



Oregon Grasshopper and Mormon Cricket Survey Summary for 2021

Introduction

The 2021 Oregon Grasshopper (GH) and Mormon cricket (MC) survey season, conducted by the Oregon Department of Agriculture (ODA) in cooperation with the United States Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS) Plant Protection and Quarantine (PPQ) State Plant Health Director office, spanned from 28 April to 5 August 2021. In 2021, a total of 2416 sites were visited, (2416 include looking for MC, 2379 GH; Fig. 1). Location of survey stops is based both on our standard search for and assessment of GH and MC populations and responding to requests for assistance with delimitation.

Grasshoppers

The 2020 season was considered the worst experienced in a long time. The 2021 season turned out to exceed the densities and geographic scope seen in 2020. This year 66 percent of our stops were at an economic density¹ (Table 2), and for those stops the mean density was 65 GH/yd² (Table 2). At the end of 2019 we had hope grasshoppers were on the decline (Fig. 4), but the 2020 and 2021 survey seasons have shown the populations are instead on the increase. Few areas across eastern Oregon missed out on the grasshopper explosion (Fig. 2). Since the outbreak was so widespread only a few areas are highlighted in this report (Fig. 2). While we had areas of high density consistent with the historical pattern (Fig. 5) there were a few populations in outbreak at either new locations or those only infrequently experiencing high densities.

Of the total stops made 1634 were during the period for nymphal grasshopper survey and 745 during the adult period (Table 2). Nymphal survey takes place early in the season and is used to locate potential outbreak areas for response during the current year. Adult survey (this year 6 July – 5 August) is used by ODA and APHIS to make predictions for the following season, considering economic levels as 8 or more grasshoppers per square yard. The 240 Common Data Sites (CDS) (standard locations visited each year for year-to-year comparison) were included in the survey. Only 238 out of 240 CDS sites were visited as two sites were burned in the Klamath County Bootleg fire.

Approximately 10.1 million acres across 18 counties in eastern Oregon were estimated to contain economically infested locations (Fig. 3, Table 2). Thirteen of these counties had greater than 750,000 economically infested acres with Harney County having the most at 2.4 million and Malheur County second with 1.4 million (Fig. 6; Table 3; Appendix 1). Oregon has not seen infestations of this magnitude since the 80's and early 90's.

Survey resources have been reduced since 2011 (Sites Surveyed, No. of Surveyors, Table 2) so the percent of economically infested acreage to the total surveyed acreage may be more useful for comparing the

¹ Note: 'Economic density' is a term used in this report and in historical survey data to indicate a population level of 8 grasshoppers per square yard or greater. This is considered a minimum population level for potentially damaging impacts to occur. The actual rate of damage will vary by season, species complex, climate, and the combined ecological and agronomical features of the site. Economic density should therefore not be considered a functional threshold for recommending treatment, but rather an indication that a closer look may be warranted. For help in determining if a grasshopper population meets a site specific minimum threshold for economically justifying treatment, please refer to the Decision Support Tools section of APHIS' Grasshopper Integrated Pest Management User Handbook (www.sidney.ars.usda.gov/grasshopper/Handbook/index.htm).

between year trend in population density. Such a comparison from 2013 through 2019 shows grasshopper population densities in the eastern Oregon may have been starting a decline (Fig. 4, Table 1, Table 2), though this year’s findings contradict the pattern.

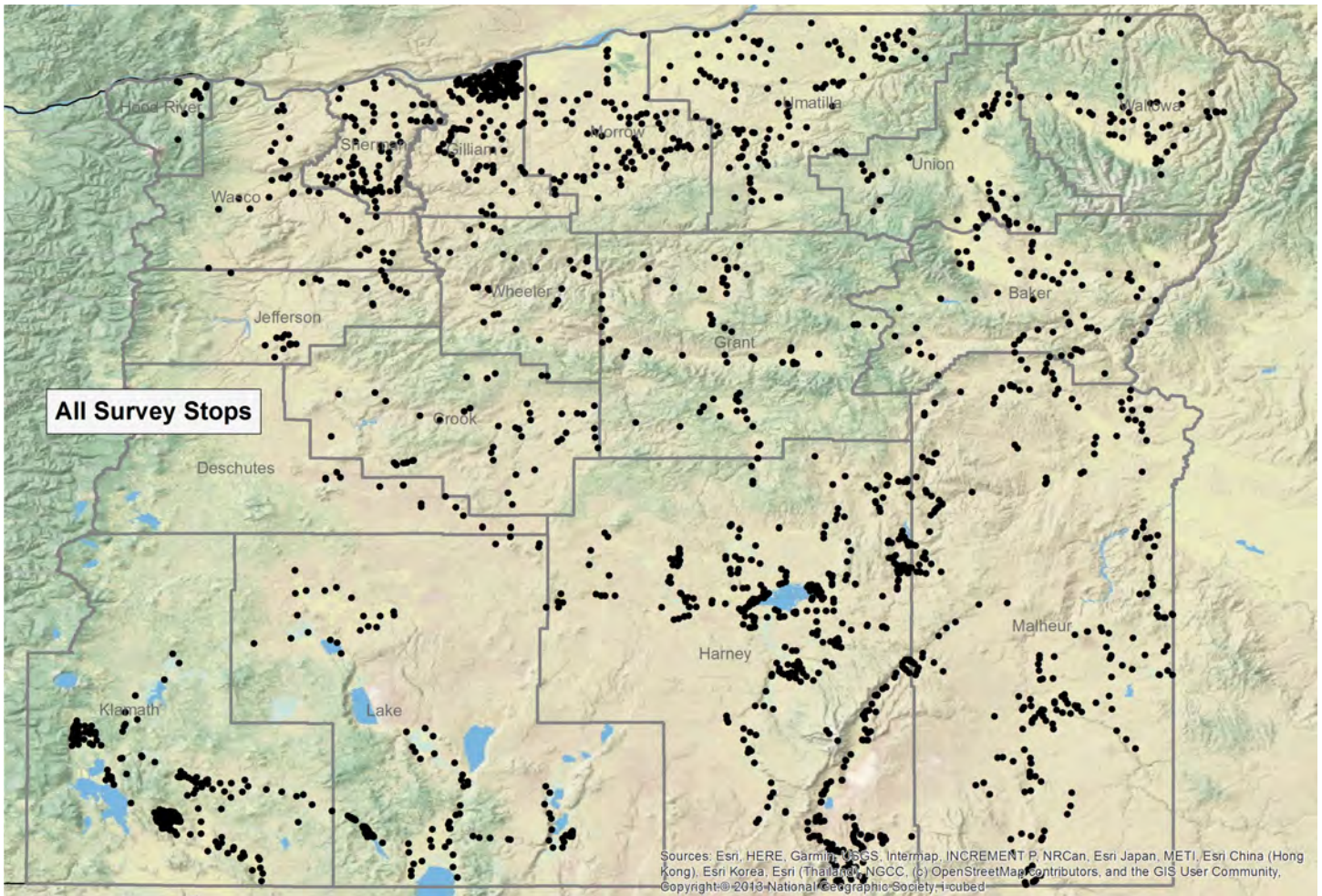
Table 1. A comparison of grasshopper (GH) infestation densities (/ yd²) adjusted for effort (percentage of total surveyed acres within each year).

Year	<u>Percent of Total Surveyed Acres</u>		
	Economic	Non-Econ	No GH
2021	66	22	12
2020	60	26	14
2019	26	43	31
2018	40	37	23
2017	43	36	21
2016	39	42	19
2015	35	40	25
2014	23	39	38
2013	14	39	47
2012	34	47	20
2011	39	43	18

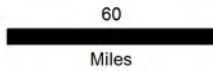
Table 2. Oregon Grasshopper Survey Statistics from 2005 through 2021. Economic infestation ≥ 8 grasshoppers / yd².

Year	Number Counties Infested	Acres of Econ. Infest.	Grasshopper Sites Surveyed				Samples w/Econ Density	Mean GH / yd ² *	Number of GH Surveyors
			Total	Nymph	Adult	Treatment			
2021	18	10,147,416	2379	1634	745	0	1045	65	3
2020	18	4,804,265	1,436	501	935	0	810	57	2
2019	17	2,364,191	1,620	674	946	0	399	33	2.5
2018	18	3,838,637	2,183	1,147	1,036	0	748	44	2.5
2017	17	3,314,742	1,657	769	888		653	58	2.5
2016	18	2,980,051	1,381	507	874	0	484	21	2
2015	17	2,495,073	1,712	803	909	0	437	25	3
2014	19	1,031,673	1,767	914	853	0	333	29	2.5
2013	15	869,857	1,489	462	935	92	280	50	2.5
2012	17	1,178,872	1,135	387	748	34	526	34	2.5
2011	18	2,888,455	3,139	1880	914	345	1093	20	6
2010	12	1,910,222	1,905	795	750	360	488	21	6
2009	11	151,974	998	491	507		108	18	4
2008	12	1,129,820	2,722	1116	1606		360	29	6
2007	13	798,358	1,585	706	870		298	18	6
2006	14	97,399	1,368	750	618		100	16	6
2005	9	64,751	859	306	423		115	15	5

*Economically infested samples



Prepared By: Todd Adams
 Date Printed: 11/11/2021
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Figure 1. 2021 Grasshopper / Mormon cricket Survey stops distributed across eastern Oregon. (1:2,400k)

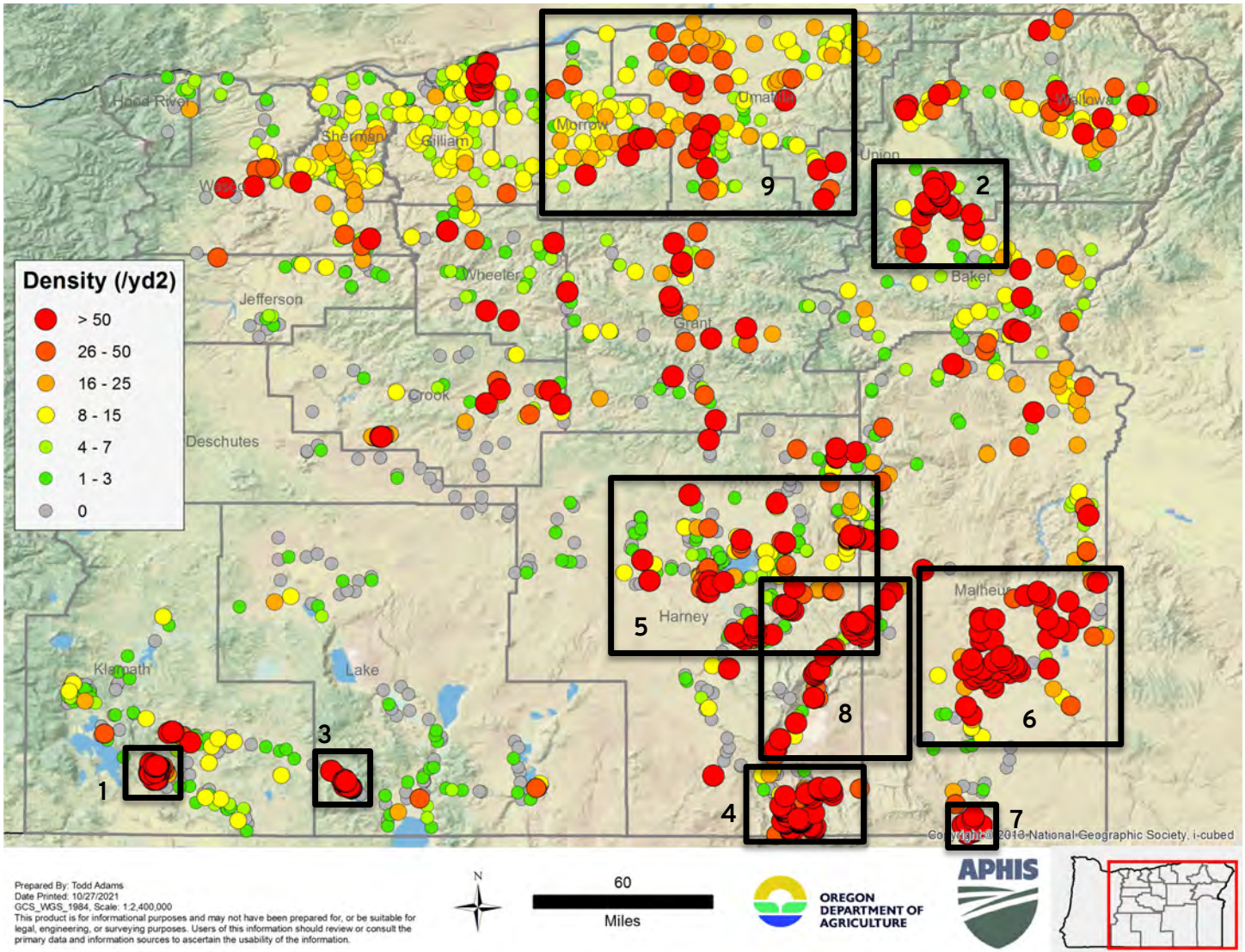


Figure 2. 2021 grasshopper survey densities (/yd²) classified to seven levels. Black rectangles indicate areas given a closer examination below. (1:2,400k)

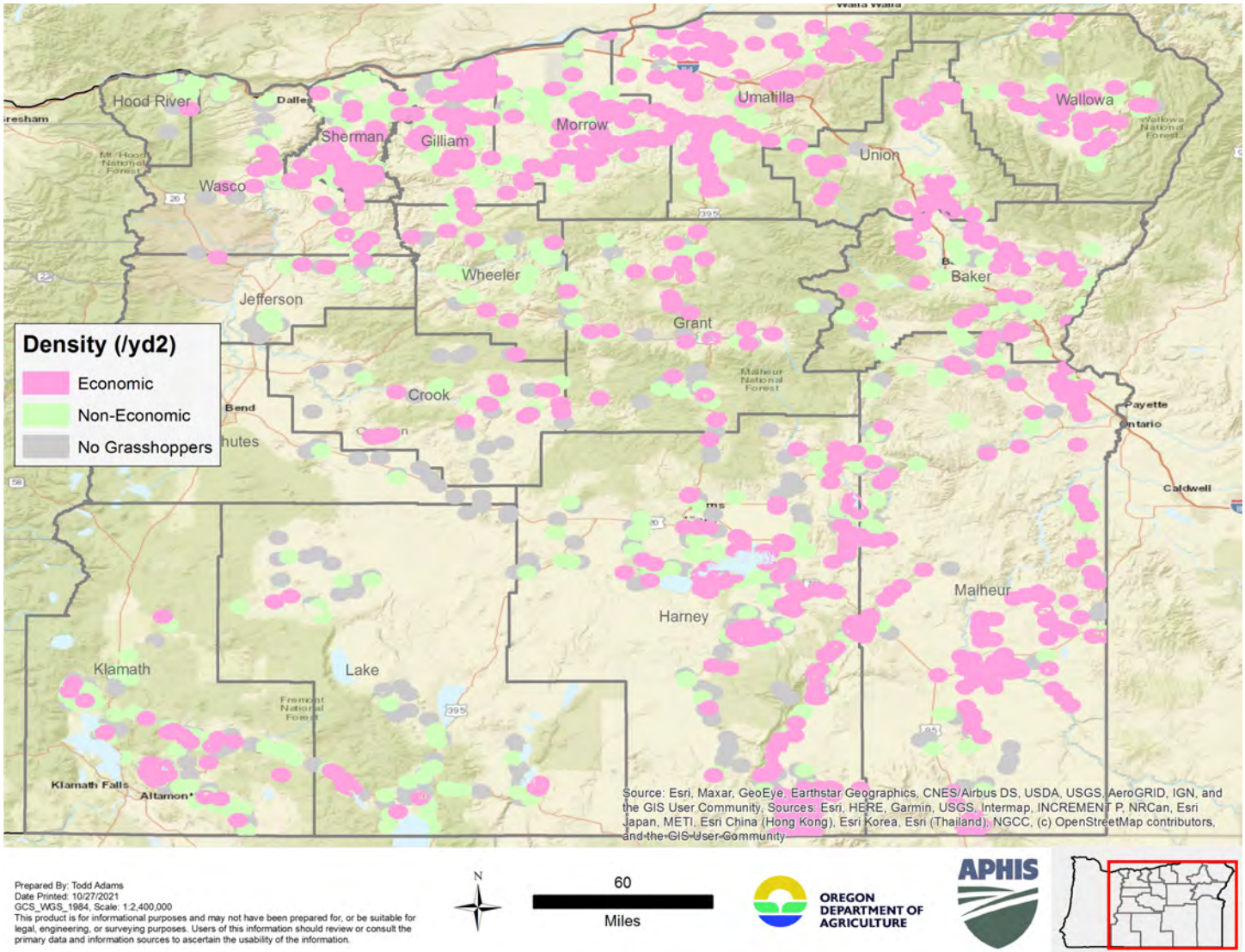


Figure 3. 2021 grasshopper density area estimates (/yd²) classified by economic category. (1:2,400k)

