

**CALIFORNIA DEPARTMENT OF FISH AND GAME**

**LIVE-BIRD AND HUNTER-HARVEST**

**AVIAN INFLUENZA SURVEILLANCE**

**IN CALIFORNIA WATERFOWL**

**July 2008-February 2009**

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## EXECUTIVE SUMMARY

This report has been prepared to summarize the 2008-2009 state-wide Highly Pathogenic Avian Influenza (HPAI) H5N1 early detection efforts undertaken by California Department of Fish and Game (CDFG), in accordance with the *California Department of Fish and Game Surveillance and Response Plan for the Occurrence of Highly Pathogenic Avian Influenza in Wild Birds*, with partial funding provided through cooperative agreements with United States Department of Agriculture (USDA) and United States Fish and Wildlife Service (USFWS). The state-wide surveillance program has been implemented to directly sample live and hunter-harvest birds for avian influenza (AI) viruses, as well as increased surveillance for morbidity and mortality (M&M) events through routine surveys of major waterfowl areas and the Dead Bird Surveillance Program (DBSP), which compiles public reports of dead birds. Surveillance is accomplished through multi-agency cooperation to collect samples for AI testing and to increase the awareness of agency personnel, industry, and the public.

Included in this report are a brief summary of the 2008-2009 avian influenza sampling efforts, with sampling goals and actual numbers of samples collected. Also included are test results and prevalence of samples positive for AI viruses, as well as H5 and H7 subtypes. Swab samples were collected from live-birds between July and October 2008. Bird species sampled primarily included gadwall, mallard, and Northern pintail. A total of 1,244 live-bird samples were collected in California by CDFG personnel; this included 300 CDFG, 240 USDA, and 704 USFWS funded samples. Ten live-caught waterfowl tested positive for AI viruses; 3 tests were suspect AI positive. Avian influenza virus positive birds included 4 pintail sampled at Delevan National Wildlife Refuge (NWR), Colusa County (Co.), in September and 1 pintail at Sacramento NWR, Glenn Co., in October. Four mallards tested positive for AI viruses at Mendota Wildlife Area (WA), Fresno Co., in July and one gadwall tested positive at Lower Klamath NWR, Siskiyou Co., in August. None of the positive samples were positive for H5 or H7 subtypes.

Hunter-harvest birds were sampled between October 2008 and January 2009. Bird species sampled included American green-winged teal, American wigeon, Northern pintail, Northern shoveler, and greater white-fronted geese. A total of 1,982 hunter-harvest samples were collected throughout California; this included 399 CDFG, 564 USDA, and 1,019 USFWS funded samples. No HPAI H5N1 was detected in any of the samples submitted to diagnostic laboratories. A total of 136 hunter-harvest waterfowl tested positive for AI viruses. Of these positive samples, 5 were identified as the H5 subtype and 6 were H7 subtype; all were low pathogenic. Two tests were suspect AI positive. Avian influenza virus prevalence was highest in October (80/568; 14.1%), followed by November (32/414; 7.7%), December (11/497; 2.2%), and January (13/503; 2.6%). Avian influenza viruses were detected in hunter-harvest waterfowl at all 11 check stations in which they were sampled. Waterfowl positive for H5 subtypes were sampled at Gray Lodge WA, Butte Co., Imperial WA, Imperial Co., Los Banos WA, Merced Co., and Sacramento NWR, Glenn Co., California. Waterfowl positive for H7 subtypes were sampled at Imperial WA, Imperial Co., and Mendota WA, Fresno Co., California.

A detailed summary of M & M surveillance efforts can be found in the *Highly Pathogenic Avian Influenza H5N1 Surveillance in California Wild Birds: Morbidity and Mortality Surveillance July 2008-June 2009* report.

