets were deployed more than 1,000 meters from shore, it is likely that a bird could drift well over 2,000 meters up or down the beach before it comes ashore.

Three factors affected the detectability of diving bird carcasses on the beach or whether the birds came ashore at all. These were wind direction, wind speed, and scavenging by gulls. Wind direction appears to be the major determinant of whether birds will wash ashore. How far the bird drifts before coming ashore is determined by wind speed, wind direction, and the distance offshore the bird is discarded.

Wind Direction

Wind data were obtained from the National Weather Service for wind speed and direction at five coastal weather stations, Wildwood, NJ, Dover, DE, Wallops Island, MD, NOAA Buoy CHLV2 off the mouth of Chesapeake Bay, and Cape Hatteras, NC. Since wind direction appears to determine if birds will wash ashore, a summary of wind directions is necessary to interpret the beached bird surveys. The wind directions were summarized by the percent of total hours and the percent of daylight hours (between 0700 hours and 1900 hours EST) when the wind blew towards the shore at the nearest coastal station. The orientation of each beach was determined and winds were categorized as to onshore or offshore based on a 180 degree arc of the beach's orientation (Table 3). Overall winds blew towards shore (onshore) 47 percent of the daylight hours, ranging from 35 to 56 percent.

Table 3. Beach orientation, percent of 24 hours with onshore winds, percent of daylight hours with onshore winds, and weather stations used to determine the wind directions in March and April 1998.

Beach	Beach Orientation (Degrees, True N)	Percent of 24 hours with Wind Onshore	Percent of Days with Winds Onshore	Weather Station
Atlantic City, NJ	148	52	56	Wildwood
Ocean City, NJ	135	53	55	Wildwood
Sea Isle, NJ	122	53	56	Wildwood
Avalon, NJ	123	53	56	Wildwood
Wildwood NJ	138	53	55	Wildwood
Cape May, NJ	162	45	43	Wildwood
Delaware Bay	85	33	35	Dover
Cape Henlopen, DE	82	32	35	Wallops Is.
Delaware Seashore State Park, DE	82	32	35	Wallops Is.
Fenwick Island State Park, DE	85	32	35	Wallops Is.
Assateague National Seashore (N)	108	40	43	Wallops Is.
Assateague National Seashore (S)	121	54	54	Wallops Is.
Chincoteague NWR (North)	122	54	54	Wallops Is.
Chincoteague NWR (South)	208	56	53	Wallops Is.
Fisherman Island NWR	NA	52	48	Buoy CHLV2
Virginia Beach / Camp Pendleton, VA	76	49	46	Buoy CHLV2
Dam Neck / Sandbridge, VA	72	50	47	Buoy CHLV2
Back Bay NWR, VA	72	50	47	Buoy CHLV2
False Cape State Park, VA	82	49	46	Buoy CHLV2
Cape Hatteras National Seashore, NC	165	53	51	Hatteras
Mean	115	47	47	

Wind Speed

Wind speed combined with wind direction determines the surface currents and how fast a bird drifts. If the wind was blowing toward the shore at low speed a bird may have taken many hours to drift ashore, and may not have arrived at shore until after the beach was surveyed. When daytime winds blew onshore the mean speed at Buoy CHLUV2 was 12.3 knots (SD=6.5) and the wind blew less than 4 knots for 15.7 percent of the time. When winds were less than 4 knots, few birds would wash ashore when most observers were on the beaches. Observers were asked to categorize the condition of dead birds as “fresh,” “decomposing,” “old,” or “previously tagged.” The condition of 137 dead diving birds found on beaches were categorized as fresh. Only 38 fresh birds were found when winds were blowing offshore and 99 fresh birds were found when winds were blowing onshore (Table 4). Red-throated loons were the only species in which a higher number of fresh birds were found with onshore winds than with offshore winds. Some observers may have categorized some birds as fresh that had been on the beach for one or more days (especially during cold weather) and winds often shifted from day to day. Observers found that red-throated loons are quickly scavenged by gulls (see below) and thus may be the best representative of truly fresh birds.

Table 4. Number of fresh birds found washed up on shore when winds were blowing onshore or offshore.

