Oregon Grasshopper and Mormon Cricket Survey Summary for 2020

Introduction

The 2020 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 22 April to 25 August 2020. In 2020, a total of **1,601** sites were visited, (1601 include looking for MC, 1443 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

This year was probably the worse experienced in a very long time with 60 percent of our stops being at an economic density[1] (Table 2), and for those stops the mean density was 57 GH/yd2 (Table 2). At the end of 2019 we had hopes grasshoppers were on the decline (Fig. 4). Few areas across eastern Oregon missed out on the grasshopper explosion (Fig. 2). Because extreme densities were so widely distributed it made it difficult to select but several regions are highlighted for a closer look (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 **501** were during the period for nymphal grasshopper survey and **935** 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 – 25 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 237 Common Data Sites (standard locations visited each year for year-to-year comparison) were included in the survey.

Approximately 4.8 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 100,000 economically infested acres (Fig. 6; Table 3; Appendix 1).

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 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 contradicted the pattern.

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[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).

Table 1. A comparison of grasshopper (GH) infestation densities (/ yd^2) adjusted for effort (percentage of total surveyed acres within each year).

	Percent of Total Surveyed Acres		
Year	Economic	Non-Econ	No GH
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 2020. Economic infestation ≥ 8 grasshoppers / yd^2.

			Grasshopper Sites Surveyed						
Year	Number Counties Infested	Acres of Econ. Infest.	Total	Nymph	Adult	Treatment	Samples w/Econ Density	Mean GH / yd^2*	Number of GH Surveyors
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

