SEANET Online Expansion

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Introduction

Disease, pollution, weather, invasive species, fishers, weather, and trauma threaten coastal and sea birds of the world and are all causes of significant seabird mortality. In order to detect and monitor the effects of such threats on the Atlantic Coast, the Tufts Center for Conservation Medicine / Wildlife Clinic launched the Seabird Ecological Assessment Network (SEANET). The goal of SEANET is to gather information about the status of seabird populations by monitoring individual and species mortality events and also by collecting samples from carcasses. Using this information, SEANET wishes to increase awareness of seabird lifecycles, understand the human population's impact on seabird survival, monitor the overall health of coastal ecosystems, and benefit seabird conservation efforts.

SEANET involves both citizen and scientist in conducting regular beached bird surveys (BBS) specifically along the Atlantic Coastal Region. Beached bird surveys are counts of stranded live birds and corpses found along regularly patrolled coasts and bodies of water. Because of the magnitude of this project, beached bird surveys are done primarily through a network of volunteers. The SEANET project organizes a network of over 60 seabird and ecological health organizations stretching from Canada down to Florida. Additionally, over 300 volunteers both citizen and scientists help the program by performing the actual beached bird surveys.

Beached bird surveys began in the 1950's and 60's when it became evident that chronic oil pollution posed a serious threat to seabird populations. In Europe, South America, and South Africa, beached bird surveys proved to be a valuable source of information regarding the adverse effects of chronic oil pollution on coastal and seabird populations (Avery, 1989; Gandini, 1994; Kuyken, 1978; Raevel, 1992; Vauk, 1989). Beached bird surveys continue to be a valuable tool for monitoring oil pollution and supporting conservation efforts. One example of the benefit of these surveys occurred in the Netherlands. The surveys from 1977-1997 indicated a decline in oiled seabird mortality after efforts were set into place to reduce oil pollution at sea (Camphuysen, 1998).

In 1974 observers in the United States began monitoring several beached bird sites along the Atlantic Coast that indicated significant numbers of oiled seabirds. The area ranged along the Atlantic coast from Nantucket to Florida (Simons, 1985). No additional surveys, however, were conducted after Simons' report in 1985 until recent indications that oiling was becoming an increasing threat again. Beached bird surveys conducted by the Canadian Wildlife Service and the Atlantic Cooperative Wildlife Ecology Research Network revealed that the levels of oiling had increased to 74% of all sea accidents in the late 1990's as result of illegal dumping of oil bilge waste (Chardine, Elliott & Ryan, 1990; Wiese & Ryan, 1999). In response to this increasing threat, Tuft's developed SEANET in 2002 in an effort to begin gathering information about the status of coastal and seabird populations in the United States.

Because seabird populations fluctuate naturally due to disease, weather, predators, availability of resources, etc, one of the major problems associated with any beached bird survey is the accuracy of the counts. One of the objectives of SEANET is thus to develop a long-term monitoring system in an effort to establish baseline levels of mortality. In other words, the SEANET program wishes to establish mortality numbers that occur naturally for each species and can therefore be referenced in later years to indicate increasing or decreasing mortality rates. Previous surveys have indicated that analysis of the collected data through beached bird surveys takes 15 to 20 years to detect trends in oiling and other gross mortality rates (Camphuysen, 1998).

In order to investigate the distribution and relativity of mortality events, SEANET collects carcass samples for necropsy and lab analysis. The data generated from these analyses are collected and stored in an extensive database that can be used to detect patterns in seabird mortality. With this information and analyses, SEANET aims to increase awareness about infectious diseases, ectotoxins, and other natural and anthropogenic threats to seabird populations to the general public, the scientific community, and government agencies. Close monitoring of incidences of seabird mortality can result in early detection of and quick responses to disaster events such as oiling, algal blooms, diseases, poisons, etc. In addition, seabirds also have the potential of being used as a "bioindicator" of ecological changes in the marine environment (Buger & Gochfeld, 2004; Furness & Camphuysen, 1997). Seabirds are known to be sensitive to changes in food supply and can therefore also be potential monitors of fish stocks (Furness & Ainley, 1984; Furness & Barrett, 1991). Monitoring of sea and coastal birds has also proven effective in monitoring oil pollution (Bourne, 1976; Camphuysen, 1998). Seabirds and their eggs can also be monitors of pollutants that accumulate at the trophic level such as pesticides and heavy metals (Furness, Lewis & Mills, 1990; Furness, Muirhead & Woodburn, 1986). Finally monitoring seabirds may help assess disease and contaminants that are threatening to human health (Furness, Lewis & Mills, 1990; Furness, Muirhead & Woodburn, 1986).

SEANET & WPI

Since its birth in 2002, SEANET has collected a vast amount of data both from the beached bird surveys and from necropsies. These data, however, have only been partially analyzed. Since 2002, SEANET has been rapidly expanding while its website, the main source for volunteer information and input, is outdated and needs to be made current and user-friendly.

The goal of WPI's partnership with SEANET was to help analyze the beached bird survey and necropsy data collected by SEANET and to help expand SEANET's outreach by updating and adding pertinent information to their website. The following objectives were established:

1. Research the seabirds and waterfowl common to the Atlantic coast as well as the natural and anthropomorphic events that lead to seabird mortality in an effort to disseminate that information on the website.

2. Analyze and identify trends within the beached bird survey data collected by Tufts since 2002.

3. Analyze and identify trends within the necropsy data collected at Tufts, as well as mortality data collected by the National Wildlife Health Center (NWHC) a branch of the U.S. Geological Survey (USGS)

4. Research and propose ideas relating to education about seabirds and their conservation

5. Expand SEANET website with the material and data obtained

Following these objectives the WPI SEANET project was successful in reporting a preliminary analysis of SEANET's beached bird survey and necropsy data as well as expanding the SEANET website.

Background

Common Avian Species Affected

Coastal bird and seabird populations of all nations are in decline. From among these populations, Tufts Center for Conservation Medicine / Wildlife Clinic focuses its attention on the most common seabirds of the North Atlantic region. These species are the black duck, the common loon, common eider, shearwater birds, cormorants, and northern gannets. In order to optimize success of conservation efforts, the lifestyles of these birds must first be understood. Aspects like their habitats, mating practices, clutch size, and migration habits effect how conservationists approach the problem.

The Black Duck

The Black Duck is known by several names throughout the country: Dusky Duck, Black Mallard, and Black English Duck. This duck has been seen as far inland as Utah and as far north as Labrador but mainly stays along the Atlantic coast from Maine to Florida. Both male and female Black Ducks have a readily identifiable purple/blue patch on the wing. Both male and female also have brown to black feather coloration with a pale brown head. The only distinguishing feature between males and females appears during breeding season when the bill of the male becomes bright yellow.

The Black Duck only migrates as far south as is necessary to escape frigid temperatures and frozen waters. If the winter is not too severe, the ducks will remain in the New England area where they prefer to mate and nest. When the winter months become too severe the Black Duck migrates further south or inland.

The nest of the Black Duck is made on the ground and is usually very large. The structure is comprised of pieces of wood and sticks while the Black Duck lines the inside of the nest with its own breast feathers. Typically, the Black Duck tries to hide its nest in reeds or tall grass found locally around ponds and swamps. A clutch of between 6-12 eggs is laid and tended to during the months of April, May, and June. These eggs vary in their coloration from a very pale white or buff to a pale green.

These ducks face many problems both man made and natural. As they look very much like the common mallard, competition and hybridization within the two species has begun to take place. There is competition for food and even the same females among the populations. Additionally, since the black duck mainly scrounges for food at night, it is an easy target for a growing number of duck hunters. The number of ducks each hunter collects is not readily monitored making the loss of ducks during the hunting season high. Finally, as these ducks eat mainly around their nesting areas, i.e. swamps and ponds, they are also highly susceptible to duck plague outbreaks when they occur. (USGS, “American Black Duck)

Common Eider

The common Eider is the largest duck in the Northern Hemisphere. The common Eider stands about 20-28 inches tall and weighs in the range of 2.5 pounds to 6.5 pounds again with the male eider weighing the most. Males are typically larger than the females. The males typically have striking plumage with black, white, and pockets of green while the females are more subdued.

During the winter months, Eiders typically spend time in the southern portion of Alaska, around the Hudson Bay, in Massachusetts, and also along the coasts of Europe. During the summer months, Eiders breed and live on coastal islands, along ponds, or around lagoons in the same areas as during the winter as well as further north into Canada. They build nests on the ground using the vegetation found locally and lay a clutch size of between 1-14 eggs. These eggs are olive or green in color and usually have no other coloration on them. The female's dull plumage provides camouflage while tending to the eggs.

Eiders are dropping in numbers from a variety of causes. Fishing and habitat loss due to humans limit the area for successful nesting as well as substantial food availability. A second problem stems from lead ingestion. Fishing equipment, such as sinkers, get stuck in the gut tract either causing blockage or lead poisoning and unfortunately Eiders ingest these pieces at an alarming rate. In any case, Eiders are a species conservationists are striving to protect. According to the USGS, from August 27th to September 20th 2007, 500 Eider deaths were reported from a variety of causes (USGS, 2004). (Cornell Lab of Ornithology, Eider).

Common Loon

Common Loons spend nearly all of their time near or on the water. They stand from 26-36 inches and weigh between 5.5 pounds and 13.5 pounds with the males being the largest. The wingspan extends from 41-52 inches from tip to tip. The plumage of these birds varies based on the stage in their life. Non-breeding adults have grey plumage with white around their eyes. Their eyes are dark and they have a white line extending from their throat to the back of their neck. It takes several years before loons can reproduce and the plumage changes as they mature. Breeding adults have a white chest with a white patched back area. The head, neck, and sides are black. Loons have red eyes and black bills and are readily spotted both flying or on the ground.

During the winter months, the Loon lives on the coasts as well as inland throughout much of the United States as well as the coasts of Europe and Iceland. Like the Eider, they breed during the summer months and stay along Alaska and the Atlantic coasts of the United States and Canada. Loons build a nest from wet mass and plant material found near their coastal homes. Loons build the nest either directly on the ground or on a mound of dirt to elevate it slightly. The clutch size is usually only two eggs which are brown in color.

Common Loons are often seen by the Wildlife clinic at Tufts suffering from trauma, emaciation, and often lead poisoning. The numbers of Loons are declining mainly from their reproductive process. The number of eggs in a clutch size is small in comparison to other seabirds and the number of breeding adults in the population is less than in other species. This means that the loss of one breeding adult is a major detriment to the population as a whole. (Cornell Lab of Ornithology, Loon)

Shearwaters

Shearwater is a category encompassing several species of seabird. They all share similar characteristics, placing them in the same family. One commonality shared among the species is their life cycle. Shearwaters spend the majority of their time actually at sea only ever visiting the land. This remains true during times of breeding. When reproducing, the shearwater birds will often form large floating colonies just off shore. When night falls, they will go on land to bury the one egg that they lay either in a burrow or just on top of the sand. The parents take turns incubating the egg, and for a short time after it hatches, the parents will provide food.

One common shearwater bird is the Manx Shearwater. The Manx Shearwater is typically 12-15 inches in height and has a wingspan of 30-35 inches. To find food, the Manx Shearwater will glide close to the water and dive below the water's surface for small fish, cephalopods, and small crustaceans

Shearwater conservation has to focus on maintenance of the habitat and feeding grounds for these birds. Since they dive to find their food, fishing nets pose a threat. Another threat stems from the fact that only one egg is laid per eligible adult. Again, this is a species for which the loss of one reproductively capable adult drastically effects the population's survival. (USGS, Manx)

Northern Gannet

The Northern Gannet is a large seabird standing between 34-39 inches tall. Their wingspan is between 65-71 inches. Adulthood is not reached until the birds are 3 years of age at which point their plumage begins to turn all white. Between 3-5 years of age, Northern Gannets pick a mate for life and always return to the same site for their nesting. They build nests of seaweed, grass and feathers about 1-2 feet high to protect their clutch of 1-2 eggs.

As is true of the other seabirds, the adults dive up to 80 feet to find their food which usually consists of haddock, mackerel, cod, sand eels, and other fishes. Habitat encroachment and fishing practices contribute to the loss of capable breeding adults either from netting or lack of food. Additionally, because these birds mate for life and are unable to reproduce until at least 3 years of age, each breeding adult is imperative to the population's survival. (Cornell Lab of Ornithology, Gannet)

Double-Crested Cormorant

The Double-Crested Cormorant is similar in size to the Gannet standing from 29-36 inches tall. They have a wingspan of 48-54 inches. The Double-Crested Cormorant is the most popular North American Cormorant and the population sizes were once very high. These birds stay in large groups and also dive below sea level for their food usually of fish. Unlike the Gannet, however, they can only dive for 30 seconds at a time.

When the Double-Crested cormorant breeds, they build nests in large groups often on cliffs, islands, or in trees near water and typically these nests are bulky and made of sea wood and weeds. Both the male and female take turns incubating the clutch which can be from 3-4 eggs in size. The largest problems facing these birds is loss of food and habitat coupled with their own nesting choices. Many nests fall from trees or off cliffs due to their sheer weight and cramped nesting areas. Additionally, hunting, fishing, and habitat loss are forcing more and more of these birds into smaller and smaller areas. (Cornell Lab of Ornithology, Cormorant)

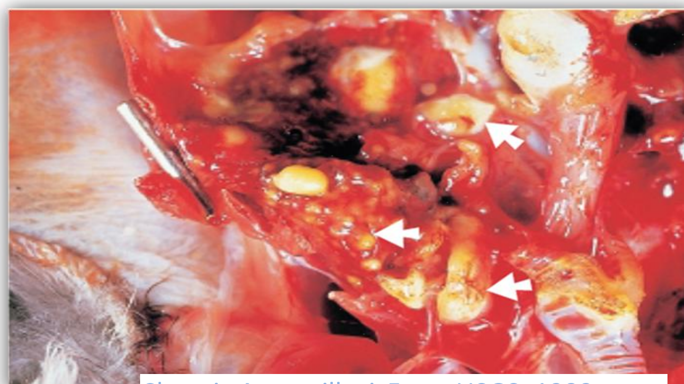
Common Avian Causes of Mortality

Aspergillosis

(Friend, 1999a)

Causes

Aspergillosis is a respiratory tract infection caused by the saprophytic mold, *Aspergilius fumigates*. The mold grows in dampened soils, decaying vegetation, organic debris, and feed grain. It's transmitted to birds and other animals when the mold releases its spores into the atmosphere. These spores are then inhaled by the animal. The spores colonize the lungs and can disseminate to other parts of the body. Birds and other animals are constantly exposed to *Aspergilius* spores; however, they only develop disease under certain circumstances such as a weakened immunity caused by infection, stress or poor diet, or if there is an unusually high exposure rate.



Chronic AspergillosisFrom USGS, 1999.

There are two types of aspergillosis infection: acute and chronic. Acute infections are rare but are often responsible for large-scale mortality events in birds. Acute infections occur when birds are exposed to a large number of spores. The fungus grows quickly in the lungs, blocking air passages and ultimately causing death by asphyxiation. Acute infections usually occur during inclement weather when a bird's normal food source is low and it has to resort to waste grain and silage pits.

Chronic aspergillosis is characterized by constant infection with the fungus that gradually results in reduction of respiratory function and a weakened immunity. Under these circumstances, the fungus can then disseminate into other organs and tissues. The fungus then results in ascities (fluid in the body cavity) caused by peritonitis (inflammation of the membrane that lines the body cavity)(Bauck, 1994). The fungus can also cause fibrous clots in the pulmonary blood vessels resulting in heart and lung impairment. In some cases, aspergillosis reaches the brain causing loss of muscular coordination, similar to lead poisoning.

Species affected

Mallards and other ducks are particularly susceptible to aspergillosis because they will often resort to poor grain and corn sources during inclement weather. Loons, gulls, and other waterfowl are less commonly infected due to their food choices.

Field Signs

A bird suffering from Aspergillosis can be identified by 4 main signs. The first is emaciation. The bird will lose both fat and muscle mass and appear very sickly. These birds also have difficulty breathing and will often rapidly open and close their bill in an effort to breathe easier. Aspergillosis can also lead to a heavy feeling in the wings giving them a droopy appearance and making it difficult for the bird to use. Finally, when the case is advanced, birds with Aspergillosis lose muscle coordination similar to lead poisioning.