Species	Winds Offshore	Winds Onshore	Total
Red-throated Loon	22	82	104
Common Loon	8	8	16
Northern Gannet	3	2	5
Brown Pelican	0	1	1
Red-breasted Merganser	4	5	9
Surf Scoter	1	1	2
Total	38	99	137

Scavenging by Gulls

Great black-backed gulls (*Larus marinus*) fed extensively on dead floating and beached birds. On several occasions black-backed gulls sitting on the water's surface were observed feeding on red-throated loons that later washed ashore. Most of the red-throated loons that washed ashore were quickly scavenged by adult great black-backed gulls followed by immature great black-backed gulls, herring gulls (*L. argentatus*), and finally ring-billed gulls (*L. delawarensis*). The breast muscle, entrails, and leg muscle often would be eaten within two hours. By the next day, if found at all, often only skeleton, feathers, and skin and would be found. Dead common loons, northern gannets (*Sula bassanus*), and large gulls were seldom scavenged and often remained on the beaches for weeks.

How long carcasses remained on the beach is illustrated by three days of observations at Assateague National Seashore:

> On 3 April, I surveyed the 35.9 km beach from north to south with the wind blowing from the northeast then the east (onshore) at 2 to 10 knots. While surveying to the south between 1000 and 1500 hours two fresh dead red-throated loons were found on the beach. Gulls were seen feeding on at least three dead birds from 200 to 400 meters offshore. While driving back north to

> the beach access between 1500 and 1630 hours an additional 15 red-throated loons were found washed ashore, 14 of them occurring within a 5 km stretch of beach. All birds were marked with aluminum tags held by copper wire. I resurveyed the beach the following morning at starting about 1000 hours. Only one of the 17 birds tagged the previous day was found. One fresh red-throated loon had washed ashore and was tagged. On the morning of 5 April, I surveyed the beach again. No tagged birds were found, but six fresh red-throated loons were found.

Another example of the short residence time of birds on beaches occurred at Delaware Seashore State Park:

> On 16 March, 7 dead red-throated loons were tagged between 1500 and 1745 hours. The following morning, between 1000 and 1200 hours, observers found only two of the previously tagged birds and tagged 14 new dead birds. A survey 23 hours later revealed only one of the 14 birds tagged the previous day and none of the seven birds tagged on 16 March.

Dead birds, particularly smaller birds such as red-throated loons and probably red-breasted mergansers (*Mergus serrator*), were quickly scavenged. The remains often washed away on the next high tide. To ensure that birds were not double counted, aluminum tags with unique numbers were attached to the legs of all birds left on the beaches (approximately 20 birds were collected and frozen for other studies of contaminants and age structure of the population). Of the approximately 180 diving birds tagged and left on beaches, only 28 were recovered on subsequent surveys. Most small birds that were tagged and recovered on subsequent surveys were those which washed ashore during storms or on extremely high tides and were washed above the wrack line. Scavenging by gulls was so severe that estimates of small diving bird mortality derived from beached bird surveys is probably greatly underestimated.

To limit our results to diving birds caught in nets, we attempted to eliminate birds that died from other causes. It was difficult to determine if a scavenged bird had starved, since gulls ate the breast muscle first. At least six of the intact dead diving birds were determined to have starved (lack of breast muscle). A few other birds had outward signs of the probable causes of death such as entanglement in sport fishing gear or oiling of the feathers. If the probable cause of death was determined to be other than gillnets the bird was not included in the analysis or maps. Dead gulls and other non-diving birds were also excluded as they are unlikely to be caught in gillnets. Figures 3-6 show the location of dead diving birds found on beaches and the location of nets observed from shore. Beaches were surveyed with different frequencies, at various times of day, and under various environmental conditions. Therefore, to interpret these maps it is important to remember that the number of dead birds is related in part to the number of surveys and weather conditions, while the number and position of nets usually remained constant throughout the season. Generally, where there were nets, dead diving birds were found and where nets were not present, few to no dead birds were found.

An estimate of bycatch mortality was calculated based on a rate of birds washing ashore. Overall, 210 dead diving birds were found on 1,732 km of beach surveyed or 0.12 birds/km. Each dead bird was classified as to whether gillnets occurred within 2 km of the position it was found. The length of each beach survey was measured and classified into a) distance surveyed with nets within 2 km and b) survey length with no nets within 2 km. On 851 km of beaches without nets surveyed only 20 dead diving birds were found or 0.02 birds/km, whereas on 881 km of beaches with nets surveyed, 190 birds were found dead or 0.22 birds/km. Similar differences (P=0.016 Wilcoxon rank sum test) were found for each summary area (Figure 7).