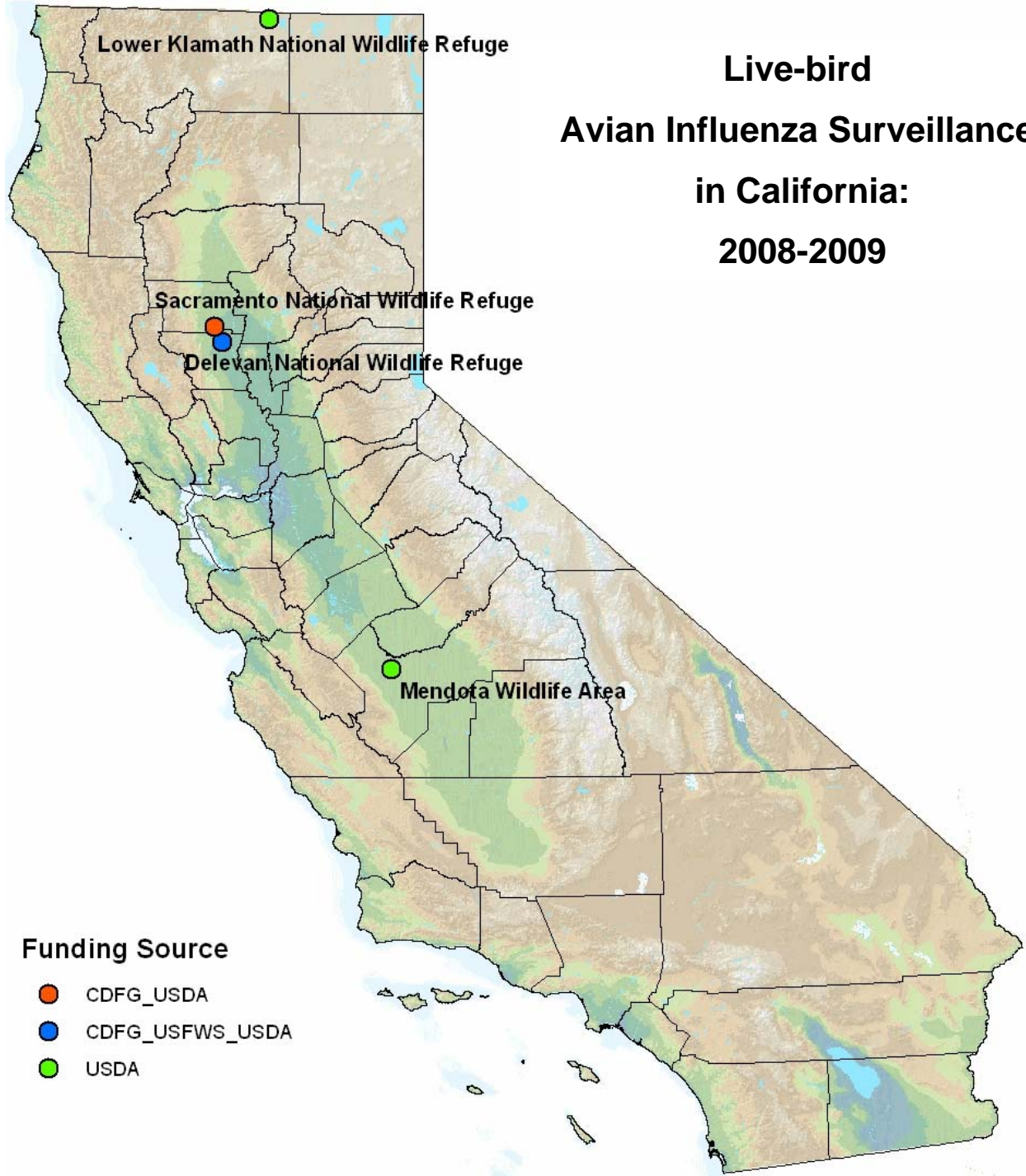
## **I. SURVEILLANCE SUMMARY**

### **A. Live-bird Surveillance**

Live-bird sampling was conducted between July and October 2008. A total of 1,244 samples were collected from live-caught birds during banding activities in California (Figure 1; Table 1). Bird species sampled primarily included gadwall, mallard, and Northern pintail. A few incidental species sampled included American wigeon, western Canada goose, cinnamon teal, and wood duck. CDFG personnel collected 75% (n = 938) of the samples at Delevan NWR, Colusa Co., 13% (n = 166) at Sacramento NWR, Glenn Co., 7% (n = 90) Lower Klamath NWR, Siskiyou Co., and 4% (n = 50) at Mendota WA, Fresno Co., California (CA) (Figure 1; Table 1). Samples were funded by CDFG, USDA, and USFWS (Figure 1; Table 2).

An original total of 1,544 live-bird AI samples were to be collected between July and December 2008. This included 300 CDFG, 240 USDA, and 1,300 USFWS live-bird samples. Of the 1,300 USFWS samples, 1,000 were to be collected from Northern pintail at Delevan NWR and Sacramento NWR (or Sacramento NWR Complex) between September and October 2008, while 300 were to be collected from Aleutian Canada geese at San Joaquin River NWR, Stanislaus Co., in December 2008. An additional 4 samples were collected from pintail at the Sacramento NWR Complex bringing the original total of 1,000 to 1,004. Due to the irregularity in which the geese utilized the habitat at San Joaquin River NWR, the 300 Aleutian Canada geese samples were unable to be collected. As such, the number of samples for live-bird avian influenza surveillance was reduced from 1,544 to 1,244.