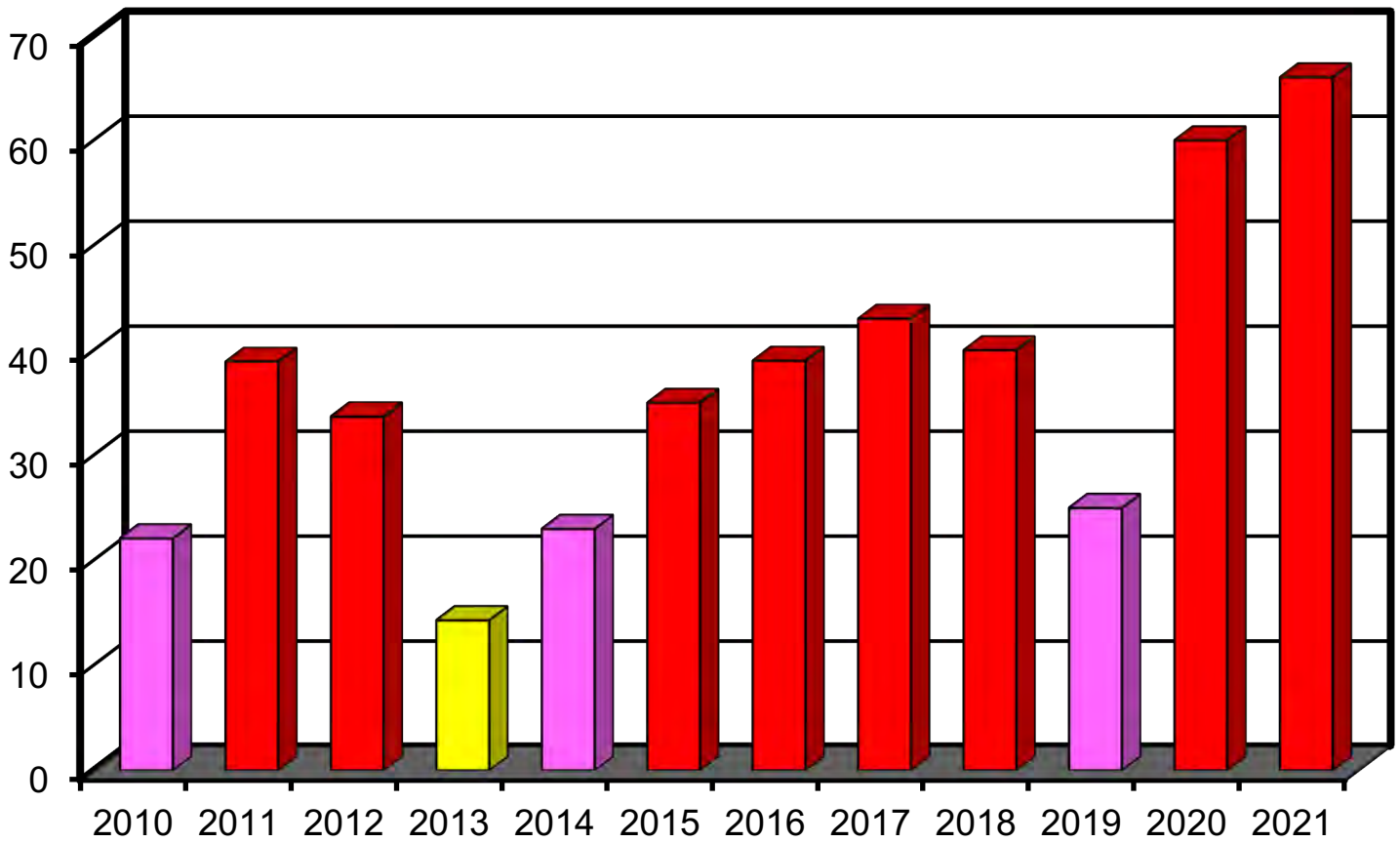


Figure 4. Percentage (within each season) of surveyed area (acres) estimated to have grasshoppers at an economic density.

Economic Infestations of Grasshoppers in Oregon since 1953 through 2021

Oregon Department of Agriculture in cooperation with USDA APHIS PPQ

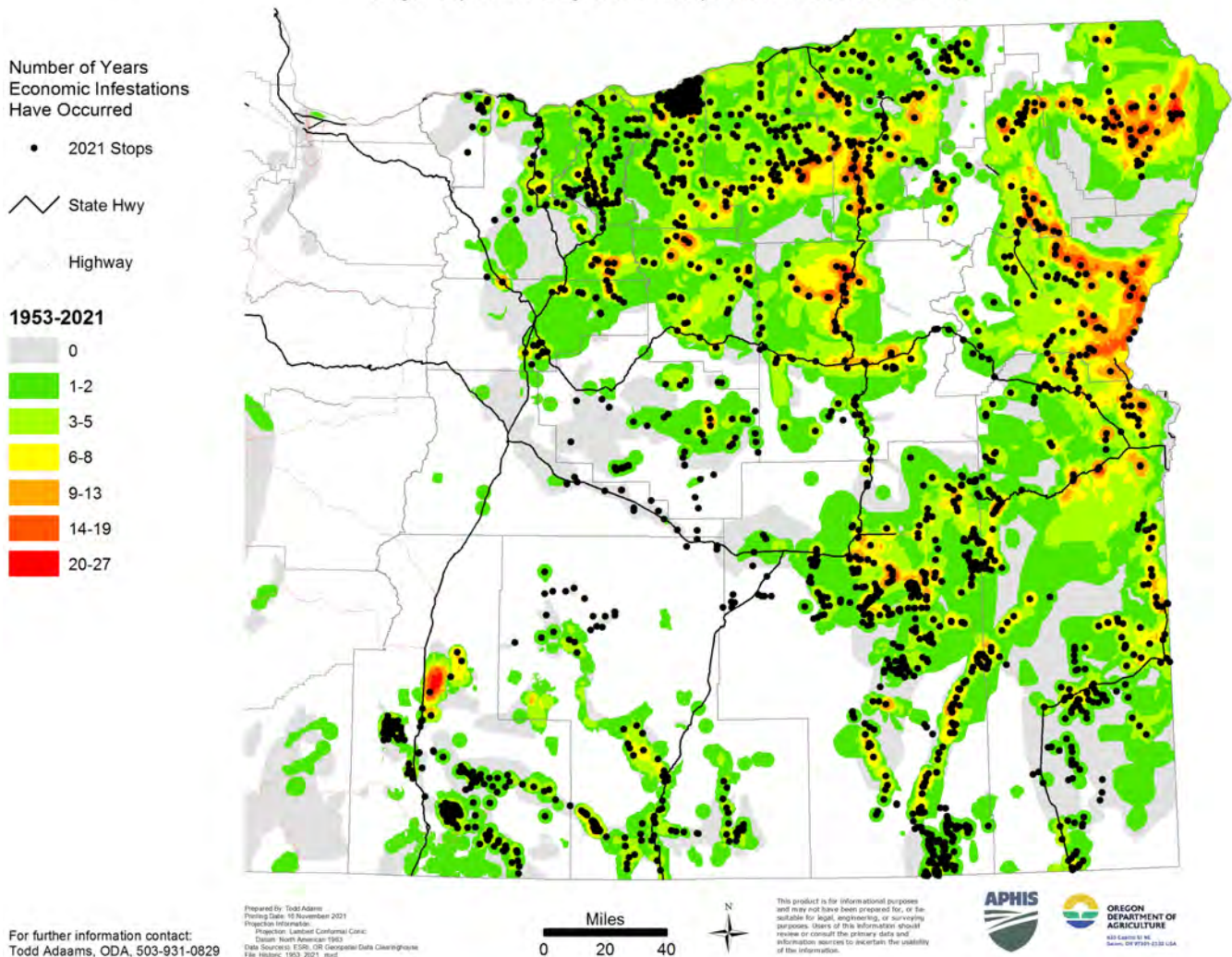
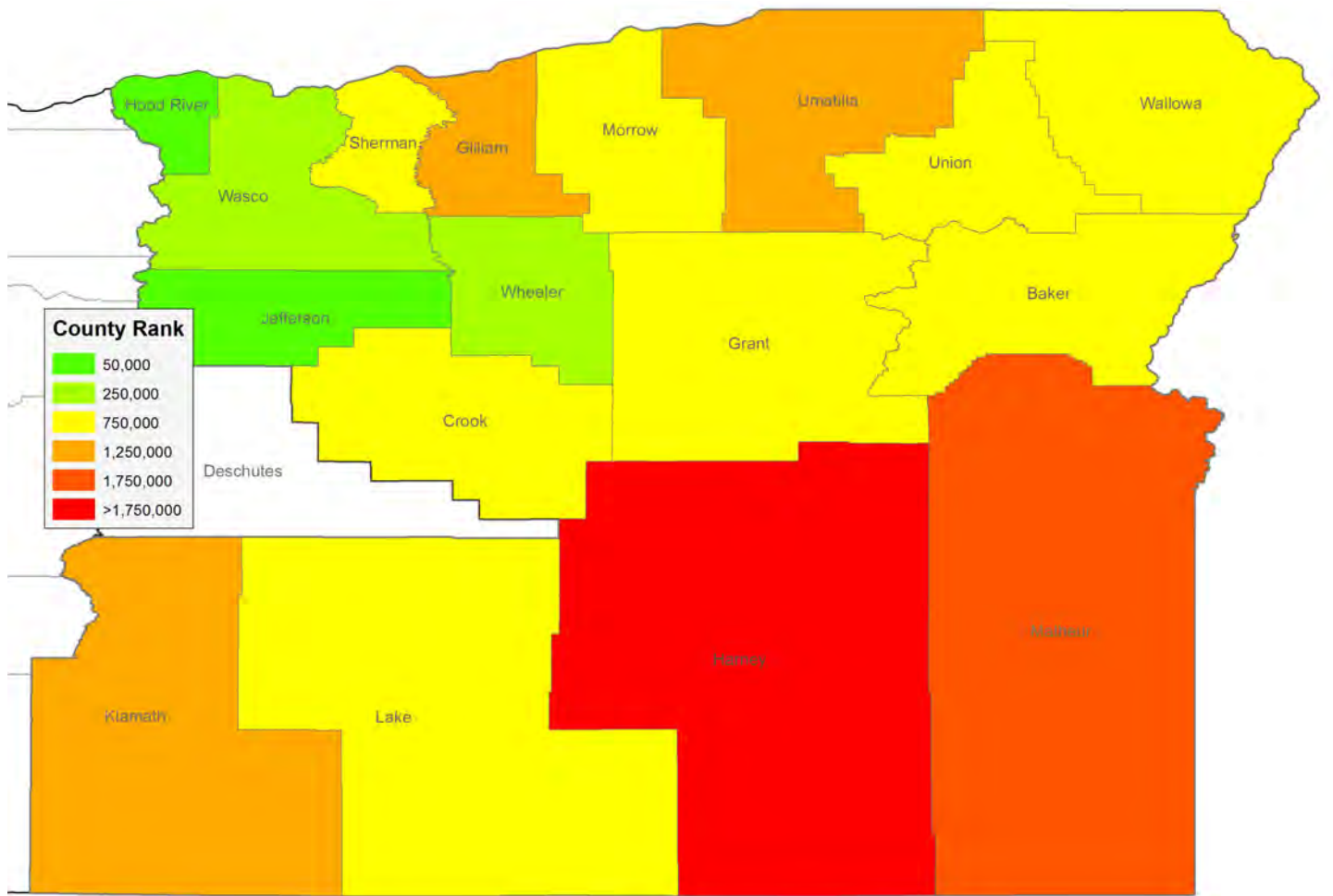
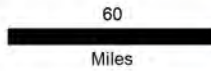


Figure 5. Number of economically infested years for grasshoppers in eastern Oregon 1953 – 2021, overlaid with 2021 survey locations. (1:2500k)



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Figure 6. 2021 Eastern Oregon counties ranked by economically infested acreage. (1:2400k)

Table 3. Surveyed area (ac) density estimates 2021 summarized by economic classification within a county.

County	Economic Classes Summed by County				Economic Classes as % within County		
	Economic	Non-Economic	No GH	Totals	Non-Economic	Economic	No GH
Baker	428,906	212,620	24,166	665,693	64.4	31.9	3.6
Crook	250,282	70,004	172,611	492,897	50.8	14.2	35.0
Deschutes	0	25,114	97,335	122,449	0.0	20.5	79.5
Gilliam	766,281	190,962	22,038	979,282	78.2	19.5	2.3
Grant	352,031	176,041	100,614	628,686	56.0	28.0	16.0
Harney	2,354,327	562,208	395,703	3,312,238	71.1	17.0	11.9
Hood River	11,093	60,694	25,675	97,462	11.4	62.3	26.3
Jefferson	45,506	110,315	48,013	203,834	22.3	54.1	23.6
Klamath	883,863	329,158	131,027	1,344,048	65.8	24.5	9.7
Lake	522,850	312,545	315,153	1,150,547	45.4	27.2	27.4
Malheur	1,431,203	382,549	198,996	2,012,748	71.1	19.0	9.9
Morrow	595,750	196,849	8,343	800,943	74.4	24.6	1.0
Sherman	460,712	163,636	12,118	636,466	72.4	25.7	1.9
Umatilla	915,800	191,985	23,801	1,131,586	80.9	17.0	2.1
Union	393,986	45,730	12,561	452,277	87.1	10.1	2.8
Wallowa	373,753	85,378	20,444	479,575	77.9	17.8	4.3
Wasco	203,044	89,411	68,530	360,985	56.2	24.8	19.0
Wheeler	158,026	189,662	43,465	391,154	40.4	48.5	11.1
Totals	10,147,415	3,394,861	1,720,593	15,262,870	66.5	22.2	11.3

Table 4. The number of grasshopper stops by Density Category (/yd²) and Dominant Life Stage encountered across the entire season.

Density	Totals	Dominant Developmental Stage						
		Egg	1	2	3	4	5	Adult
0	647							
1 - 3	409	0	102	69	10	9	8	211
4 - 7	278	0	74	68	11	8	12	105
8 - 15	313	0	77	109	15	9	11	92
16 - 25	200	0	69	50	9	11	10	51
26 - 50	185	0	52	35	18	14	6	60
> 50	347	0	120	37	19	13	8	150
	2379	0	494	368	82	64	55	669
Percentages:		0.0	28.5	21.2	4.7	3.7	3.2	38.6

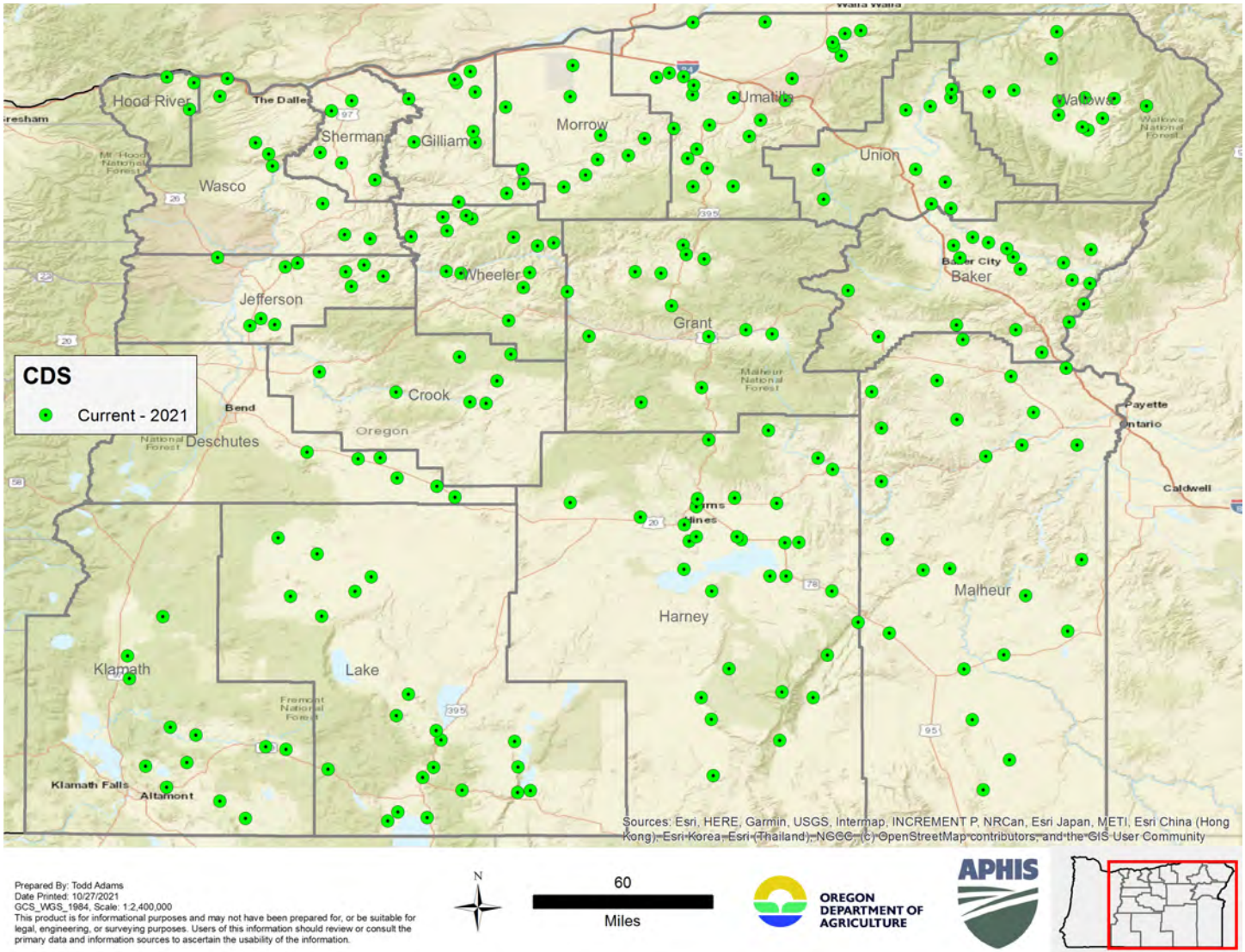


Figure 7. Common Data Sites current locations. (1:2400k)

Table 5. The 238 grasshopper stops of the Common Data Sites surveyed in 2021. Summarized by Density Category (/yd²) and Dominant Developmental Stage over the entire Season.

