Chapter 22

Avian Influenza

Synonyms

Fowl pest, fowl plague, avian influenza A.

Wild birds, especially waterfowl and shorebirds, have long been a focus for concern by the poultry industry as a source for influenza infections in poultry. Human health concerns have also been raised. For these reasons, this chapter has been included to provide natural resource managers with basic information about avian influenza viruses.

Cause

Avian influenza is usually an inapparent or nonclinical viral infection of wild birds that is caused by a group of viruses known as type A influenzas. These viruses are maintained in wild birds by fecal-oral routes of transmission. This virus changes rapidly in nature by mixing of its genetic components to form slightly different virus subtypes. Avian influenza is caused by this collection of slightly different viruses rather than by a single virus type. The virus subtypes are identified and classified on the basis of two broad types of antigens, hemagglutinan (H) and neuraminidase (N); 15 H and 9 N antigens have been identified among all of the known type A influenzas.

Different combinations of the two antigens appear more frequently in some groups of birds than others. In waterfowl, for example, all 9 of the neuraminidase subtypes and 14 of the 15 hemagglutinin subtypes have been found, and H6 and H3 are the predominant subtypes. In shorebirds and gulls, 10 different hemagglutinin subtypes and 8 neuraminidase subtypes have been found. Many of the antigenic combinations of subtypes are unique to shorebirds. H9 and H13 are the predominate subtypes. More influenza viruses from shorebirds infect waterfowl than chickens. Hemagglutinin subtypes H5 and H7 are associated with virulence or the ability to cause severe illness and mortality in chickens and turkeys. However, two viruses with the same subtype antigens can vary in virulence for domestic birds.

Species Affected

Avian influenza viruses have been found in many bird species, but are most often found in migratory waterfowl, especially the mallard duck (Fig. 22.1). However, the only mortality event known in wild birds killed common terns in South Africa in 1961. This was the first influenza virus from marine birds and it was classified as subtype H5N3. Other wild birds yielding influenza viruses include various species of shorebirds, gulls, quail, pheasants, and ratites (ostrich and rhea). Experimental infections of domestic birds with viruses

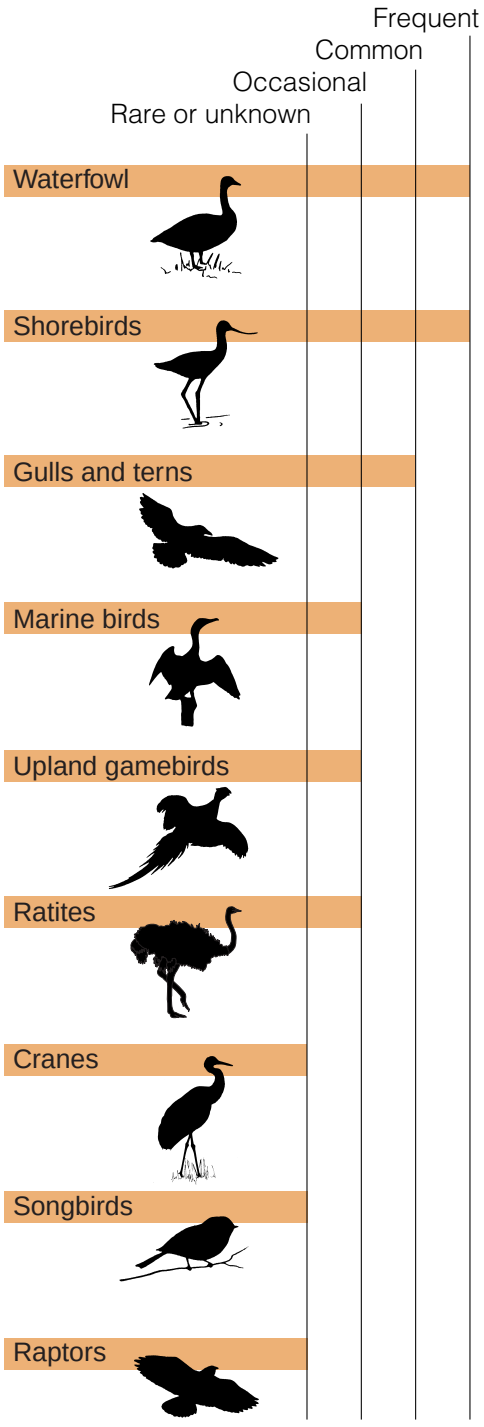

Figure 22.1 *Relative occurrence of avian influenza virus in various bird groups.*

