CALIFORNIA DEPARTMENT OF FISH & WILDLIFE

Avian Influenza Surveillance Summary

July 2023 - June 2024 Season

Executive Summary

Avian influenza H5N1 (Eurasian lineage goose/Guangdong H5 clade 2.3.4.4b) was detected for the first time along the Atlantic Coast of North America in late 2021 and early 2022 in both wild and domestic birds. By early July 2022, avian influenza H5N1 had been detected in wild birds in California. During the July 2022 - June 2023 season, avian influenza H5N1 was detected in 367 wild birds collected from 44 counties. The last detection of the season was made in a bird collected in mid-June 2023.

The first avian influenza H5N1 detections of the July 2023 - June 2024 season were in wild birds collected in mid-October 2023, including greater white-fronted geese collected from Glenn and Butte counties and an American white pelican collected from Stanislaus County. Detections were delayed by roughly 3 months compared to the previous season, occurring in October rather than July. Detections also declined 2 months earlier, with the last detection in early April 2024 rather than June.

Between October 2023 and April 2024, avian influenza H5N1 was detected in 117 wild birds during mortality surveillance. Detections were made in birds collected from 29 counties. Initial detections of the virus had no clear north to south geographic pattern this season, compared to the first season. Rather, initial detections were made in mid- to late-October in 9 different counties across California.

Overall, detections this season were much lower than during the previous season. Although similar to the previous season, the number of avian influenza detections gradually increased through the fall in 2023, then declined in late winter - early spring 2024. Detections peaked in December 2023, declined slightly in January 2024, and then fell sharply between February and April 2024. This pattern coincides with the southward fall migration and over-wintering of numerous waterfowl in the state, which appeared to occur later than during the previous season. By late winter and spring, birds begin spring migration northward to breeding areas, which appeared to occur earlier than during the previous season.

Detections were made in about 31 different species of wild and feral birds. Detections were generally highest in species of waterfowl, followed by raptors, waterbirds, and scavengers. Species with the highest number of detections included snow geese, red-tailed hawks, peregrine falcons, and Canada geese.

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Snow geese roosting on a wetland pond in Glenn County, California. Photo credit: Krysta Rogers, CDFW.

1. Introduction

Avian influenza is an infectious disease of birds caused by avian-origin influenza A viruses. Viruses are classified based on two surface proteins, Hemagglutinin (H) and Neuraminidase (N), which combine to form different subtypes (e.g., H5N1, H5N2, H7N3, H12N5) (Stallknecht et al. 2007). Different subtypes, and strains within a subtype, vary in their ability to cause disease in birds. Avian influenza viruses may be further categorized as highly pathogenic (HP) or low pathogenic (LP) based on their ability to cause disease in domestic poultry.

Avian-origin influenza A viruses naturally circulate in wild waterbirds including species within the orders of Anseriformes (ducks, geese, and swans) and Charadriiformes (gulls, terns, and shorebirds) (Hill et al. 2022; Stallknecht et al 2007). Avian influenza viruses are shed in bodily fluids such as saliva, nasal secretions, and feces. Water is important for virus transmission between individual waterbirds. These birds may be inadvertently exposed to viruses when eating, drinking, preening, and/or bathing in water potentially contaminated with viruses. In wild waterbirds, virus circulation has historically increased during fall migration as individual birds co-mingle at various stopover locations (e.g., wetlands, ponds, lakes) through migration (van Dijk et al. 2014). These naturally circulating viruses are of low virulence and rarely cause illness or death of wild birds (Stallknecht et al. 2007).

Avian influenza H5N1 (Eurasian lineage goose/Guangdong H5 clade 2.3.4.4b) was detected for the first time along the Atlantic Coast of North America in Canada in December 2021 and in the United States in January 2022 (Alkie et al 2022; Youk et al. 2023). Detections of this virus had been on the rise across parts of Europe during the preceding years, and especially in 2022 with detections in both wild and domestic birds (EFSA et al., 2022). Prior to this current outbreak, avian influenza viruses considered highly pathogenic had been more of a disease of domestic poultry with occasional spill-over into wild birds which may or may not have caused mortality (Ramey et al. 2022). This current outbreak is unprecedented in terms of the geographic range and diversity of wild birds and mammals potentially impacted. The virus has near world-wide circulation with detections on all continents except Oceania (Xie et al. 2025). Notably, this was the first avian influenza virus to reach seabirds in Antarctica. A high diversity of

wild birds and mammals are susceptible to fatal infection with avian influenza H5N1. Since 2022, outbreaks have impacted backyard and commercial domestic poultry in the United States and elsewhere, and dairy cattle in the United States since 2024 (Xie et al., 2025).