# Live-bird Avian Influenza Surveillance in California: 2008-2009



**Figure 1. Live-bird avian influenza sampling locations in California between July and October 2008, funded by California Department of Fish and Game (CDFG), United States Department of Agriculture (USDA), and United States Fish and Wildlife Service (USFWS).**

**Table 1. Live-bird sampling goals and totals for the 2008-2009 avian influenza surveillance season conducted by California Department of Fish and Game personnel for locations in California.**

SPECIES <sup>a</sup>	LOCATION <sup>b</sup>	COOPERATORS <sup>c</sup>	FUND SOURCE <sup>c</sup>	SAMPLING GOAL	NO. BIRDS SAMPLED <sup>d</sup>
GADW	Lower Klamath NWR	CDFG, USFWS	USDA, CDFG	90	90
NOPI	Delevan NWR	CDFG, USFWS	USFWS, CDFG	700	704
	Delevan NWR	CDFG, USFWS	CDFG	300	200
	Sacramento NWR	CDFG, USFWS	CDFG		100
MALL	Mendota WA	CDFG	USDA, CDFG	50	50
MALL	Sacramento NWR	USFWS, CDFG	USDA	100	87
Misc. Ducks	Complex			0	13
ACGO	San Joaquin River NWR	CDFG, USFWS	USFWS, CDFG	300	0

<sup>a</sup> MALL: mallard, GADW: gadwall, NOPI: Northern pintail, ACGO: Aleutian Canada goose; <sup>b</sup> WA: Wildlife Area, NWR: National Wildlife Refuge; <sup>c</sup> CDFG: California Department of Fish and Game, USDA: United States Department of Agriculture, USFWS: United States Fish and Wildlife Service; <sup>d</sup> See text for explanation of discrepancies.

**Table 2. Sampling totals for both live-bird and hunter-harvest avian influenza surveillance for each funding partner for the 2008-2009 surveillance season in California. Samples collected by California Department of Fish and Game personnel.**

FUNDING PARTNER <sup>a</sup>	LIVE BIRD	HUNTER-HARVEST	TOTALS
CDFG	300	399	699
USDA	240	564	804
USFWS	704	1,019	1,723
Totals	1,244	1,982	3,226

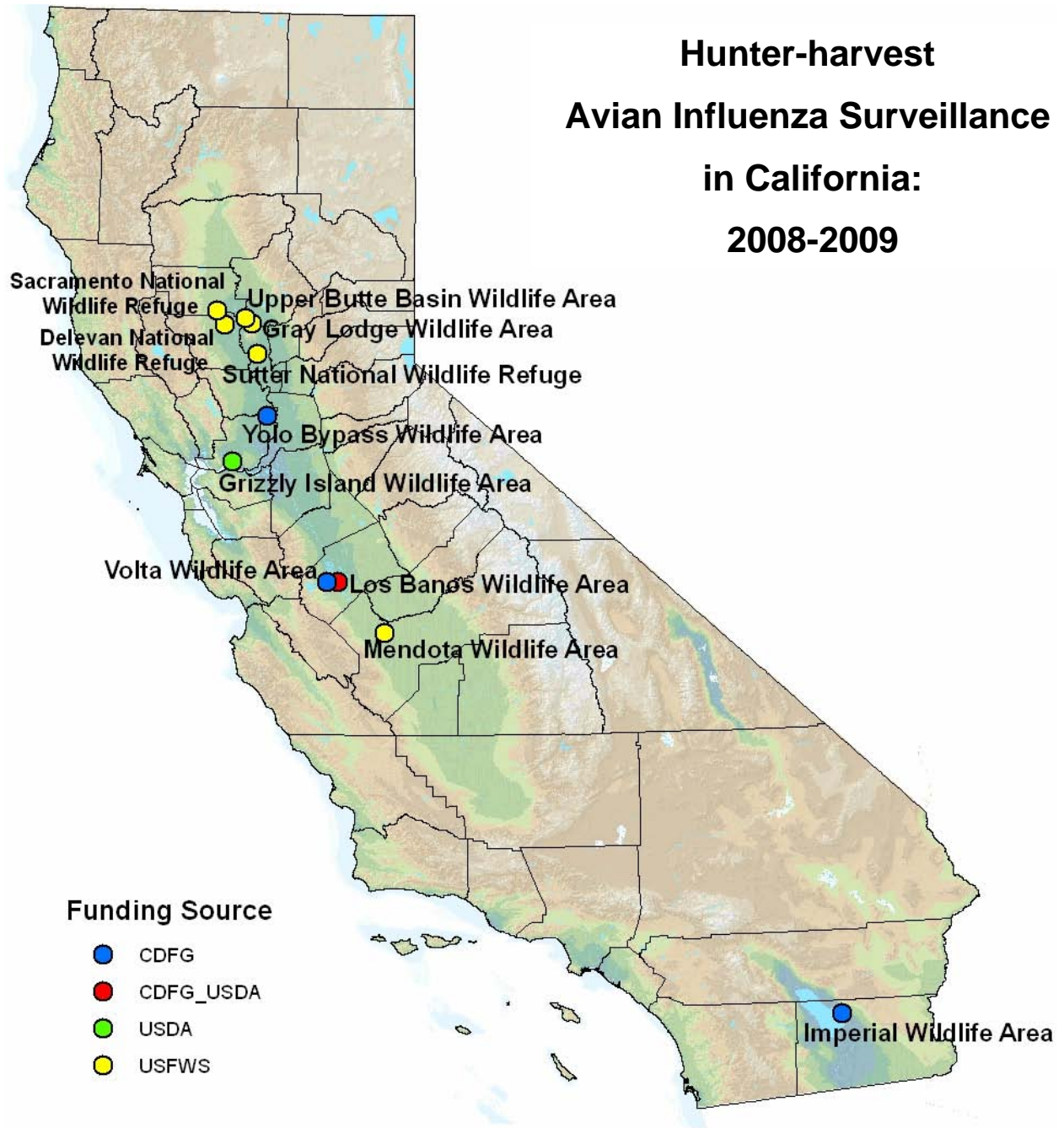
<sup>a</sup> CDFG: California Department of Fish and Game, USDA: United States Department of Agriculture, USFWS: United States Fish and Wildlife Service.