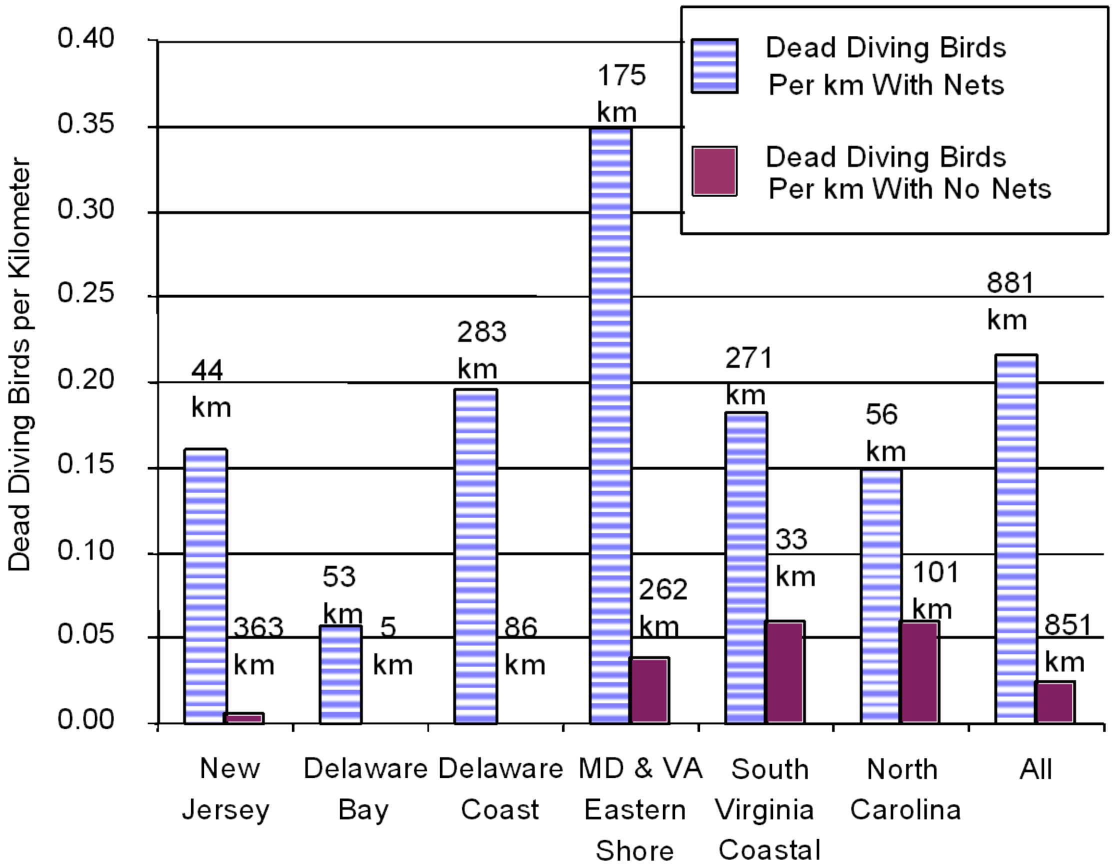

Figure 7. Dead diving birds found on beaches with nets within 2 km and on beaches with no nets within 2 km. Labels show length of beach surveyed in each category.

Based on our beached-based and aerial surveys, at least 115 km of shoreline had nets deployed during the fishing season. A minimum estimate of daily bird mortality can be derived by multiplying the number of diving birds found dead per kilometer of beaches with nets (0.22 birds/km) by the length of coast with nets. Using an estimate of 115 km of shore fished results in a mortality estimate of 25.3 birds per day, times 50 days equals 1,265 birds per season. Because wind direction, scavenging by gulls, and fishers keeping birds result in underestimates, the actual number killed could be substantially higher.

Aerial Surveys

Aerial surveys of different sections of the coast were conducted on 13 February, 5 March, and 26 March 1998 to determine the distribution and number of nets along the coast, the distance of the nets from shore, and to count live birds in nearshore waters. Nets were deployed later in 1998 than in 1997 and the first two aerial surveys were prior to net deployment in areas north of the mouth of the Chesapeake Bay. The final aerial survey was conducted in poor weather and many nets were not detected. Nevertheless, some nets were detected in areas without shore-based surveys (Figs. 1 and 2). The majority of nets were located in seven areas: southern Long Beach Island, NJ; Ocean City, NJ; Delaware Seashore State Park; Fenwick Island, DE; north Assateague National Seashore, MD; south of Chincoteague VA; and the Virginia coast from Virginia Beach to Back Bay National Wildlife Refuge (Figure 2).