*Mean of economically infested samples

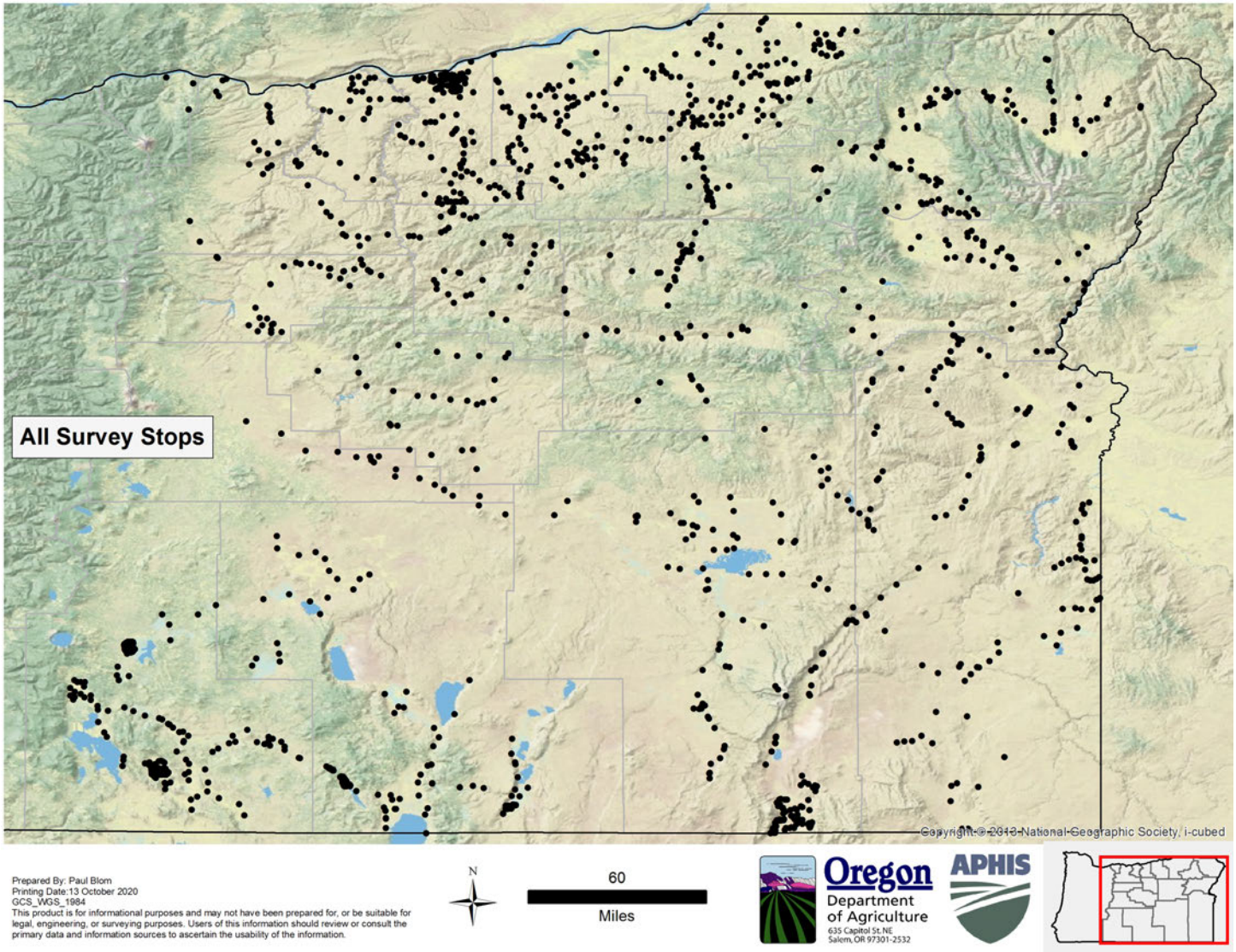

Figure 1. 2020 Grasshopper / Mormon cricket Survey stops distributed across eastern Oregon. (1:2,400k)