### B. Hunter-harvest Surveillance

Between 18 October 2008 and 25 January 2009, samples were collected from 1,983 hunter-harvest waterfowl and submitted to diagnostic laboratories for testing; one sample was not tested bringing the total tested to 1,982 (Table 3). CDFG personnel collected 18% (n = 364) of the samples at Grizzly Island WA, Solano Co., 15% (n = 299) at Mendota WA, Fresno Co., 10% (n = 200) at Gray Lodge WA, Butte Co., 9% (n = 173) at Sutter NWR, Sutter Co., and 8% (n = 160) at Imperial WA, Wister Unit, Imperial Co., CA. Seven percent (n = 147) of the samples were collected at Upper Butte Basin WA, Little Dry Creek Unit, 5% (n = 100) at Yolo Bypass WA, Yolo Co., 5% (n = 96) at Delevan NWR, Colusa Co., and 5% (n = 104) at Sacramento NWR, Glenn Co., CA. In Merced Co. 16% (n = 309) of the samples were collected at Los Banos WA and 2% (n = 30) at Volta WA. Birds sampled primarily included American green-winged teal, American wigeon, Northern pintail, Northern shoveler, and greater white-fronted goose. Again, samples were funded by CDFG, USDA, and USFWS (Figure 2; Table 2).

An original total of 1,960 hunter-harvest AI samples were to be collected between 18 October 2008 and 25 January 2009. Included in this total were 400 CDFG, 560 USDA, and 1,000 USFWS hunter-harvest AI samples. One CDFG vial from Los Banos WA was misplaced during sampling reducing the total CDFG samples collected from 400 to 399. Four additional USDA samples were collected at Grizzly Island WA increasing the total from 560 to 564. Two USFWS vials from Sutter NWR were misplaced during sampling, while an additional 22 USFWS samples were collected at Upper Butte Basin WA in October 2008, due to low water conditions at Sutter NWR. One USFWS sample collected at Mendota WA was submitted to the diagnostic laboratory, but not tested. This resulted in a net increase of 19 additional USFWS hunter-harvest samples being collected, bringing the USFWS total from 1,000 to 1,019.

## Hunter-harvest Avian Influenza Surveillance in California: 2008-2009



**Figure 2. Hunter-harvest avian influenza sampling locations in California between October 2008 and January 2009, funded by California Department of Fish and Game (CDFG), United States Department of Agriculture (USDA), and United States Fish and Wildlife Service (USFWS).**

**Table 3. Hunter-harvest sampling goals and totals for the 2008-2009 avian influenza surveillance season conducted by California Department of Fish and Game personnel for locations in California.**

SPECIES <sup>a</sup>	LOCATION <sup>b</sup>	COOPERATORS <sup>c</sup>	FUND SOURCE <sup>c</sup>	SAMPLING GOAL	NO. BIRDS SAMPLED <sup>d</sup>
AGWT, AMWI, NOPI, NSHO	Sutter NWR	CDFG	USFWS	175	173
	Upper Butte Basin WA	CDFG	USFWS	125	147
	Gray Lodge WA	CDFG	USFWS	200	200
	Yolo Bypass WA	CDFG	CDFG	100	100
	Grizzly Island WA	CDFG	USDA	360	364
	Los Banos WA	CDFG	CDFG	140	109
	Volta WA	CDFG	CDFG		30
	Los Banos WA	CDFG	USDA	200	200
	Mendota WA	CDFG	USFWS	300	299
	Imperial WA	CDFG	CDFG	160	160
GWFG	Delevan NWR	CDFG	USFWS	200	96
	Sacramento NWR	CDFG	USFWS		104