Aerial surveys were flown offshore so that observers could view about 400 meters of the water's surface, the same approximate area observed with shore surveys. A different area of the coast was flown each survey, but overall the length of coast surveyed on each flight was similar (range 550 to 572 km) (Figure 8). Aerial surveys with large transect widths such as these are not good estimators of diving bird populations, but the results can be used to indicate relative abundance, occurrence, and concentration areas. To compare the distribution of diving birds among surveys, the three days' surveys were plotted on the same map by displaying each successive survey a degree of longitude to the east of the previous survey.

Diving birds were relatively abundant on all three aerial surveys (Figure 8); however, the species composition changed as spring migration progressed. Red-throated and common loons were present on all three surveys, with loon abundance decreasing in Virginia and North Carolina by the end of March (Appendix 1). Red-breasted mergansers were abundant on the February survey, but few were seen on the March surveys (Appendix 4). Surf scoters (*Melanitta perspicillata*) and black scoters (*M. Nigra)* appeared to remain in the study area longer than mergansers, but by late March most had migrated north (Appendix 5). Few northern gannets and double-crested cormorants were seen north of Cape Hatteras, NC in February, but were common by the end of March and abundant in areas with beach-based shoreline surveys in late April (Apps. 2 and 3).

Several concentrations of diving birds were seen. A flock of about 8,000 surf and black scoters was observed in the nearshore waters of Cape Henry, VA and another flock of about 4,000 surf scoters was observed about 40 km north of Cape Hatteras NC. (Appendix 5). Large numbers of red-breasted mergansers were observed in nearshore waters extending from about 30 km south of Cape Henry, VA to Oregon Inlet, NC (Appendix 4). These large concentrations of mergansers and scoters observed in Virginia and North Carolina did not occur in areas with gillnets.

Distance of Nets from Shore

The distance of the nets from shore was not summarized from the aerial surveys because observation conditions were poor on the 26 March flight when most nets were present. Better data were obtained by the shore-based observers. The distance of nets from shore was recorded by most observers during the shoreline census, however the data are biased, because some observers could not detect or did not record distant nets. Also, rain, fog, or high seas sometimes obscured nets beyond 400 meters. Additionally, distant nets could have been drift nets or bottom gillnets. Overall, the mean distance of nets recorded by observers was 727 meters from shore. Less than 29.6 percent of the nets were less than 499 m from shore (Table 5). Although biased towards nearshore nets, this data is important when compared to the distribution of birds recorded during surveys.

Table 5. Distance of gillnets from shore recorded by observers on shore during bird surveys in March and April 1998. Data are biased towards nearshore nets, as observers could not see distant nets in rain, fog, or high winds.

Distance From Shore (meters)	Number of Nets	Percent of Nets	Cumulative Percent
0 - 99	4	0.7	0.7
100 - 199	16	2.7	3.4
200 - 299	29	4.9	8.3
300 - 399	58	9.9	18.2
400 - 499	67	11.4	29.6
500 - 599	77	13.1	42.8
600 - 699	61	10.4	53.2
700 - 799	36	6.1	59.3
800 - 899	62	10.6	69.8
900 - 999	40	6.8	76.7
1000 - 1099	45	7.7	84.3
1100 - 1199	19	3.2	87.6
1200 - 1399	19	3.2	90.8
1400 - 1599	22	3.7	94.5
1600 - 1999	13	2.2	96.8
2000 +	19	3.2	100.0

Distribution and Abundance of Birds in Nearshore Waters from Beach-based Surveys

The nearshore waters were surveyed out to 400 m from shore to determine if the number of live birds counted in areas with nets differed from areas without nets.

The sample areas were largely determined by accessibility of beaches and the location of volunteers' homes. Observers varied in abilities, experience, and optical equipment used. More than 70 percent of the censuses were conducted by experienced observers with excellent optics. We standardized the estimation of distances by using binoculars with a reticle pattern in "mils." These allow the observer to measure distances offshore if their height above the water is known.

Surveys could not be controlled for the spring migration or the time of day surveys occurred. Both factors make the interpretation of species abundances difficult. Many species of waterbirds have a great affinity for their wintering areas. It was hoped this study would encompass wintering populations followed by migratory populations. Unfortunately, due to a mild winter and a late fishing season, surveys were initiated after some birds had started their northward migration. This confounded our ability to detect if differences existed in bird abundance in netted and non-netted areas prior to migration.