Avian influenza H5N1 in free-ranging wild birds may be maintained in waterfowl and shorebirds, the natural hosts of avian influenza viruses, and water is important for transmission among these species (Harvey et al. 2023; Hill et al. 2022). As such, the focus of virus activity tends to occur around some type of waterbody, typically a closed or semi-closed waterbody, where waterfowl may congregate and the virus has the potential to become more concentrated. Avian and mammalian predators and scavengers that feed on infected animals also may be at risk of becoming infected. Bird species that spend little to no time in wetlands and other water-dominant habitats are generally less likely to be exposed to the virus (e.g., small songbirds).

Northern shoveler ducks roosting on a flooded field in Yolo County, California. Photo credit: Krysta Rogers, CDFW.

2. Surveillance & diagnostic testing

2.1. Mortality-based surveillance

The California Department of Fish and Wildlife's (CDFW) Wildlife Health Laboratory conducts mortality-based surveillance for avian influenza which involves testing wild birds found dead. Mortality-based surveillance occurs year-round and is opportunistic when dead birds are submitted. Birds may be submitted by agencies, wildlife rehabilitation centers, other organizations, and members of the public. Mortality surveillance can help identify what species are susceptible to clinical or fatal infection rather than those that may be reservoirs of the virus.

Mortality events involving multiple dead birds are prioritized for surveillance. Mortality events are generally more easily detected than an individual dead bird. Additionally, mortality surveillance generally increases the likelihood of a detection since many dead birds in a location may indicate an infectious disease outbreak. Surveillance testing of individual birds may be considered for certain species known to be at higher risk of infection (e.g., predators, scavengers) and for lower risk species found in locations with a known outbreak and/or presenting with suspicious clinical signs. Since reporting of dead birds relies on observations made by people, submissions of dead birds, and therefore testing of birds, tends to be biased towards areas with more people including

the San Francisco Bay Area and the South Coast. Birds that die in more remote or less human-populated areas are less likely to be represented during testing. Submissions also tend to bias larger-bodied birds since they are more visible and persist longer on the landscape.

Mortality-based surveillance provides a broad account of virus activity over time across the entire state. Initial surveillance generally targets areas without virus detections. Once a detection is made in an area, subsequent testing may occur periodically thereafter to monitor virus activity over the longer term. It is important to note, only a portion of birds are tested, although many more may be reported. Therefore, the number of birds with detections does not accurately represent the total number of birds that may have ultimately died of infection.

Surveillance testing of wild birds is primarily coordinated though CDFW's Wildlife Health Lab. Although, other agencies and organizations may perform surveillance testing of wildlife independently from CDFW. For example, the United States Fish and Wildlife Service (USFWS) may conduct surveillance testing during mortality investigations on federal public lands. In some cases, CDFW may or may not be made aware of the details of testing performed by other partners.

American white pelican in a park pond in Orange County, California. Photo credit: Krysta Rogers, CDFW.

2.2. Diagnostic testing

For wild birds, the diagnostic standard for avian influenza testing is the collection of an oropharyngeal swab and a cloacal swab from each bird. The swabs are inoculated into viral transport medium.

The CDFW's Wildlife Health Lab receives dead birds year-round for mortality investigation and surveillance testing. Bird species and age are routinely recorded. Swab samples are collected from each bird and submitted for testing to the California Animal Health and Food Safety (CAHFS) Laboratory system which is part of the National Animal Health Laboratory Network.

A real-time reverse-transcriptase polymerase-chain-reaction (rRT-PCR) is commonly used for surveillance testing for avian influenza viruses (USDA 2022). The PCR test detects the genetic material of the virus, if present. Generally, preliminary testing at CAFHS includes an initial PCR to detect influenza A viruses. If detected, a subsequent PCR is performed to determine if the virus is an H5 subtype. If an influenza A virus is detected, a sample is forwarded to the United States Department of Agriculture's (USDA) National Veterinary Services Laboratories (NVSL) for confirmatory testing. The NVSL performs PCR testing for influenza A and the H5 subtype. Virus isolation is also attempted to further genetically characterize the virus and to determine if the virus is of low or high

pathogenicity. Because highly pathogenic avian influenza is a federally regulated disease for poultry, all detections of avian influenza must undergo confirmatory testing by NVSL.