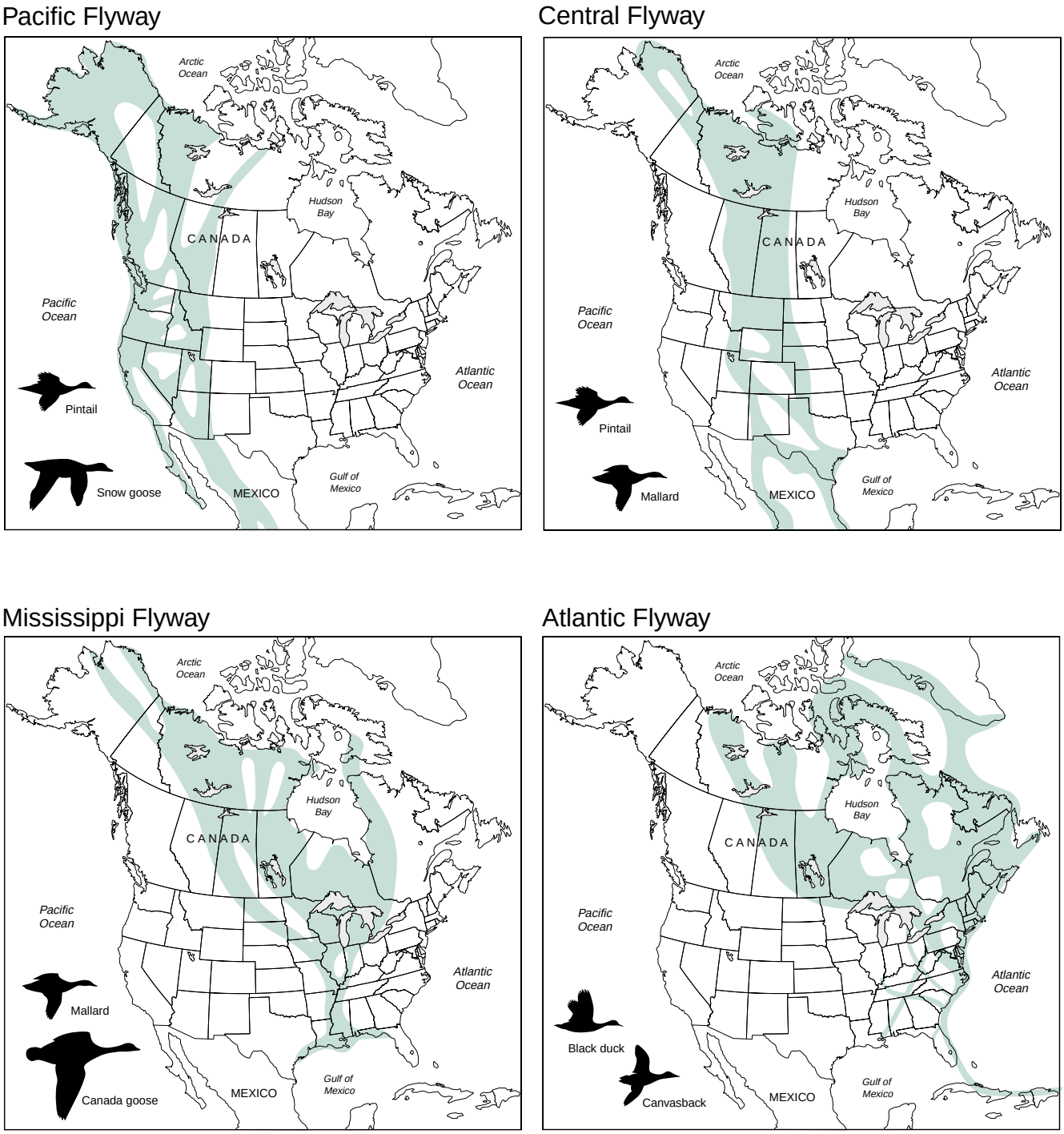

Figure 22.2 *General migratory pathways followed by North American waterfowl. Species shown are typical of these flyways (Modified from Hawkins and others, 1984).*

from wildlife do not cause mortality. Likewise, virulent viruses or viruses that cause disease in domestic fowl do not cause mortality in wild waterfowl.