Coastal censuses of live birds were conducted out to 400 m offshore on 590 km of shoreline with nets offshore, and 953 km of shore with no nets within 1 km. Beaches were classified as having nets if a net was within 1 km. The rationale was that local abundance of birds may only be affected to 1 km away rather than the 2 km chosen for the analysis of dead birds, which may drift long distances. For all census areas and species combined, we counted 10.25 birds/km in non-netted areas and 4.64 birds/km in areas with nets. When broken down by species for all areas, higher numbers of diving birds were counted in areas with no nets than areas with nets for all species or species groups except northern gannets (Table 6, Figure 9).

The distance from shore that diving birds were observed was categorized into 100 meter zones. Species varied considerably in their distribution within the 400 m survey area. More than 30 percent of black scoters, gannets, red-throated loons, and cormorants occurred in the 300 to 400 m zone, while red-breasted mergansers, oldsquaw (*Clangula hyemalis*), and common loons occurred in disproportionately higher numbers in the 0 to 100 m zone (Figure 10). Diving birds that primarily occur in the 300 to 400 m zone may be underestimated, because birds beyond 300 m are difficult to detect in poor observation conditions. Small birds such as red-throated loons, are also especially difficult to detect at great distances.

The difference in the distributions of these birds along the coastal shores is probably reflected in their vulnerability to being caught in gillnets. For example, 91 percent of the red-breasted mergansers and less than 3.4 percent of the nets occurred within 200 meters of shore, thus their vulnerability to nets is low. The vulnerability of red-throated loons is high, since more than 56 percent of the birds detected were observed in the 200 to 400 m zone where about 15 percent of the nets occurred.

Table 6. Birds per kilometer of shore counted out to 400 meters along the mid-Atlantic coast during March and April 1998. Beaches were categorized as having "No Nets" if there were no gillnets within 2 kilometers.

Species/ Km Surveyed	Nets Within 2 km	New Jersey	Delaware Bay	Delaware Coast	MD - VA E. Shore	VA Coast	No. Carolina	All Areas
Km Surveyed	No Nets	366.8	12.7	98.5	270.2	93.9	111.1	953.2
Km Surveyed	Nets	61.6	52.9	128.3	167.2	133.9	46.3	590.1
Red-throated Loon	No Nets	1.04	0	2.12	0.29	0.28	0.11	1.08
Red-throated Loon	Nets	0.75	0	0.55	0.42	0.40	0.04	0.41
Common Loon	No Nets	0.28	0	0.18	1.21	0.14	0.57	0.59
Common Loon	Nets	0.36	0.02	0.16	0.54	0.46	0.02	0.33
Grebes	No Nets	0.17	0	0.03	0.05	0.07	0.23	0.14
Grebes	Nets	0.11	0.09	0.04	0.01	0.10	0.02	0.06
Northern Gannet	No Nets	0.02	0	0.06	0.12	0.06	0.09	0.08
Northern Gannet	Nets	0.13	0	0.12	0.28	0.22	7.49	0.76
Double-crested Cormorant	No Nets	0.13	0.32	0.56	3.56	0.01	11.77	2.50
Double-crested Cormorant	Nets	0.03	0.57	0.24	0.66	0.06	6.57	0.82
Oldsquaw	No Nets	2.96	0	0.79	0.06	0	0	1.59
Oldsquaw	Nets	1.28	0	0.11	0.05	0.01	0	0.17
Scoters	No Nets	0.23	0	0.19	2.35	0.44	0.04	1.25
Scoters	Nets	0.05	1.32	0.24	1.47	0.46	0.06	0.70
Red-breasted Merganser	No Nets	0.33	0	0.38	0.57	0.93	20.37	2.81
Red-breasted Merganser	Nets	0.03	2.97	0.02	0.41	2.59	3.30	1.24
Other divers	No Nets	0.25	0	0.02	0.21	0.01	0.38	0.21
Other divers	Nets	0.06	0.08	0	0.29	0.07	0.48	0.15
All Divers	No Nets	5.41	0.32	4.33	8.42	1.94	33.56	10.25
All Divers	Nets	2.81	5.05	1.47	4.12	4.38	17.99	4.64