Density	Totals	Dominant Developmental Stage						
		Egg	1	2	3	4	5	Adult
0	61							
1 - 3	52	0	0	0	0	0	0	52
4 - 7	31	0	0	0	1	1	0	29
8 - 15	28	0	0	0	0	0	2	26
16 - 25	16	0	0	0	0	0	1	15
26 - 50	14	0	0	0	0	1	0	13
> 50	36	0	0	0	0	0	1	35
	238	0	0	0	1	2	4	170
Percentages:		0	0	0	0.6	1.1	2.3	96

A Closer Look

In the following section we zoom in on nine different geographic areas depicting local grasshopper densities. Local managers and landowners may wish to use these maps to put early season scouting into their 2022 plans.

1-Swan Lake Valley, Klamath County.

In 2020, we received reports of a grasshopper outbreak in the Swan Lake area. On May 18th, 2021, a meeting was organized including governmental agencies and landowners to discuss available response options. On the meeting day we found that hatch was already under way. The area was surveyed over the next two weeks and results were shared with all stakeholders (Fig. 8). A successful, coordinated suppression effort was undertaken (Fig. 9).

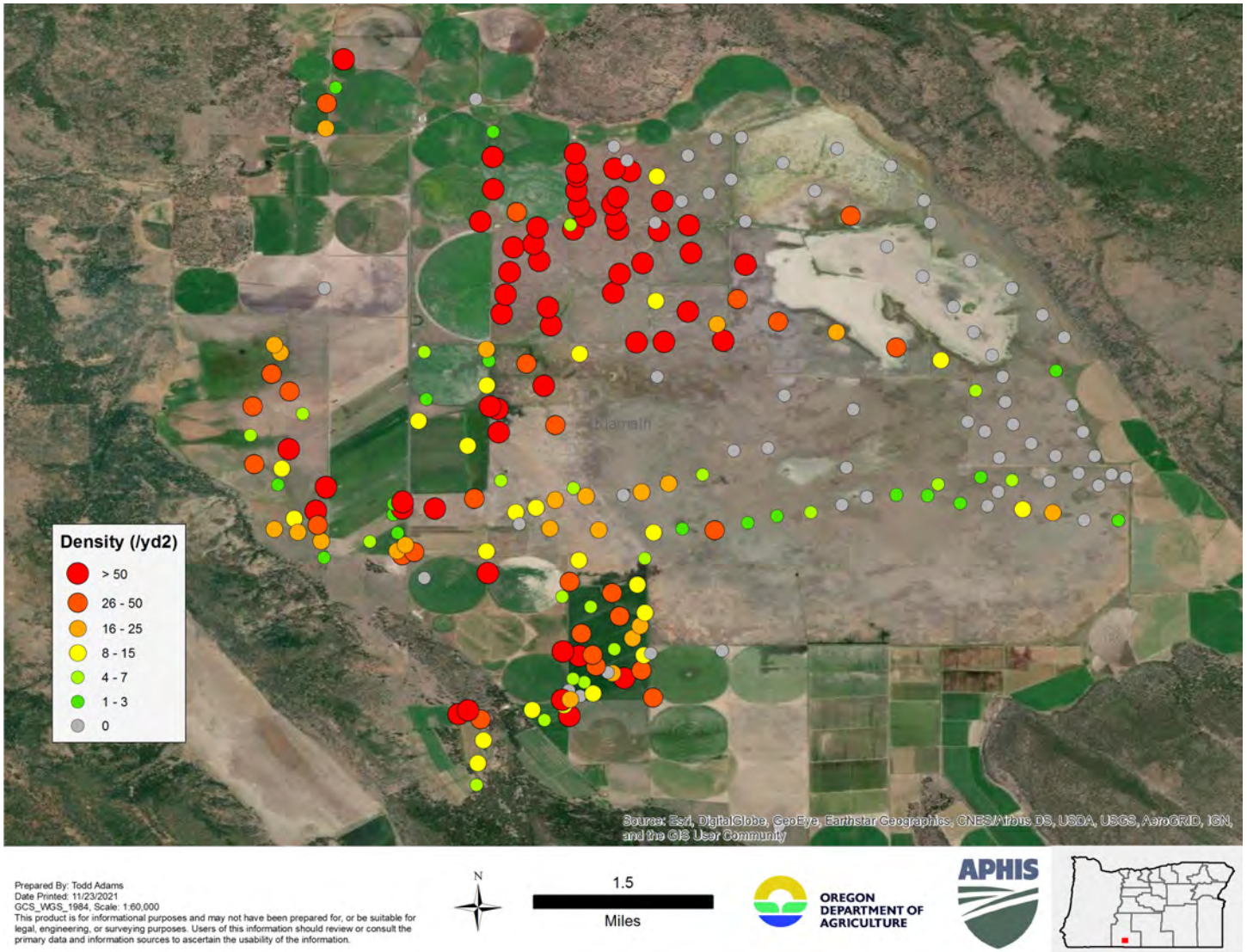


Figure 8. Grasshopper classified densities (GH/yd²) at survey locations in Swan Lake Valley in Klamath County. (1:53k)

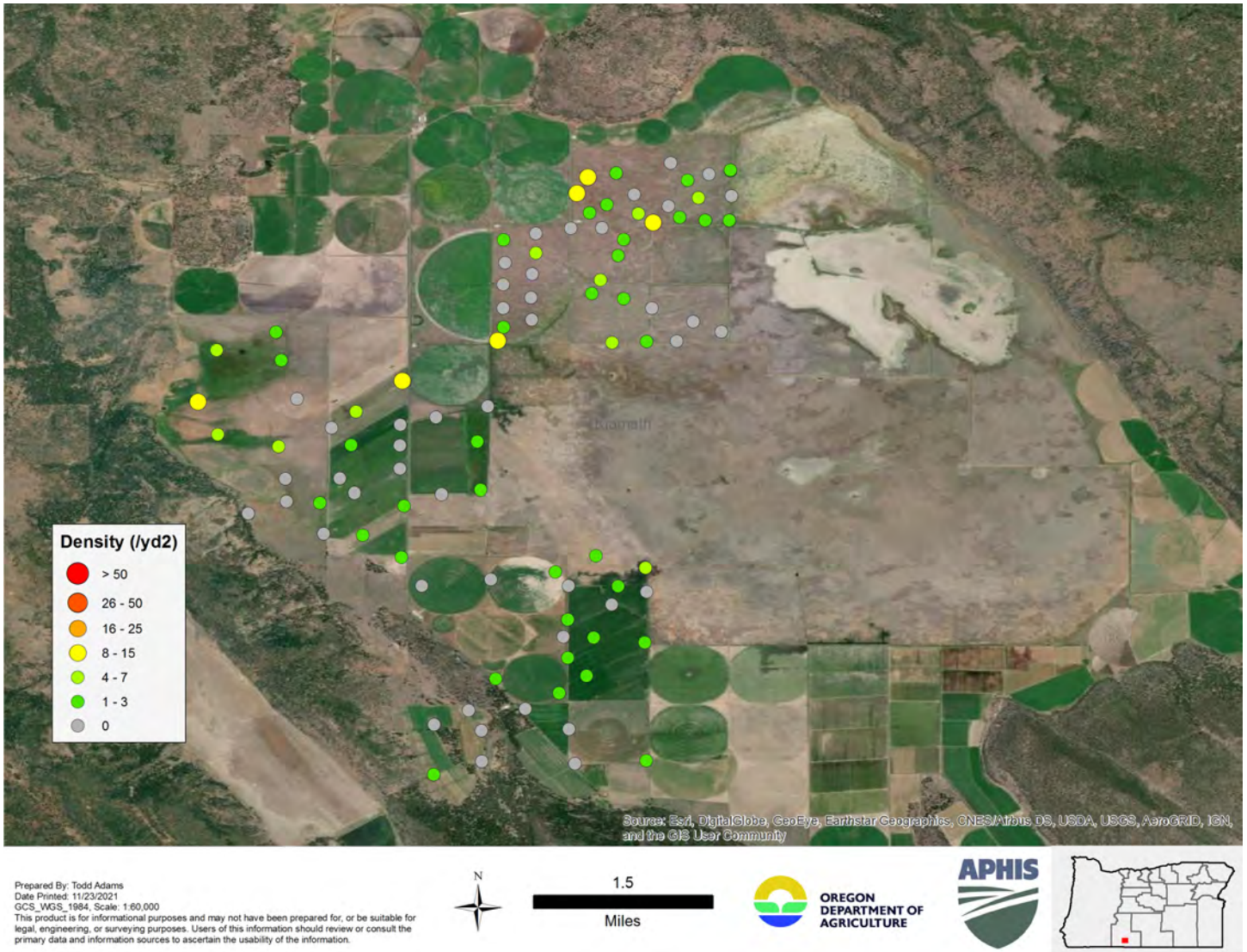


Figure 9. Grasshopper classified densities (GH/yd²) at survey locations in Swan Lake Valley of Klamath County after a coordinated suppression program. (1:53k)

2-Pyles Canyon, Union County.

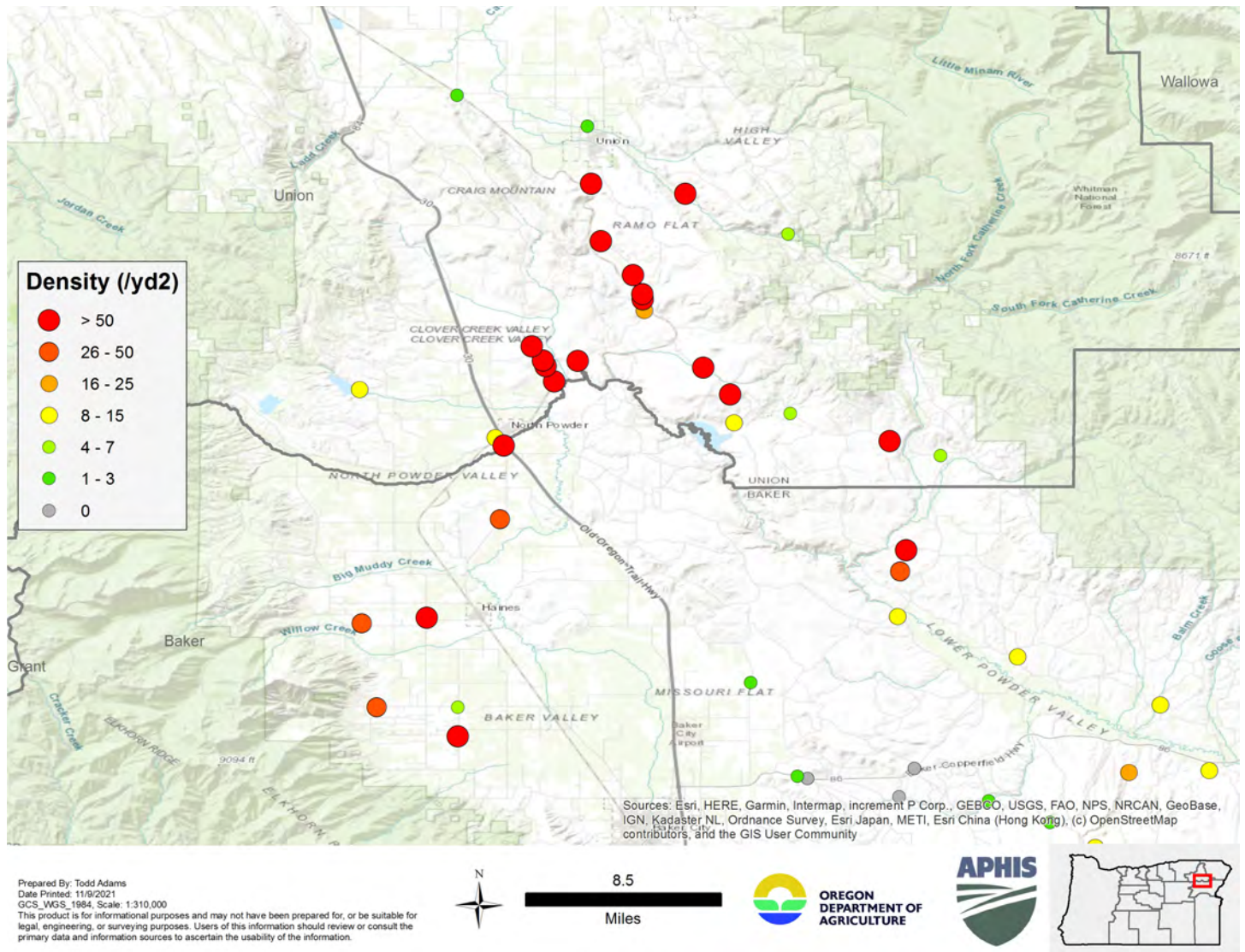


Figure 10. Grasshopper classified densities (GH/yd²) in Pyles Canyon, Union County. (1:310k)

3-Drews Valley, Lake County.

High densities were developing in 2019 and came to a head in 2020 and 2021. Local management had to undertake two major interventions in both 2020 and 2021.

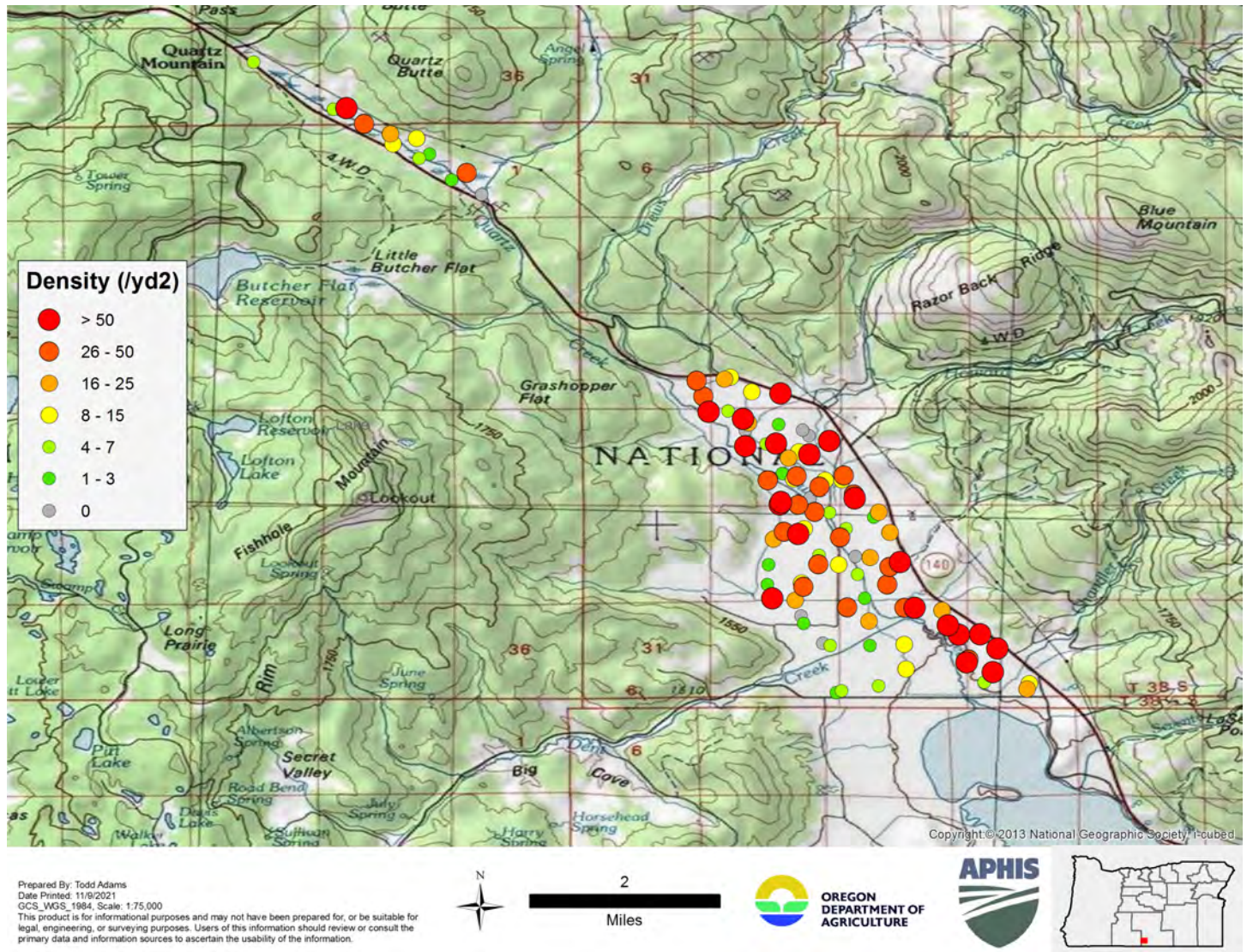


Figure 11. Grasshopper survey classified densities (GH/yd²) at locations northwest of Lakeview, Drews Valley, Lake County. (1:75k)

4-Fields, Harney County.

2021 was no different than 2020 in much of south Harney County from Fields to the Nevada border. Suppression efforts were undertaken in much of this area.