3. Surveillance results

3.1. Mortality investigations

Between July 2023 and June 2024, roughly 934 birds were received at the CDFW's Wildlife Health Lab, and of these birds, 457 were selected for surveillance testing. Approximately 228 birds were tested by other agencies and organizations. Note, the results of surveillance testing presented in this summary report should be considered preliminary and subject to change.

3.2. Avian influenza detections

In California, the first avian influenza H5N1 detections of the 2023-24 season occurred in mid-October 2023. This included detections in two greater white-fronted geese collected from Glenn and Butte counties in the North Valley and one American white pelican collected from Stanislaus County in the Central Valley. Between June 2023 and July 2024, approximately 685 wild birds were tested for avian influenza by CDFW and partners. There were no detections of avian influenza in wild birds collected between July and September 2023. Between October 2023 and April 2024, avian influenza H5N1 was detected in about 117 wild birds collected from 29 counties (Fig. 1; Appendix Table 1). No detections were made in wild birds collected between May and June 2024.

Great horned owl perched in a tree in Sacramento County, California. Photo credit: Krysta Rogers, CDFW.

Figure 1. California counties shaded in orange with avian influenza detections in wild birds during the July 2023 - June 2024 season. The black stars indicate the locations of the first detections of the season in October 2023. Map credit: Krysta Rogers, CDFW.

3.3. Detections over time

No avian influenza detections were made in birds collected between July and September 2023 despite ongoing surveillance testing (Fig. 2). Unlike during the previous season (July 2022 - June 2023), avian influenza detections did not occur in an obviously geographic north to south direction coinciding with fall migration. Initial detections were made in mid- to late-October in 9 counties across the state including Butte, Contra Costa, Glenn, Sacramento, San Diego, San Luis Obispo, Santa Clara, Solano, and Stanislaus. Detections were made between October 2023 and April 2024 (Fig. 2). No detections were made in May and June 2024.

During the 2023-24 season, compared to the previous 2022-23 season, there were fewer detections overall and detections started roughly 3 months later occurring in October

rather than in July (Fig. 3). Similar to the 2022-23 season, the number of avian influenza detections gradually increased through the fall in 2023, peaking in November and December (Fig. 2, 3). Detections then declined in January 2024. Only six detections were made in birds collected between February and April 2024. The last detection of the season was made in a bird collected on April 10, 2024. Detections in waterfowl generally lead detections through the fall, followed in a few weeks with detections in raptors, waterbirds, and scavengers. (Fig. 4; see Appendix Table 2 for generalized bird group taxonomic classifications).