Control

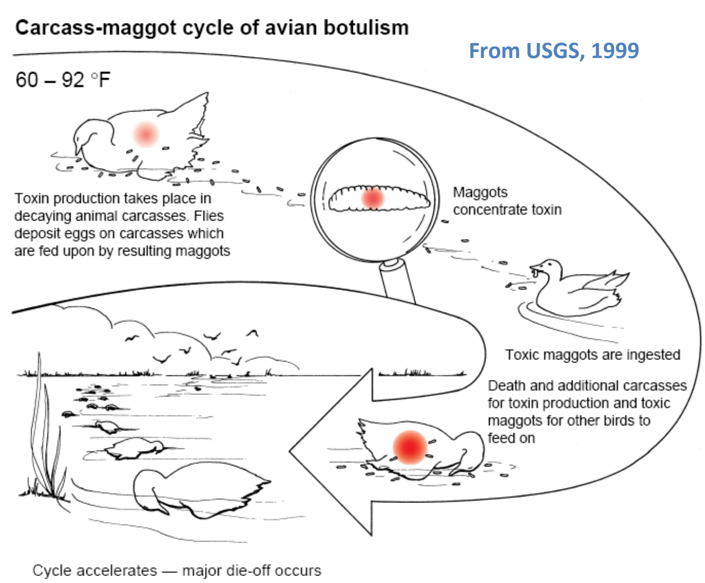
The best method for control of the disease is prevention. By monitoring use of moldy or dusty straw for silage or feed as well as dumping of moldy waste grain by humans in areas where waterfowl feed, the amount of viable spores that seabird populations can ingest is limited. Additionally, areas where these seabirds nest should establish contingency plans to be implemented at the onset of inclement weather that include provisions for clean sources of food and removal of moldy waste. (Friend, 1999)

Avian Botulism

(Rocke & Friend, 1999)

Causes

Avian Botulism is caused by a toxin produced from a phage that infects the bacteria *Clostridium botulinum.* This bacterium is then what infects seabirds. *C. botulinum* is thought to feed off decaying matter and is very common in wetlands. There are different varieties of the toxin which affect different species. The toxin affects the avian peripheral nervous system eventually resulting in paralysis of voluntary muscles.



In some cases, affected birds obtained the toxin by directly ingesting decaying matter. More often however, the toxin is indirectly transferred to the birds by means of zooplankton or insects.

Invertebrates are unaffected by the toxin and therefore effectively concentrate the toxin as they consume infected decaying matter. Once an outbreak starts, it is self-perpetuating. As more birds die of botulism, more maggots consume the dead carcasses and the botulism toxin increases until another bird feeds off that maggot. This is called the "carcass-maggot cycle."

It is uncertain what exactly causes botulism outbreaks. The current theory is that optimal environmental factors such as temperature, pH, salinity, temperature, and oxidation-reduction potential influence the reproduction and transfer of botulism toxin to birds. Human factors, such as pollution, wetland flooding, and pesticides increase the amount of damp, organic material and then in turn also increase the concentration of *C. botulinum*

Species affected

Die-offs that occur yearly are common in most waterfowl, shorebirds, and gulls which are affected mainly by the Type C toxin. Gulls and loons are also equally affected by the Type E toxin. Losses of 50,000 birds or more in a single outbreak are relatively common. In a single year, more that a million deaths from avian botulism have been reported.

Seasonality

Type C avian botulism outbreaks mostly occurs during warm-weather periods of July thru September, however, outbreaks have been known to occur year-round. Type E outbreaks more commonly occur during the late fall and spring.

Field Signs

Major die-offs of birds have been found concentrated around the water's edge and in areas of flooded vegetation. In the first stages of the disease birds will be unable to fly and walk. As the disease progresses they start to loose control of their head movements as well as their inner eyelids. These diseased birds eventually die from drowning or from respiratory failure caused by complications of botulism infection.

Control

Because botulism infections are not very well understood, it is difficult for the human population to control its outbreaks. If the interaction could be better understood between the agent of infection and the host as well as what environmental factors favorably effect infection, outbreaks could be prevented. Additionally, because the initial phage infected bacteria is thought to feed off decaying material, reduction of organic materials, like vertebrate carcasses, would limit the amount of initial phage present in the environment. Finally, thorough documentation of each outbreak, to include the environmental conditions and birds afflicted, would allow for analysis of this disease and better preparation for the next event.

Lead Poisoning

(Friend, 1999b)

Causes

The most common cause of lead poisoning in waterfowl is ingestion of lead pellets. These pellets come from shot shells, fishing sinkers, bullets, mine wastes, and lead-based paints. Once in the gizzard, the lead is worn down by the stomach acids and begins to dissolve into the bloodstream where it is taken up by various tissues. Muscle paralysis and eventual death result from absorption of toxic levels of lead.

Species affected

All species of waterfowl as well as a large number of other birds, including eagles, are affected. Before the ban of lead shot in 1991, the annual losses of waterfowl were 1.6-2.4 million based on fall flight of 100 million birds.

Field Signs

When a bird is experiencing the symptoms of lead poisoning a readily noticeable symptom is its reluctance to fly. When the bird manages to take flight, the flight pattern is erratic. Eventually, as the disease progresses, the bird becomes flightless. The wings will take on a 'roof'-shaped position and eventually begin to droop as the bird becomes more and more moribund. Fluid may discharge from the bill. The birds may also have bile-stained feces.

Control

Because lead poisoning is caused from human made objects, the only method of control is to inform the public. Programs and informational items should be distributed or made readily available to the public and should include safe practices for fishing items and proper disposal of lead items. If the public becomes more aware of the dangers there will ideally be fewer and fewer sources of lead which will limit the number of cases. (Friend, 1999)

Organophosphorus and Carbamate Pesticides

(Glaser, 1999)

Causes

Organophosphate and carbamate pesticides inhibit cholinesterase enzymes which are involved in transmitting normal nerve impulses throughout the nervous system. In acute doses the nervous system becomes paralyzed which may result in death, usually from respiratory failure. Organophosphates and carbamate pesticides are usually ingested indirectly through tainted plants/prey but they can also be absorbed through the skin and/or inhaled. Commonly birds are exposed to the OP-carbamate pesticides via consumption of treated seeds, vegetation with pesticide residue, dead/struggling poisoned insects, tainted grit/food, and live animals intoxicated with pesticide, or from tainted water from runoff irrigation.

Species Affected

A large variety of vertebrate species are affected by organophosphate and carbamate pesticides, however birds seem to be the most sensitive. OP-carbamate mortalities are an especially common problem with waterfowl due to their diet. Along with diet, age, sex, and body condition (i.e. low fat reserves, poor body condition, and high energy expenditures such as migration), are all factors that affect a bird's susceptibility to pesticide poisoning. Embryos and young birds are particularly sensitive to OP-carbamate poisoning.

Field Signs

Birds suffering from pesticides have a large number of field signs. The bird, possibly due to the organic nature of the pesticide, can go into convulsions. They can also become highly excitable shown by nervous tendencies or increased vocal tendencies. Ataxia can also occur where the bird appears to have spasms. The animal can no longer control its movements which would affect its ability to fly, fish, and even walk. This could also lead toward the tenesmus affliction which is when the animal has spasms of anal sphincter contraction.

More severe signs are myasthenia or muscle weakness coupled with dyspnea, which is difficulty breathing, and tachypnea, which is rapid breathing usually done in response to the difficulty. These birds tend to vomit and defecate more usually having diarrhea. They are also more lethargic and even tranquil probably set on by the difficulty in breathing weakness of muscles. Additionally, the bird can develop excessive thirst as with polydypsia and even begin to bleed from the nares as with epistaxis.

Birds affected by these organophosphorus and carbamate pesticides can also develop many afflictions for the eyes. These conditions are blindness, Misosis (contraction of the pupils) or Mydriasis (dilation of the pupils), Ptosis (drooping of the eyelids), Exopthalmia (protrusion of the eyes), and Lacrimation (excessive tear formation).

When the head and limbs begin to arch backwards as with Opisthotonos, or the contour feathers actually begin to go erect as with Piloerection, the bird can also be suspected of organophosphorus or carbamate pesticide poisoning.

Duck Plague

(Friend, 1999c)

Causes

The Duck Plague is caused by a herpes virus. Herpes viruses attack the bird's total vascular system which causes gross hemorrhaging across the gastrointestinal tract. Herpes viruses can exist in long periods of latency within a host that has survived the initial exposure. Duck Plague outbreaks are thought to be caused when birds that carry the virus shed it through fecal or oral discharge. Physiological stresses such as daylight change and onset of breeding are thought to stimulate virus shedding mainly in the spring.

Species Affected

Only ducks, geese, and swans are susceptible to the disease. Some species of each family are more susceptible than others though specifics are not known at this time.

Seasonality

The Duck Plague has been noted all year round, however, according to Friend, 1999 86% of events during 1967-1996 occurred between March and June. This seems to support the thought of daylight change and breeding being factors in virus exchange or shedding.

Field Signs

There are no observable symptoms to this disease. Animals will often seem in perfect health one day and then be dead the next. Birds might be hypersensitive to light, experience extreme thirst, have blood discharge from the vent, and may be droopy. Prior to death, birds will undergo a series of convulsions.

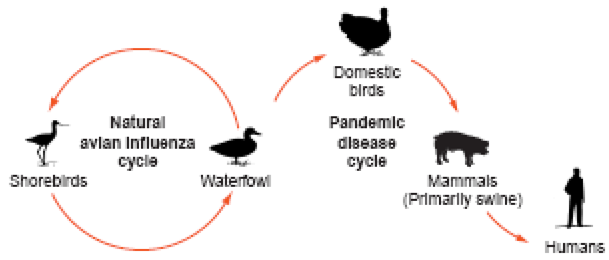
Avian Influenza

(Hansen, 1999)

Causes

Avian influenza in birds is caused by virus classified as Type A influenzas. Type A influenzas consist of different subtypes which are determined by two surface antigens, hemagglutinan (H) and neuraminidase (N). There are 15 known types of H antigens and 9 N antigens and each type of influenza subtype varies among bird species.

Avian influence is spread through the fecal-oral route (contact with fecal droppings, saliva and nasal discharge). Occasionally, the virus mutate in such a way that it is able to jump from species to species as seen in the figure below.



Natural cycle of avian influenza virus, From USGS, 1999.

Species Affected

Avian influenza is found in many bird species; however it is most common in migratory waterfowl, especially mallards. The virus does not generally cause disease or mortality in wild birds. Until recent events, only one mortality event which was in Common Terns in South Africa in 1961 had ever been reported (Rowan, 1962). Over the past few years, the newest strain, H5N1 has caused mortality in over 80 species of wild bird, although large-scale mortality has occurred mostly in domesticated chickens and turkey

Distribution

Avian influenza in wild birds occurs throughout the world, although it is more commonly detected along the major waterfowl flyways.

Seasonality

Year round

Field Signs

Observable signs in wild birds have yet to be clearly identified. Domesticated birds may have respiratory, enteric and reproductive abnormalities, especially a decreased egg production.

Gross Lesions

No gross lesions have been yet detected. A few birds during the South African turn outbreak had microscopic evidence of meningoencephalitis (inflammation of membrane that covers the brain).

Oil

(Rocke, 1999)

Causes

An average of 14 million gallons of oil annually spill into the salt and fresh water around the United States. Most oil pollution is caused from transport, refining operation, industrial discharge and urban runoff. Oil pollution also occurs from accidental spillage from tankers, barges, pipeline, refinery, and bulk storage.

Oiled herring gull, From USGS, 1999

Oil contamination of a bird's feathers disrupts their natural ability to fly, insulate, and waterproof. As a result oiled seabirds die from hypothermia, starvation, exhaustion, and drowning. During the reproductive season, petroleum can transfer to the eggs. It only takes minute amounts of oil to kill an embryo.

Ingestion of oil is also toxic to seabirds. Seabirds will unintentionally ingest oil stuck to the feathers they attempt to preen. The degree of poisoning depends on the type of oil ingested and the species of bird. Symptoms include gastrointestinal irritation and hemorrhaging, anemia, reproductive impairment, depressed growth, and osmoregulatory dysfunction.

Species Affected

Oiling can affect all species of bird, however gregarious birds such as auks, guillemots, murres, puffins, sea ducks and penguins are particularly susceptible.

Seasonality

Peak oil spilling occurs during the winter storm season, generally in January, February, and March. Mortality events in birds are also high in the winter season because seabirds and waterfowl tend to congregate closely in wintering areas.

Distribution

Oil spills have occurred in all 50 states. Chronic oiling is more of a problem around marinas and ports.

Field Signs

Most oils are visibly noticeable; however some oils are light and transparent. Oiled birds will often have matted feathers. Heavy oiled birds will not be as buoyant and ride lower in the water or conjugate on land masses such as islands, rocks, beams and so on.

Gross Lesions

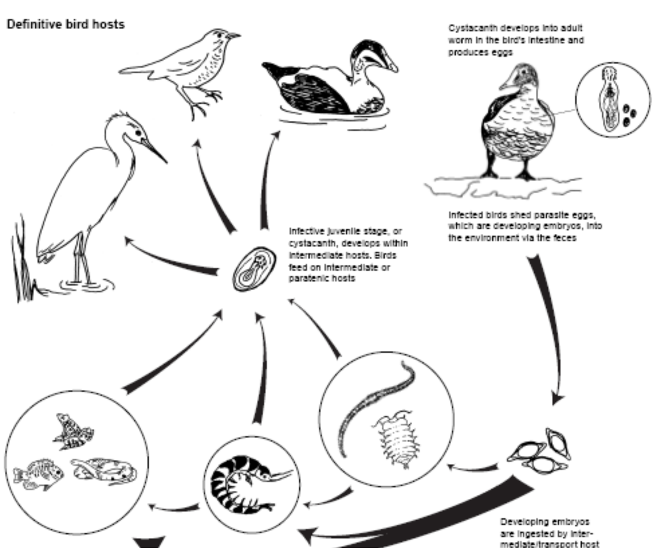
Gross Lesions include emaciation, oil present in trachea, lungs, digestive tract and around vent, reddening/ hemorrhaging of intestinal lining, salt glands above the eyes appear swollen, adrenal glands enlarged

Acanthocepaliasis (Acanths)

(Cole, 1999)

Causes

Acanthocepaliasis are parasitic worms which live and absorb nutrients in a bird's digestive tract. The life cycle of the worm begins as egg which is passed with the feces of the definitive host. If the egg is ingested by the intermediate host (most insects and crustaceans) the worm develops into its juvenile stage. When the intermediate host is eaten by the final definitive host, the parasite attaches itself to the bird's intestinal lining and matures. Once mature, acanths continues to reproduce and absorb the host's nutrients, which in turns weakens the host, making it more susceptible to disease and predation.



Life cycle of Acanthocepaliasis, from USGS 1999

Species Affected

Acanths infects all vertebrates and is common in most birds. Ducks, geese and swans are the most commonly infected. Food habits may increase susceptibility to acanths as in the case of Eiders which have had severe outbreaks in the past.

Seasonality

Acanths infection occurs year-round. Epizootics can correspond with food shortages, exhaustion and stressful circumstances

Field Signs

Common field signs include lethargy and emaciation.

Gross Findings

Gross findings have included white nodules on surface of intestine and white to orange colored parasites attached to intestinal lining.

Heavy acanths infestation, USGS, 1999

Algal Bloom from USGS 1999

Algal Toxins (Red Tide Toxins)

(Creekmore, 1999a)

Causes

Periodically algae rapidly overgrow to produce what is known as an algal bloom. Algal blooms are a natural phenomenon; however, some blooms are the results of excess nutrients, typically phosphorus and nitrogen. Agricultural runoff and other pollutants increase the nutrient content of fresh and marine environments and thereby increase the frequency of algal blooms. Although many blooms are not harmful, some species involved in algal blooms (dinoflagellates and cynobacteria for example) produce harmful toxins such as domoric acid, saxitoxin, brevetoxin and cynobacterial toxins.