<sup>a</sup> AGWT: American green-winged teal, AMWI: American wigeon, NOPI: Northern pintail, NSHO: Northern shoveler, GWFG: greater white-fronted goose; <sup>b</sup> WA: Wildlife Area, NWR: National Wildlife Refuge; <sup>c</sup> CDFG: California Department of Fish and Game, USDA: United States Department of Agriculture, USFWS: United States Fish and Wildlife Service; <sup>d</sup> See text for explanation of discrepancies.

## II. DIAGNOSTIC PROCEDURE

All AI testing for USDA and CDFG sampling was performed at the California Animal Health and Food Safety Laboratory (CAHFS) at the University of California, Davis. The USFWS samples were submitted to the National Wildlife Health Center (NWHC), Madison, Wisconsin. Both laboratories are members of the National Animal Health Laboratory Network (NAHLN). Each sample (oropharyngeal and cloacal swab per bird) was first tested for type A influenza viruses via real-time reverse transcriptase polymerase chain reaction (rRT-PCR) assay which amplifies the avian influenza virus (AIV) matrix gene. If the matrix assay was positive for type A influenza, then specific subtyping was completed to determine if the virus was H5 or H7. Samples positive for H5 or H7 subtype were then forwarded to the National Veterinary Services Laboratory (NVSL) in Ft. Collins, Colorado for confirmation. NVSL performed rRT-PCR analyses for H5, H7, and N1. Virus isolation was then performed to determine the H and N subtypes, when possible.

## III. RESULTS

### A. Live-bird Surveillance

A total of 1,244 live-bird samples were collected during the 2008-2009 AI season (Table 4). Of these, 540 were submitted to CAHFS between 8 July and 6 October 2008, while 704 samples were submitted to NWHC between 16 September and 1 October 2008. To date, HPAI H5N1 has not been detected. Ten (10/1,244; 0.8%) live-caught birds were matrix positive for type A influenza virus, but negative for H5 and H7 subtypes (Table 4). Four (4/137; 2.9%) mallard sampled at Mendota WA were AIV positive. Five (5/1,004; 0.5%) Northern pintail sampled at Delevan NWR (n = 4) and Sacramento NWR (n = 1), as well as one (1/97; 1.0%) gadwall sampled at Lower Klamath NWR, were positive for type A influenza virus, but negative for H5 and H7 subtypes.

**Table 4. Sampling totals and test results for avian influenza virus (AIV) and prevalence (%) for live-bird avian influenza surveillance between July and October 2008 at Delevan National Wildlife Refuge (NWR), Colusa County, Lower Klamath NWR, Mendota Wildlife Area (WA), Fresno County, Sacramento NWR, Glenn County, California.**

LOCATION	SPECIES <sup>a</sup>	NUMBER TESTED	AIV POSITIVE	PREVALENCE (%)
Delevan NWR	GADW	2	0	0.0
	MALL	30	0	0.0
	NOPI	904	4	0.4
	WODU	2	0	0.0
		938	4	0.4
Lower Klamath NWR	AMWI	1	0	0.0
	MALL	89	1	1.1
		90	1	1.1
Mendota WA	GADW	6	0	0.0
	MALL	44	4	9.1
		50	4	8.0
Sacramento NWR	CAGO	1	0	0.0
	CITE	2	0	0.0
	MALL	63	0	0.0
	NOPI	100	1	1.0
		166	1	0.6
TOTALS		1,244	10	0.8

<sup>a</sup> Species: AMWI: American wigeon, CAGO: western Canada goose, CITE: cinnamon teal, GADW: Gadwall, MALL: Mallard, NOPI: Northern pintail, WODU: wood duck.

## B. Hunter-harvest Surveillance

A total of 1,983 hunter-harvest samples were collected during the 2008-2009 AI season (Table 5). Of these, 963 were submitted to CAHFS between 18 October 2008 and 21 January 2009, while 1,020 samples were submitted to NWHC between 18 October 2008 and 25 January 2009. However, only 1,019 of the 1,020 samples submitted to NWHC were tested for AI viruses. To date, HPAI H5N1 has not been detected. A total of 136 (136/1,982; 6.9%) birds were matrix positive for type A influenza viruses (Table 5). Samples positive for AIV were collected from each location in which birds were sampled (see Tables 6-9 for details). Avian influenza virus prevalence was highest in October (80/568; 14.1%), followed by November (32/414; 7.7%), December (11/497; 2.2%), and January (13/503; 2.6%) (Figure 3). Avian influenza prevalence also varied between species of birds sampled throughout the season (Figure 3).