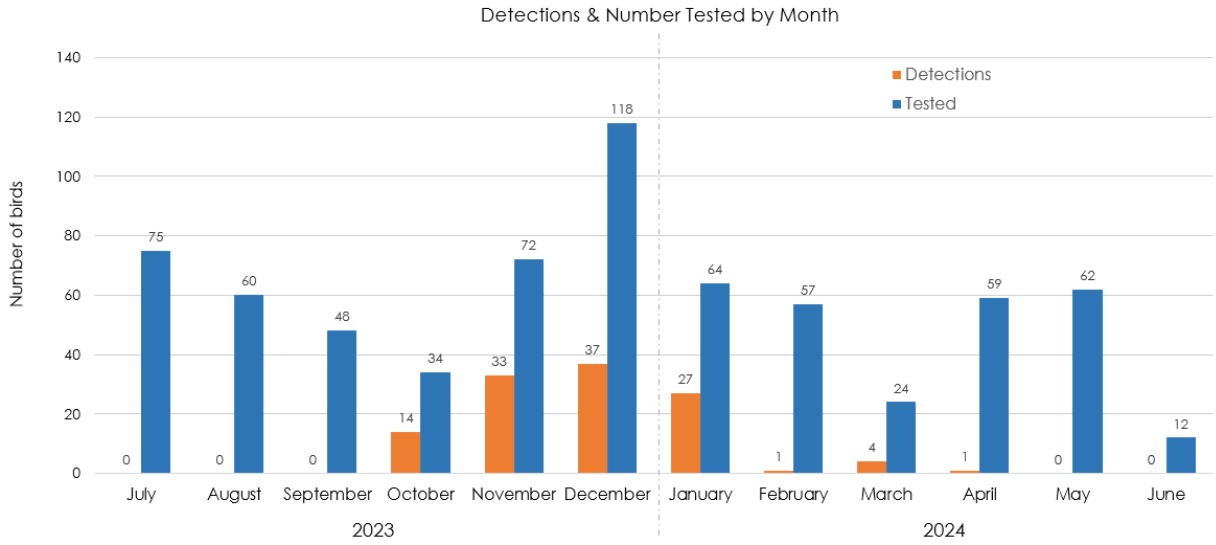


Figure 2. Detections of avian influenza H5N1 in wild birds by month in California during the July 2023 - June 2024 season. The orange bars indicate the number of detections in wild birds. The blue bars indicate the number of wild birds tested for avian influenza. Image credit: Krysta Rogers, CDFW.

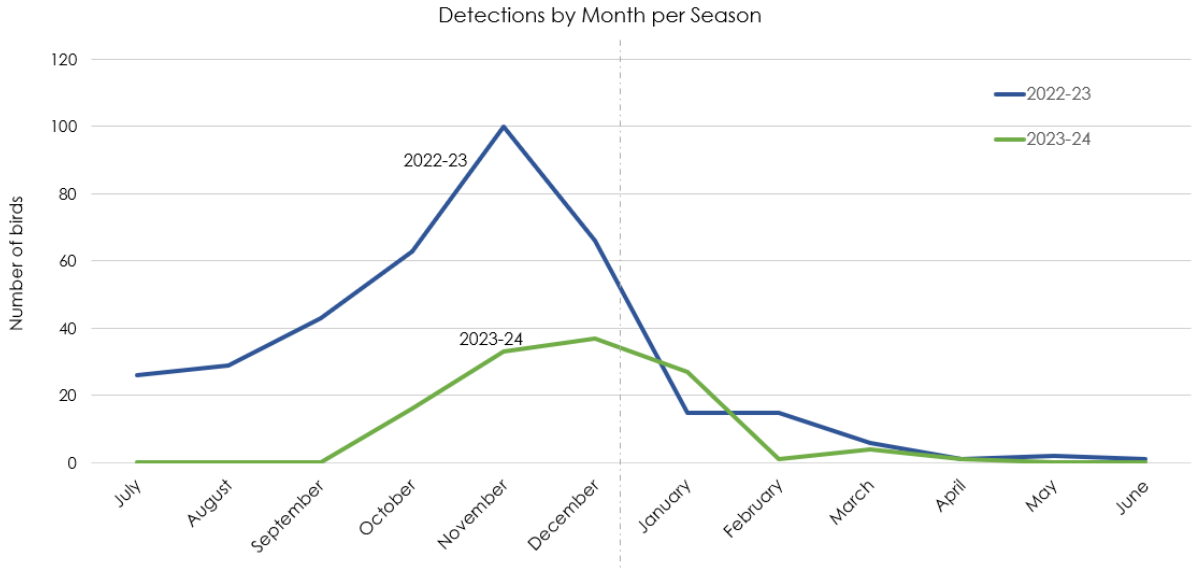


Figure 3. Detections of avian influenza H5N1 by month in California during the July 2022 - June 2023 season (blue line) and July 2023 - June 2024 season (green line). Image credit: Krysta Rogers, CDFW.