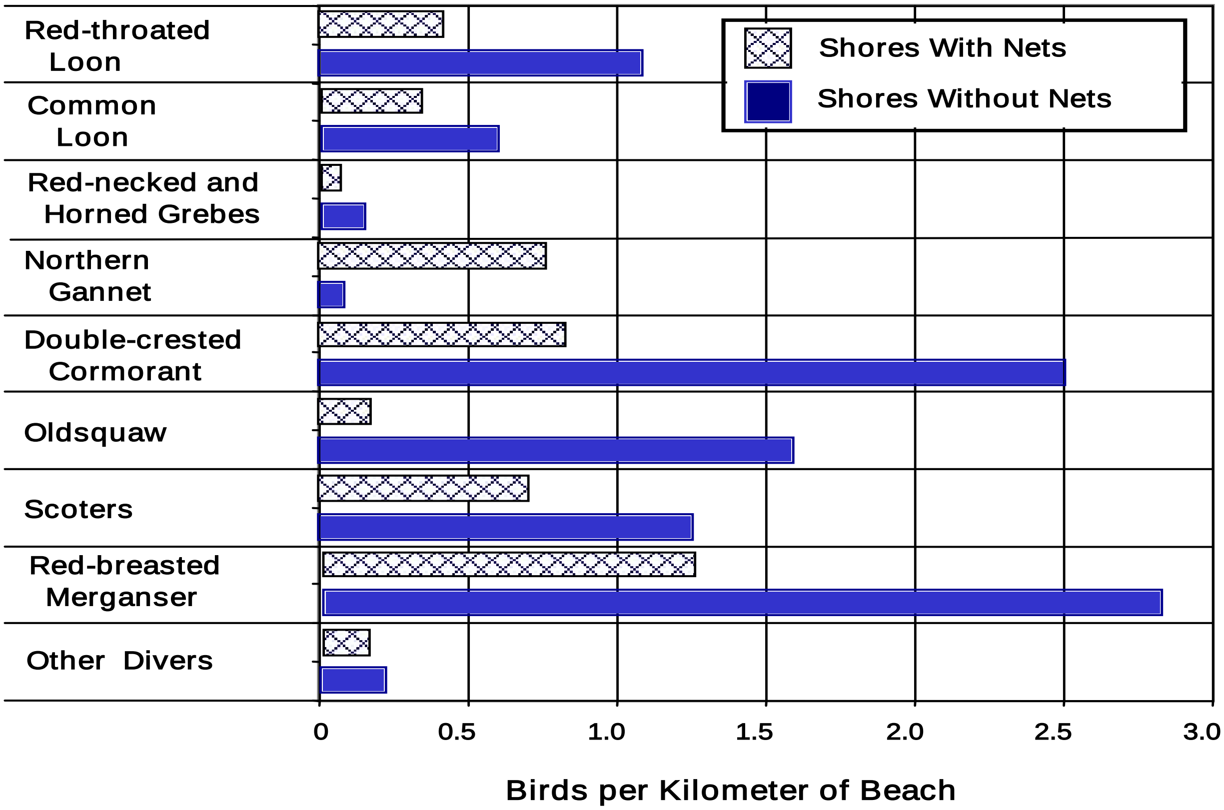

Figure 9. Number of birds observed out to 400 m offshore in areas with nets and in areas without nets in March and April 1998.

A gillnet vulnerability index for birds in mid-Atlantic nearshore waters was developed based on three variables: residence time, foraging behavior, and distribution in nearshore waters. Birds were ranked for residence time as: "low" if they are spring migrants only and were not in the waters for most of the fishing season (e.g. gannets) or are winter residents and most birds migrated north by the middle of the fishing season (e.g. scoters); "medium" if they are winter residents and many birds did not migrate north until the end of the fishing season (e.g. oldsquaw); or "high" if they are winter residents and migrants that move into the area throughout the fishing season (e.g. loons). Birds were ranked on their foraging behavior as: "low" for plunge divers (e.g. brown pelicans (*Pelecanus occidentalis*); "medium" for benthic foragers (e.g. scoters) or plunge divers with limited pursuit (e.g. gannets); or "high" for pursuit divers and underwater foragers (e.g. loons and mergansers). Birds were ranked by their distribution out to 400 m offshore as: "low" if more than 70 percent of the birds occurred within 200 m of shore (e.g. mergansers); "medium" if they were evenly distributed to 400 m (e.g. cormorants); or "high" if more than 30 percent of birds were observed in the 300 to 400 m zone (an area where some birds were probably not detected in surveys, thus the percentage is probably higher (e.g. red-throated loons). A sum of the rankings indicate that red-throated loons should be the most vulnerable to gillnets, followed by common loons then scoters, cormorants, and gannets. The number of birds found washed up on beaches with the cause of death undetermined or with net marks roughly corresponds to the index rankings (Table 7).