Species Affected

Toxin	Algal species	Toxin type(s)	Migratory bird species affected	Route of exposure
Cyanobacterial	***Microcystis*** sp., ***Anabaena*** sp., ***Aphanizomenon*** sp., ***Nodularia*** sp., and ***Oscillatoria*** sp.	Hepatotoxins (microcystins and nodularin) Neurotoxins (anatoxin-a and anatoxin-a(s))	Unidentified ducks, geese, and songbirds, Franklin's gull, American coot, mallard, American wigeon	Oral (water)
Domoic acid (amnesic shellfish poisoning)	***Pseudonitzschia*** sp.	Neurotoxin	Brown pelican, Brandt's cormorant	Oral (food items)
Saxitoxin (paralytic shellfish poisoning)	***Alexandrium*** sp.	Neurotoxin	Shag, northern fulmar, great cormorant, herring gull, common tern, common murre, Pacific loon, and sooty shearwater	Oral (food items)
Brevetoxin	***Gymnodinium*** sp.	Neurotoxin	Lesser scaup	Oral (food items)

Harmful Algal Toxins, USGS 1999

See USGS table above

Field Signs

Field signs are variable and depend on the toxin and species involved. Brown Pelicans with Domoic acid toxicosis for instance tend to have muscle tremors, side-to-side head movement, pouch scratching, awkward flight, toe clenching, vomiting, and loss of righting reflex before death.
The field signs of Brevetoxin toxicosis in Lesser Scaup tend to be lethargy, weakness, reluctance/inability to fly, head droop, excessive nasal and oral discharge.

Aflatoxicosis

(Creekmore, 1999b)

Causes

Aflatoxicosis results from ingestion of food contaminated with aflatoxins. Certain strains of fungi, including *Aspergillus flavus* and *A. parasiticus* produce aflatoxins under favorable conditions. Aflatoxin contamination has been reported in a variety of foods, including peanuts, tree nuts, corn and cottonseed. In birds aflatoxins decrease egg production, suppress immunity and cause fatal liver damage

Species affected

Most species of mammals and birds are susceptible.

Distribution

Aflatoxicosis occurs in areas where there is mass farming and grain storage. In the U.S. aflatoxicosis is primarily a problem in the Southeastern and Gulf Coast States where temperature and the climate can provide ideal conditions for the toxin's production.

Seasonality

Aflatoxicosis occurs mostly in the fall and winter when waterfowl are migrating or wintering and can consume waste grains

Field Signs

Field signs include depression, lethargy, lack of awareness, inability to fly, tremors and wing flapping

Gross Lesions

Gross anatomy includes a swollen pale liver, liver hemorrhaging, and peritonitis.

Methodology

Since one of the main goals of the SEANET program is to reach a greater number of people at all levels of ability, the first step of the project was to better understand the most common seabirds and their afflictions. This data was derived from many research papers as well as Atlantic Seabird books. The main focus of these readings was to determine breeding habits, coloration at all maturation levels, nesting habits, and specific afflictions both natural and human inflicted.

Julie Ellis of the SEANET program at Tufts supplied the project with Beached Bird Surveys from 2003-2006. This data was used to tabulate bird totals for each species as well as for each affliction. Julie Ellis also supplied necropsy information collected during the same years. The data was supplied in a large Excel file and contained information about every bird seen and necropsied at the Wildlife Clinic. This data was sorted to only include sea birds and other waterfowl.

Data was also collected from the United States Geological Survey from the posted Quarterly Mortality Reports. The information was found at http://www.nwhc.usgs.gov/publications/quarterly_reports/index.jsp). Field Investigation Teams across the United States at federal, state, and local levels gather the information for these reports. The data focuses strictly on all types of seabirds and waterfowl and only on those mortality events that took place on the Eastern Coast (East of Ohio). The data collected encompassed 1995-2006 which was what was compiled at the time.

Using the information collected from the Beached Bird Surveys, Necropsy database, and the USGS, graphs were created to show trends in species type, mortality rate, mortality cause, and afflicted area.

The Dreamweaver program was used to create the website. Pages were set aside for the basic bird information gathered, common mortality causes, volunteer information such as beaches and contact information, as well as an educational fun page. Images were collected from the internet to pictorially display the species' traits. Images were also collected from the necropsy photos to display the afflictions visual signs.

Results

SEANET Beached Bird Survey Results

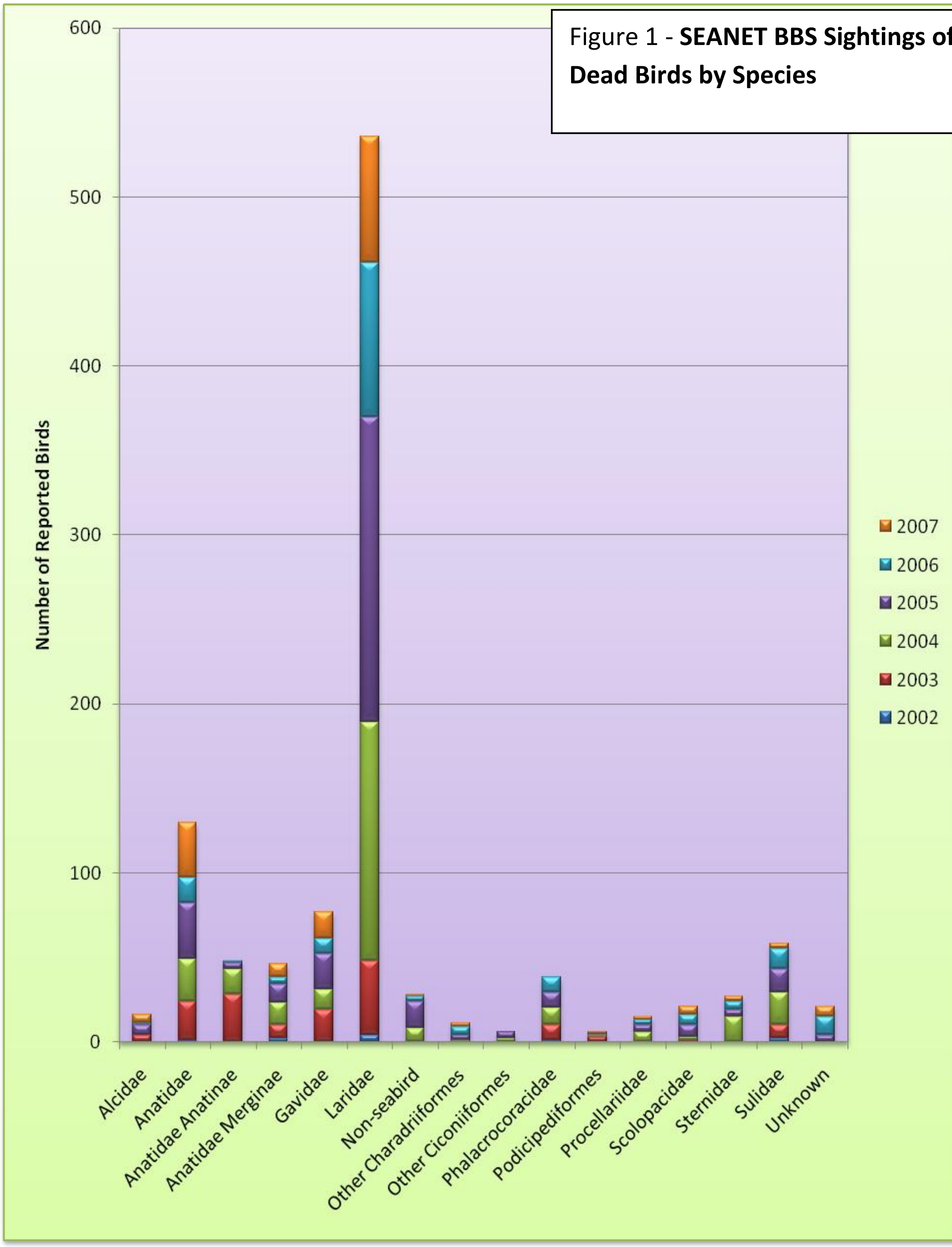


Figure 1 - **SEANET BBS Sightings of Dead Birds by Species**

Figure 1 above shows all dead beached birds reported to SEANET from 2003-2007. There were a total of 73 species with 1084 beached birds reported. Birds were collected from various beaches along the Atlantic coast, although nearly 44% of beached birds reported were from Massachusetts (Figure 2). Note that this data is taken from volunteers who are not necessarily trained professionals. Each volunteer does undergo a training session, however, there is a large variety of birds that may be difficult to identify especially if there had been considerable autolyzation of the bird. In each beached bird sighting volunteers are asked about their confidence level in their identification (Figure 3). A little over half of all volunteers were confident in their identification; however, there was still a great deal of uncertainty.

Families	
Alcidae	Auks, puffins
Anatidae	Geese, Eiders, Ducks
Anatidae Anatinae	Dabbling Duck
Anatidae Merginae	Seaduck
Gavidae	Loons
Laridae	Gull
Phalacrocoracidae	Comortants and Shags
Podicipediformes	Grebes
Procellariidae	Petrals and s
Scolopacidae	Shorebird
Sternidae	Terns
Sulidae	Gannets
Orders:	
Charadriiformes	small medium birds
Ciconiiformes	wading - storks, herons, spoonbills, ibis

Table 1: Family Organization

Figure 2 – States with beached bird reports

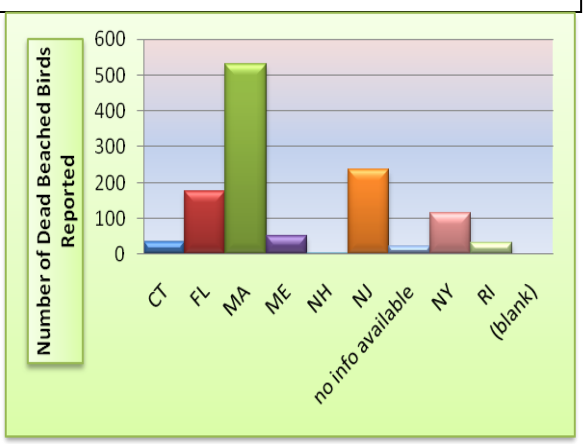
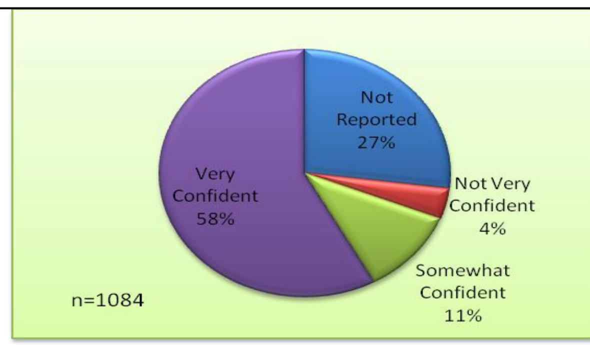


Figure 3 – Volunteer confidence in species identification



The number of reported beached birds to SEANET decreased after 2005 (Figure 4). This trend may be consequence of a decrease in volunteer activity but could also indicate a reduction in the number of beached birds. With this decrease in actual numbers, the percentages of the most commonly reported families from 2002-2007 remained relatively constant each year. Upon first look at Figure 5, it appears that the Laridae family had a substantial elevation in numbers. However, when each family is considered at its beginning and end points in terms of percent change, the Laridae family also seems to remain relatively constant.

Figure 4 – Total Reports from 2003-2007

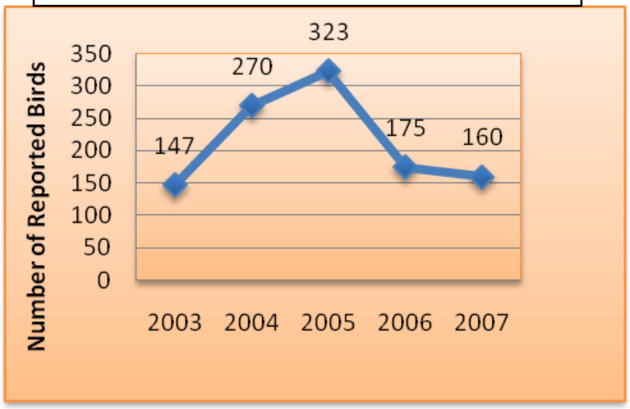
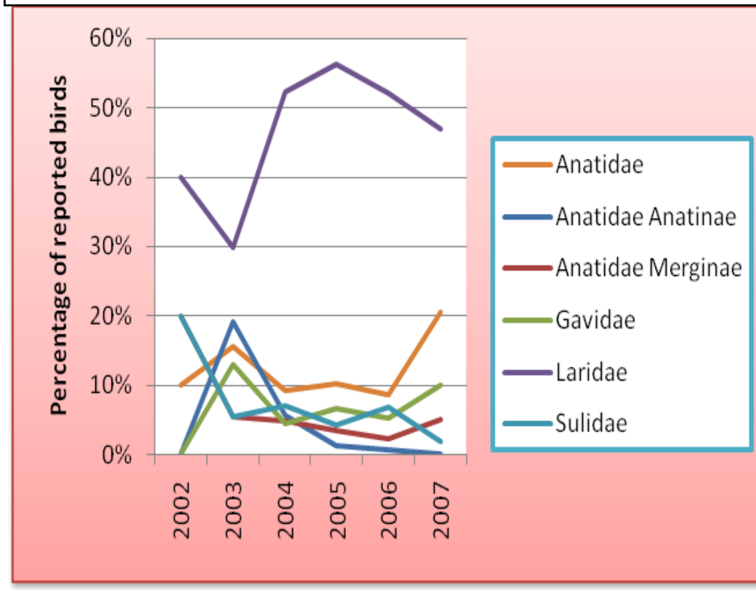
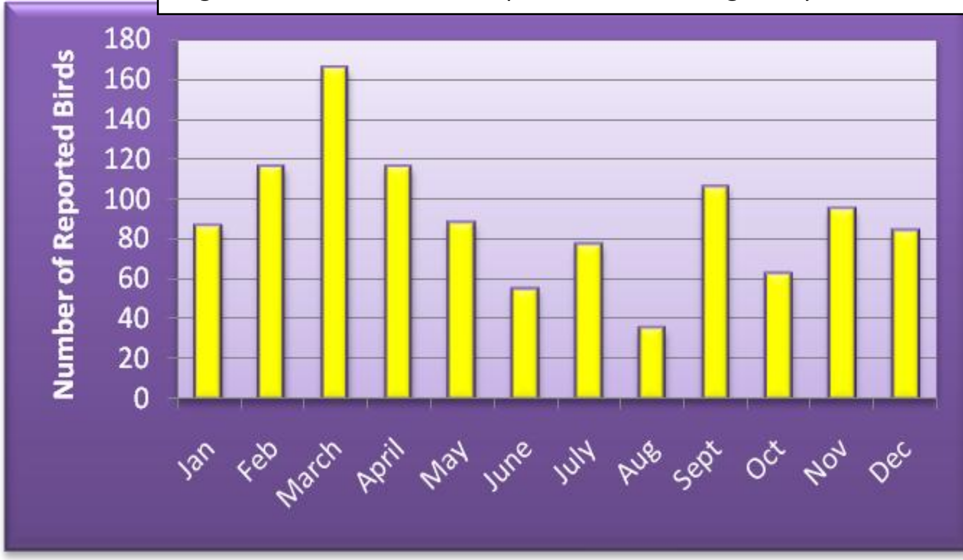


Figure 5 – Percentage of commonly reported families 2003-2007



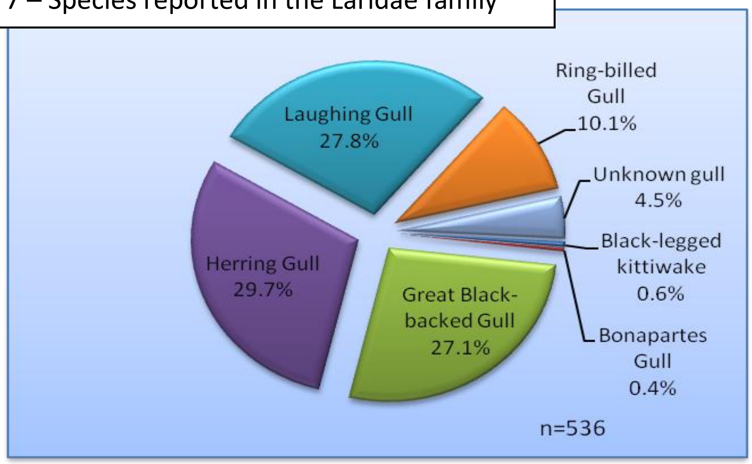
From 2002-2006, the highest numbers of beached birds were reported in the late winter and early spring months of February, March, and April (Figure 6). These months are the common breeding season for many seabirds in New England meaning more birds would congregate in a smaller area. This congregation leads to more difficulty finding food, fights over mates and nesting ground, as well as an increased chance of more birds being caught in fishing net or being hunted.