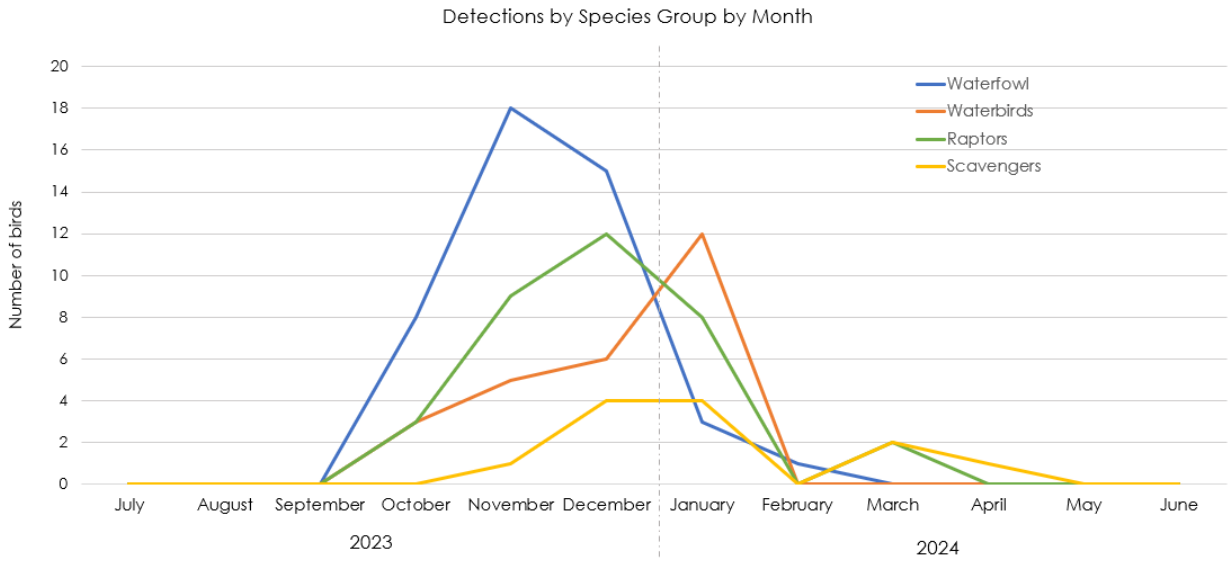


Figure 4. Detections of avian influenza H5N1 by wild bird group by month in California during the July 2023 - June 2024 season. Line colors correspond to waterfowl in blue, waterbirds in orange, raptors in green, and scavengers in yellow (see Appendix Table 2 for bird group taxonomic classifications). Image credit: Krysta Rogers, CDFW.

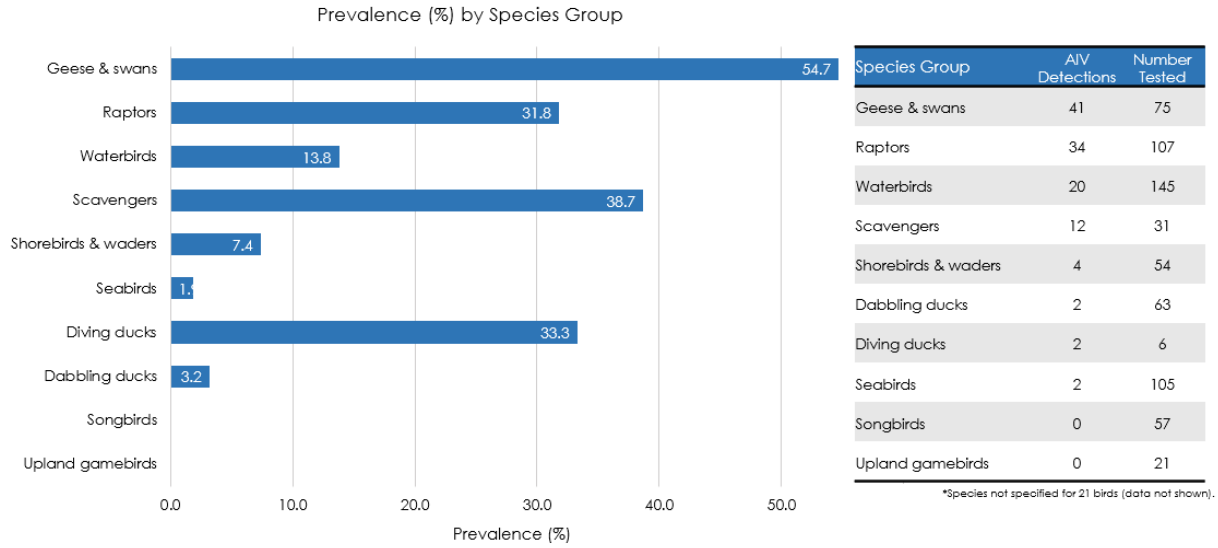
3.4. Detections by avian species

Detections were made in about 31 different species of wild and feral birds between October 2023 and April 2024 (Appendix Table 1). Detections were made in 10 waterfowl species, 8 predator and scavenger species, 6 waterbird species, 4 shorebird and wader species, and 3 seabird species (Appendix Table 2).