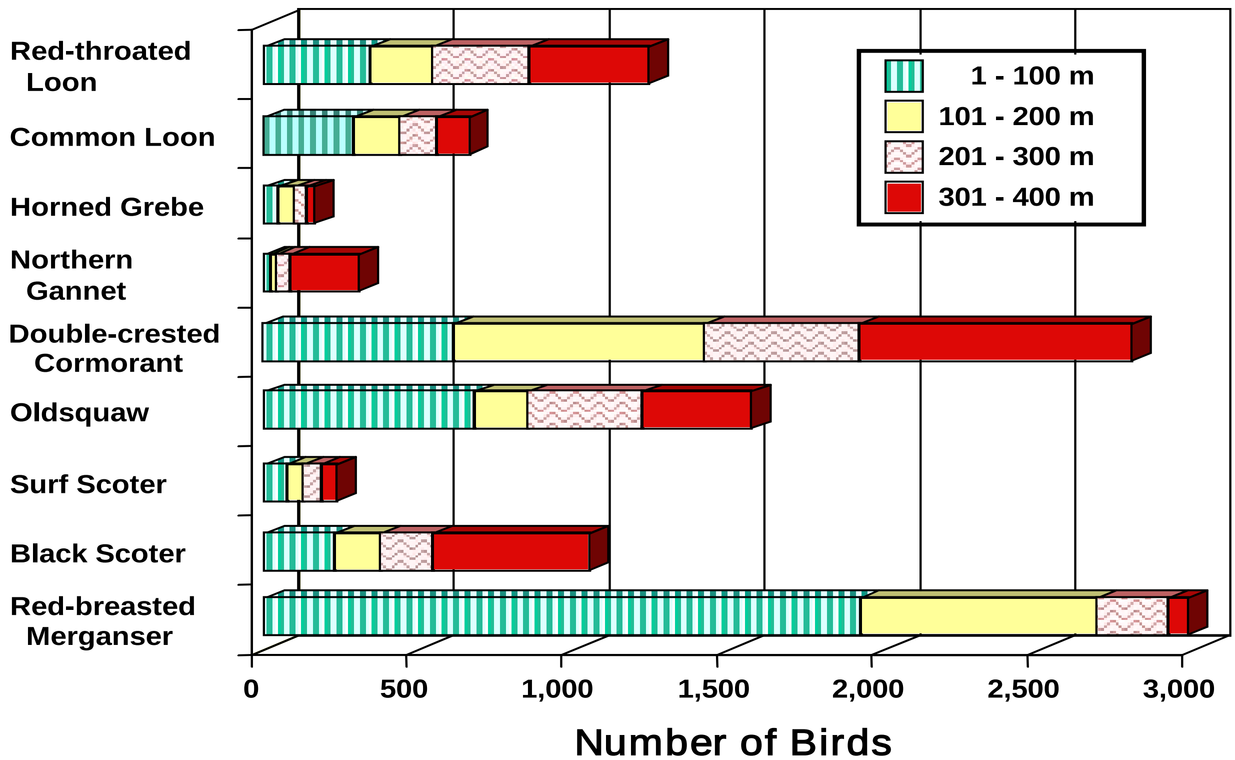

Figure 10. Number of live birds observed in 100 meter zones out to 400 m along the mid-Atlantic coast during March and April 1998.

Vulnerability Index

Foraging behavior and migration are reasonably stable factors in predicting a bird's interaction with nets, while the distance from shore is only known for the closest 400 meters. Most red-breasted mergansers, at least based on daytime distribution, would not be caught in nets if nets were not placed within 400 meters of shore. The distribution of birds beyond 400 meters from shore was not known, but NMFS observers see many red-throated loons, common loons, and northern gannets caught in offshore waters. On calm days these birds were often observed out to 600 meters. Many of the birds found on beaches likely came from nets located beyond 400 meters. Without data on the distribution of birds offshore and better bycatch data predicting a reduction in mortality due to moving nets further offshore is not possible.

Populations of Diving Birds

Little data exists on populations and distribution of waterbirds along the mid-Atlantic coast. The beach-based surveys are possibly the first along the mid-Atlantic coast.

The U.S. Fish and Wildlife Service's Migratory Bird Management Office conducts a coastal seaduck survey in late January, but few loons are counted. Additionally, many of the birds that are caught in gillnets during spring migration are wintering in areas not surveyed.