Figure 6 – Distribution of reported birds throughout year, 2002-2007



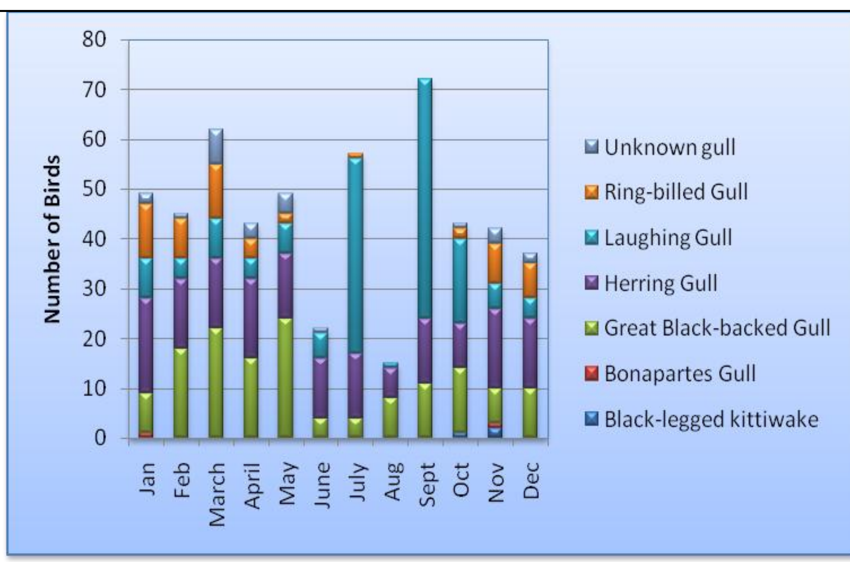
The Laridae family (gulls) compromised SEANET's largest number of reported beached birds. They compromised 49.4% of the total identified sightings. The laughing gull, herring gull, and great black-backed gull were the most reported birds in this family and the most represented species overall as shown in Figure 7.

Figure 7 – Species reported in the Laridae family



The distribution of beached gulls from 2002-2006 does not have any particularly definable pattern as shown in Figure 8. The number of beached herring gulls remained relatively constant all throughout the year. A good number of great black-backed gulls were also found throughout the year, although their numbers increased between February and May. Laughing gulls were the only species whose numbers peaked in the summer months of July through September.

Figure 8 – Distribution of reported birds from Laridae family through year



The Antidae family, which consists of wading ducks, sea ducks, swans, eiders, and geese, comprised about 12% of reported findings. Common Eiders and the American Black Duck comprised the majority of the findings within the Antidae family (Figure 9). The distribution of Antidae (Figure 10) is similar to overall distribution of all reported beached birds in Figure 6. The greatest occurrence of beached Antidae was in the late winter and early spring months where peaking occurred in March. The fewest beached birds were reported during the summer months of July through September.

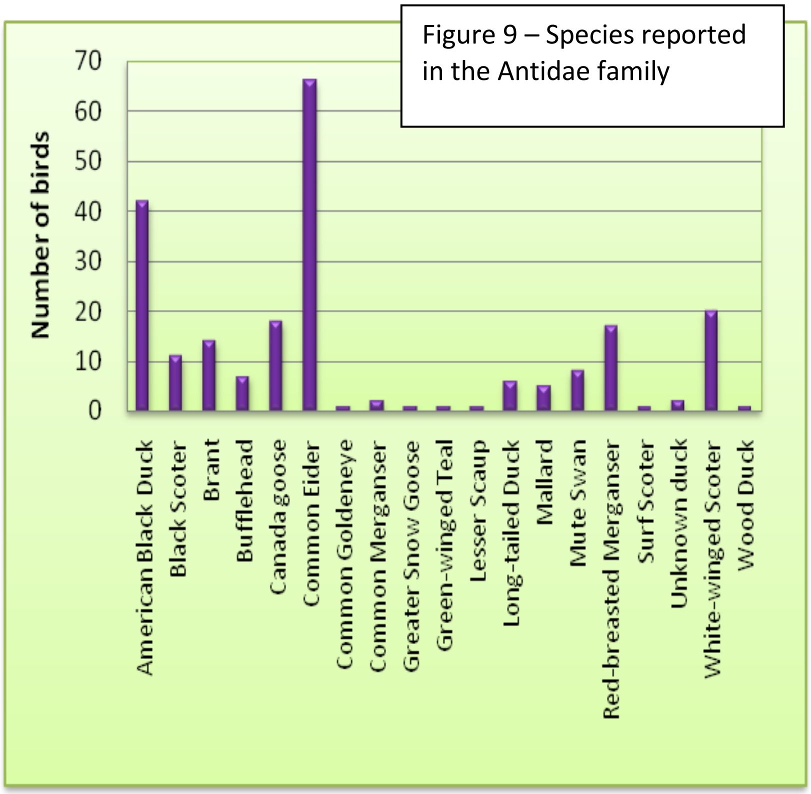
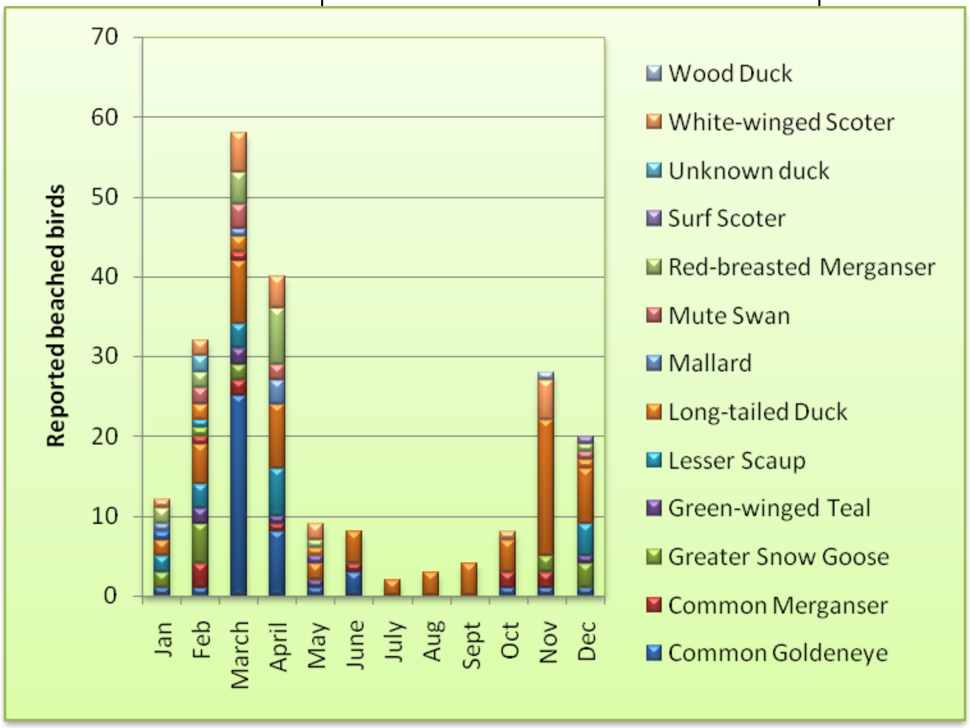


Figure 9 – Species reported in the Antidae family

The Common Eider was the only species in the Antidae family that was found throughout the entirety of the year, with unusually high reports in November. Almost all these Common Eider reports were from Massachusetts and the sighting rate was consistent every year from 2002-2006. This data correlates with that from investigations of Common Eider mortalities on Cape Cod (Madin, 2008) by SEANET and the Woods Hole Oceanographic Institution. So far the cause of death is unknown for a vast majority of these birds, but the suspect is a viral agent.

Figure 10 – Distribution of reported birds from the Antidae Family through the year



There are only two common species of Gavidae family common in the Atlantic American region: Red-Throated and Common Loons. The greatest percentage of reported beached loons was the Common Loon (Figure 11). However, there was a surprisingly large number of Red-Throated Loons reported as compared with reports from an earlier 8-year survey in Massachusetts (Simons, 1985). Numbers for both loon species were higher during the spring months vs. the winter months as shown in Figure 12.

Figure 11– Species reported in Gavidae

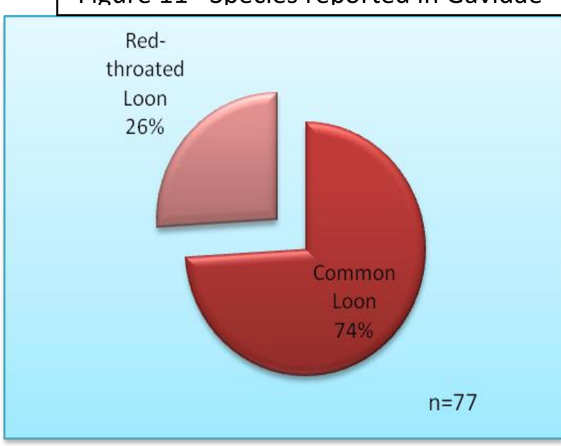
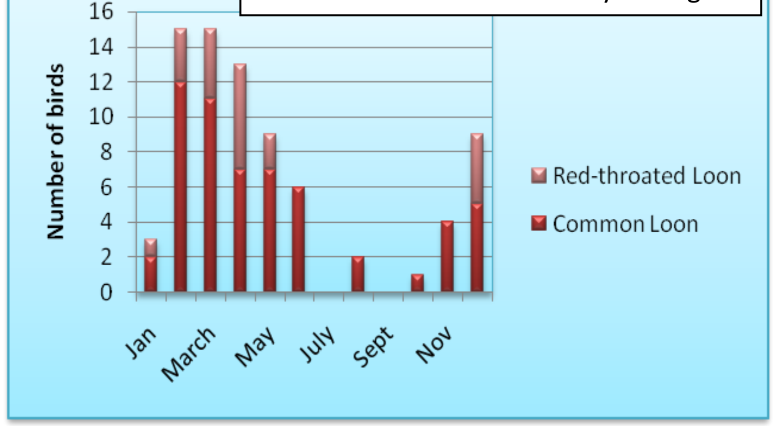


Figure 12– Distribution of reported birds from the Gavidae family through



The Northern Gannet is the only species from the Sulidae family common to the North American Atlantic Coast. Most of the gannet mortality reports occurred in winter (November, December and January) with an usually high number in May as well (Figure 13). SEANET is investigating potential reasons for this high number of Northern Gannet mortalities.

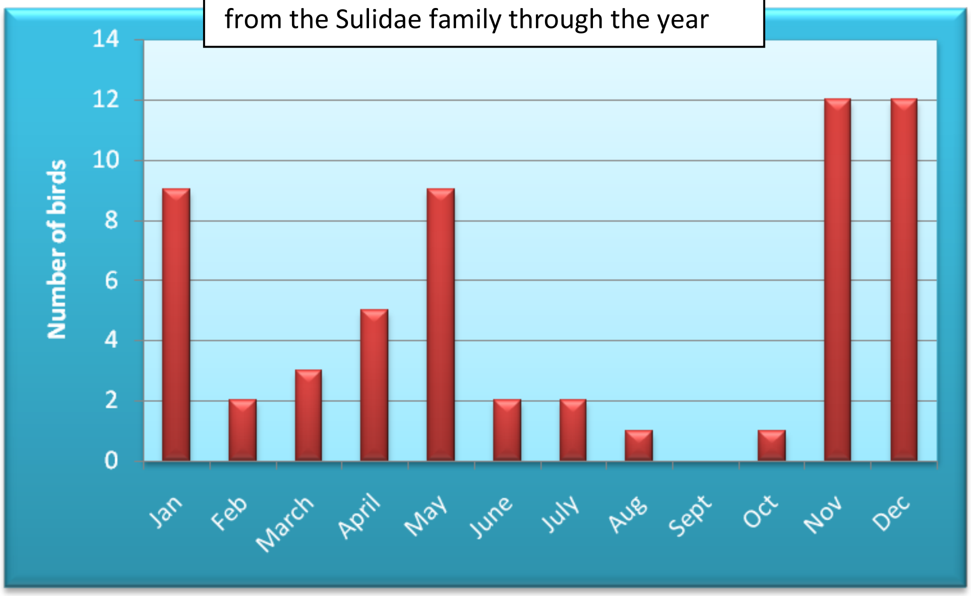
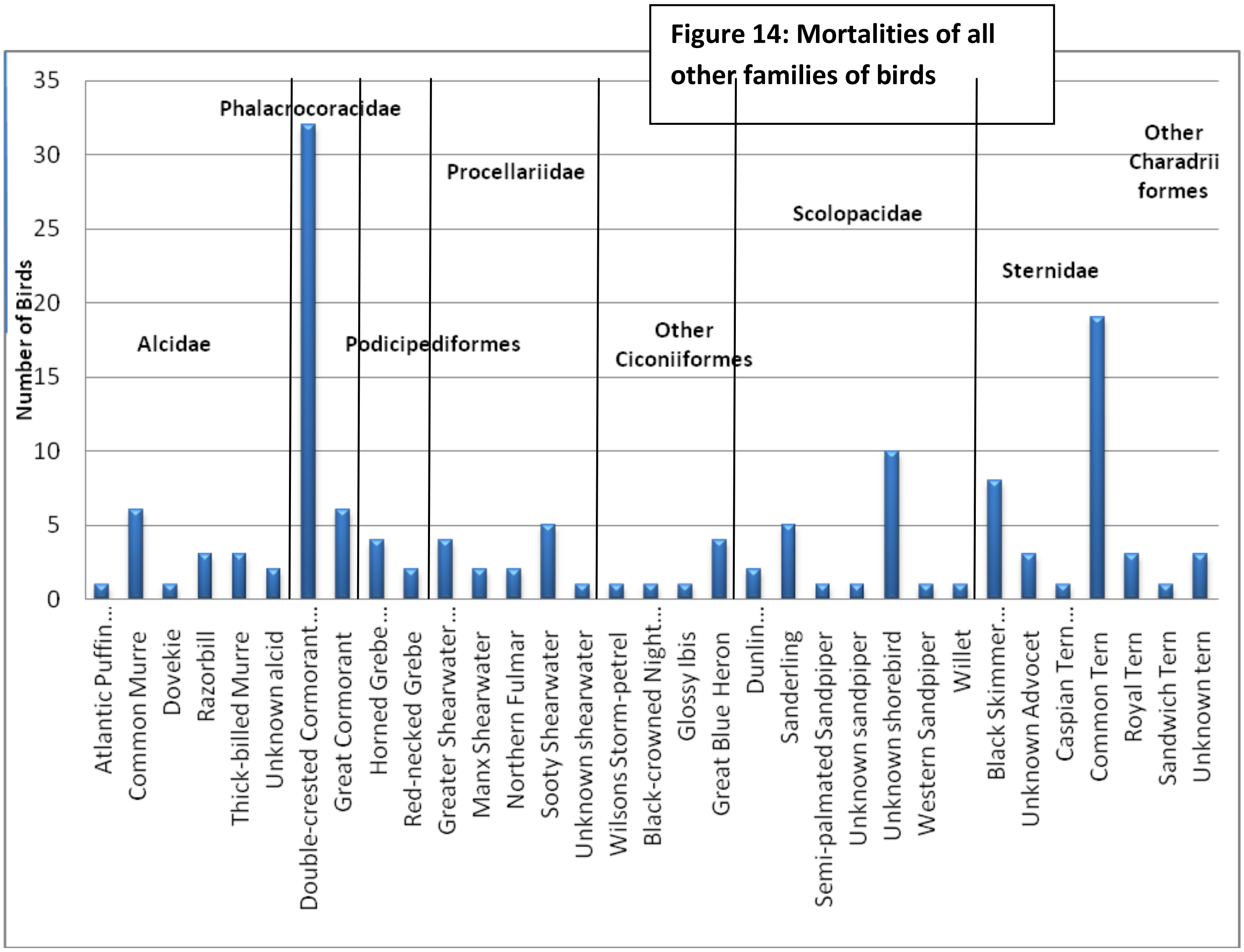
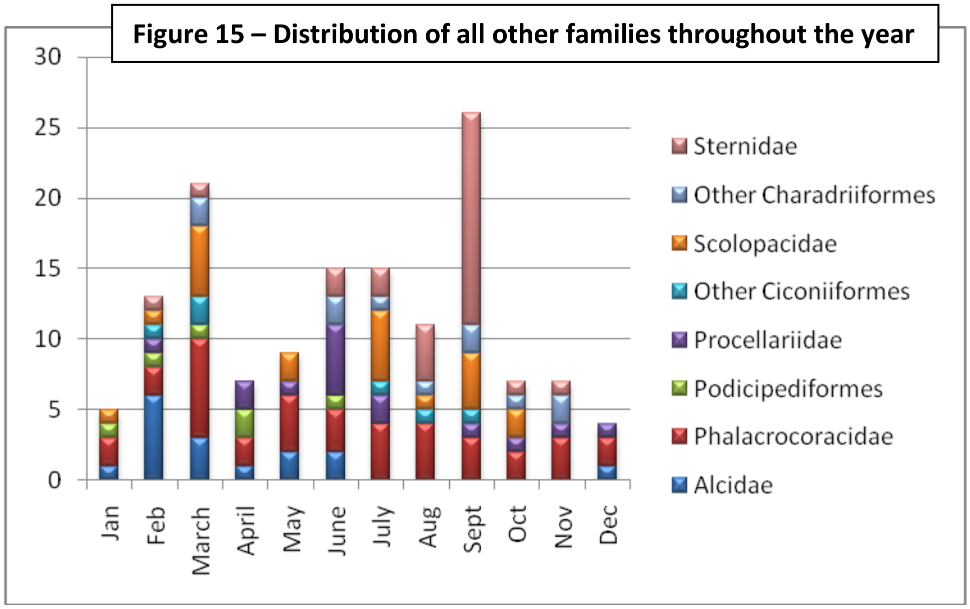