Evaluating detections by bird functional group, in which similar species are grouped together, the highest number of detections were in geese and swans as a group, followed by raptors as a group, then waterbirds, scavengers, shorebirds and waders, dabbling ducks, diving ducks, and seabirds (Fig. 5; see Appendix Table 3 for bird functional group taxonomic classifications). No detections were made in songbirds or upland game birds, out of about 57 and 21 birds tested, respectively (Fig. 5). Detection prevalence was highest for geese and swans, followed by scavengers, diving ducks, raptors, waterbirds, shorebirds and waders, dabbling ducks, and seabirds (Fig. 5).

The wild bird species with the highest number of detections included snow geese, red-tailed hawks, peregrine falcons, and Canada geese (Fig. 6; Appendix Table 1). It is important to note, the number of detections gives a general idea of virus activity in these species but since not all birds reported dead are tested, detections do not relate directly to actual number of birds that died during the outbreak.

Greater white-fronted geese, Canada geese, black-necked stilts, and Brewer's blackbirds roosting and foraging at a pond in Yolo County, California. Photo credit: Krysta Rogers, CDFW.



Species Group	AIV Detections	Number Tested
Geese & swans	41	75
Raptors	34	107
Waterbirds	20	145
Scavengers	12	31
Shorebirds & waders	4	54
Dabbling ducks	2	63
Diving ducks	2	6
Seabirds	2	105
Songbirds	0	57
Upland gamebirds	0	21

*Species not specified for 21 birds (data not shown).

Figure 5. Graph depicting the percent prevalence (%) of avian influenza H5N1 detections by wild bird functional group in California during the July 2023 - June 2024 season. Table depicting the number of avian influenza (AIV) H5N1 detections and the total number tested for each wild bird functional group for the same period (see Appendix Table 3 for bird functional group taxonomic classifications). Image credit: Krysta Rogers, CDFW.

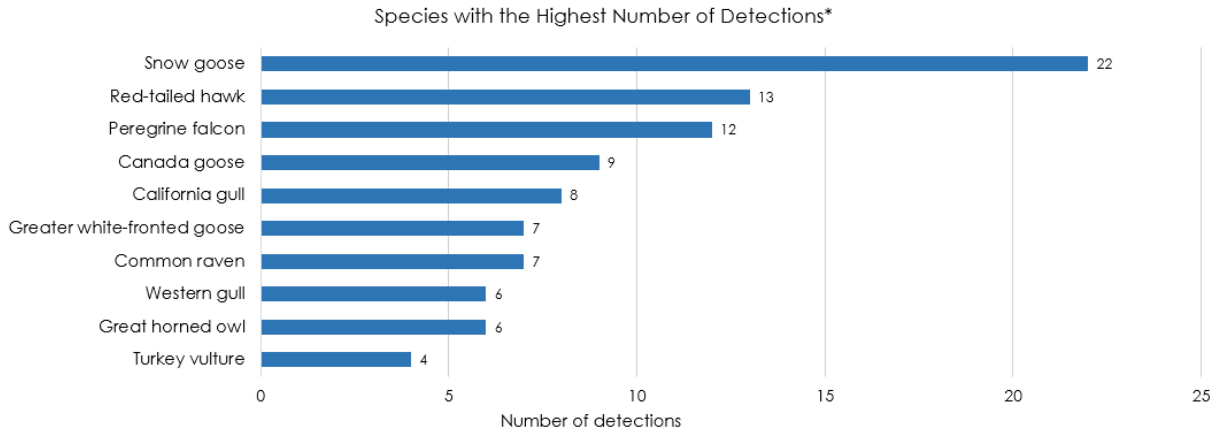


Figure 6. Wild bird species with the highest number of avian influenza H5N1 detections in California during the July 2022 - June 2023 season. *Note, only a portion of reported birds are tested. Actual mortality due to infection may be higher. Image credit: Krysta Rogers, CDFW.