Distribution

Although influenza tends to be most commonly detected in birds that use the major waterfowl flyways, these viruses are found throughout North America and around the world. The majority of North American waterfowl migration takes place within four broad geographic areas (Fig 22.2). Many species other than waterfowl follow these same migratory pathways from their breeding grounds to the wintering grounds and return to the breeding grounds. The virus subtype that are found in birds in adjacent flyways will differ, especially if the birds from each flyway do not mix during migration. In any given year the percentage of waterfowl and shorebirds carrying influenza viruses will vary by flyway. Likewise, the percentage of birds carrying virus in an flyway will vary in consecutive years. The virus subtype found in birds that use a flyway are rarely the same in consecutive years.

Seasonality

Influenza virus has been found in wild birds throughout the year, but waterfowl are the only group in which these viruses are found year round (Fig. 22.3). The highest occurrence of infection is in the late summer months in juvenile waterfowl when they assemble for their first southward migration. The number of infected waterfowl decreases in the fall as birds migrate toward their southern wintering grounds and is lowest in the spring, when only one bird in 400 is infected during the return migration to the north. In contrast, the number of birds infected is highest in shorebirds (primarily ruddy turnstone) and gulls (herring) during spring (May and June). Infection in shorebirds is also high in September and October. Influenza viruses have not been found in shorebird and gull populations during other months of the year. Influenza viruses have been found in marine birds such as murres, kittiwakes, and puffins while they have been nesting, but the pelagic habits of these species preclude sampling during other periods of the year.

Field Signs

In domestic birds, the signs of disease are not diagnostic because they are highly variable and they depend on the strain of virus, bird species involved, and a variety of other factors including age and sex. Signs of disease may appear as respiratory, enteric, or reproductive abnormalities. Included are such nonspecific manifestations as decreased activity, food consumption, and egg production; ruffled feathers; coughing and sneezing; diarrhea; and even nervous disorders, such as tremors. Observable signs of illness have not been described for wild birds. In domestic chickens and turkeys, certain virus subtypes like H5N2 and H7N7, respectively, are usually highly virulent and may cause up to 100 percent mortality in infected flocks. Another major impact of influenza viruses in domestic birds is decreased egg production. Too little is known about the impact of influenza viruses on the reproductive performance of wild birds to assess whether or not they are affected in the same manner as poultry.

Gross Lesions

Avian influenza virus infection in wild birds is not indicated by gross lesions. Common terns that died in South Africa did not have gross lesions, but a few birds had microscopic evidence of meningoencephalitis or inflammation of the membrane that covers the brain. These lesions were not reproducible during experiments. Mallards experimentally infected with a virulent influenza virus developed discrete purple areas of lung firmness and cloudy lung coverings. However, virulent viruses are rarely found in wild birds, and these lesions may not appear in natural infections.