Of the 1,982 hunter-harvest samples tested for avian influenza viruses, 5 (5/1,982; 0.3%) birds were positive for the H5 subtype, but negative for N1 (see Tables 5-9 for details). H5 subtypes were collected from birds sampled at Gray Lodge WA (Table 6), Sacramento NWR (Table 6), Los Banos WA (Table 8), and Imperial WA (Table

9). One H5 subtype virus, from a Northern pintail sampled at Gray Lodge WA, was identified as low pathogenic H5N1. Six (6/1,982; 0.4%) samples were positive for the H7 subtype (Table 5). Four H7 subtype viruses were from birds sampled at Imperial WA (Table 9), including two from American green-winged teal, one from a Northern pintail, and one from a Northern shoveler; the two H7 subtypes from the green-winged teal were identified as low pathogenic H7N3 and H7N2. The remaining two H7 subtype viruses were from American green-winged teal sampled at Mendota WA (Table 8).

**Table 5. Monthly sampling totals and test results for avian influenza virus (AIV) and H5 and H7 subtypes for hunter-harvest avian influenza surveillance between October 2008 and January 2009 at Delevan National Wildlife Refuge (NWR), Colusa County, Sacramento NWR, Glenn County, Sutter NWR, Sutter County, Gray Lodge Wildlife Area (WA) and Upper Butte Basin WA, Butte County, Yolo Bypass WA, Yolo County, Grizzly Island WA, Solano County, Los Banos WA and Volta WA, Merced County, Mendota WA, Fresno County, and Imperial WA, Imperial County, California.**

MONTH	SPECIES <sup>a</sup>	NUMBER TESTED	AIV POSITIVE	H5 POSITIVE	H7 POSITIVE
October	AGWT	70	3	0	0
	AMWI	48	4	0	0
	GWFG	200	47	1	0
	NOPI	190	21	1	1
	NSHO	60	5	0	0
		568	80	2	1
November	AGWT	112	10	0	0
	AMWI	77	6	0	0
	NOPI	149	9	1	0
	NSHO	76	7	0	0
		414	32	1	0
December	AGWT	165	5	0	0
	AMWI	64	0	0	0
	EUWI	1	0	0	0
	NOPI	213	4	0	0
	NSHO	54	2	0	1
		497	11	0	1
January	AGWT	103	7	0	4
	AMWI	125	0	0	0
	NOPI	232	4	2	0
	NSHO	43	2	0	0
	UNDU	1 <sup>b</sup>			
		503	13	2	4
	TOTAL	1,982	136	5	6

<sup>a</sup> Species: AGWT: American green-winged teal, AMWI: American wigeon, EUWI: Eurasian wigeon, GWFG: greater white-fronted goose, MALL: mallard, NOPI: Northern pintail, NSHO: Northern shoveler, UNDU: unidentified duck; <sup>b</sup> Sample submitted to diagnostic laboratory, but not tested; not included in totals.

**Table 6. California Department of Fish and Game Region 2 sampling totals and test results for avian influenza virus (AIV), H5 and H7 subtypes, and prevalence (%) for hunter-harvest avian influenza surveillance between October 2008 and January 2009.**

SPECIES <sup>a</sup>	NUMBER TESTED	AIV POSITIVE	H5 POSITIVE	H7 POSITIVE	OVERALL PREVALENCE <sup>b</sup> (%)
Delevan National Wildlife Refuge, Colusa County					
GWFG	96	27	0	0	28.1
	96	27	0	0	28.1
Gray Lodge Wildlife Area, Butte County					
AGWT	4	1	0	0	25.0
AMWI	17	3	0	0	17.6
EUWI	1	0	0	0	0.0
NOPI	173	8	1	0	4.6
NSHO	5	1 <sup>c</sup>	0	0	20.0
	200	13	1	0	6.5
Sacramento National Wildlife Refuge, Glenn County					
GWFG	104	20	1	0	19.2
	104	20	1	0	19.2
Sutter National Wildlife Refuge, Sutter County					
AGWT	15	0	0	0	0.0
AMWI	15	1	0	0	6.7
NOPI	136	8	0	0	5.9
NSHO	7	0	0	0	0.0
	173	9	0	0	5.2
Upper Butte Basin Wildlife Area, Butte County					
NOPI	147	6	0	0	4.1
	147	6	0	0	4.1
<b>TOTAL</b>	<b>720</b>	<b>75</b>	<b>2</b>	<b>0</b>	<b>10.4</b>

<sup>a</sup> Species: AGWT: American green-winged teal, AMWI: American wigeon, EUWI: Eurasian wigeon, GWFG: greater white-fronted goose, MALL: mallard, NOPI: Northern pintail, NSHO: Northern shoveler, UNDU: unidentified duck; <sup>b</sup> Prevalence represents the number positive for avian influenza viruses (AIV) divided by the total number tested, expressed as percentage (%); <sup>c</sup> Virus identified as low pathogenic H5N1.