3.5. Detections by virus subtype and strain

The USDA's NVSL attempts to genetically characterize the subtype and strain of virus detections. Avian influenza viruses are constantly changing, and Eurasian (EA) subtypes and strains may reassort with North American (AM) subtypes and strains circulating in the same avian host. During the 2023-24 season, the subtype for detected viruses included EA/AM 2.3.4.4b H5N1 (n = 55), which is a recombination of Eurasian and North American viruses, and EA 2.3.4.4b H5N1 (n = 16), which is a predominately Eurasian virus. More specifically, virus strain was reported for 71 of the 117 birds with detections. The virus strains reported for wild birds in California included EA/AM 2.3.4.4b H5N1 B3.6 (n = 51), followed by EA 2.3.4.4b H5N1 A3 (n = 16), EA/AM 2.3.4.4b H5N1 B3.7 (n = 2), and EA/AM 2.3.4.4b H5N1 B3.13 (n = 1), and EA/AM 2.3.4.4b H5N1 C2.1 (n = 1). Virus subtype/strain was not reported for 46 birds.

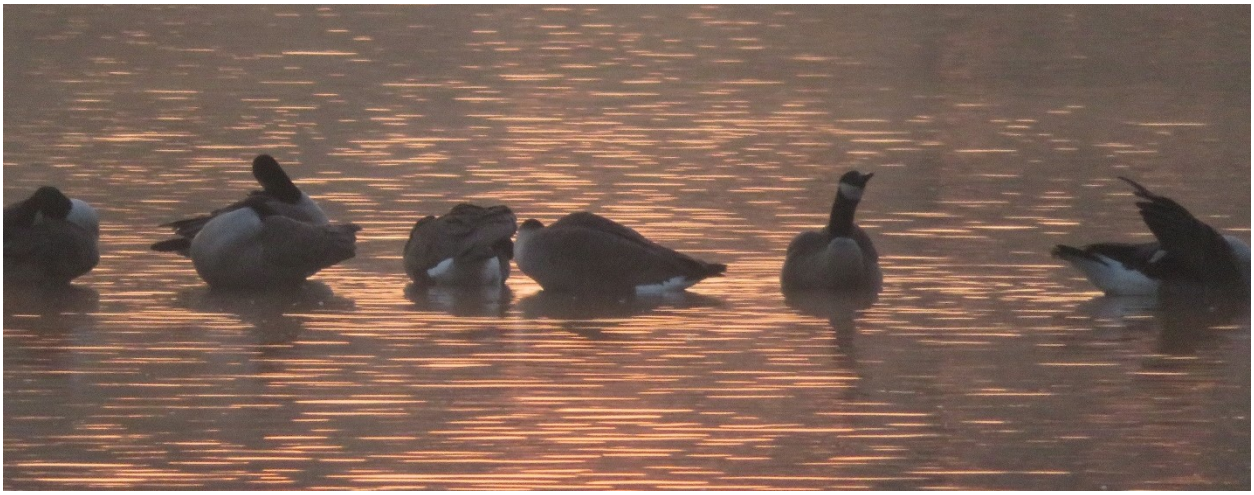
Turkey vulture perched on a light pole in Sacramento County, California. Photo credit: Krysta Rogers, CDFW

4. Conclusions

Overall, mortality-based surveillance was useful to assess the geographic distribution of avian influenza activity and the wild bird species impacted. The highest number of detections in California wild birds occurred in the fall, peaking in December, which coincided with the arrival and southward movements of migratory birds. A higher number of detections were made initially in waterfowl species followed within a few weeks by detections in predators, that prey on infected animals, and other waterbirds, that share habitat with waterfowl. A high diversity of wild bird species appeared to be susceptible to infection with detections in about 31 different species in California.

It is difficult to assess the full impact of this disease on wild bird populations. Mortality may go unreported and uninvestigated in more remote or natural areas. Additionally, only a portion of reported birds are able to be tested. It also is challenging to get an accurate account of how many birds may have died over a prolonged period across the entire state. Mortality reporting can be helpful to fill in some of these information gaps but reporting consistency over time may be variable due to reporting fatigue and it may be absent in more remote areas or when fewer numbers of birds are observed.

Since this virus appears to be adapting to certain migratory bird hosts (e.g., dabbling ducks), the H5 clade 2.3.3.4b virus is likely to remain in circulation at some level increasing in some seasons and decreasing in others. Additionally, if the virus persists in domestic poultry and dairy cattle year-round, there may be more opportunities for spill-over into wild birds outside of the fall migratory period. Given that testing resources are limited, it will be important to balance the need for avian influenza surveillance with the need for mortality investigations caused by other threats.