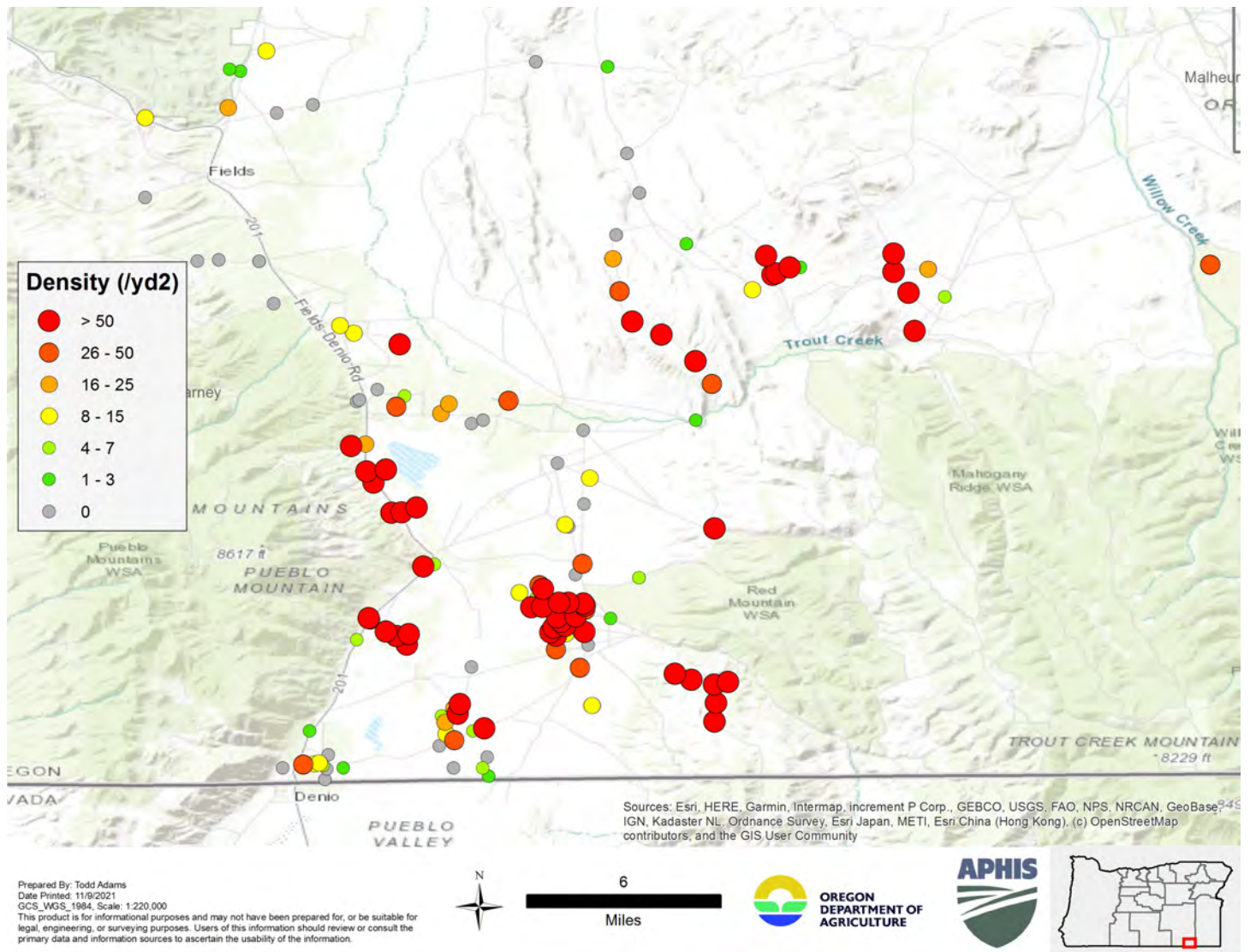


Figure 12. Grasshopper classified densities (GH/yd²) in the region south-southeast of Fields, down to the Nevada border. (1:220k)

5- Steens Mountain area, Harney and Malheur Counties.

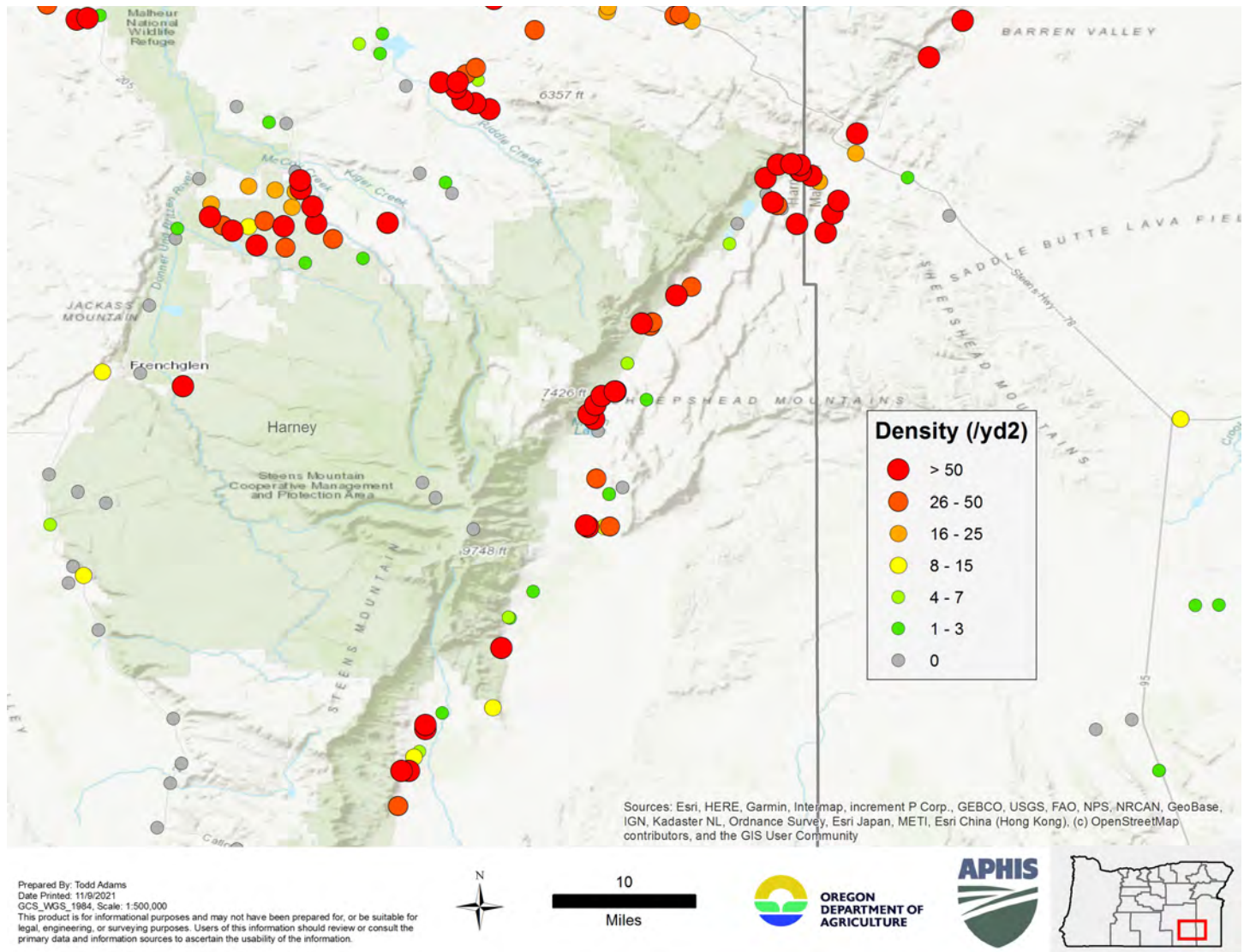


Figure 13. Grasshopper classified densities (GH/yd²) east of Steens Mountain and to the northeast. (1:500k)

6-Burns Junction – Jordan Valley, Malheur County.

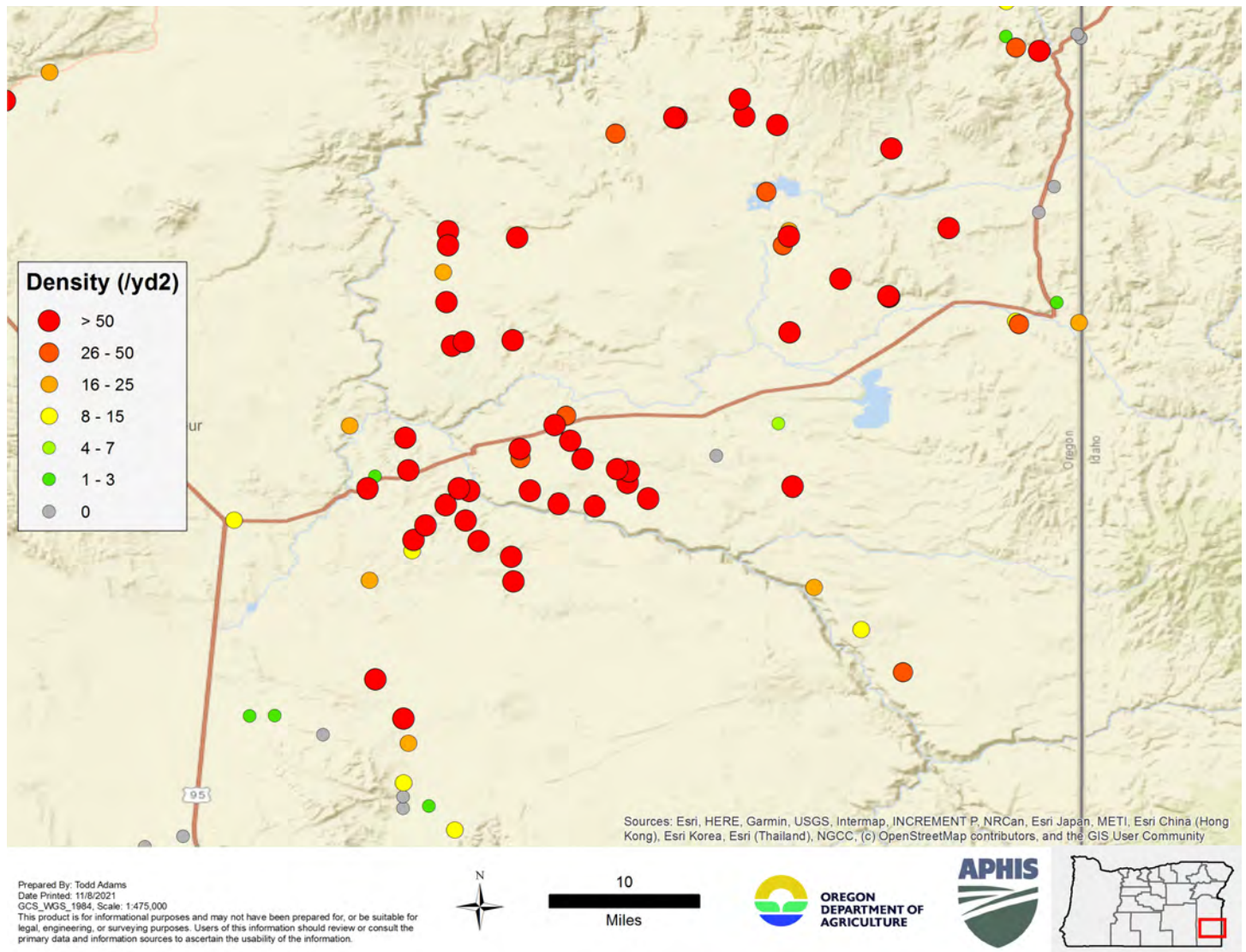


Figure 14. Grasshopper classified densities (GH/yd²) in the region from Burns Junction to Jordan Valley. (1:475k)

7-McDermitt, Malheur County.

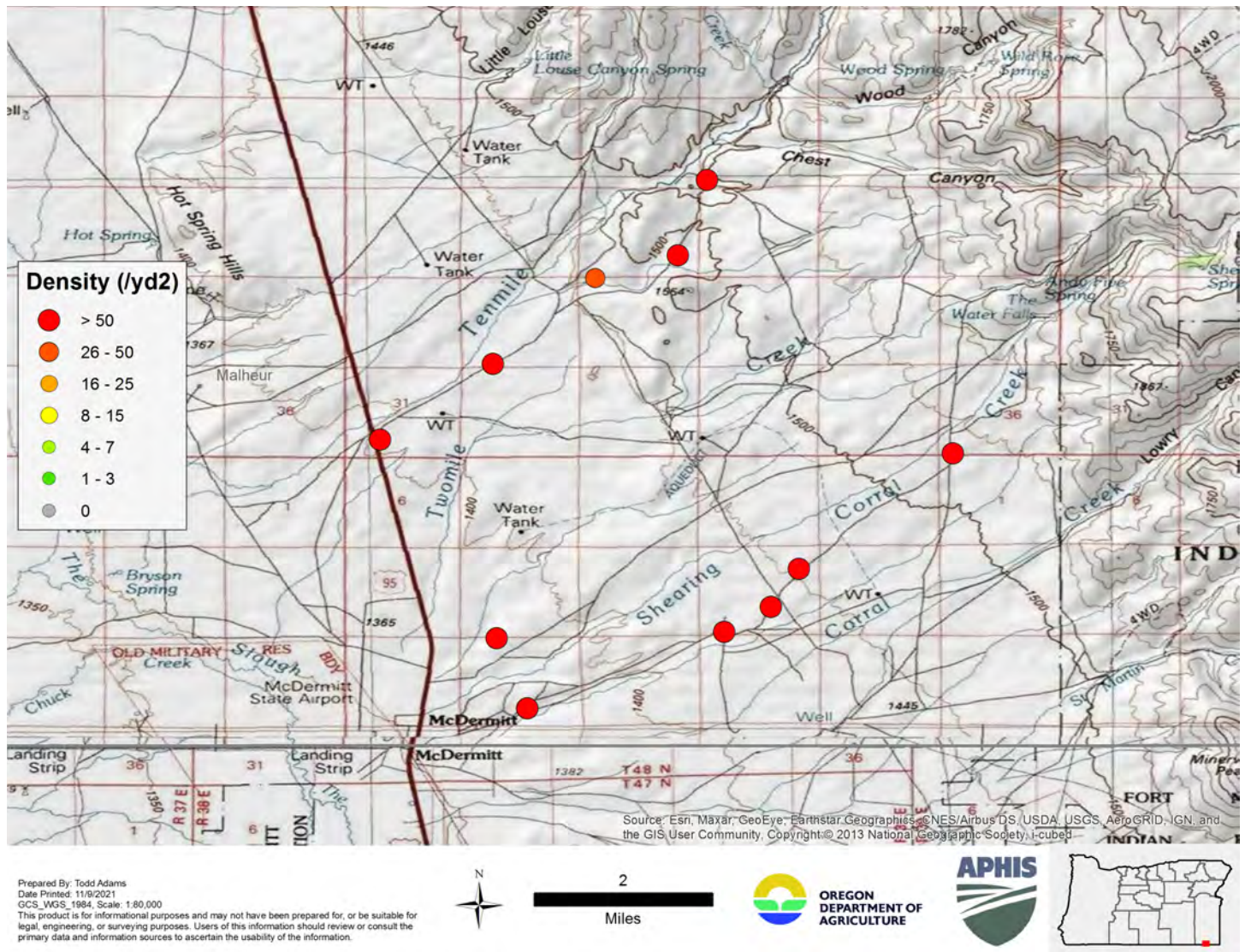


Figure 15. Grasshopper classified densities (GH/yd²) in the McDermitt area, Malheur County. (1:80k)

8-Northern Harney county.

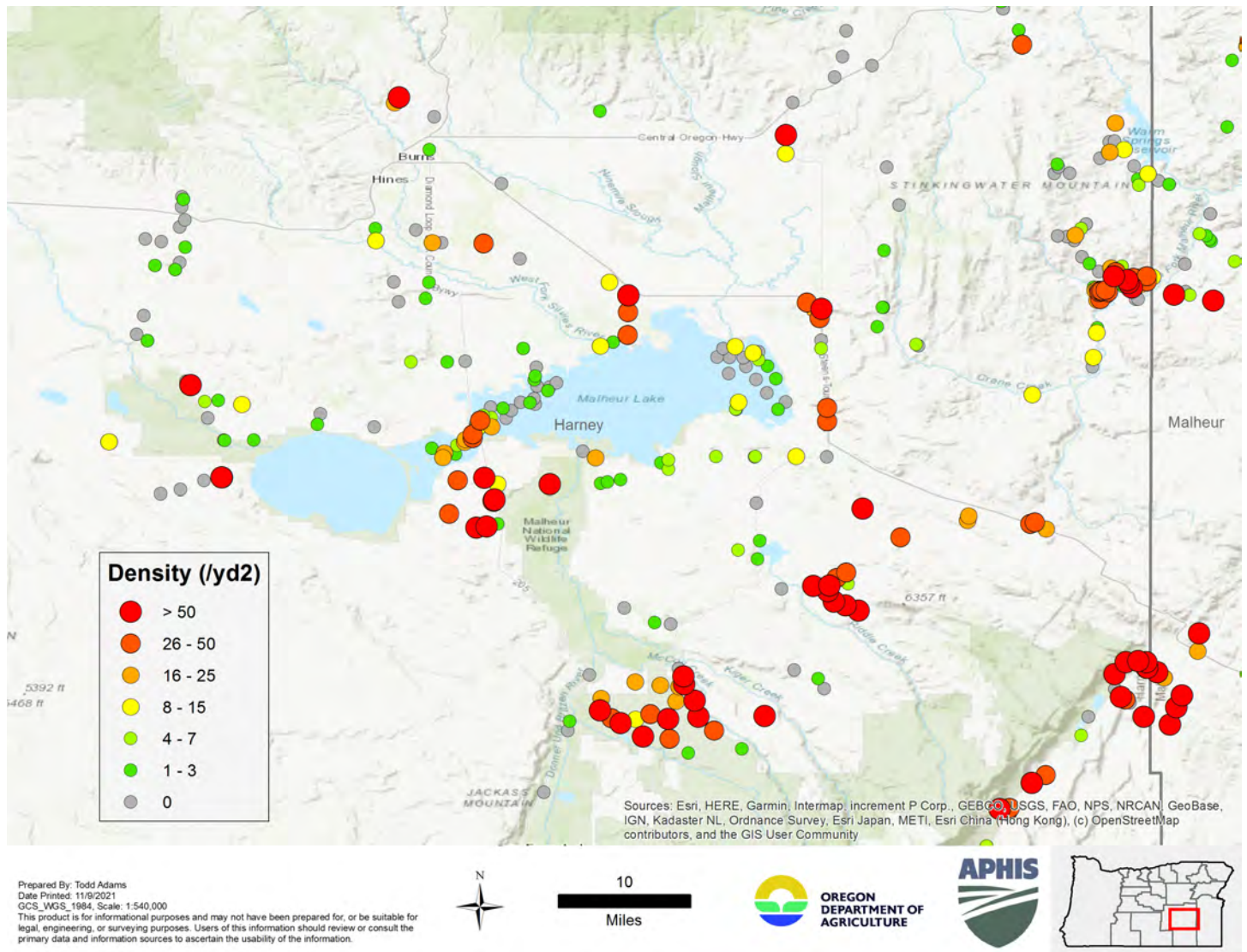


Figure 16. Grasshopper classified densities (GH/yd²) in the region of northern Harney County. (1:540k)

9-Umatilla-Morrow Counties.