Figure 13– Distribution of reported birds from the Sulidae family through the year



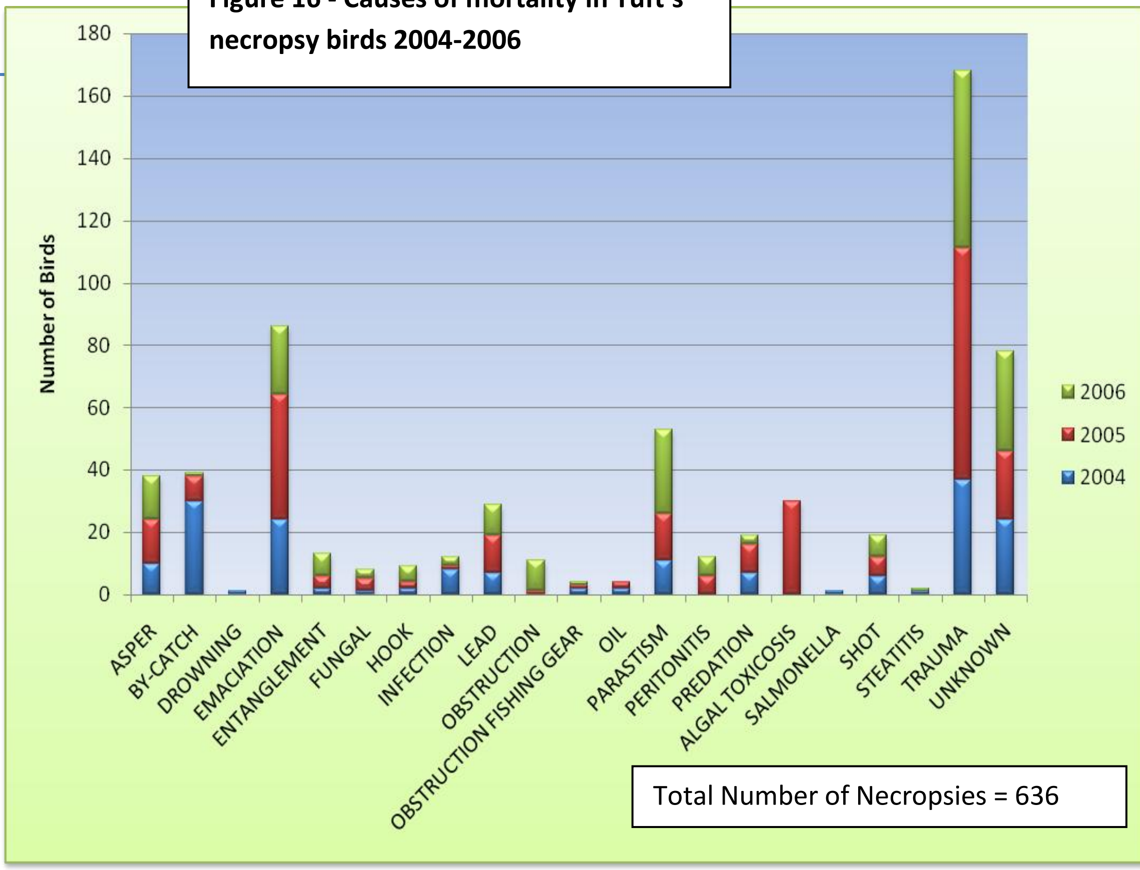
There were many other species with lower frequencies of reports than the Anatidae, Gavidae, Laridae and Sulidae families (Figure 14). The Double-Crested Cormorant (Phalacrocoracidae) and the Common Tern (Sternidae) had a notable number of reports. There were an unusually high number of reports for the Common Tern in September 2004 in Massachusetts, which correlates with a massive Common Tern mortality (~1,700) at Cape Code and Monomoy NWR (USGS National Wildlife Health Center, 2004). Again, though unknown definitively, the cause of death was thought to be a viral infection.



SEANET Necropsy Results

Figure 16 displays data collected and analyzed from Tuft's necropsy database from 2004-2006. The seabirds and waterfowl analyzed were collected from all New England States as well as New York, however, the majority (69%) were collected from Massachessettes (Figure 17).

Figure 16 - Causes of mortality in Tuft's necropsy birds 2004-2006



Total Number of Necropsies = 636

Figure 17 – Regional Distribution of necropsied

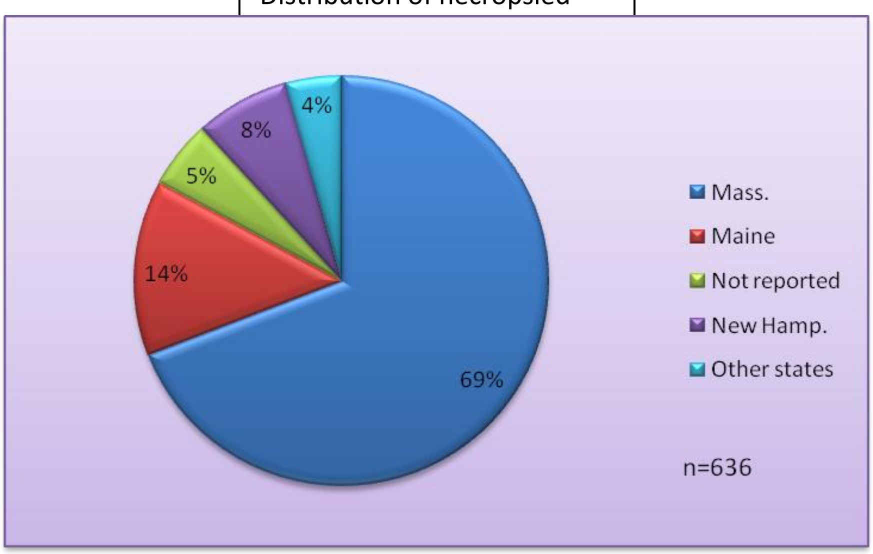


Table 2: Species necropsied by SEANET

Species	Total Necropsies	Percent Necropsied
American Bittern	3	0.47
American Black Duck	1	0.16
American Oystercatcher	3	0.47
Atlantic Brandt	1	0.16
Atlantic Puffin	5	0.79
Belted Kingfisher	4	0.63
Black Guillemot	2	0.31
Black Scoter	3	0.47
Black-crowned Night Heron	4	0.63
Bufflehead	4	0.63
Common Eider	103	16.19
Common Goldeneye	1	0.16
Common Loon	170	26.73
Common Merganser	1	0.16
Common Murre	2	0.31
Common Tern	68	10.69
Double-crested Cormorant	21	3.30
Dovekie	5	0.79
Great Black-backed Gull	20	3.14
Great Blue Heron	11	1.73

Species	Total Necropsies	Percent Necropsied
Great Cormorant	10	1.57
Greater Shearwater	30	4.72
Greater Yellowlegs	1	0.16
Green Heron	1	0.16
Herring Gull	37	5.82
Hooded Merganser	1	0.16
Horned Grebe	2	0.31
Laughing Gull	2	0.31
Leach's Storm-petrel	1	0.16
Least Tern	5	0.79
Long-tailed Duck	2	0.31
Mallard	1	0.16
Manx Shearwater	1	0.16
Northern Fulmar	1	0.16
Northern Gannet	62	9.75
Osprey	13	2.04
Piping Plover	1	0.16
Pomarine Jaeger	1	0.16
Purple Sandpiper	6	0.94
Red Knot	1	0.16
Ring-necked Duck	1	0.16
Sora Rail	1	0.16
Spotted Sandpiper	5	0.79
Virginia Rail	1	0.16
White-rumped Sandpiper	11	1.73
Willet	5	0.79
Grand Total	**636**	

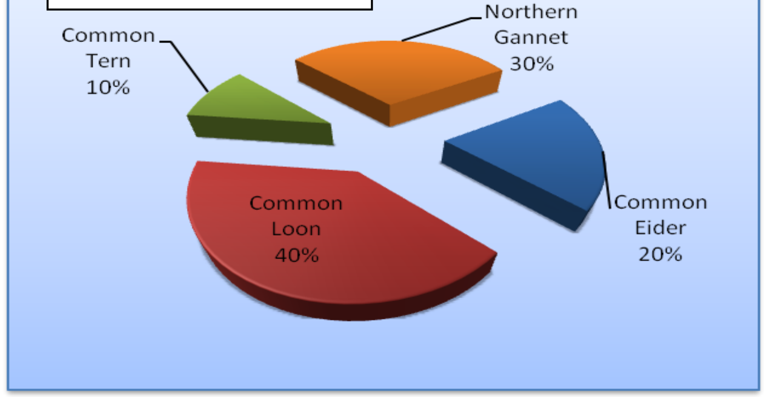
Table 2 displays all the species that SEANET necropsied from 2004-2007. The most frequent species necropsied were Common Eiders, Common Loons, Common Terns, Herring Gulls, and Northern Gannets.

The most common known cause of death was trauma accounting for nearly 26% of cases. Trauma included acute cases (i.e. hit by car/boat, flew into window) as well as chronic cases such as broken bones that disabled birds from gathering food. Unfortunately the exact causes of all trauma in seabirds could not always be determined in necropsy.

The second leading cause of death was emaciation (13.5%). The causes of emaciation are difficult to diagnose. Birds can become emaciated because of starvation from lack of food, infection, poison, weakness caused by underlying trauma, and old age.

Lead poisoning was the cause of death for approximatly 29 birds (4.6%). Most causes of lead poisoning were ingestion of lead-based fishing gear. Birds also died of lead toxicosis resulting from ingestion or trauma from a lead bullet or case. The majority of lead toxicosis occurred in common loons (Figure 18). Lead toxicity accounted for about 16% of common loon mortality. This high rate of lead toxicity in common loons correlates well with data reported by Ward Stone, Joesph Okoniewski (2001) and from Igna Sidor, Mark Pokras, et al (2003).

Figure 18 – Lead Toxicosis in birds



The majority of birds necropsied had some type of parasitic or fungal infection. The data shown in Figure 19 is from birds where parasitic infection was determined to be the cause of death. Types of parasitic infection included river flukes, nematodes, tapeworms, roundworms, cestodes and acanthacephalans. Interestingly, 100% of the acanthacephalans caused deaths were in common eiders. Aspergellosis was the most common and only identified fungal infection.

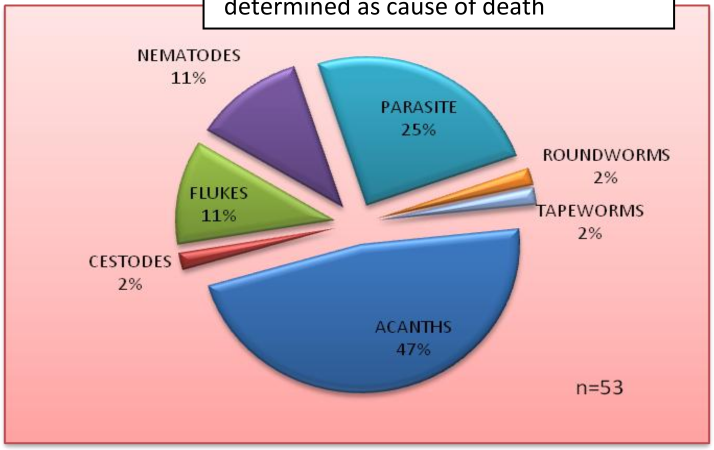


Figure 19 – Percent of type of parasitic determined as cause of death

A common loon that starved to death because fishing line entangled its beak

By-catch caused signifigant mortality during 2004-2006 (6.1%). By-catch included hook trauma and trauma caused by line/net entanglment including drowning, predation, suffication, and starvation. Species most affected by by-catch were the Common Eider, Greater Shearwater, and Northern Gannet (Figure 20). The year 2004 saw the majority of by-catch mortalities (77%). The following years show a signifigant decline in by-catch deaths which may be due to new techniques, like safer fishing nets, used to reduce unnessary by-catch. Obstruction mortalities were mostly caused by ingestion of too much food or large pieces that blocked their airways or the digestive tract. In some cases however, obstruction was from ingestion of large fishing gear.

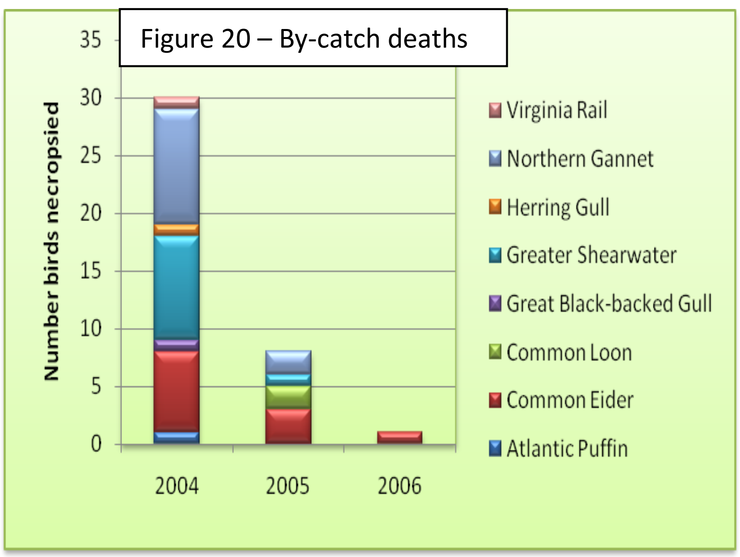


Figure 20 – By-catch deaths

Peritonitis means inflammation of the peritoneum, the lining that encloses the gastrointestinal tract. Many cases of peritonities were caused by ingestion of sharp crustacian shells.

The only incident of toxicosis caused by Red Tide toxins in New England was in June 2005 (Sohn, Converse, McLaughlin, Miller, 2005; SEANET, 2006). Approximately 40 Terns, most of them egg-bearing females, were found on Monomoy NWR in Chatham, MA. Analysis of liver samples indicated that the toxin was saxitoxin, the biotoxin that cases paralytic selfish poisoning. The last red tide incident in MA was in 1978 when at least 70 Terns were poisoned with saxitoxin (Nisbet, 1983; SEANET, 2006). This incident also occurred off of Monomoy NMR.