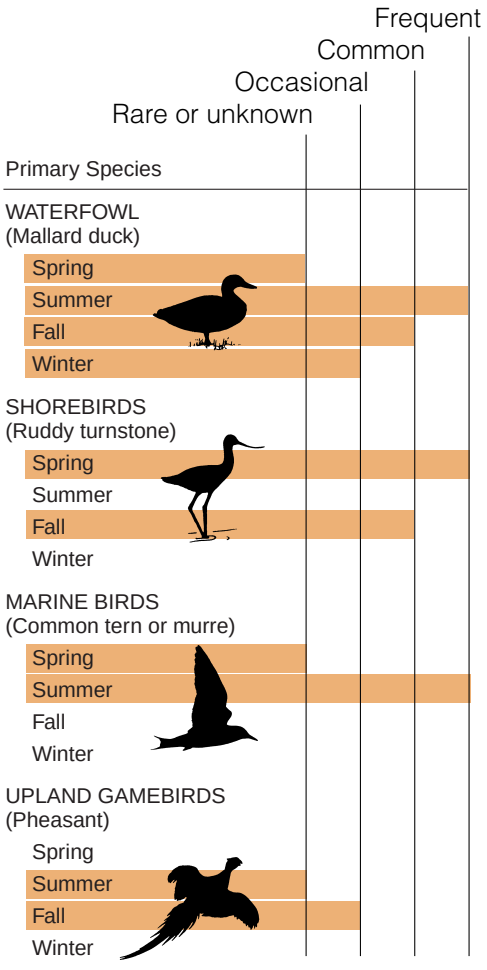

Figure 22.3 *Relative seasonal occurrence of influenza A in birds.*

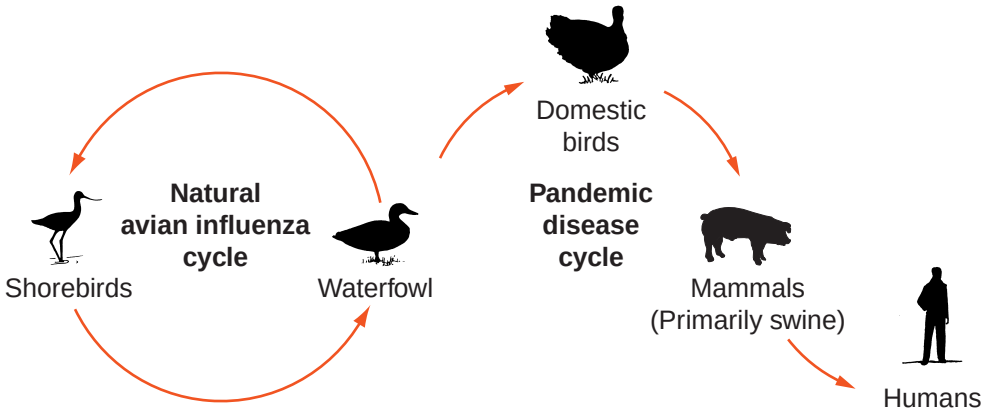

Figure 22.4 *Global cycle of avian influenza viruses in animals.*

Diagnosis

Infected birds are detected by virus isolation from cloacal swabs in embryonated chicken eggs, and by serological testing of blood for antibody. The last test indicates that a bird was exposed to these viruses rather than if it is infected or carries the disease. Reference antisera to all of the subtype antigen combinations are used to determine the identity of the virus; however, the virulence of a virus cannot be determined by the antigenic subtype. Virulent and avirulent strains of the same subtype can circulate in nature. Laboratory and animal inoculation tests are required to establish the virulence of strains based on an index established for domestic birds.

Control

Avian influenza viruses in wild birds cannot be effectively controlled because of the large number of virus subtypes and the high frequency of virus genetic mixing resulting in new virus subtypes. Also, virus has been recovered from water and fecal material in areas of high waterfowl use. During experiments, influenza virus was recovered from infected waterfowl fecal material for 8 days and from fecal contaminated river water for 4 days when both were held at 22 °C. Poultry manure is a primary residual source of virus for domestic flocks. The virus has been recovered from poultry houses more than 100 days after flock depopulation for markets.

In the domestic bird industry, preventing the entry of the virus into poultry flocks is the first line of defense. Killed vaccines are selectively used to combat less virulent forms of this disease. Antibody present in the blood of recovered and vaccinated birds prevents virus transmission. Therefore, these birds pose little risk to other birds. Flocks are generally killed when they are infected with highly virulent viruses.

In the past, the poultry industry and the wildlife conservation community have been in conflict regarding wildlife refuge development and other waterbird habitat projects. The fear that waterbirds are a source of influenza viruses for infection of poultry has resulted in strong industry opposition that has negatively impacted some projects. This issue should be considered when land use near wetlands is planned and when wildlife managers plan for development for wildlife areas. Open communication during project development and sound plans that are developed in a collaborative manner may help industry and conservation groups avoid confrontation and support each others' interests.

Human Health Considerations

Although this group of viruses includes human influenza viruses, the strains that infect wild birds do not infect humans. It is believed that waterfowl and shorebirds maintain separate reservoirs of viral gene pools from which new virus subtypes emerge. These gene pools spill over into other animals (mammals) and may eventually cause a new pandemic (Fig. 22.4).

Wallace Hansen

Supplementary Reading

Easterday, B.C., and Hinshaw, V.S., 1991, Influenza, *in* Calnek, B.W., and others, eds., Diseases of Poultry (9th ed.): Ames, Iowa, Iowa State University Press, p. 532–552.

Hinshaw, V.S., Wood, J.M., Webster, R.G., Deible, R., and Turner, B., 1985, Circulation of influenza viruses and paramyxoviruses in waterfowl originating from two different areas of North America: Bulletin of the World Health Organization 63, 711–719.

Kawoka, Y., Chambers, T.M., Sladen, W.L., and Webster, R.G., 1988, Is the gene pool of influenza viruses in shorebirds and gulls different from that in wild ducks?: Virology, v. 163, p. 247–250.

Stallknecht, D. E., Shane, S. M., Zwank, P. J., Senne, D. A., and Kearney, M. T., 1990, Avian influenza viruses from migratory and resident ducks of coastal Louisiana: Avian Diseases, v. 34, p. 398–405.