The grasshopper populations in the dryland growing area of Umatilla and Morrow counties could pose a threat to next year's crops. The same drought conditions hard on dryland crops is favorable for grasshoppers, which could come to a head in 2022. Irrigated crops may be affected as well.

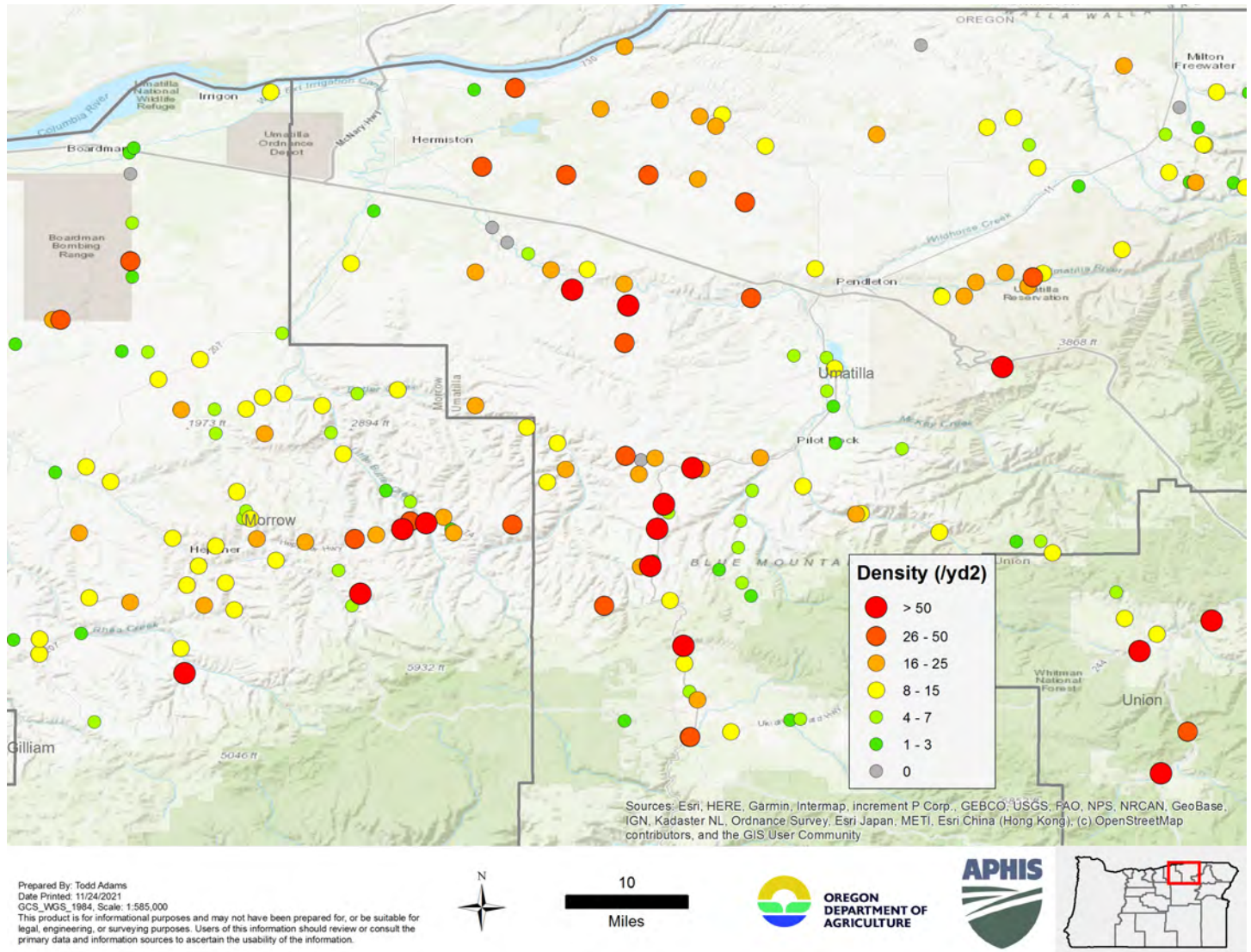


Figure 17. Grasshopper classified densities (GH/yd²) at locations in Umatilla and Morrow Counties. (1:585k)

Tribal Lands

The grasshopper survey intersected tribal holdings at several locations across eastern Oregon (~244,107 ac; 98,786 ha), including the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) and Confederated Tribes of the Warm Springs Reservations (CTWSIR, Fig. 18). Area estimates on the Umatilla and Warm Springs Reservations contained both Economic and Non-economic densities (Table 6). The tribal holdings with the largest area, including survey density estimates, was the CTUIR (Fig. 19), followed by acreage on the CTWSIR (Fig. 20).

Table 6. 2021 grasshopper surveyed area intersecting with eastern Oregon tribal lands.

	Economic		Non-Economic		No Grasshoppers	
	Acres	Hectares	Acres	Hectares	Acres	Hectares
Burns Reservation	0	0	205	83	0	0
Ft McDermitt Reservation	3,166	1,281	0	0	0	0
Umatilla Reservation	133,042	53,840	77,270	31,270	0	0
Warm Springs Reservation	12,557	5,082	0	0	16,159	6,539
Other*	0	0	1682	681	26	10
Totals	148,765	60,203	79,157	32,034	16,185	6,549
Grand Total All classes	244,107	98,786				

*BIA lands not identified with a particular tribe or confederation in GIS resources available to ODA.

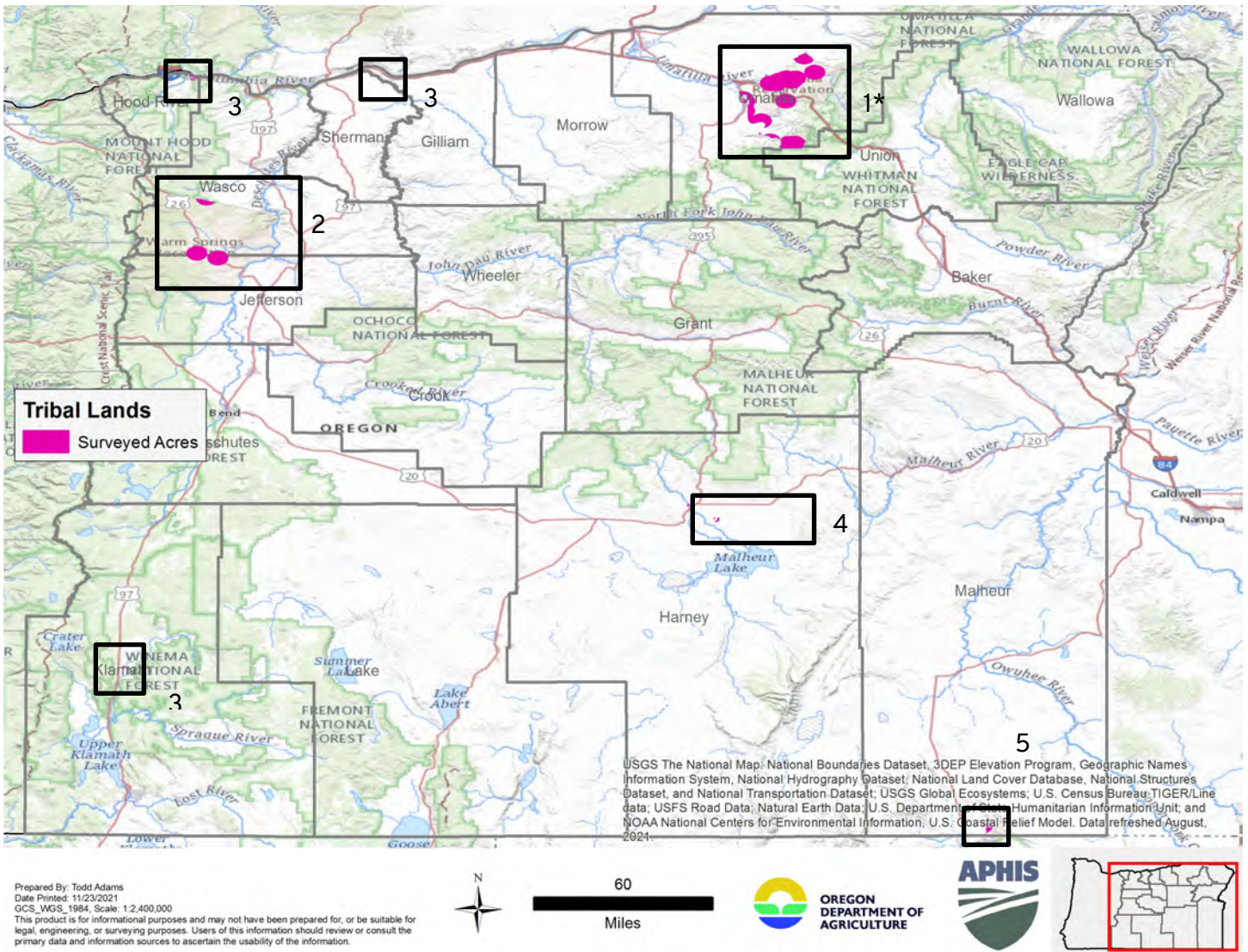


Figure 18. 2021 grasshopper survey areas intersecting tribal lands. Superimposed black rectangles indicate the six geographic areas where this occurred. Black rectangles with an asterisk indicate areas given a closer examination below. 1=CTUIR, 210,312 ac; 2=CTWSIR, 28,716 ac; 3=Other, 1,708 ac; 4=Burns, 205 ac; 5=McDermitt, 3,166 ac. (1:2400k)

A Closer Look

1-CTUIR Area, Umatilla County.

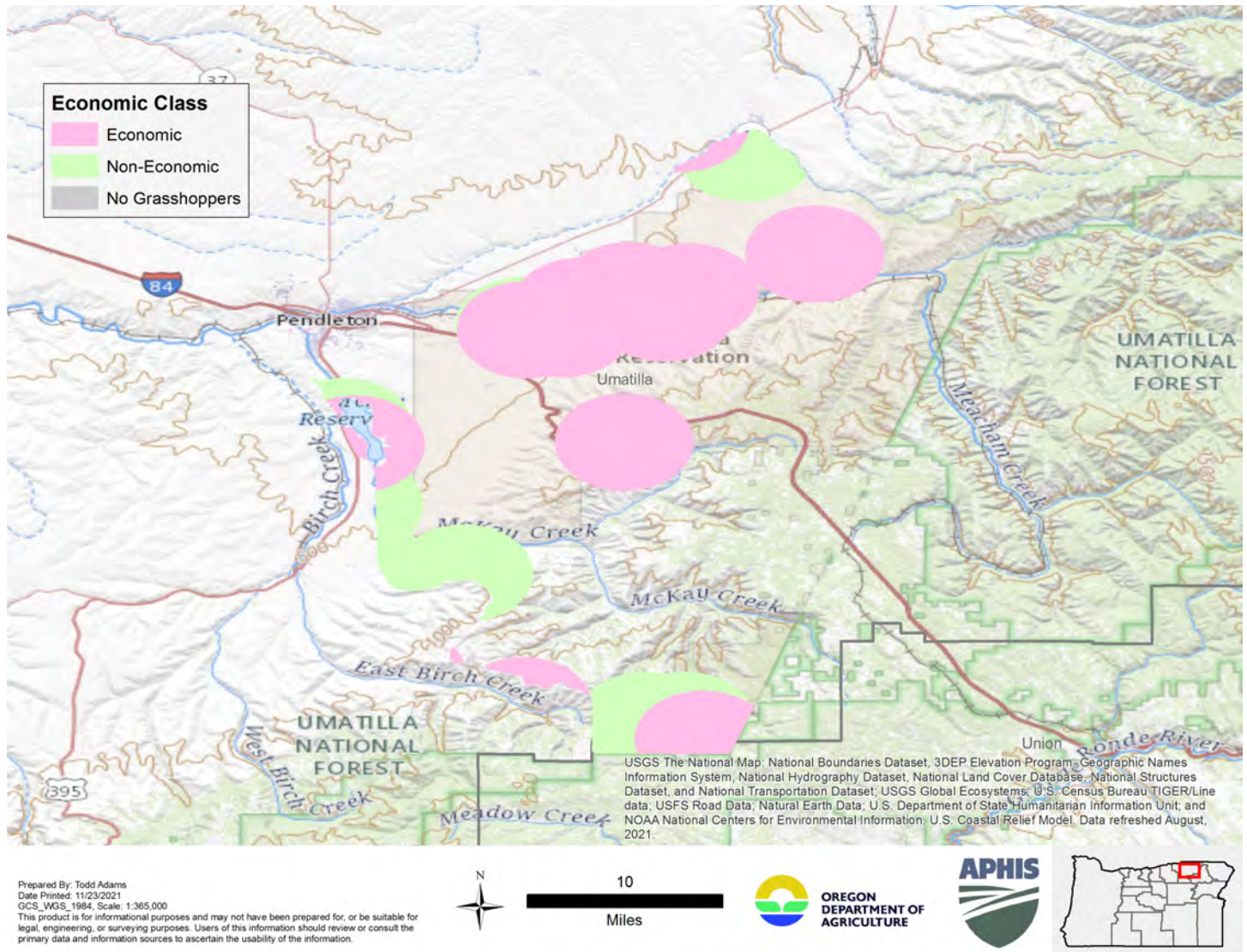


Figure 19. Grasshopper survey areas of economic density intersecting tribal land on the Confederated Tribes of the Umatilla Indian Reservation. Economic density: ≥ 8 grasshoppers per square yard. (1:365k)

2-Warm Springs Area, Jefferson and Wasco Counties.

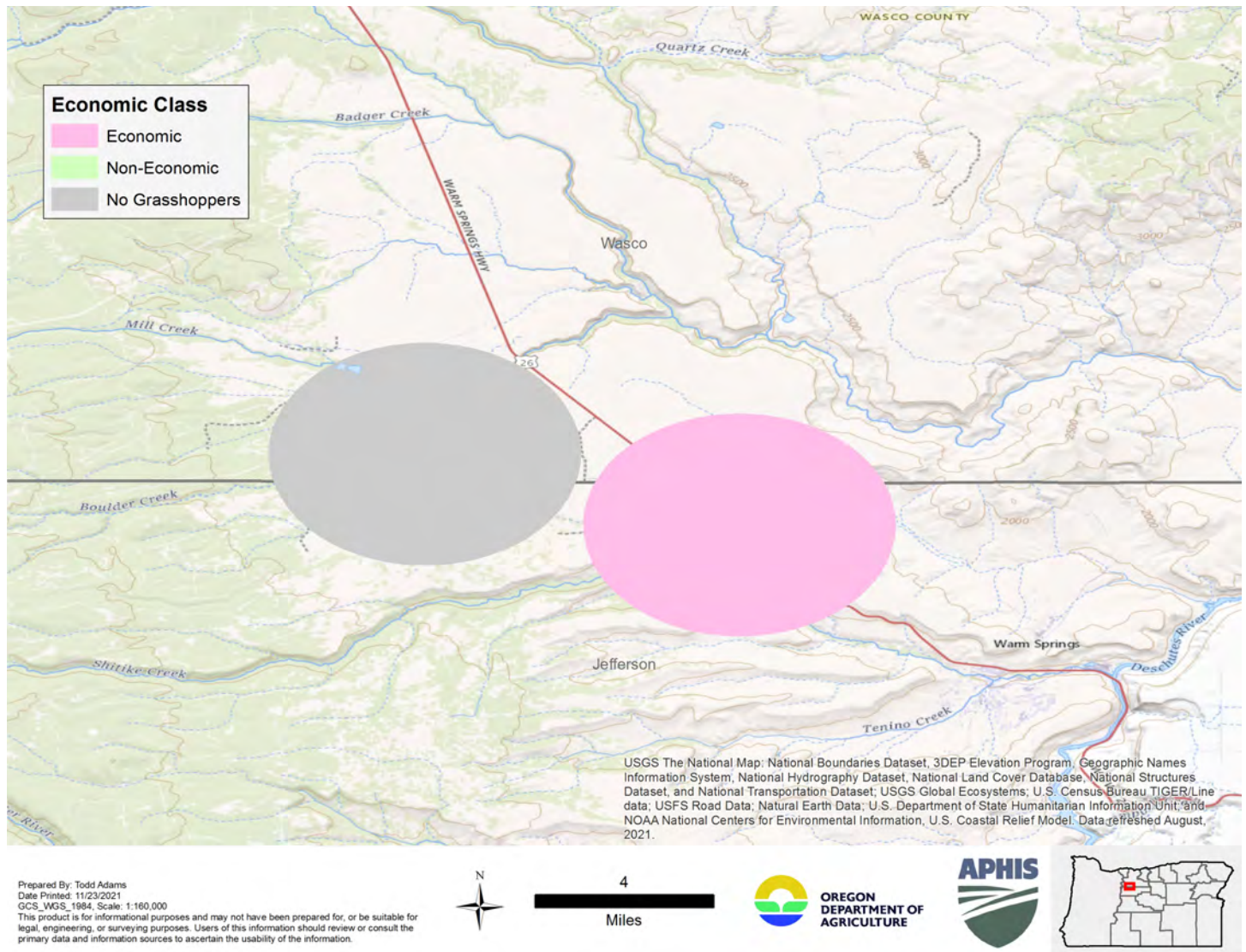


Figure 20. Grasshopper survey areas of economic density intersecting tribal land on the Confederated Tribes of the Warm Springs Indian Reservation. Economic density: ≥ 8 grasshoppers per square yard. (1:160k)

Mormon crickets

In 2021, the outbreak population of 2018 which overran Jordan Valley (central Malheur County) and surrounding areas further reduced its presence and severity. Though our survey only encountered 1 significant site in Jordan Valley, others reported sightings and issues around this area and over the state line into Idaho.