Figures 21 and 22 below compare natural verses anthropogenic causes of mortality in seabirds and waterfowl necropsied from 2004-2006. Anthropogenic causes of death (not including unidentified trauma) compromise a large portion of known seabird and waterfowl mortality. The most common causes of anthropogenic mortality are by-catch, lead toxicosis, and trauma due to gun shot.

Figure 21 – Natural verses Anthropogenic causes of mortality

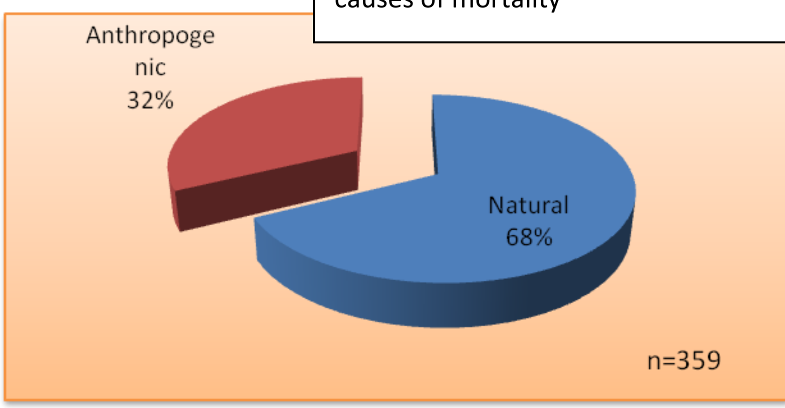
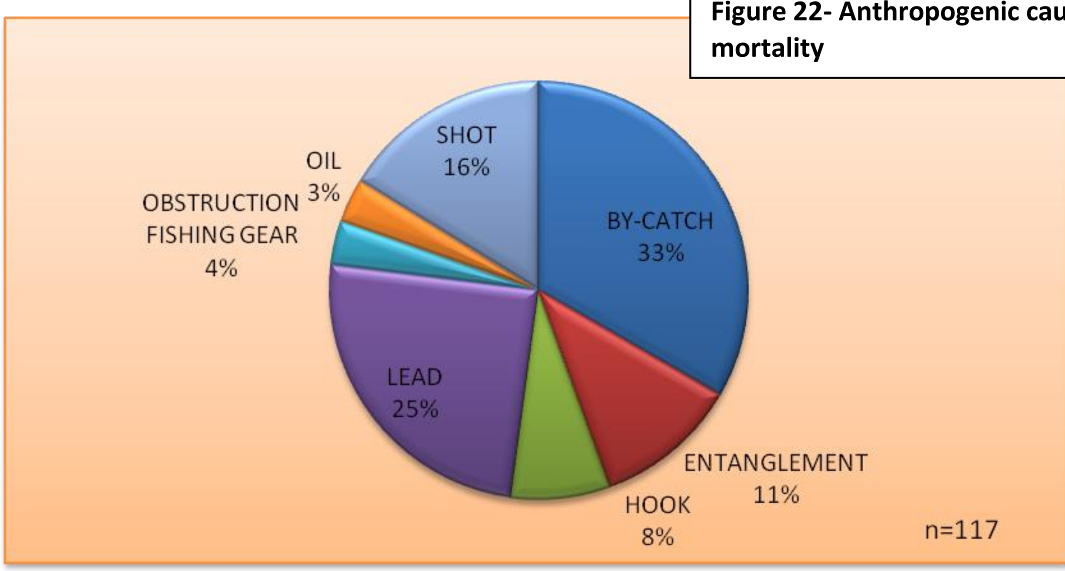
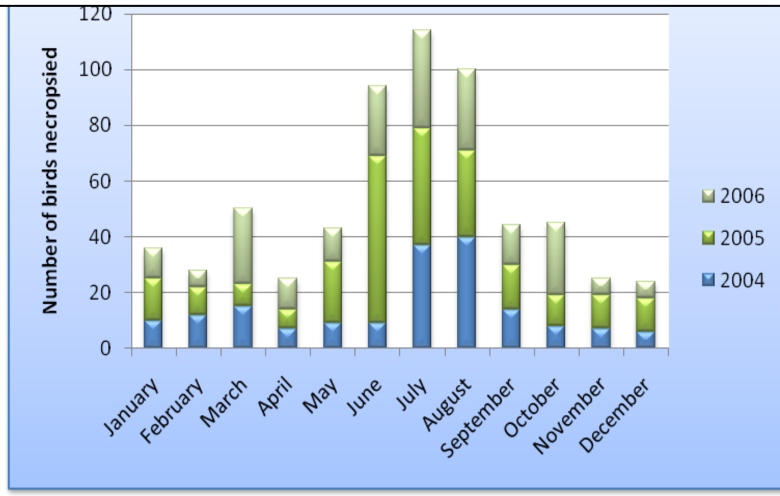


Figure 22- Anthropogenic causes of mortality



The majority of birds necropsied were collected in the summer months of June, July, and August (Figure 23). There were 636 total necropsies done in 2004, 2005, and 2006 and of that number 308 or 48% of the necropsied birds were collected in June, July and August These data are slightly puzzling since according to the SEANET data the majority of beached birds are found in the months of February to April.

Figure 23 – Distribution of when necropsied birds were originally collected



USGS NWHC Mortality Event Data

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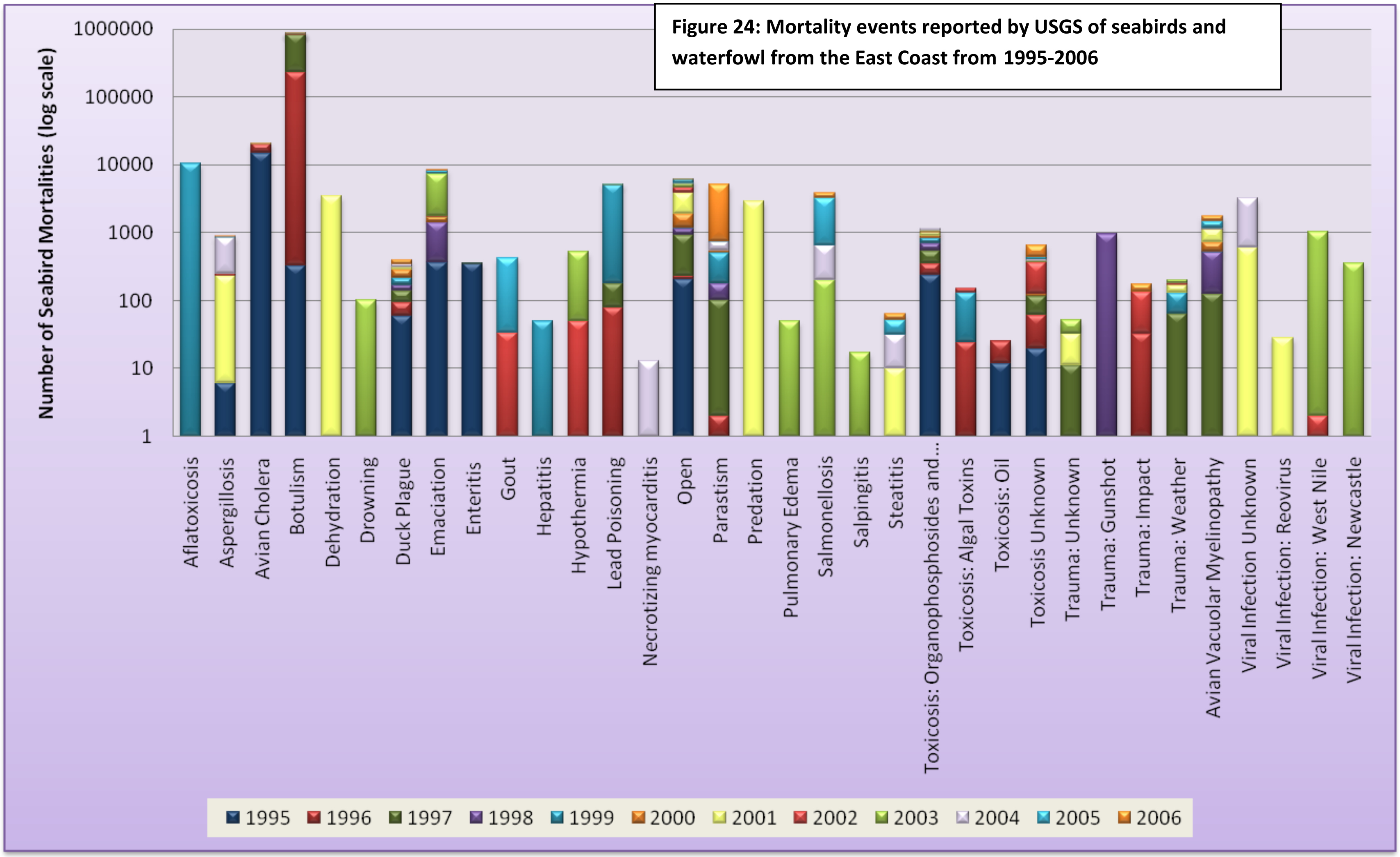
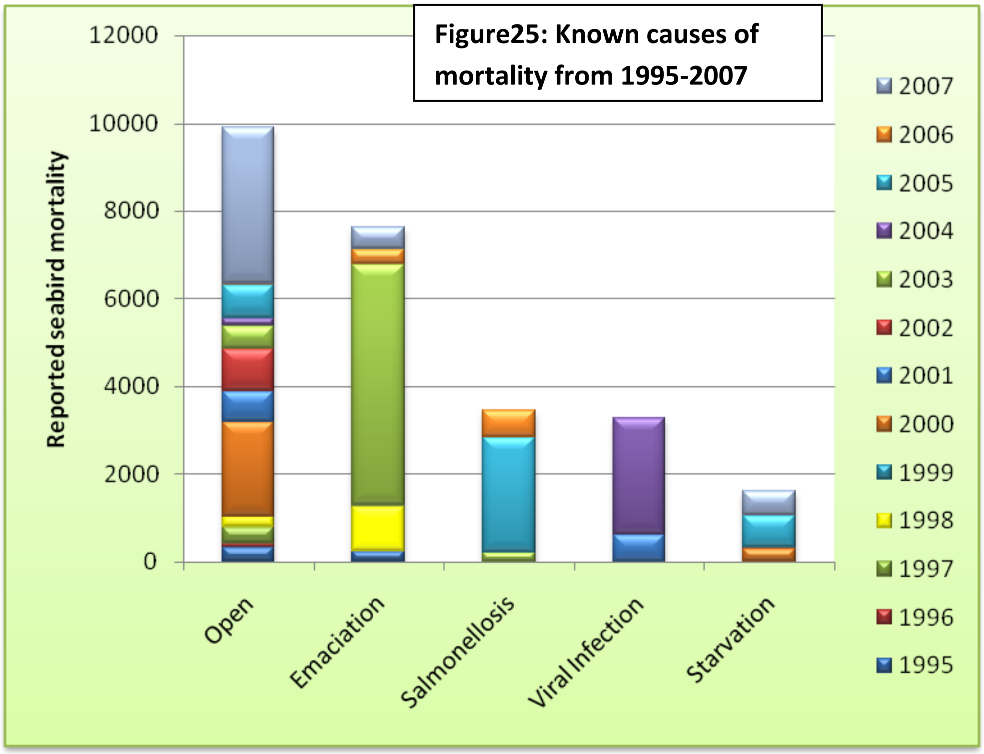
Figure 24: Mortality events reported by USGS of seabirds and waterfowl from the East Coast from 1995-2006





Figures 24 and 25 sum the total number of birds reported in each mortality event between 1995 and 2006 by the USGS NWHC. There were a total of 35,506 birds reported in these major die-off events. The majority of the numbers reported are estimations based on the number of birds actually found and other calculations. Some mortality events such as botulism (Figure 28), duck plague, parasitism, and toxicosis occurred frequently during 1995-2006, however most occurred only a few times if not once over the course of 11 years.

Figure 26 displays the trend of total seabird mortality in large-scale mortality events from 1995-2007. The trend seems to have an alternating pattern, where one year there will be high mortality, the next year it dramatically drops and then the following year it dramatically increases again. The dramatic increases in mortality were usually due to a single or a couple very large die-off events. There did not appear to be any single cause of mortality to attribute these dramatic increases to, however, large die-off events included viral infection, salmonellosis, and emaciation. There also appears to be a definite upward trend in the number of birds reported in mortality events from 1995 to 2007 (Figure 26).

Figure 26: Large Scale mortality events from 1995-2007

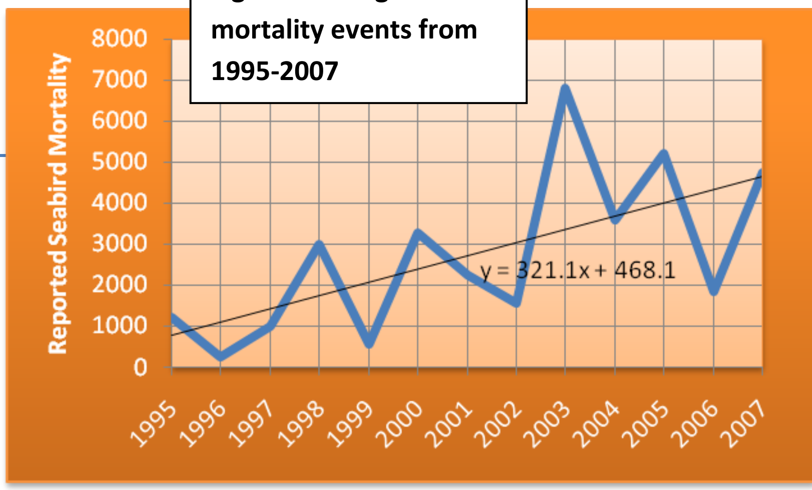
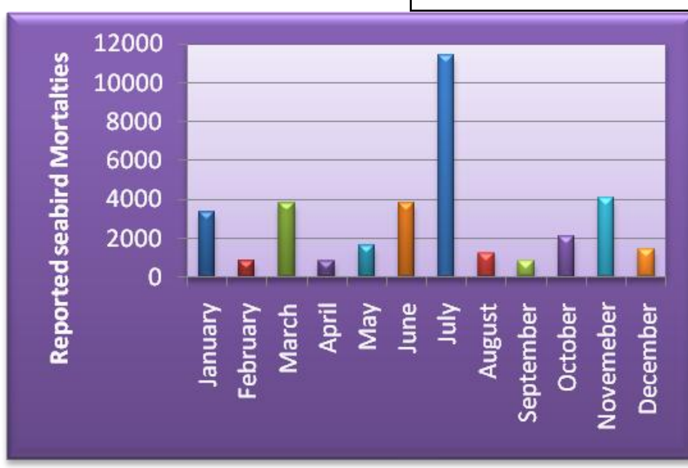


Figure 27: Distribution of reported mortality throughout year from 1995-2007



The distribution of reported bird mortalities in die-off events throughout the year from 1995 to 2007 was random (Figure 27). Unlike the SEANET beached bird survey results (Figure 6), there does not seem to be any particular season where there are more die-off events. The month of July did seem however, to have a few events of particularly large magnitude, including the massive Tern mortality in 2004 thought to be due to a viral infection (see Figure 14), a massive Tern mortality in Massachusetts in 2005 due to salmonellosis, and a large Ring-Billed Gull event of undetermined causes in New York.

Botulism, an important cause of mortality, is not included in the above figures since the numbers of bird mortality due to botulism overshadow all other mortality events. Figure 28 below displays the trend of botulism mortality from 1995-2006.