Canada geese bathing and preening along the American River at dawn in Sacramento County, California. Photo credit: Krysta Rogers, CDFW.

Mortality Reporting

Wildlife mortality may be reported to CDFW using the Wildlife Mortality Reporting System, link for website: [Wildlife Mortality Reporting (ca.gov)]

Alternatively, the link may be accessed through the CDFW homepage (*https://wildlife.ca.gov/)*, just *scroll partway down and click on "report what you've seen."*

5. Appendices

5.1. Appendix 1

Appendix Table 1. Number of avian influenza H5N1 detections by wild bird species in California during the July 2023 - June 2024 season. *Note, only a portion of reported birds are tested. Actual mortality due to infection may be higher.

Bird Species	No. of Detections*
AMERICAN CROW	1
AMERICAN WHITE PELICAN	2
BALD EAGLE	1
BLACK-BELLIED PLOVER	1
BUFFLEHEAD	1
CALIFORNIA GULL	8
CANADA GOOSE	9
CATTLE EGRET	1
COMMON MURRE	1
COMMON RAVEN	7
COOPER'S HAWK	1
DOMESTIC DUCK (feral)	1
DOMESTIC GOOSE (feral)	1
GADWALL	1
GLAUCOUS-WINGED GULL	2
GOLDEN EAGLE	1
GREAT HORNED OWL	6
GREATER WHITE-FRONTED GOOSE	7
HERRING GULL	1
MUTE SWAN (feral)	1
NORTHERN FULMAR	1
PEREGRINE FALCON	12
RED-NECKED GREBE	1
RED-TAILED HAWK	13
RING-NECKED DUCK	1
ROSS'S GOOSE	1
SNOW GOOSE	22
TURKEY VULTURE	4
WESTERN GULL	6
WESTERN SANDPIPER	1
WILLET	1

5.2. Appendix 2

Appendix Table 2. Taxonomic classifications, and corresponding common names, included in each generalized bird group for raptors, scavengers, waterfowl, and waterbirds (Chesser et al. 2024).

Generalized Bird Group	Taxonomic Classification	Common Name
Raptors	Orders Accipitriformes, Falconiformes, & Strigiformes	eagles, falcons, hawks, owls
Scavengers	Genera Cathartes & Corvus	crows, ravens, vultures
Waterbirds	Orders Charadriiformes, Gaviiformes, Gruiformes, Pelecaniformes, Podicipediformes, Procellariiformes, & Suliformes	auks, cormorants, grebes, gulls, loons, pelicans, shorebirds, terns, waders, other seabirds
Waterfowl	Order Anseriformes	ducks, geese, swans

5.3. Appendix 3

Appendix Table 3. Taxonomic classifications included in each bird functional group for dabbling ducks, diving ducks, geese & swans, raptors, scavengers, seabirds, shorebirds & waders, songbirds, upland gamebirds, and waterbirds (Chesser et al. 2024).

Bird Functional Group	Taxonomic Classification
Dabbling ducks	Genera Aix, Anas, Cairina, Mareca, & Spatula
Diving ducks	Genera Aythya, Bucephala, Lophodytes, Melanitta, Mergus, & Oxyura
Geese & swans	Genera Anser, Branta, & Cygnus
Raptors	Orders Accipitriformes, Falconiformes, & Strigiformes
Scavengers	Genera Cathartes & Corvus
Seabirds	Families Alcidae, Gaviidae, Hydrobatidae, Oceanitidae, Phalacrocoracidae (except *Nannopterum auritum*), Procellariidae, & Stercorariiae; *Pelecanus occidentalis*
Shorebirds & waders	Families Ardeidae, Charadriidae, Gruidae, Haematopodidae, Raillidae, Recurvirostridae, Scolopacidae, & Threskiornithidae
Songbirds	Orders Apodiformes, Caprimulgiformes, Coraciiformes, Cuculiformes, Passeriformes (except Corvidae), & Piciformes
Upland gamebirds	Orders Columbiformes & Galliformes
Waterbirds	Families Laridae & Podicipedidae; *Pelecanus erythrorhynchos*; *Nannopterum auritum*

6. References

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Elegant terns roosting on mud flats along coastal Orange County, California. Photo credit: Krysta Rogers, CDFW.