Significant numbers continued to be found in the area around Arlington (Gilliam County) and local efforts made several targeted suppressions to discourage development of excessive densities and subsequent banding and movement. Again, this year bands did not enter into the town of Arlington.

A new population of Mormon Crickets was found in the McDermitt Area. This is likely a population from Nevada and may only be an incursion like the Jordan Valley population from Idaho. We will keep surveying this area/population.

Field support was provided to Robert Srygley (USDA, ARS, Sidney, MT), as he continues his research on Mormon cricket egg development and delayed hatch ('hedge betting') in the Arlington and Blalock Canyon areas. All hope that Bob's work will help anticipate population outbreaks and assist in planning the long-term local response which is needed now and will be in the future.

Table 7. The number of Mormon cricket stops by Density Category (/yd²) and Dominant Life Stage encountered across the entire season.

Density	Totals	Dominant Developmental Stage								
		Egg	1	2	3	4	5	6	7	Adult
0	2,264									
1 - 2	30	0	4	11	2	3	2	1	0	7
3	10	0	0	7	2	0	0	0	0	1
4 - 6	24	0	4	5	5	5	0	0	0	5
7 - 10	21	0	3	4	3	3	2	2	0	4
11 - 25	30	0	3	9	4	6	1	1	0	6
> 25	37	0	0	12	6	10	1	1	0	7
	2,416	0	14	48	22	27	6	5	0	30
	Percentages:	0.0	9.2	31.6	14.5	17.8	3.9	3.3	0.0	19.7

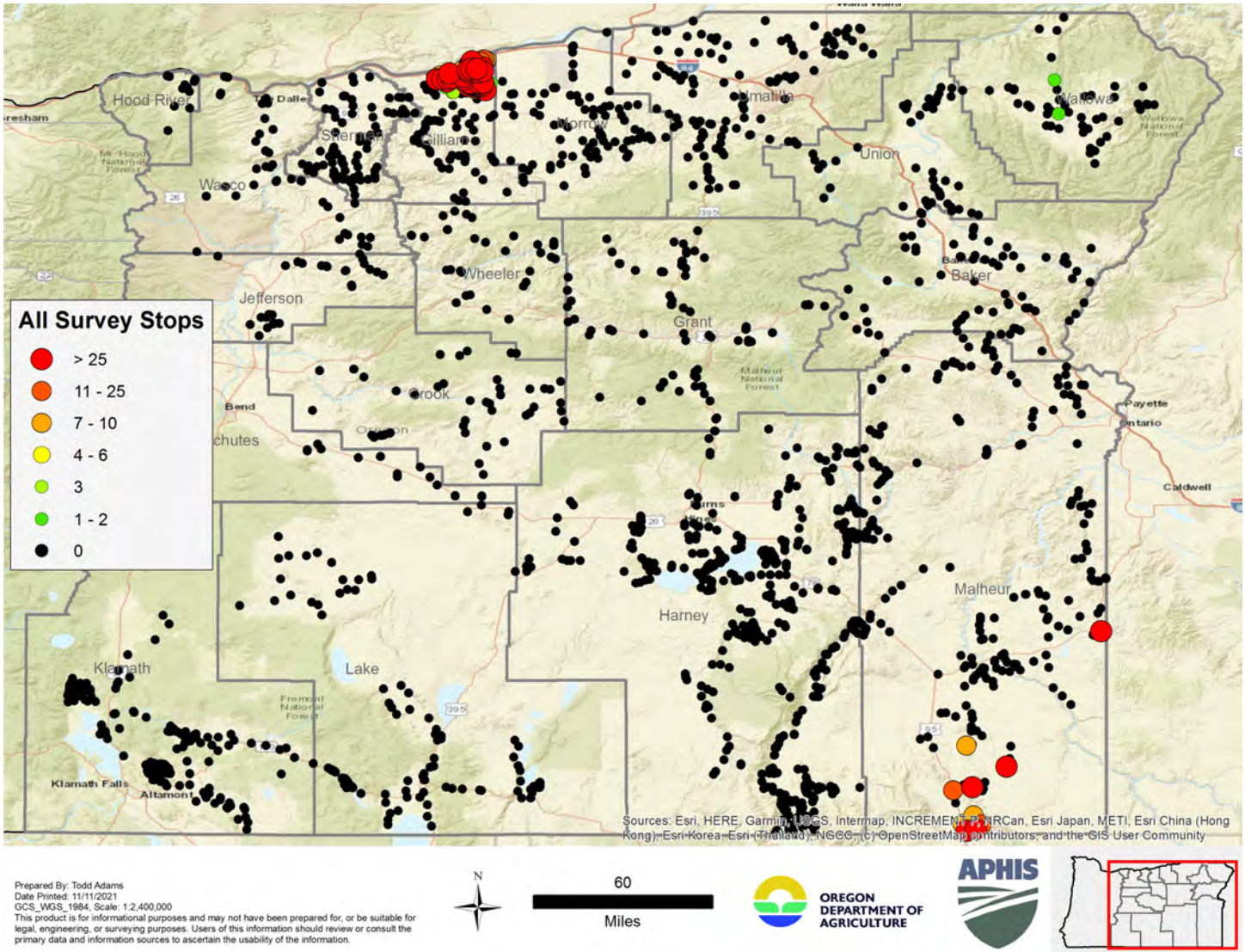


Figure 21. Locations surveyed for Mormon crickets (*Anabrus* spp.) in eastern Oregon classified by density (/yd²). (1:2400k)

A Closer Look

1-Arlington Area, Gilliam County.

Mormon crickets continue to spread eastward from Blalock Canyon/Arlington making it to HWY 74 this summer.

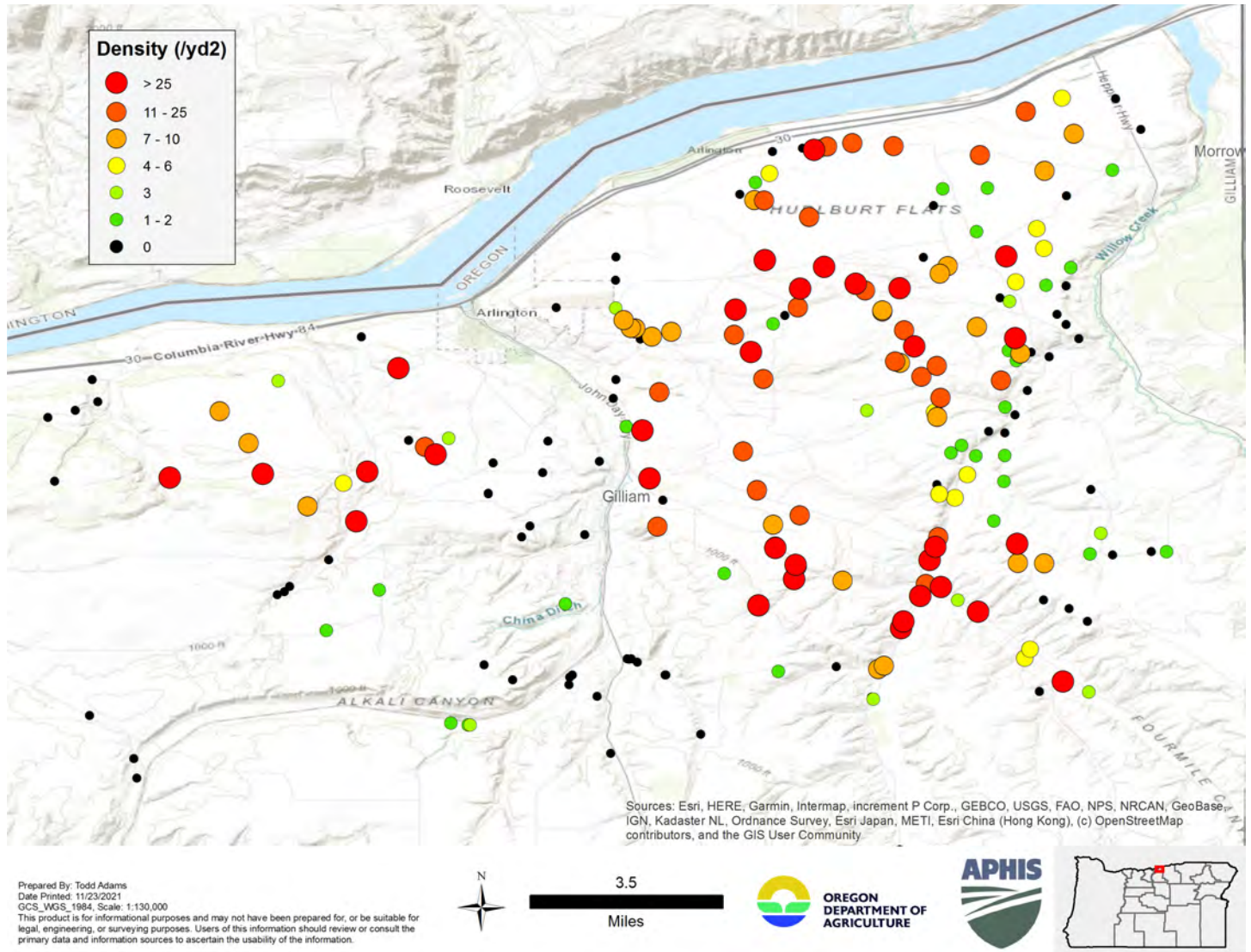


Figure 22. 2021 Mormon cricket survey results in the Arlington - Blalock Canyon area. (1:130k)

2-Jordan Valley Area, Malheur County.

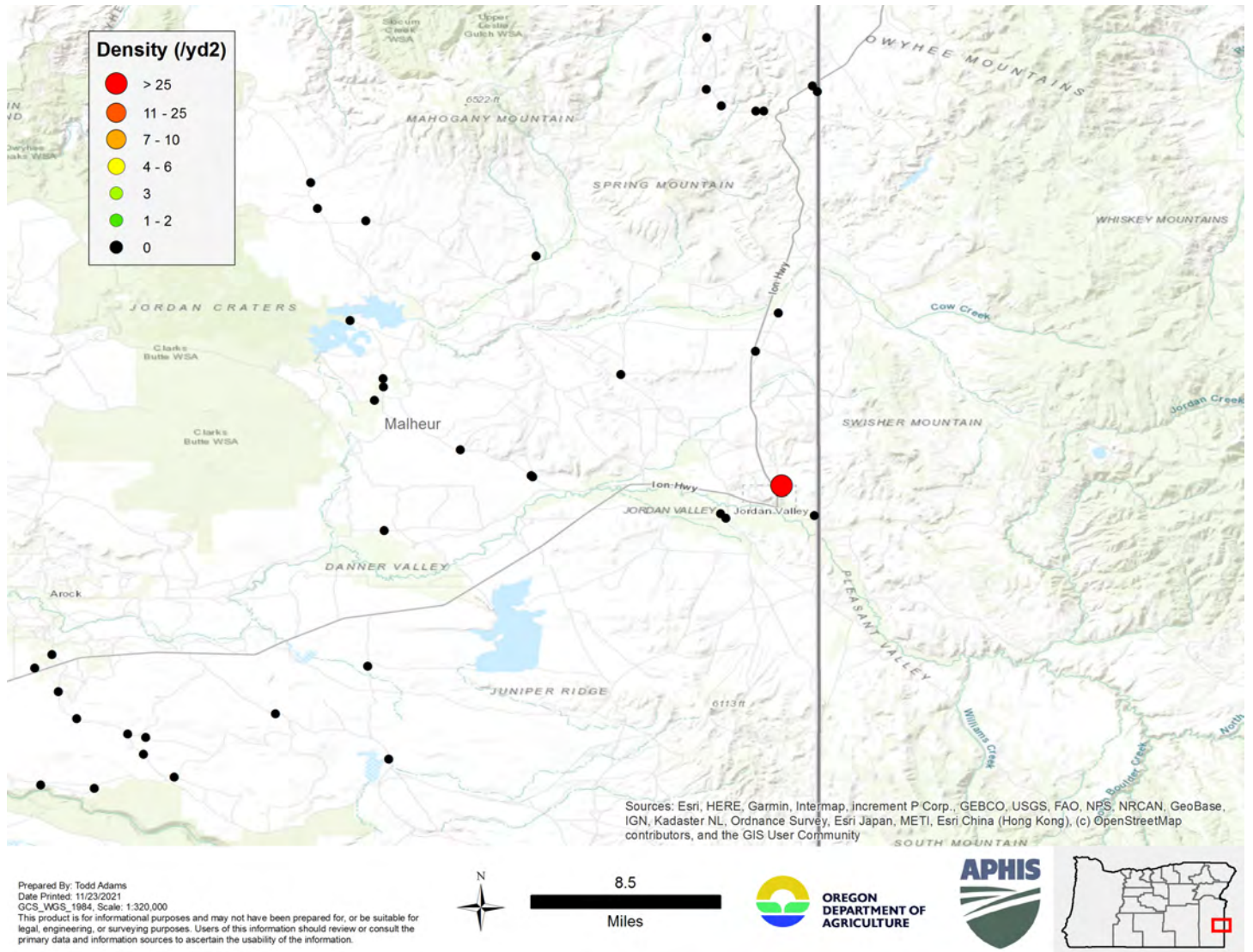


Figure 23. 2021 Mormon cricket survey results in the Jordan Valley area. (1:320k)

3-McDermitt Area, Malheur County.

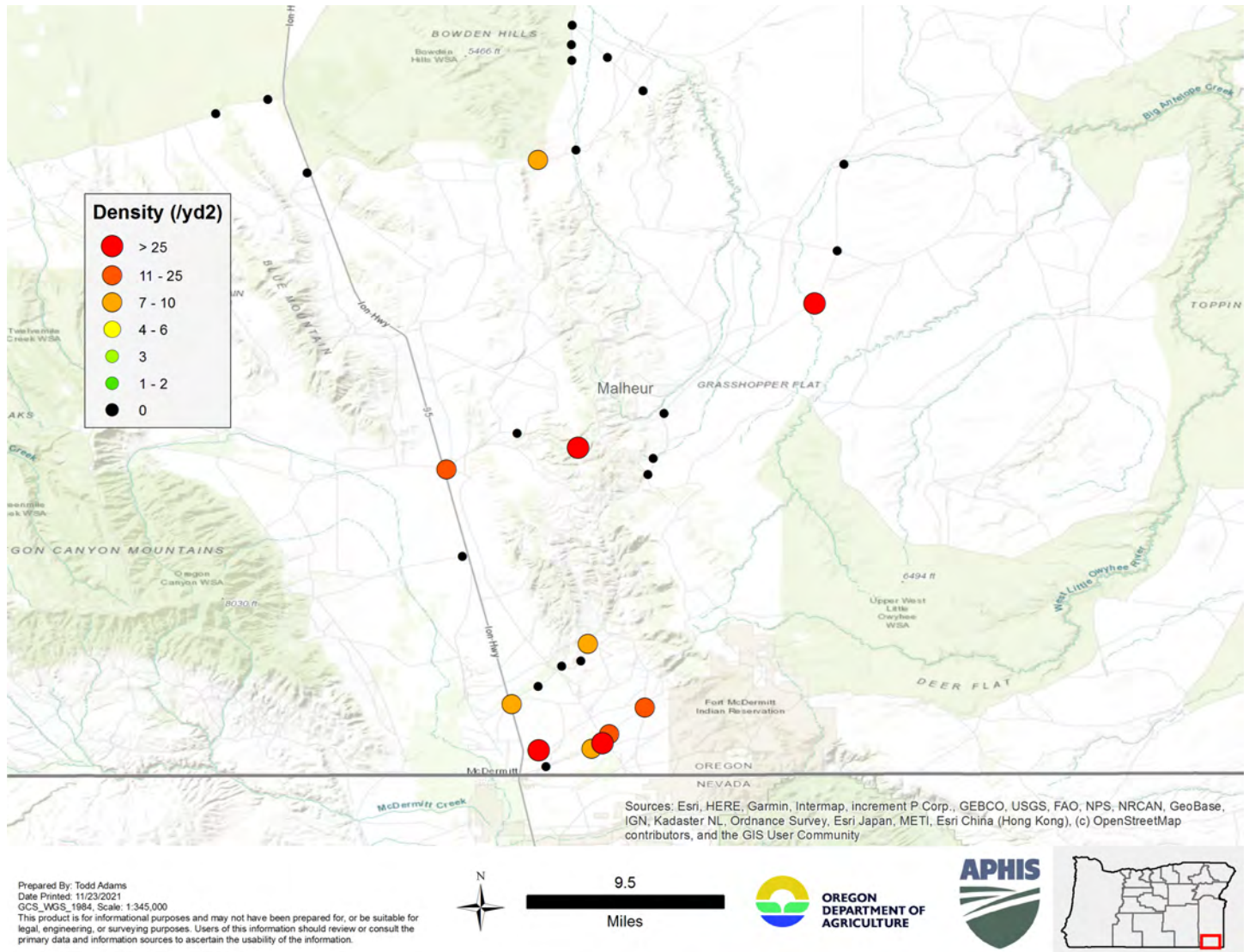


Figure 24. 2021 Mormon cricket survey results in the McDermitt, OR area. (1:345k)

4-Wallowa County.