**Table 7. California Department of Fish and Game Region 3 sampling totals and test results for avian influenza virus (AIV), H5 and H7 subtypes, and prevalence (%) for hunter-harvest avian influenza surveillance between October 2008 and January 2009.**

SPECIES <sup>a</sup>	NUMBER TESTED	AIV POSITIVE	H5 POSITIVE	H7 POSITIVE	OVERALL PREVALENCE <sup>b</sup> (%)
<b>Grizzly Island Wildlife Area, Solano County</b>					
AGWT	114	1	0	0	0.9
AMWI	103	4	0	0	3.9
NOPI	59	1	0	0	1.7
NSHO	88	4	0	0	4.5
	364	10	0	0	2.7
<b>Yolo Bypass Wildlife Area, Yolo County</b>					
AMWI	1	1	0	0	100.0
NOPI	88	4	0	0	4.5
NSHO	4	0	0	0	0.0
	100	6	0	0	6.0
<b>TOTAL</b>	<b>464</b>	<b>16</b>	<b>0</b>	<b>0</b>	<b>3.4</b>

<sup>a</sup> Species: AGWT: American green-winged teal, AMWI: American wigeon, EUWI: Eurasian wigeon, GWFG: greater white-fronted goose, MALL: mallard, NOPI: Northern pintail, NSHO: Northern shoveler, UNDU: unidentified duck; <sup>b</sup> Prevalence represents the number positive for avian influenza viruses (AIV) divided by the total number tested, expressed as percentage (%).

**Table 8. California Department of Fish and Game Region 4 sampling totals and test results for avian influenza virus (AIV), H5 and H7 subtypes, and prevalence (%) for hunter-harvest avian influenza surveillance between October 2008 and January 2009.**

SPECIES <sup>a</sup>	NUMBER TESTED	AIV POSITIVE	H5 POSITIVE	H7 POSITIVE	OVERALL PREVALENCE <sup>b</sup> (%)
<b>Los Banos Wildlife Areas, Merced County</b>					
AGWT	127	10	0	0	7.9
AMWI	80	0	0	0	0.0
NOPI	66	2	2	0	3.0
NSHO	36	2	0	0	5.6
	309	14	2	0	4.5
<b>Volta Wildlife Areas, Merced County</b>					
AGWT	7	0	0	0	0.0
AMWI	4	0	0	0	0.0
NOPI	16	1	0	0	6.3
NSHO	3	0	0	0	0.0
	30	1	0	0	3.3
<b>Mendota Wildlife Areas, Fresno County</b>					
AGWT	141	7	0	2	5.0
AMWI	48	0	0	0	0.0
NOPI	50	1	0	0	2.0
NSHO	60	6	0	0	10.0
	299	14	0	2	4.7
<b>TOTAL</b>	<b>638</b>	<b>29</b>	<b>2</b>	<b>2</b>	<b>4.5</b>

<sup>a</sup> Species: AGWT: American green-winged teal, AMWI: American wigeon, EUWI: Eurasian wigeon, GWFG: greater white-fronted goose, MALL: mallard, NOPI: Northern pintail, NSHO: Northern shoveler, UNDU: unidentified duck; <sup>b</sup> Prevalence represents the number positive for avian influenza viruses (AIV) divided by the total number tested, expressed as percentage (%).

**Table 9. California Department of Fish and Game Region 6 sampling totals and test results for avian influenza virus (AIV), H5 and H7 subtypes, and prevalence (%) for hunter-harvest avian influenza surveillance between October 2008 and January 2009.**

SPECIES <sup>a</sup>	NUMBER TESTED	AIV POSITIVE	H5 POSITIVE	H7 POSITIVE	OVERALL PREVALENCE <sup>b</sup> (%)
Imperial Wildlife Areas, Imperial County					
AGWT	35	5	0	2 <sup>c</sup>	14.3
AMWI	46	1	0	0	2.2
NOPI	49	7	1	1	14.3
NSHO	30	3	0	1	10.0
<b>TOTAL</b>	<b>160</b>	<b>16</b>	<b>1</b>	<b>4</b>	<b>10.0</b>

<sup>a</sup> Species: AGWT: American green-winged teal, AMWI: American wigeon, EUWI: Eurasian wigeon, GWFG: greater white-fronted goose, MALL: mallard, NOPI: Northern pintail, NSHO: Northern shoveler, UNDU: unidentified duck; <sup>b</sup> Prevalence represents the number positive for avian influenza viruses (AIV) divided by the total number tested, expressed as percentage (%); <sup>c</sup> Viruses identified as low pathogenic H7N3 and low pathogenic H7N2.