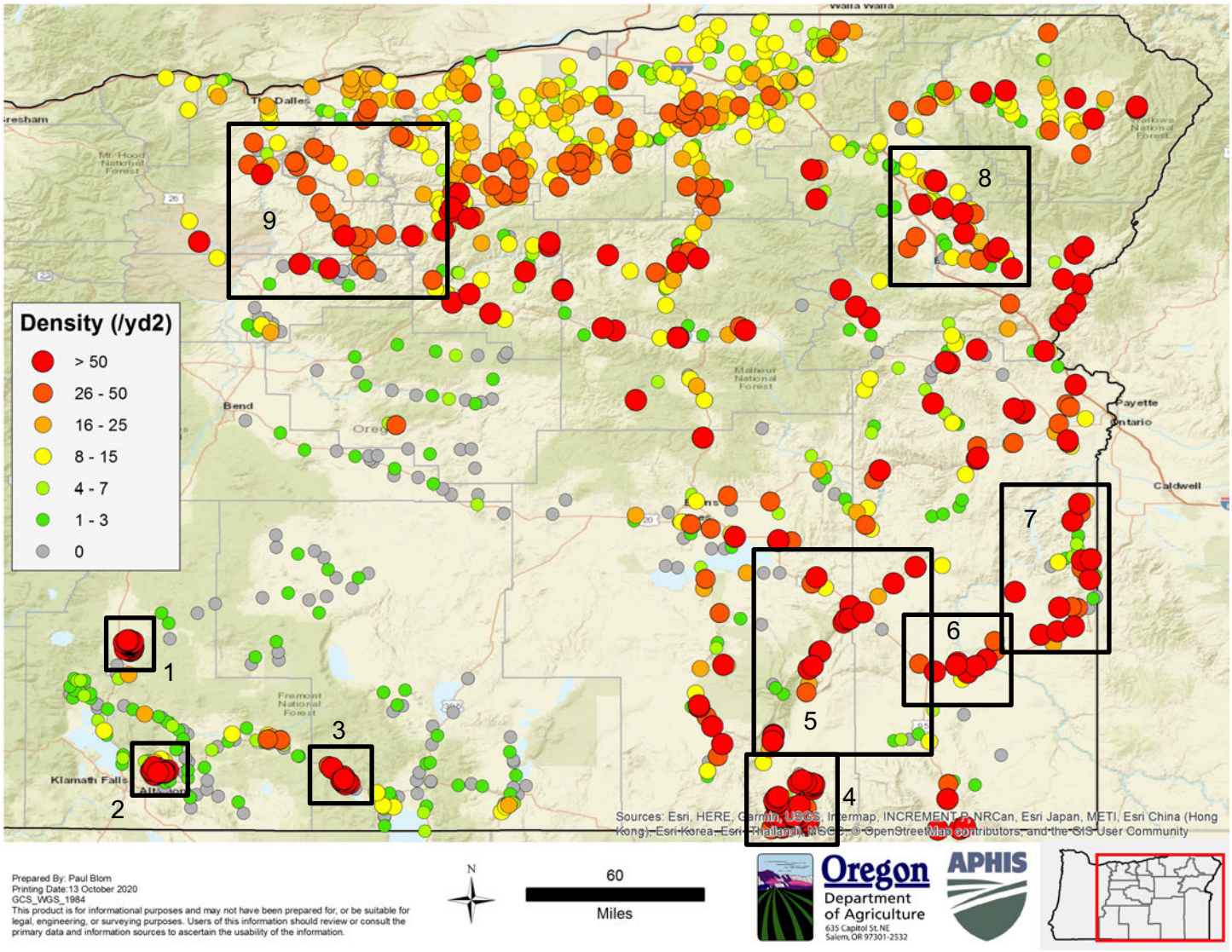

Figure 2. 2020 grasshopper survey densities (/yd^2) classified to seven levels. Black rectangles indicate areas given a closer examination below. (1:2,400k)

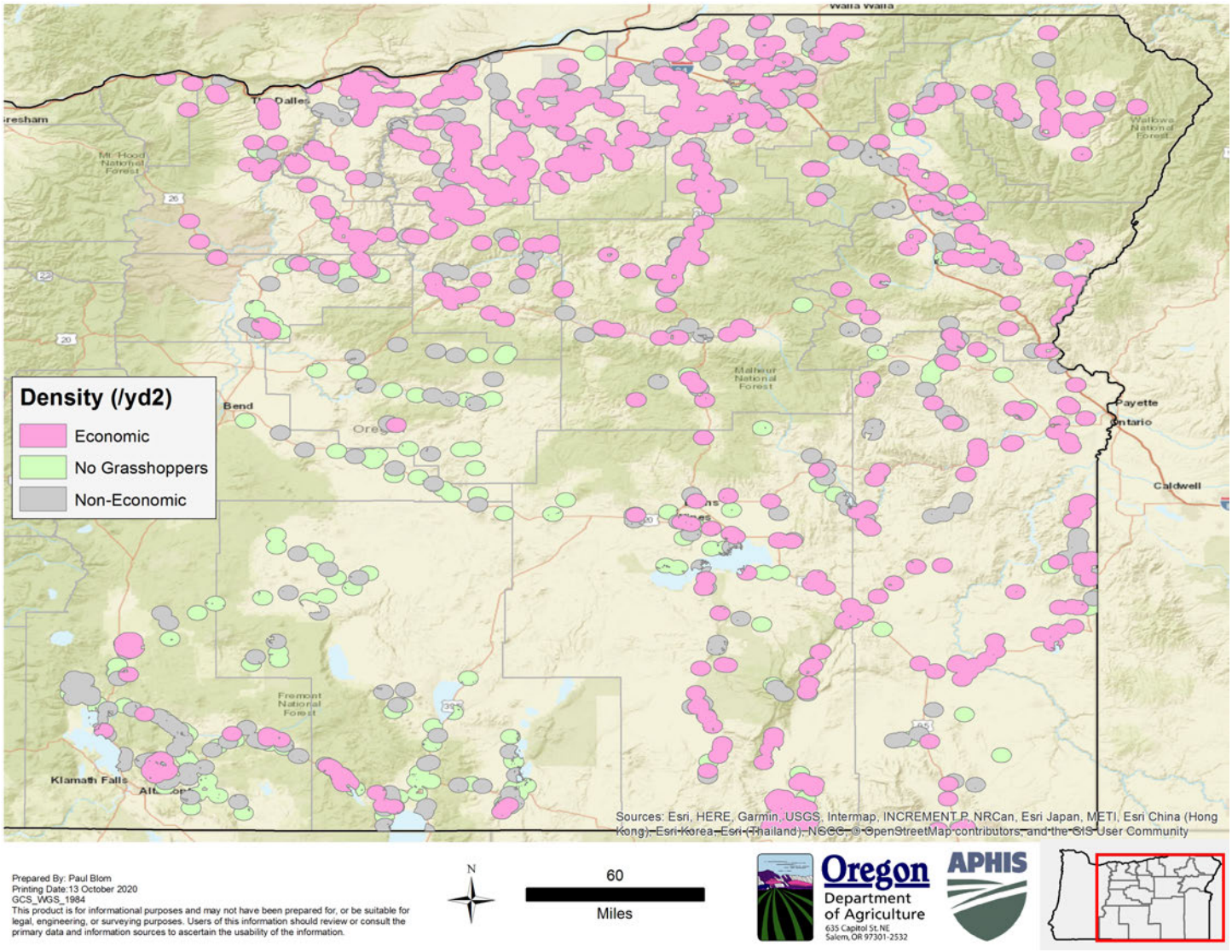

Figure 3. 2020 grasshopper density area estimates (/yd^2) classified by economic category. (1:2,400k)