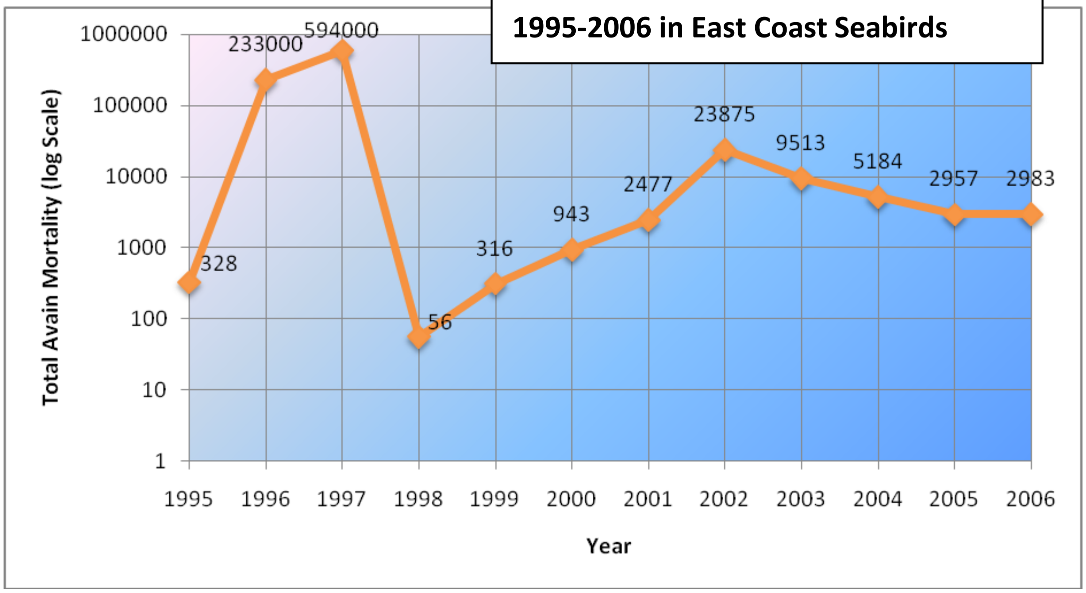


Figure 28: Botulism Mortality from 1995-2006 in East Coast Seabirds

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There are many mortality events reported in Figures 24-25, some of which occurred frequency between 1995-2007, such as duck plague, parasitism and toxicosis; however, most events transpired only a few times between those years. The following describes some noted events:

Duck Plague in Virginia

There is a history of duck plague outbreaks in the residential Virginia Beach area (Figure 29). The NWC confirmed duck plague in a third waterfowl die-off in a private flock in Poquosen, Virginia since 1997. Mortalities were in penned ducks and geese. (Converse, Miller, Glaser, et al, 1997 Qrt2).

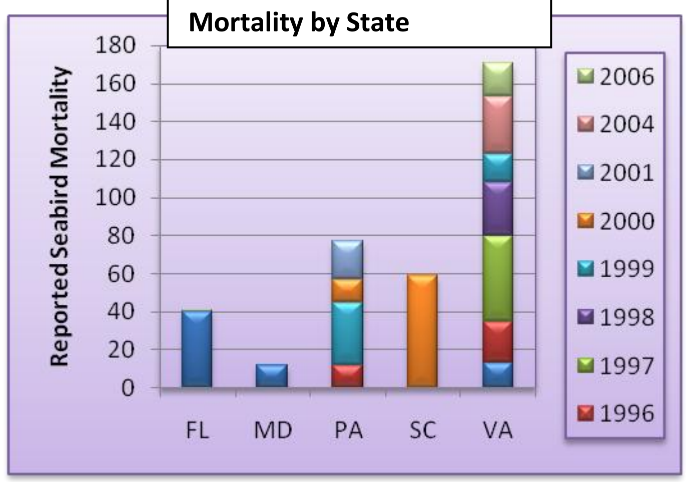


Figure 29: Duck Plague Mortality by State

Avian Vacuolar Myelinopathy

The NWHC confirmed Avian Vacuolar Myelinopathy (AVM), a recently discovered neurological disease, in several water birds, including mallards, ring-necked ducks, bald eagles, Canada geese and America coots. The disease has been occurring annually since 1994. The majority of cases occurred at Woodlake in North Caroline and J. Strom Thurmond/Clark's Hill Lake on the Georgia-South Caroline border. All cases of AVM occurred in October and November, which is the typical time for wintering populations to move in. The cause of AVM is still unknown, but from studies with sentinel mallards, the disease was determined to be site-specific and is though to be caused by a naturally occurring or man-made chemical. (Converse, Miller, Glaser, Schrader, 1999 Qrt4) (Miller, Converse, Schrader, 2001 Qrt1)(Rocke, Thomas, Auspurger, Miller, 2002)

Unknown Atlantic Brant die-off

In November 2000 and January 2001 there was a large Atlantic Brant die-off in New Jersey along the coast at Edwin B. Forsyth NWR in New Jersey and near Atlantic City. Over 700 Brant were collected during each wave of mortality for a total of over 1400 birds. Birds had extensive tissue hemorrhage and lung edema. Many state and federal agencies collaborated on the diagnostic and field response to this event; however, no viral or bacterial etiologic agents including West Nile virus, duck plague, Newcastle disease, and avian influenza were detected. Botulinum toxins and rodenticides tests were also negative (Miller, Converse, Schrader, 2001 Qrt1)

Cormorant Newcastle Virus

The USDA National Veterinary Services Lab (NVSL) isolated Cormorant Newcastle virus (CNV) in several double-crested cormorants collected in Lake Oneida, New York and Lake Champlain in New York and Vermont. Morbidity and mortality rates were first studied in July 2003 in hatch-year Cormorants. Newcastle disease virus was also isolated in Wisconsin cormorants for a total of approximately 350 mortalities. (Converse, Sohn, Miller, McLaughlin, 2003 qrt3)

Parasitism in Massachusetts Common Eiders

Common Eider die-offs occurred frequently off the coast of Cape Code (Figure 30). NWHC reported at least two of these events in October 2000 and May 2004. The eiders were severely emaciated with large loads of acanthocephalans and in some birds, cestodes. Wildlife rehabilitators and National Park Service's personnel reported approximately 50 Common Eiders in 2000 and 350 Common Eiders in 2004 dead in Wellfleet Bay. This data correlates with SEANET Beached Bird Survey findings (Figures 9 and 10) and SEANET Necropsy Findings. (Converse, Sohn, McLaughlin, Lemanski, 2004 qrt2)

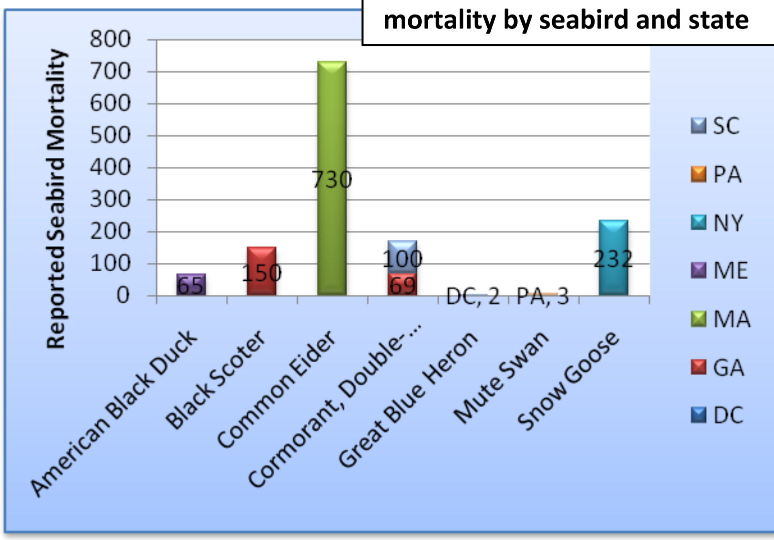


Figure 30: Parasitism causes of mortality by seabird and state

Unknown cause of seabird mortality along the Atlantic Coast.

In June 2005, there were unusual seabird mortality events involving shearwaters, terns, and gulls along the Atlantic Coast from Assateague Island, Maryland to Brevard County, Florida. Approximately 700 birds, primarily shearwaters, were found dead or sick along these shorelines. About 50% of the reports were from Florida, primarily Volusia and Brevard counties. Unfortunately many of these species live offshore so by the time the carcasses washed ashore they were often decomposed which made examination and analysis difficult. Emaciation was the only common finding. (Sohn, Converse, McLaughlin, Miller, 2005 qrt2)

Immature greater shearwaters die of suspected starvation along the Atlantic coast

Approximately 500 immature greater shearwaters were found washed up dead on the coasts of Florida and North Carolina in mid-June, 2007. The shearwaters were extremely emaciated and thought to have died from starvation on their migratory route from Newfoundland. It is not unusual for immature greater shearwaters to die during migration; however, the magnitude of this event is much greater than normal. (Jankowski, Schuler, 2007 qrt2)

Visceral gout in snow geese and tundra swans.

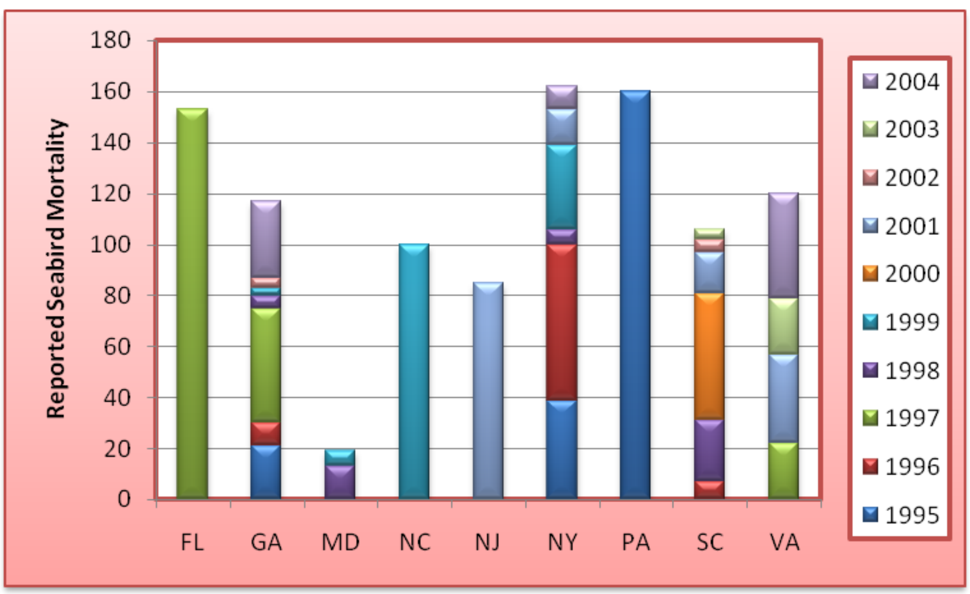
The NWHC reported visceral gout in snow geese in Pasquotank County, North Carolina in January, in Back Bay NWR, Virginia in February, and in Mackey Island NWR, North Carolina in March, 2005. On necropsy, no kidney parasites were present and bacteriology and virology yielded no significant findings. Severe acute renal tubular necrosis was present without inflammation. A corn sample from Virginia was tested for nephrotoxins but the results were below detectable limits. Similar episodes of visceral gout occurred in the same species in Virginia in 1980 and 1981 and in North Carolina in 1979, 1992, 1994 and 2002. (Sohn, Converse, Saito, McLaughlin, 2005, QRT1).

Organophosphate and Carbamate Toxicosis

The New York State Department of Environmental Conservation (NYDEC) reported many cases of carbamate and organophosphate poisoning in 1995 and 1996(Figure 31). Some events were caused by inadvertent application of diazinon pesticides. Diazinon mortality events have since decreased since the 90's and were hardly reported from 2000-2007. Others mortality events in New York were linked to organochlorine pesticides, chlordane/diedrin. These now banned chemicals were used in the mid 50's to the early 70's for termite and turf insect control. Unfortunately, even though banned, the pesticides have a long half-life and toxicosis mortality might continue in New York through the 1990's (1995, QRT 3)(1996 Qrt1)(1996 Qrt4)

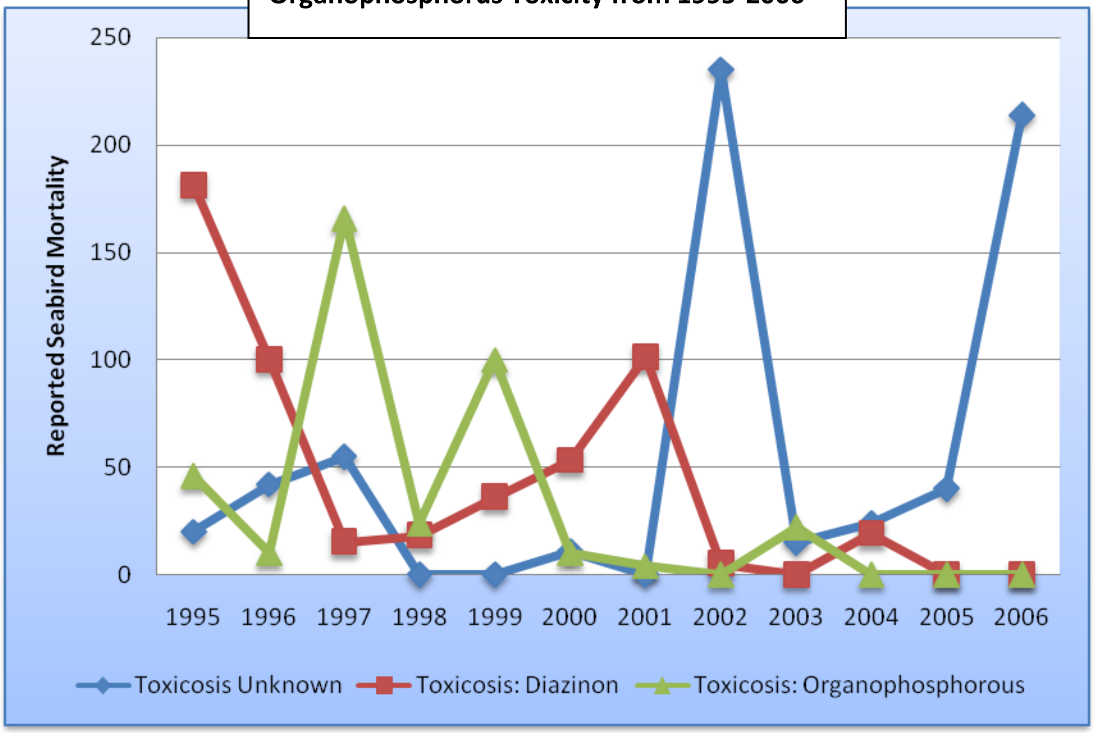
Another organophosphorus toxicosis event occurred in July and October 1997 on Marco Island in Collier County, Florida (Figure 31). Subsequent contaminant analysis of birds from the July event confirmed an unusual combination of very high levels of phorate, diazinon, dimethoate, dursban, and malathion in one bird and dursban in another bird. The mortality event included approximately 150 western sandpipers, black skimmers, and a few other shorebirds. (1997, Qrt4).

Figure 31: Organ. & Carb. Toxicosis from 1995-2007



Carbamate and organophosphorus toxicity has decrease until both are at 0 reported events in 2005 and 2006 as shown in Figure 32. Toxicity of unknown causes however is on the rise, which may be due to either natural or anthropogenic factors.