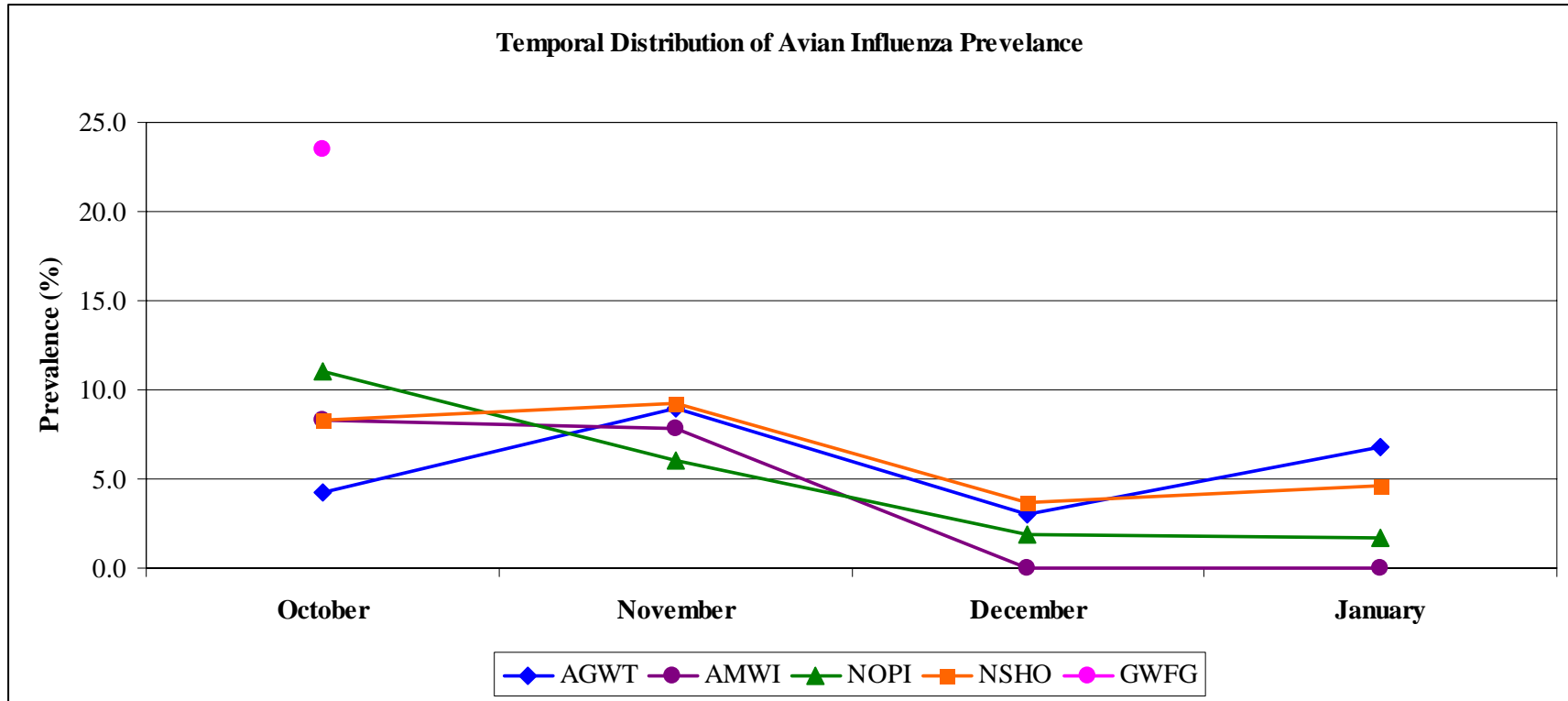


Figure 3. Temporal distribution of avian influenza prevalence for hunter-harvest avian influenza samples collected between 18 October 2008 and 25 January 2009 in Butte County (Upper Butte Basin Wildlife Area and Gray Lodge Wildlife Area), Colusa County (Delevan National Wildlife Refuge), Glenn County (Sacramento National Wildlife Refuge), Sutter County (Sutter National Wildlife Refuge), Yolo County (Yolo Bypass Wildlife Area), Solano County (Grizzly Island Wildlife Area), Merced County (Los Banos Wildlife Area and Volta Wildlife Area), Fresno County (Mendota Wildlife Area), and Imperial County (Imperial Wildlife Area), California. Bird species sampled included American green-winged teal (AGWT), American wigeon (AMWI), Northern pintail (NOPI), Northern shoveler (NSHO) and greater white-fronted goose (GWFG).