Table 7. Vulnerability index for birds along the mid-Atlantic coast exposed to gillnets in March and April. The higher the total index number the more vulnerable the bird is to being caught in gillnets based on their distribution from shore, foraging and feeding behavior, and time in the area.

Species	Residence Time[1]	Foraging Behavior[2]	Distance From Shore[3]	Total Index	Number Found Dead on Beaches
Red-throated Loon	3	3	3	9	137
Common Loon	3	3	1	7	37
Northern Gannet	1	2	3	6	15
Double-crested Cormorant	1	3	2	6	2
Brown Pelican	1	1	1	3	2
Red-breasted Merganser	1	3	1	5	14
Scoters	1	2	3	6	2

[1] Residence Time 1 = Late spring migrants in or early spring migrants out, 2 = winter residents and many birds did not migrate north early, or leaves area early, 3 = residents and/or migrants for whole period.

[2] Foraging Behavior: 1 = Plunge diver; 2 = Benthic foraging or plunge diver with limited pursuit; 3 = Pursuit diver and underwater forager

[3] Distance from shore 1 = >70 % in 1 to 200 m from shore, 2 = Evenly distributed to 400 m; 3 = > 30 percent of birds in 300 to 400 m zone.

Breeding populations of some birds susceptible to gillnets are well known for species such as northern gannets which nest on large colonies and are regularly censused. Others such as scoters and red-breasted mergansers nest in forested and coastal areas and indexes are available, but population estimates are lacking. Little data exists for common loons that nest on lakes throughout the northern forests. Red-throated loons nest on ponds on the coastal arctic plain, much of which is not surveyed.

Since 1995, Cape May Bird Observatory has conducted a sea watch where observers attempt to count all waterbirds migrating along the shore of southern New Jersey. The counts are made in all daylight hours from 22 October through 22 December. These counts provide a minimum number of birds passing Cape May in the fall. They do not provide data for red-breasted mergansers, oldsquaw, or white-winged scoters (*Melanitta fusca*) because most of these birds migrate overland to the coast. Large numbers of black and surf scoters are counted during the survey, but the numbers are quite variable. Common loons move along the coast, but some also migrate overland, and some are found off the coast out to over 50 miles offshore. Thus, while the numbers may provide an index to populations, they are not populations. Red-throated loons, appear to migrate along the coast and the numbers are consistent with populations in some bays. Forsell (1994) estimated about 14,000 red-throated loons winter in Chesapeake Bay. If other coastal bays and coastal areas have similar numbers as the Chesapeake Bay than the 67,400 birds passing Cape May (Joan Walsh, Cape May Bird Observatory, pers. com.) may be an approximate estimate of the south-Atlantic population (Table 8).

Table 8. Number of birds counted passing southern New Jersey during coastal sea watches conducted from 15 October through 15 December 1993 to 1997. Data provided by Joan Walsh, Cape May Bird Observatory.

Year	Red-throated Loon	Common Loon	Unidentified Loons	Black and Surf Scoters [1]
1993	53,206	3,231	900	197,932
1994	53,865	4,778	264	228,041
1995	58,881	4,818	109	444,425
1996	55,175	5,026	65	470,070
1997	67,269	4,129	250	344,432
Mean	57,679	4,396	318	336,980

[1] Scoters include unidentified scoters which may have included a small percentage of white-winged scoters.

Conclusions

Based on observation of commercial gillnet fishing an estimated 2,387 birds were killed in the mid-Atlantic gillnet fishery from February through April 1998. Approximately 68 percent of birds observed dead in nets were red-throated loons and 21 percent of the birds were common loons. This would represent over 1,633 and 503 birds, respectively, taken as bycatch in the gillnets. From the beached bird surveys I estimated a minimum of 1,265 diving birds were killed in gillnets along the mid-Atlantic coast. This estimate is likely to be low because offshore winds reduce the number of birds that wash ashore, scavenging by gulls reduces the residence time of birds on the beaches, and some fishers keep dead birds. Over 65 percent of the birds found on beaches were red-throated loons and about 18 percent of the birds found dead on beaches were common loons which tends to corroborate our data from observing fishers. This would represent over 825 red-throated and 225 commons loons taken as bycatch in the gillnets. A few hundred northern gannets, cormorants, and red-breasted mergansers were also taken. For red-throated loons these mortality estimates equate to about 1.2 to 2.4 percent of the 67,300 red-throated loons that migrated past Cape May, New Jersey in the fall of 1997.

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