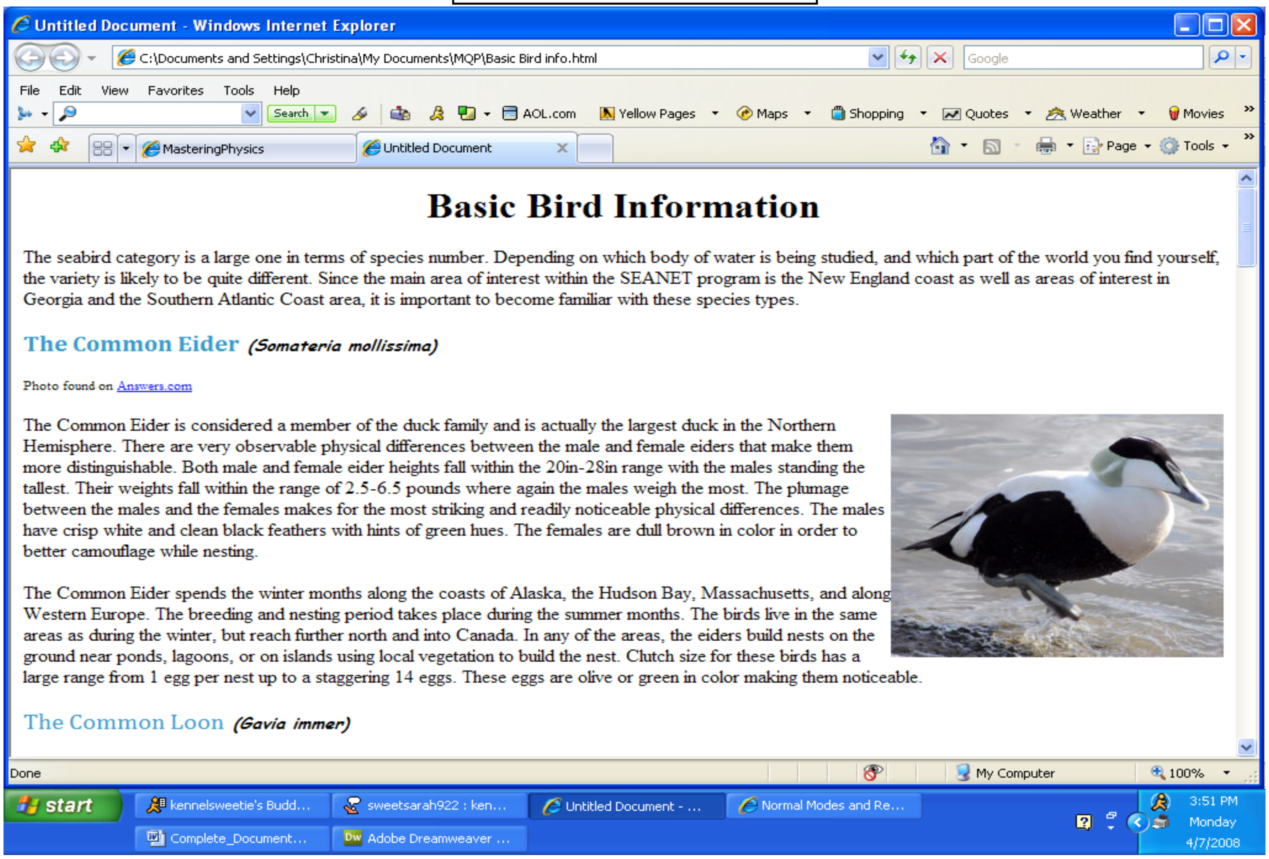
Figure 32: Mortality caused by Diazinon and Organophosphorus Toxicity from 1995-2006



SEANET Website

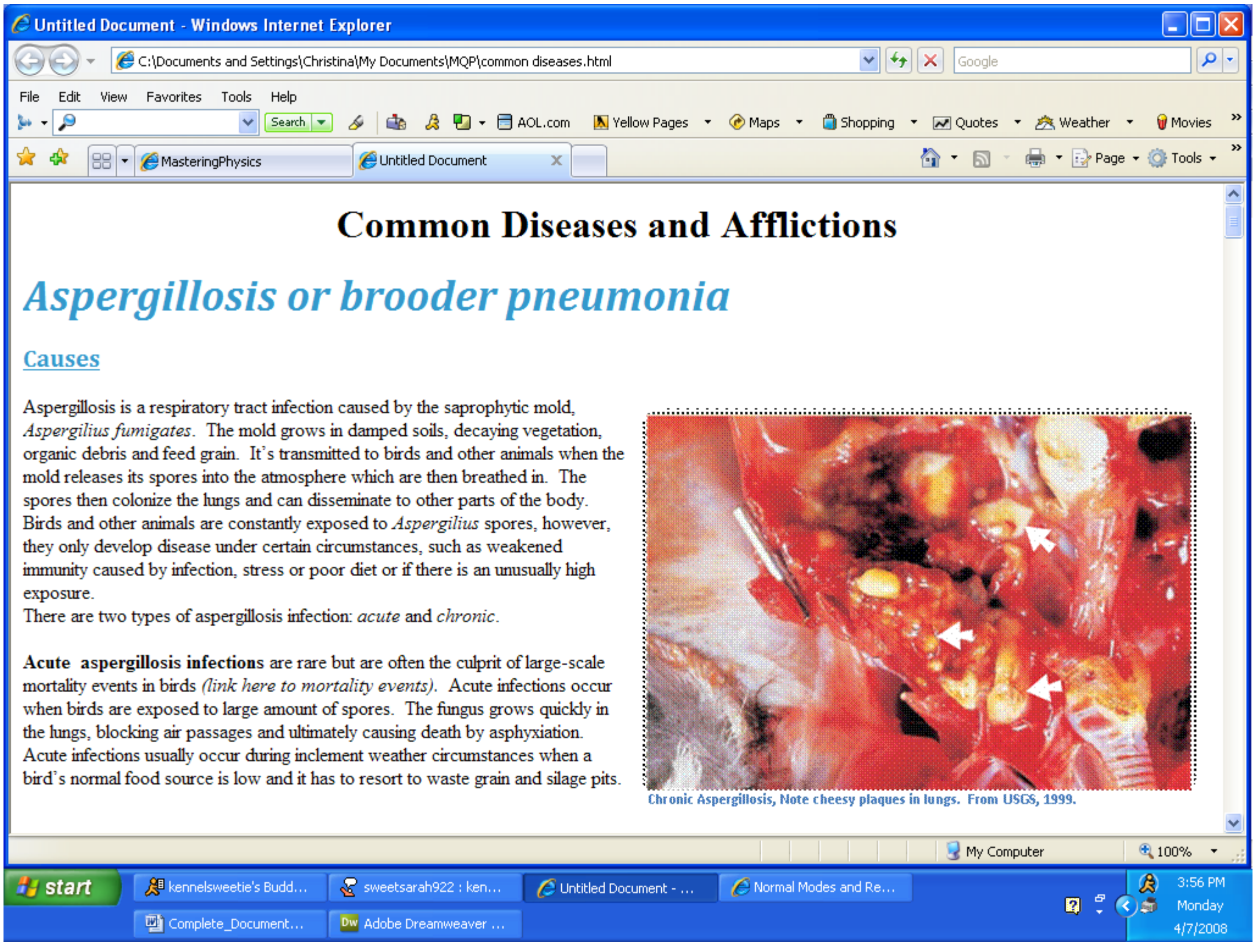
During several meetings the SEANET sponsors expressed their desire to include more generalized information on the website about seabirds and their causes of death. Because of this, the first page designed included information about the Common Eider, Common Loon, Shearwaters, Northern Gannet, Double-Crested Cormorant, Ring-Billed Gull, Brown Pelican, American White Pelican, Great Blue Heron, and the Common Tern. Along with an image of the adults of each species, there is now information about their coloration, mating behaviors, nesting behaviors, and individualized threats to their populations. Figure 33 shows a screen shot of this page.

Figure 33: Basic Bird information page



The sponsors also expressed their interest in further explaining common causes of death of seabirds on the website. The website now contains helpful images of the diseases as well as thorough explanations of symptoms and causes. Figure 34 displays this webpage.

Figure 34: Common Diseases page

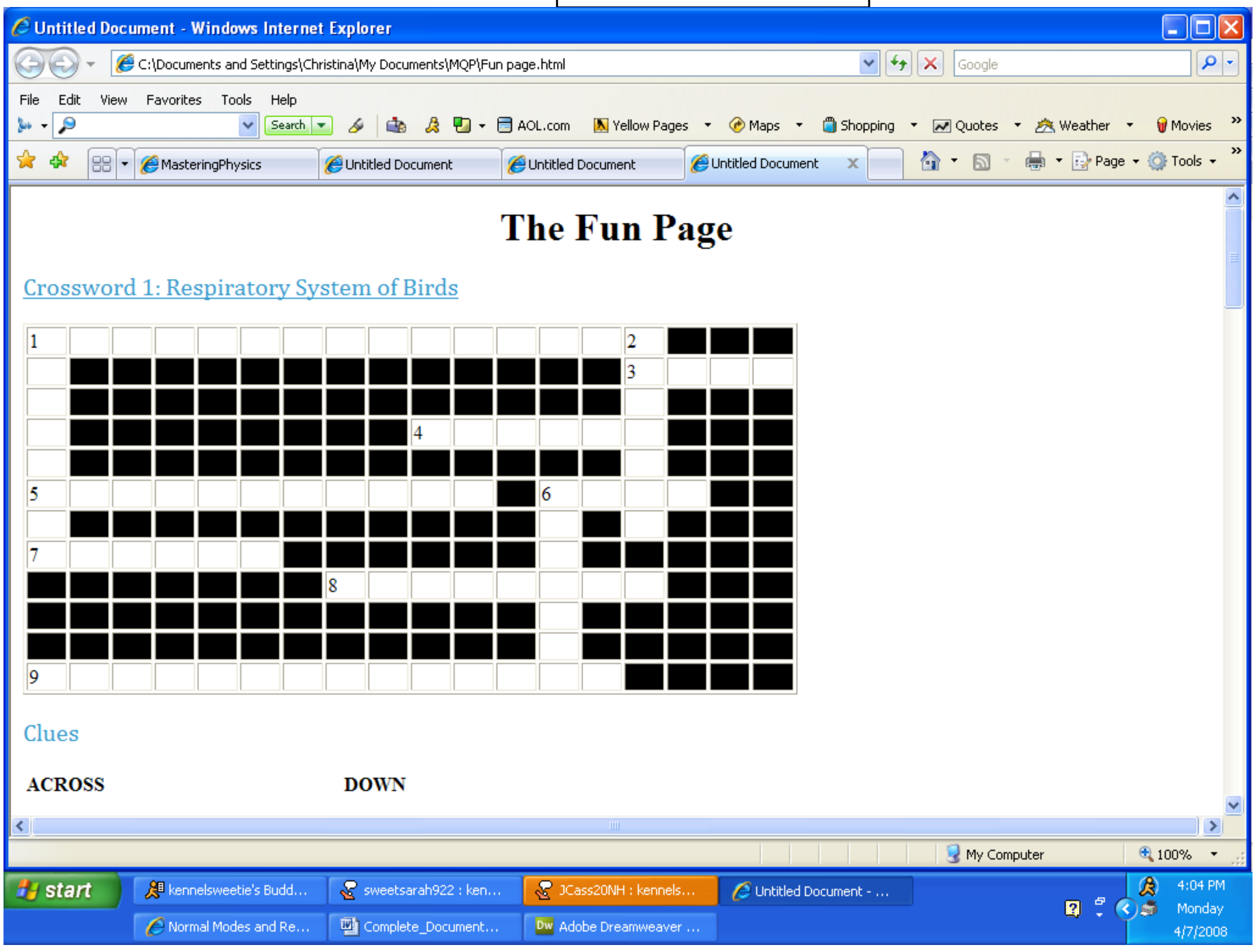


As has been discussed, SEANET relies heavily on volunteer help. These volunteers are responsible for finding the beached birds and documenting their condition as well as bringing in samples. Each state involved in the SEANET program now has its own page. On these pages are maps of the beaches volunteers walk and important telephone numbers for contact agencies and volunteer help. Figure 35 below shows a snap shot of the Massachusetts page.

Figure 35: Massachusetts volunteer page

The SEANET sponsors additionally expressed their interest in making the website more educational. To accomplish this, a “Fun Page” was created. On this page are word searches and crosswords as well as matching picture games that include information about birds but are still entertaining. Figure 36 shows an image of this page.

Figure 36: Fun Page



Discussion

The basic analysis of SEANET data revealed several features and trends in the preliminary data that may be useful for future developments in the program; additionally, it will improve the general public's awareness of seabird mortality. Tracking of BBS reports from 2002-2007 demonstrated useful and interesting trends in common seabird mortality rates (Figure 5). The results in Figure 5 show the beginning of what seems like a decent baseline trend in many of the common seabird families. With continual data collection and further statistical analysis, SEANET will be able to determine baseline mortality rates for common seabird species populations. Determination of these baseline mortality rates will then allow SEANET and other organizations to more accurately monitor the populations of seabirds along the Atlantic Coast. For instance, knowing the baseline mortality in seabirds, SEANET or another organization could see how certain changes in the seabird environment, such as oiling or global warming, affects the total population. Without this baseline data, it can be difficult to tell how chronic causes of mortality effect the seabird population as well as when an event falls outside the "acceptable" range.

Analysis of the BBS reports showed that the mortality rate in several seabird populations was highest in February, March, and April (Figure 6). Continual tracking of the distribution throughout the year will allow SEANET to determine baseline trends as well as to help spotlight any abnormalities that might indicate further investigation. The laughing gull, for instance, was the only species which had significant reports throughout the entirety of the year and unlike most other seabird species its mortality reports peaked in the summer months, particularly in July (Figure 8). These abnormal results yield further investigation as to why the mortality in this particular species is so different from other seabird populations.

There were several aspects of the of the SEANET necropsy data analysis which yielded helpful indications into the common causes of mortality in seabirds in 2004, 2005 and 2006. Figure 16 shows that trauma was the greatest cause of death in all populations. SEANET should build on this data to incorporate more definitive types of trauma. Currently, further analysis into these specific types is indeterminable because the classification is all lumped under "trauma". SEANET's ability to further break down types of trauma will allow for more specific conclusions to be reached and then information tailored to those events to be presented to the general public.

The analysis of SEANET's necropsy data also showed a decent distinction between natural and anthropogenic causes of mortality in seabirds (Figures 16, 21, and 22). Further tracking of this data may prove useful in helping to determine natural verses human-induced baseline causes of mortality in seabirds as one of SEANET's goals is to make the general public aware of the human impact on these seabird populations. Additionally, finding these baseline levels specifically for human impact will allow SEANET but also other organizations to determine whether advancements to protect these populations are working. For instance, there was a significant decrease in the by-catch mortality from 2004-2006 (Figure 20), which correlates with the efforts of the National Marine Fisheries Service (NMSF) to reduce by-catch since 2002 (Hogarth, 2003).

The great majority of BBS reports and necropsy data were from Massachusetts (Figures 2 and 17); however there is significant seabird mortality which occurs in other areas of the Atlantic coast in accordance with the analyses done by the USGS NWHC mortality reports (data not shown). SEANET should ideally try to expand in order to more equally distribute its beached bird surveys. Additionally, SEANET should analyze necropsy data collected from other SEANET partner organizations in order to compare Massachusetts seabird mortality to seabird mortality in other Atlantic regions.

The purpose of the USGS NWHC analyses was primarily to discover any trends/themes that might be useful for further investigations by SEANET. There are two patterns in the USGS NWHC data which are especially interesting and useful to further investigate: the dramatic alteration between high and low mortality every other year and the steady upwards trend of the total number of seabirds reported in large scale mortality events (Figure 26).

Investigation of the USGS NWHC data may also help identify trends with specific causes of mortality. For instance, the data collected during the Common Eider die-offs along Cape Cod in 2000 and 2004 from SEANET and its partners correlated strongly with the data reported in the USGS NWHC mortality reports (Figures 9, 10, 30). As SEANET's beached bird surveys expand there should be more correlation between SEANET's beached bird surveys and the USGS NWHC mortality reports.

Finally, SEANET should continue to do frequent analyses of the data collected from the beached bird surveys and from necropsy findings. More frequent analysis will allow for further investigation into trends, will allow SEANET to continually improve collection methods to produce more accurate data, and will also allow the volunteer community to see how their participation is being used.

Website Conclusions

The website was initially created by SEANET as a means to reach a larger audience. The program would not exist without the help of volunteers, researchers, veterinarians, rehabilitators, or other agencies. The website is the easiest means of reaching all of these parties. Because new pages were created that contain basic information on seabird species, most common diseases and afflictions, as well as a break down by state of how to get involved and become a volunteer, the website should help SEANET gain more volunteers and partnerships that will allow the program to grow.

By having more volunteers and agencies to help the project, more beached bird surveys can be conducted as well as more necropsies. This in turn allows for greater data collection and results to be obtained that are statistically relevant. Using this added help and data, SEANET can then specify its efforts to those areas of greatest concern, for example, lead poisoning.

Ideally, SEANET will continue to update its website with new studies being performed, training events for volunteers, and results once tabulated. The website is now user friendly and easy to navigate allowing for easier maintenance. In the future, the website should be further expanded to include more bird species, other diseases, information on any threats such as the Avian flu, educational tools for teachers to use in the classroom, and volunteer updates. By keeping the website up to date and easy to use, more volunteers will help SEANET expand the project and the general public will be made current on the status of many seabird populations.

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