One of our three known eastern Oregon Mormon cricket populations occur in Wallowa County. A couple individuals were spotted this year.

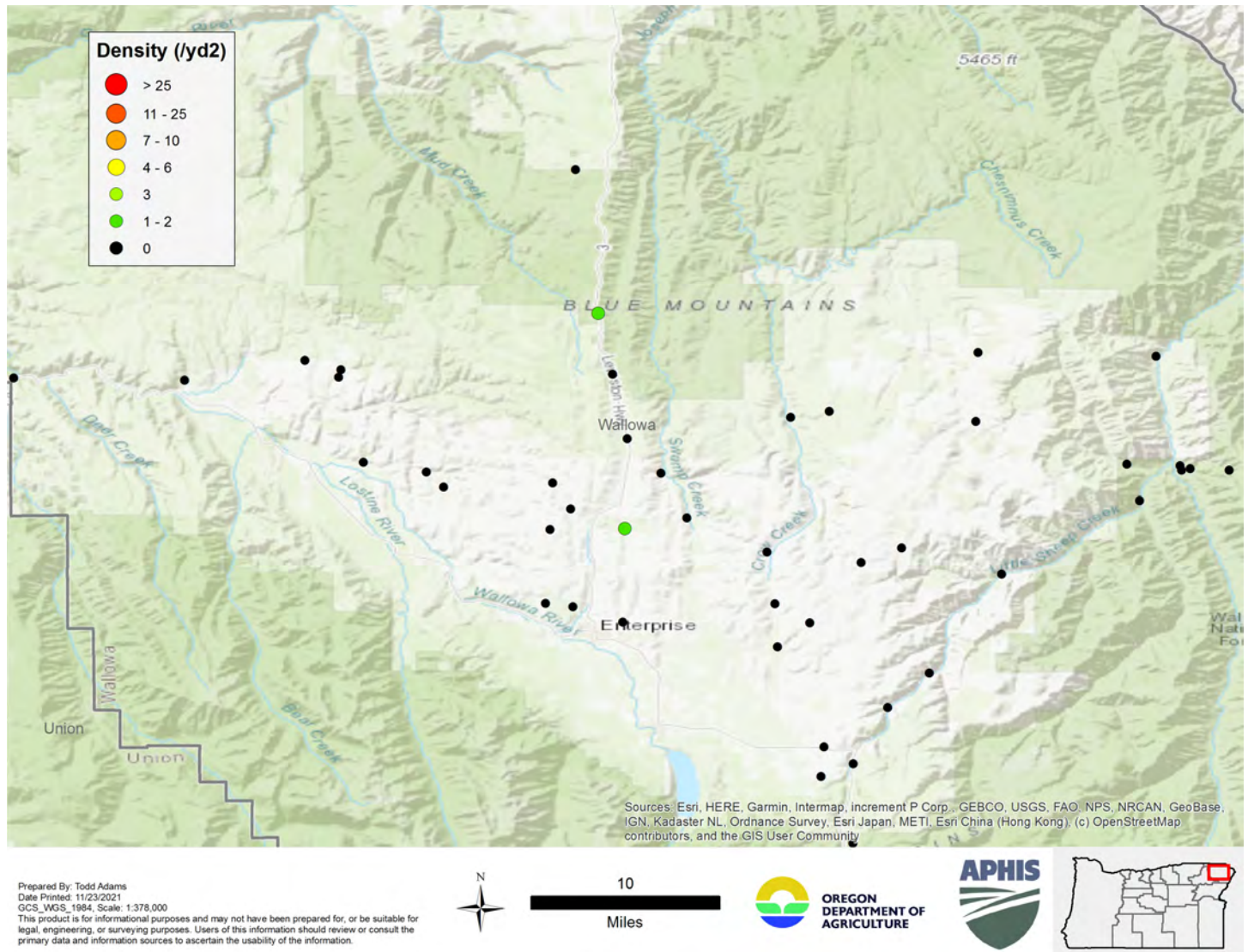


Figure 25. 2021 Mormon cricket survey results in Wallowa county. (1:320k)

Summary

The Oregon Grasshopper and Mormon cricket Survey is conducted by the Oregon Department of Agriculture (ODA) in cooperation with the United States Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS) Plant Protection and Quarantine (PPQ) State Plant Health Director office (Portland, OR).

Grasshopper populations over most of eastern Oregon appear have grown to densities and acreage impacted not seen for many years. Areas of high density were scattered across eastern Oregon, though some counties did have more acreage estimated to have economically significant populations.

During 2021 a total of 2379 sampling locations were visited, 1634 during the nymphal grasshopper survey period and 745 during the adult period (starting on 6 July). Nymphal survey takes place early in the season and is used to locate potential outbreak areas for response during the current year. Adult survey is used by ODA and APHIS to make predictions for the following season, considering economic levels as 8 or more grasshoppers per square yard. This season there were 1045 locations (66% of all sampled acres) that were estimated to have densities of ≥ 8 grasshoppers / yd². Land managers located within or near regions of high density should focus on early detection (hatch) in 2022. If early 2022 populations appear to be of significant density it is both fiscally and environmentally advantageous to intervene early in the grasshopper's life cycle.

There are three areas in eastern Oregon known for Mormon cricket populations: the Arlington-Blalock Canyon area of Gilliam County, the region around Jordon Valley (primarily an Idaho population) in Malheur County and Wallowa County. In the last few years significant populations have plagued the Arlington and Jordon Valley areas. Both *may* be on the decline now though only time will tell. Certainly, Arlington and vicinity had less pressure in 2020 this past season though densities in 2021 showed increase. Kudos to the coordinated management efforts of local city, county and private interests in Gilliam county. A new population of Mormon Crickets has shown up in the McDermitt area. This may be an incursion from a Nevada population, like the Jordan Valley population is primarily from Idaho. We will have to monitor this new population area to see if there is any long-term persistence.

If you have encountered grasshopper or Mormon cricket issues and could benefit from information or assistance (non-treatment) please contact us (below). We are happy to help with delimitation-field assessment survey work, providing information and even giving workshops.

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For more information on USDA programs to protect US Rangeland from Grasshoppers and Mormon Crickets, including Cost Sharing for Grasshopper Suppression Treatment, please consult our factsheet:

https://www.aphis.usda.gov/aphis/ourfocus/planthealth/plant-pest-and-disease-programs/pests-and-diseases/grasshopper-mormon-cricket/ct_grasshopper_mormon_cricket

Or visit our full program website: <https://oda.fyi/GrasshopperMormonCricket>

ARS resource page for grasshopper and Mormon Cricket: <https://www.ars.usda.gov/plains-area/sidney-mt/northern-plains-agricultural-research-laboratory/pest-management-research/pmru-docs/grasshoppers-their-biology-identification-and-management/grasshopper-site-highlights/>

See also: <https://oda.direct/IPPMGrasshoppersCrickets>

Appendix 1. Estimate of the acreage with economic levels of grasshopper infestation (≥ 8 grasshoppers / yd²) based on the 2021 survey.

County	Watershed	Economic Classes Summed by Watershed			Economic Classes Summed by Count		
		Economic	Non-Economic	No Grasshoppers	Economic	Non-Economic	No Grasshoppers
Baker	Alder Creek-Pritchard Creek	22,676	10,205	0	428,906	212,620	24,166
	Baldock Slough-Powder River	866	18,961	124			
	Big Creek	10,776	966	0			
	Big Creek-Burnt River	4,889	115	142			
	Birch Creek-Snake River	330	3,156	0			
	Burnt River	55,825	31,536	2,573			
	Burnt River Canyon-Burnt River	23,616	21,376	0			
	Camp Creek	0	18,091	13			
	Clarks Creek-Burnt River	16,355	10,984	0			
	Eagle Creek	8,216	0	0			
	Love Creek-Powder River	49,604	718	0			
	Lower Powder River	14,205	5,966	0			
	Middle Willow Creek	654	681	36			
	North Fork Burnt River	25,470	12,557	741			
	North Powder River	1,622	0	0			
	Pine Creek	0	11,542	0			
	Rock Creek-Powder River	73,433	1,755	0			
	Rock Creek-Snake River	6,026	13,833	0			
	Ruckles Creek-Powder River	88,472	20,548	8,394			
	South Fork Burnt River	6,392	1,493	12,142			
Sutton Creek-Powder River	12,543	15,907	0				
Upper Powder River	0	11,152	0				
Upper Willow Creek	0	1,078	0				
Wolf Creek-Powder River	6,935	0	0				
Crook	Bear Creek	99,023	662	0	250,282	70,004	172,611
	Buck Creek	0	0	1,387			
	Camp Creek	11,933	3,100	5,917			
	Chimney Rock-Crooked River	0	794	1,767			
	Deep Creek	4,881	0	3,091			
	Grindstone Creek	24,891	6,722	6,726			
	Horse Heaven Creek-Crooked River	12,556	19,975	12,379			

Appendix 1, continued.

County	Tribal Areas	Economic Classes Summed by Watershed			Economic Classes Summed by Count		
		Economic	Non-Economic	No Grasshoppers	Economic	Non-Economic	No Grasshoppers
Crook, continued							
	Lower Beaver Creek	15,864	4,947	3,090			
	Lower Crooked Valley-Crooked River	0	0	13,142			
	Lower Dry River	0	0	12,746			
	Lower North Fork Crooked River	0	6,015	192			
	Lower Ochoco Creek	0	6,237	7,342			
	Lower South Fork Crooked River	4,707	0	46,965			
	Paulina Creek	24,163	315	760			
	Prineville Reservoir-Crooked River	0	4,549	0			
	Soldiers Cap	0	0	2,613			
	South Fork Beaver Creek	24,895	21	2,686			
	Twelvemile Creek	0	0	10,003			
	Upper Beaver Creek	16,555	8,092	4,319			
	Upper Dry River	0	0	1,567			
	Upper North Fork Crooked River	0	100	31,761			
	Upper South Fork Crooked River	0	0	4,104			
	Watson Creek-Crooked River	10,813	8,477	53			
Deschutes	Juniper Butte-Crooked River	0	0	172	0	25,114	97,335
	Soldiers Cap	0	12,557	18,882			
	Upper Dry River	0	12,557	38,032			
	Upper South Fork Crooked River	0	0	40,249			
Gilliam	Butte Creek	706	3,494	0	766,281	190,962	22,038
	Eightmile Canyon	254,063	9,731	25			
	Ferry Canyon-John Day River	13,055	13,115	0			
	John Day River	500	5,249	1,078			
	Lower Lake Umatilla	120,533	44,772	16,673			
	Lower Rock Creek	82,407	40,985	4,155			
	Lower Willow Creek	108,453	7	7			
	Scott Canyon-John Day River	127,155	58,478	100			
	Thirtymile Creek	41,667	15,131	0			
	Upper Rock Creek	17,741	2	0			

Appendix 1, continued.

County	Tribal Areas	Economic Classes Summed by Watershed			Economic Classes Summed by Count		
		Economic	Non-Economic	No Grasshoppers	Economic	Non-Economic	No Grasshoppers
Grant	Bear Creek	3,887	7,489	34	352,031	176,041	100,614
	Beech Creek	19,039	677	7,701			
	Big Creek-Middle Fork John Day River	12,632	6,953	140			
	Bridge Creek-Middle Fork John Day River	0	23,752	10,906			
	Camp Creek-Middle Fork John Day River	0	1,350	0			
	Canyon Creek	1,214	0	4,742			
	Cottonwood Creek	45,755	10,178	727			
	Eight Mile Creek-Middle Fork John Day River	13,017	13,470	2,923			
	Fields Creek-John Day River	15,518	2,881	12,556			
	Grub Creek-John Day River	46,183	8,839	1,654			
	Headwaters Silvies River	16,688	35,352	20,307			
	John Day River-Johnson Creek	14,154	15,938	2,442			
	Kahler Creek-John Day River	419	514	1			
	Laycock Creek-John Day River	15,476	1,636	2,081			
	Long Creek	66,181	8,087	0			
	Lower North Fork John Day River	6,787	6,622	11,075			
	Lower South Fork John Day River	7,780	4,144	0			
	Middle South Fork John Day River	12,556	172	2,955			
	Murderers Creek	47	0	0			
	Potamus Creek-North Fork John Day River	8,779	154	0			
	Reynolds Creek-John Day River	9,469	37	0			
	Rock Creek	0	707	68			
	South Fork Beaver Creek	5,665	0	4,358			
	Upper Beaver Creek	0	2,319	0			
	Upper Middle John Day	1,784	10,857	1,346			
	Upper Silvies River	29,001	6,310	5,103			
	Upper South Fork John Day River	0	0	9,495			
Wall Creek	0	7,605	0				

Appendix 1, continued.

County	Tribal Areas	Economic Classes Summed by Watershed			Economic Classes Summed by Count		
		Economic	Non-Economic	No Grasshoppers	Economic	Non-Economic	No Grasshoppers
Harney	Alvord Lake	338,705	26,744	19,943	2,354,327	562,208	395,703
	Big Alvord Creek	3,713	850	911			
	Big Alvord Creek	84,758	20,393	7,347			
	Big Stick Creek	0	16,146	11,887			
	Buck Creek	0	0	108			
	Buckaroo Lake	0	0	25			
	Buzzard Creek	5,995	0	4,599			
	Chain Lakes-Sunset Valley	7,465	22,350	4,009			
	Cottonwood Creek-Frontal Pueblo Valley	370,732	1,817	556			
	Crane Creek	13,864	32,510	1,813			
	Griffin Creek-Upper Malheur River	21,382	21,081	6,417			
	Harney Lake-Malheur Lake	198,742	96,717	9,061			
	Headwaters Malheur River	297	0	117			
	Home Creek-Garrison Lake	1,878	0	21,956			
	Jackass Creek	913	271	5,985			
	Kiger Creek-Diamond Canal	85,392	16,222	10,998			
	Little Tank Creek-Big Tank Creek	0	12,560	15,846			
	Lower Donner und Blitzen River	62,411	6,582	7,174			
	Lower North Fork Malheur River	0	4,508	844			
	Lower Silver Creek	31,568	42,737	9,714			
	Lower Silvies River	96,422	34,570	16,004			
	Lower South Fork Malheur River	269,173	1,040	3,506			
	Malheur Gap	18,957	1,822	7,023			
	Malheur Slough	46,486	9,805	18,737			
	Middle Donner und Blitzen River	144,472	8,834	17,297			
	Middle Silver Creek	0	17,060	18,260			
	Middle Silvies River	7,463	0	2,495			
	North Basin	2,295	15,710	10,450			
	Otis Creek	45,753	2,050	60			
	Pine Creek	73	0	19,247			
	Quail Creek	47,360	1,439	0			
	Riddle Creek	62,948	41,029	6,965			
	Rincon Creek	49	89	0			

Appendix 1, continued.

County	Tribal Areas	Economic Classes Summed by Watershed			Economic Classes Summed by Count		
		Economic	Non-Economic	No Grasshoppers	Economic	Non-Economic	No Grasshoppers
Harney, continued	Sage Hen Creek	10,147	14,812	2,777			
	Shallow Lake-Slickey Lake	12,522	3,678	5,016			
	Skull Creek	0	0	30,612			
	Squaw Lake-Capehart Lake	0	7,343	7,841			
	Stinkingwater Creek	9,645	11,395	17,537			
	Summit Creek-Storehouse Canyon	115,317	13,872	4,031			
	Upper Donner und Blitzen River	3,259	0	12,293			
	Upper Silvies River	17,651	0	15,056			
	Upper South Fork Crooked River	0	0	138			
	Upper South Fork Malheur River	93,715	111	1,618			
	Walls Lake Reservoir	18,091	36,336	24,606			
	Warm Springs Reservoir-Upper Malheur River	49,206	10,667	1,077			
	Wheatgrass Lake	0	1,423	654			
	Whitehorse Creek	1,125	0	0			
	Willow Creek	54,383	808	0			
	Wilson Creek	0	6,827	691			
	Wolf Creek	0	0	12,402			
Hood River	East Fork Hood River	667	0	22,560	11,093	60,694	25,675
	Hood River	7,460	40,752	2,827			
	Mill Creek-Columbia River	8	0	0			
Jefferson	Mosier Creek-Columbia River	2,958	19,941	288			
	Antelope Creek	188	342	0	45,506	110,315	48,013
	Hay Creek	7,900	2,032	1,221			
	Juniper Butte-Crooked River	0	0	19,707			
	Lower Crooked Valley-Crooked River	0	0	11			
	Lower Trout Creek	9,819	4,136	1,868			
	Mill Creek	0	0	2,370			
	Mud Springs Creek	0	7,203	0			
	Muddy Creek-John Day River	5,370	25,114	3,568			
	Potter Canyon-Deschutes River	0	7	1,778			
	Shitike Creek-Deschutes River	9,189	0	1,905			
	Upper Trout Creek	13,041	25,495	5,136			
	Willow Creek	0	45,987	10,449			

Appendix 1, continued.