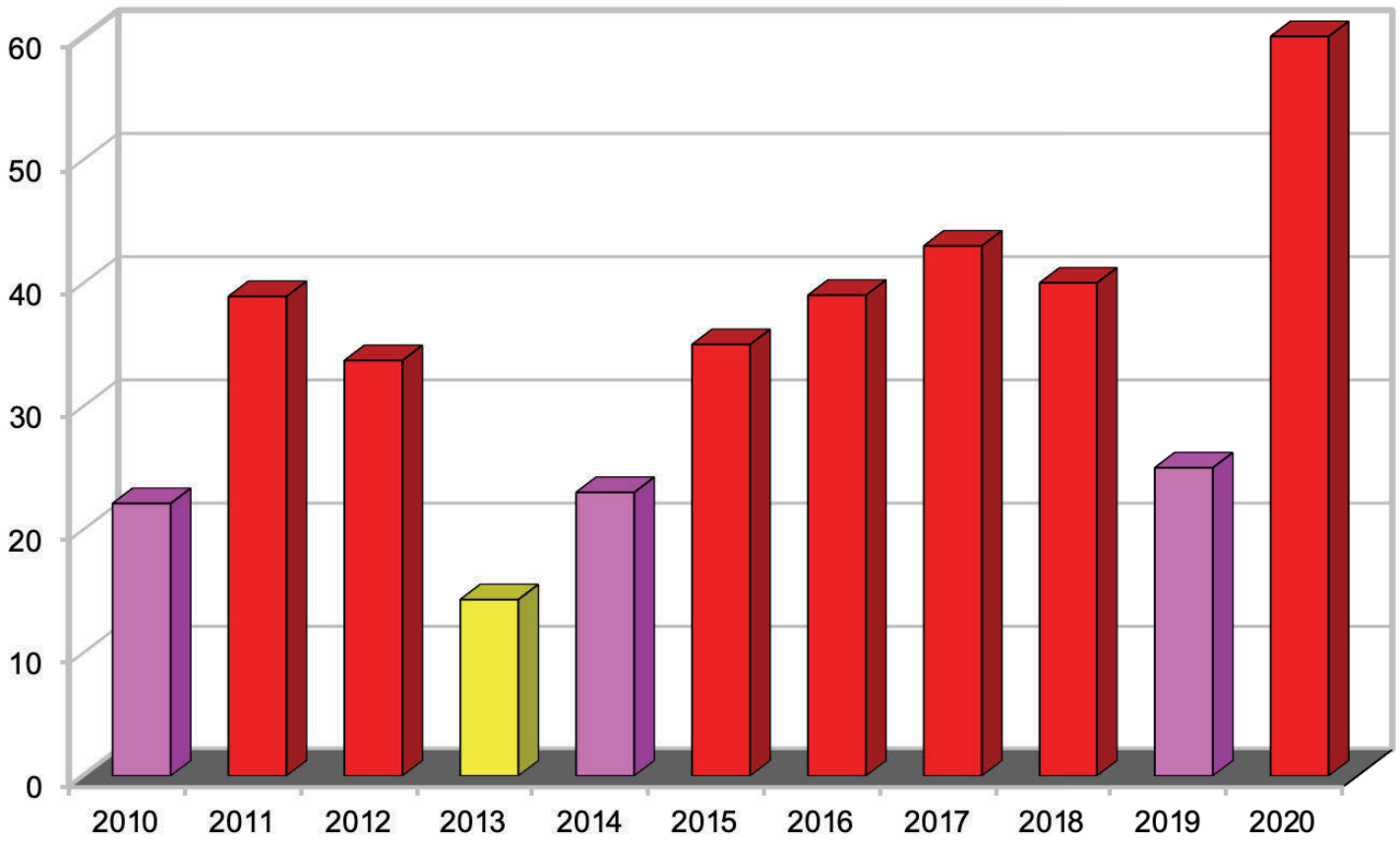

Figure 4. Percentage (within each season) of surveyed area (acres) estimated to have grasshoppers at an economic density.