County	Tribal Areas	Economic Classes Summed by Watershed			Economic Classes Summed by Count		
		Economic	Non-Economic	No Grasshoppers	Economic	Non-Economic	No Grasshoppers
Klamath	Crater Lake-Williamson River	0	19,208	0	883,863	329,158	131,027
	Fishhole Creek	11,653	4,432	0			
	Gerber Reservoir-Miller Creek	910	5,944	906			
	Hog Creek-Williamsno River	43,210	38,233	23,202			
	Jack Creek-Williamson River	12,562	9,720	11,025			
	Lake Ewauna-Klamath River	2,425	528	0			
	Langell Valley-Lost River	28,092	48,267	7,827			
	Long Lake Valley-Upper Klamath Lake	6,252	22,423	4,235			
	Lower Sycan River	853	0	4,260			
	Mills Creek-Lost River	1,793	165	38			
	North Fork Sprague River	0	965	230			
	Rock Creek-Lost River	0	2,955	0			
	South Fork Sprague River	0	29,036	6,958			
	Sprague River	174,769	54,917	31,358			
	Swan Lake Valley	542,000	12,299	3,056			
	Wood River	32,704	32,703	7,507			
	Yonna Valley-Lost River	26,643	47,362	30,425			
Lake	Anna River-Summer Lake	0	0	4,614	522,850	312,545	315,153
	Buck Creek	0	0	3,067			
	Buckaroo Lake	0	0	4,527			
	Campbell Lake	0	0	11,858			
	Christmas Lake Valley	0	0	202			
	Crooked Creek	0	29,657	8,401			
	Crump Lake	71,781	43,174	19,513			
	Deep Creek	0	41,457	15,884			
	Drews Creek	404,165	12,344	13,056			
	Dry Creek-Fort Rock Valley	0	0	9,765			
	Dry Creek-Frontal Goose Lake	0	12,415	906			
	Duncan Creek-Silver Lake	1	10,089	3,344			
	Fishhole Creek	26	51	0			
	Goose Lake	4	30	0			
	Honey Creek	0	0	2,618			
	Little Tank Creek-Big Tank Creek	0	0	2,756			

Appendix 1, continued.

County	Tribal Areas	Economic Classes Summed by Watershed			Economic Classes Summed by Count		
		Economic	Non-Economic	No Grasshoppers	Economic	Non-Economic	No Grasshoppers
Lake, continued							
	Lower Chewaucan River	0	34,028	62,198			
	Middle Chewaucan River	0	202	839			
	Pine Lake-Devils Garden	0	53	10,318			
	Post Lake	0	7,023	934			
	Rock Creek-Buck Creek	1,279	12,525	0			
	Sand Canyon-Lake Abert	0	733	2,711			
	Silver Creek	23,828	0	8,344			
	South Fork Sprague River	7,927	3,006	4,347			
	Thomas Creek	13,840	42,727	23,405			
	Thorn Lake	0	37,343	69,341			
	Tired Horse Lake	0	0	978			
	Upper South Fork Crooked River	0	0	30,824			
	Wheatgrass Lake	0	0	403			
	Willow Creek-Frontal Goose Lake	0	25,686	0			
Malheur	Antelope Creek	0	3,208	27,366	1,431,203	382,549	198,996
	Birch Creek-Snake River	28,024	2,799	0			
	Burnt River	221	0	8			
	Camp Creek	0	334	0			
	Clarks Creek-Burnt River	434	0	0			
	Clover Creek	0	18,188	0			
	Cottonwood Creek	3,249	677	52			
	Cow Creek	34,127	17,182	6,740			
	Crowley Creek	53,749	1,118	9,954			
	Dry Creek	52,685	0	350			
	Dry Creek-Jordan Creek	62,962	10,868	7,527			
	Hog Creek-Lower Malheur River	9,168	1,779	3,317			
	Hunter Creek-Lower Malheur River	2,617	12,571	1,028			
	Jackson Creek-Owyhee River	38,863	0	0			
	Jacobsen Gulch-Snake River	15,374	0	0			
	Johnston Gulch Reservoir-Lower Malheur River	18,181	0	0			
	Jordan Creek-Sheep Spring Creek	70,571	3,140	5,291			
	Juniper Basin Creek-Upper Malheur River	29,856	14,662	2,102			

Appendix 1, continued.

County	Tribal Areas	Economic Classes Summed by Watershed			Economic Classes Summed by Count		
		Economic	Non-Economic	No Grasshoppers	Economic	Non-Economic	No Grasshoppers
Malheur, continued							
	Little Malheur River	0	24,879	2,699			
	Little Sandy Reservoir-Lower Malheur River	7,621	8,179	181			
	Locket Gulch-Snake River	2,646	0	0			
	Lower Bully Creek	6,862	14,062	61			
	Lower Cow Creek	109,635	0	0			
	Lower Crooked Creek	46,584	26	78			
	Lower North Fork Malheur River	32,253	18,703	11,795			
	Lower South Fork Malheur River	72,557	44,403	943			
	Lower Succor Creek	69,955	20,253	0			
	Lower Willow Creek	10,721	0	11,622			
	Middle Willow Creek	44,734	31,779	20,947			
	Moores Hollow-Snake River	15,929	119	0			
	North Alkali Creek-Snake River	13,973	5,273	0			
	Oregon Canyon Creek	105,965	3,970	13,054			
	Otis Creek	4,736	1,427	0			
	Quail Creek	65,532	6,291	270			
	Rattlesnake Creek	58,919	41,270	19,934			
	Ryegrass Creek-Owyhee River	45,007	1,191	9,696			
	Sand Hollow Creek	5,076	574	0			
	Sand Hollow Creek-Owyhee River	16,327	9,473	0			
	Skull Creek-Owyhee River	131,932	0	0			
	Soldier Creek	17,432	82	1,378			
	Three Fingers Gulch-Owyhee River	13,291	0	0			
	Trout Creek-Jordan Creek	632	0	0			
	Upper Bully Creek	0	13,787	0			
	Upper Cow Creek	22,183	0	10,215			
	Upper Crooked Creek	0	26,381	17,237			
	Upper Dry Creek	0	0	2,602			
	Upper South Fork Malheur River	149	0	0			
	Upper Succor Creek	28,656	0	1,347			
	Upper Willow Creek	12,201	18,230	10,495			
	Warm Springs Reservoir-Upper Malheur River	6,300	5,670	1			

Appendix 1, continued.

County	Tribal Areas	Economic Classes Summed by Watershed			Economic Classes Summed by Count		
		Economic	Non-Economic	No Grasshoppers	Economic	Non-Economic	No Grasshoppers
Malheur, continued							
	West Tub Mountain Reservoir	41,593	0	706			
	Whitehorse Creek	1,723	0	0			
Morrow	Eightmile Canyon	18,412	8,095	2,250	595,750	196,849	8,343
	Hunt Ditch-Umatilla River	3,559	152	0			
	Juniper Canyon	48,125	32,830	1,259			
	Lower Butter Creek	89,053	10,546	0			
	Lower Lake Umatilla	508	907	91			
	Lower Rock Creek	4,762	12,620	0			
	Lower Willow Creek	25,837	30,423	657			
	Middle Lake Umatilla	0	11,709	2,855			
	Middle Willow Creek	76,327	8,130	0			
	Rhea Creek	51,321	13,669	0			
	Sand Hollow	59,417	9,416	0			
	Sixmile Canyon	16,253	38,540	1,231			
	Upper Butter Creek	63,906	5,671	0			
	Upper Lake Umatilla	4,537	1,422	0			
	Upper Rock Creek	14,170	8,112	0			
	Upper Willow Creek	119,564	4,606	0			
Sherman	Buck Hollow Creek	143,125	25,498	0	460,712	163,636	12,118
	Cedar Island-Deschutes River	35,724	14,030	1,979			
	Ferry Canyon-John Day River	83,068	3,658	167			
	Grass Valley Canyon	111,087	55,067	534			
	John Day River	5,637	9,602	0			
	Lower Lake Umatilla	0	7,819	0			
	Pine Hollow	31,030	0	1,661			
	Scott Canyon-John Day River	33,958	9,369	41			
	Spanish Hollow-Columbia River	17,084	38,593	7,735			
Umatilla	Alkali Canyon-Umatilla River	88,347	4,987	3,421	915,800	191,985	23,801
	Birch Creek	132,704	80,739	0			
	Cold Springs Canyon	117,017	9	0			
	Headwaters Umatilla River	3,222	0	0			
	Hunt Ditch-Umatilla River	16,645	7,072	1,913			

Appendix 1, continued.

County	Tribal Areas	Economic Classes Summed by Watershed			Economic Classes Summed by Count		
		Economic	Non-Economic	No Grasshoppers	Economic	Non-Economic	No Grasshoppers
Umatilla, continued							
	Lookingglass Creek	28	0	0			
	Lower Butter Creek	6,775	8,152	0			
	Lower Camas Creek	73,042	21,413	0			
	Lower Lake Wallula	21,981	5,116	0			
	Lower Walla Walla River	562	0	8,524			
	McKay Creek	16,232	24,770	0			
	Meadow Creek	3,041	2,393	0			
	Middle Walla Walla River	13,079	4,232	936			
	Mission Creek-Umatilla River	95,324	1,139	0			
	Pine Creek	60,424	7,024	5,705			
	Sand Hollow	44	1,151	0			
	Stage Gulch	33,812	439	2,315			
	Upper Butter Creek	112,935	0	0			
	Upper Camas Creek	0	12,037	0			
	Upper Lake Umatilla	1,806	0	0			
	Upper Walla Walla River	54,488	1,950	987			
	Wildhorse Creek	64,293	9,361	0			
Union	Beaver Creek-Grande Ronde River	11,921	0	7,380	393,986	45,730	12,561
	Big Creek	9,555	3,937	0			
	Birch Creek	2	2	0			
	Cabin Creek-Grande Ronde River	61,872	77	0			
	Five Points Creek-Grande Ronde River	0	0	5,181			
	Indian Creek-Grande Ronde River	50,467	1,179	0			
	Ladd Creek	0	8,986	0			
	Lower Catherine Creek	114	7,223	0			
	Lower Wallowa River	1,943	0	0			
	McKay Creek	732	0	0			
	Meadow Creek	47,480	8,174	0			
	Minam River	3,577	261	0			
	North Powder River	11,761	7	0			
	Rock Creek-Powder River	0	0	0			
	Upper Catherine Creek	35,986	13,959	0			

Appendix 1, continued.

County	Tribal Areas	Economic Classes Summed by Watershed			Economic Classes Summed by Count		
		Economic	Non-Economic	No Grasshoppers	Economic	Non-Economic	No Grasshoppers
Union, continued							
	Upper Grande Ronde River	33,678	0	0			
	Willow Creek	38,835	0	0			
	Wolf Creek-Powder River	86,061	1,925	0			
Wallowa	Chesnimnus Creek	19,739	3,913	0	373,753	85,378	20,444
	Lostine River	1,416	0	0			
	Lower Big Sheep Creek	75,116	23,975	0			
	Lower Grande Ronde River	27,763	0	0			
	Lower Imnaha River	9,103	12,239	3,610			
	Lower Joseph Creek	3,001	0	0			
	Lower Wallowa River	17,858	17,905	99			
	Middle Imnaha River	12,457	372	963			
	Middle Wallowa River	55,627	3,489	2,902			
	Minam River	215	1,123	0			
	Mud Creek-Grande Ronde River	7,848	5,233	10,421			
	Upper Big Sheep Creek	786	6,285	0			
	Upper Joseph Creek	65,461	6,983	2,144			
	Upper Wallowa River	77,362	3,861	305			
Wasco	Antelope Creek	33,327	12,149	593	203,044	89,411	68,530
	Bakeoven Creek	30,206	3,038	1,953			
	Beaver Creek	0	0	2,431			
	Buck Hollow Creek	26,390	2,685	3,846			
	Cedar Island-Deschutes River	520	2,100	0			
	Clarno Rapids-John Day River	5,040	20	0			
	Eightmile Creek	0	5,625	11,852			
	Fifteenmile Creek	17,583	24,391	11,744			
	Hood River	10	0	0			
	Mill Creek	0	0	7,739			
	Mill Creek-Columbia River	169	12,067	3,200			
	Mosier Creek-Columbia River	1,278	17,465	2,261			
	Muddy Creek-John Day River	4,438	3,458	0			
	Pine Hollow	8,118	0	0			
	Shitike Creek-Deschutes River	3,361	0	122			

Appendix 1, continued.

County	Tribal Areas	Economic Classes Summed by Watershed			Economic Classes Summed by Count		
		Economic	Non-Economic	No Grasshoppers	Economic	Non-Economic	No Grasshoppers
Wasco, continued							
	Tygh Creek	9,533	341	0			
	Upper Trout Creek	13	0	0			
	Warm Springs River	7	0	390			
	White Horse Rapids-Deschutes River	25,500	6,071	19,582			
	White River	37,550	0	2,816			
Wheeler	Bridge Creek	4,576	19,540	9,039	158,026	189,662	43,465
	Butte Creek	33,537	17,411	0			
	Clarno Rapids-John Day River	1,712	447	0			
	Deep Creek	4,776	0	0			
	John Day River-Johnson Creek	10,959	7,390	3,571			
	Kahler Creek-John Day River	12,139	81,531	15,606			
	Lower Beaver Creek	1,500	0	0			
	Mountain Creek	45,610	8,815	0			
	Muddy Creek-John Day River	21,015	219	9,248			
	Rock Creek	0	288	2,901			
	Service Creek-John Day River	9,501	53,600	738			
	Thirtymile Creek	12,701	0	0			
	Upper Middle John Day	0	420	2,361			
Totals for Economic Class		10,147,416	3,394,859	1,720,588			
Grand Total of Surveyed Acres		15,262,863					

Appendix 2. 2021 grasshopper survey area estimates intersecting with tribal lands by County and Reservation.

County	Tribal Areas	Economic Classes Summed by Watershed			Economic Classes Summed by County		
		Economic	Non-Economic	No Grasshoppers	Economic	Non-Economic	No Grasshoppers
Gilliam	Burns Reservation	0	0	0	0	21	0
	FT McDermitt Reservation	0	0	0			
	Umatilla Reservation	0	0	0			
	Warm Springs Reservation	0	0	0			
	Other	0	21	0			
Harney	Burns Reservation	0	205	0	0	205	0
	FT McDermitt Reservation	0	0	0			
	Umatilla Reservation	0	0	0			
	Warm Springs Reservation	0	0	0			
	Other	0	0	0			
Hood River	Burns Reservation	0	0	0	0	1,458	25
	FT McDermitt Reservation	0	0	0			
	Umatilla Reservation	0	0	0			
	Warm Springs Reservation	0	0	0			
	Other	0	1,458	25			
Jefferson	Burns Reservation	0	0	0	9,189	0	4,274
	FT McDermitt Reservation	0	0	0			
	Umatilla Reservation	0	0	0			
	Warm Springs Reservation	9,189	0	4,274			
	Other	0	0	0			
Klamath	Burns Reservation	0	0	0	0	203	1
	FT McDermitt Reservation	0	0	0			
	Umatilla Reservation	0	0	0			
	Warm Springs Reservation	0	0	0			
	Other	0	203	1			
Malheur	Burns Reservation	0	0	0	3,166	0	0
	FT McDermitt Reservation	3,166	0	0			
	Umatilla Reservation	0	0	0			
	Warm Springs Reservation	0	0	0			
	Other	0	0	0			
Sherman	Burns Reservation	0	0	0	0	0	0
	FT McDermitt Reservation	0	0	0			
	Umatilla Reservation	0	0	0			
	Warm Springs Reservation	0	0	0			
	Other	0	0	0			

Appendix 2, continued.

County	Tribal Areas	Economic Classes Summed by Watershed			Economic Classes Summed by Count		
		Economic	Non-Economic	No Grasshoppers	Economic	Non-Economic	No Grasshoppers
Umatilla	Burns Reservation	0	0	0	131,624	74,120	0
	FT McDermitt Reservation	0	0	0			
	Umatilla Reservation	131,624	74,120	0			
	Warm Springs Reservation	0	0	0			
	Other	0	0	0			
Union	Burns Reservation	0	0	0	1,418	3,150	0
	FT McDermitt Reservation	0	0	0			
	Umatilla Reservation	1,418	3,150	0			
	Warm Springs Reservation	0	0	0			
	Other	0	0	0			
Wasco	Burns Reservation	0	0	0	3,368	0	11,884
	FT McDermitt Reservation	0	0	0			
	Umatilla Reservation	0	0	0			
	Warm Springs Reservation	3,368	0	11,884			
	Other	0	0	0			
Totals for Economic Class		148,765	79,157	16,184			
Grand Total of Surveyed Acres		244,106					

Appendix 3. Methodology for Area Estimation.

1. Grasshopper and Mormon cricket density (count/yd²) is estimated at survey locations.
2. The density at each point is placed into two classification systems: a density classification (7 levels) and an economic classification with 3 groupings (Economic [$\geq 8/\text{yd}^2$], Non-economic [$1-7/\text{yd}^2$], or No Grasshoppers/Mormon crickets).
3. To generate area each point location is buffered with a 2.5 mile radius.

For the economic classes:

4. Resulting areas are merged by Economic Class.
 5. Intersecting areas of water (e.g. rivers, lakes, etc.) and city limits are removed.
 6. Overlapping Economic Classes are 'clipped' so that:
 - Non-economic area is preserved over a classification of No Grasshoppers.
 - Economic area is preserved over either a Non-Economic or a No Grasshopper classification.
 7. Calculation of area in each Economic Class is then enabled by Union with any desired geographic boundaries (e.g. counties, various federal lands, etc.).
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Appendix 4. General Information about Maps in this Report.

These maps were prepared by Todd Adams of the Oregon Department of Agriculture (ODA) in the WGS84 Datum using data sources from ESRI, OR Geospatial Data Clearinghouse and ODA field survey. The maps are for informational purposes and may not have been prepared for, or be suitable for legal, engineering, or surveying purposes. Users of this information should review or consult the primary data and information sources to ascertain the usability of the information.