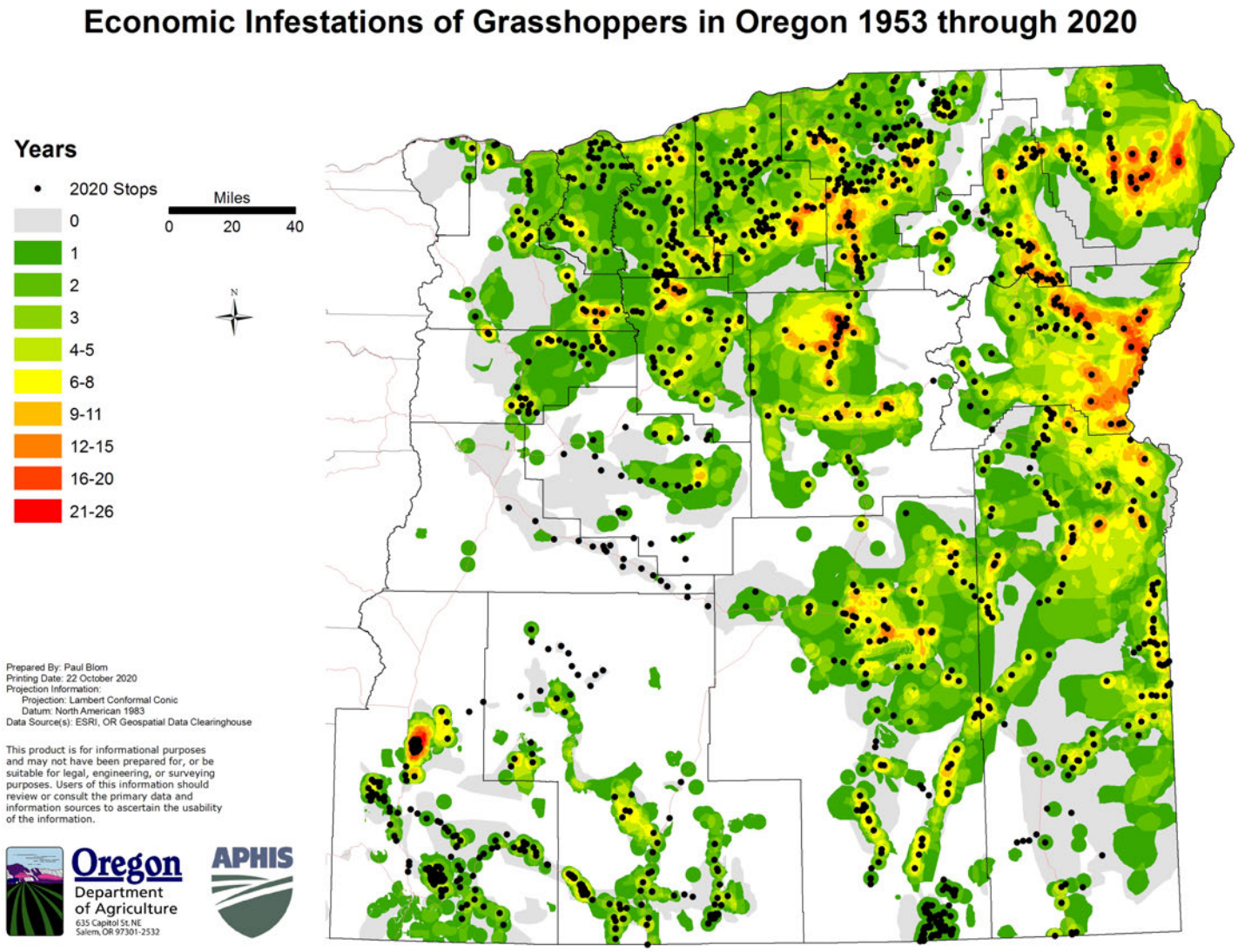

Figure 5. Number of economically infested years for grasshoppers in eastern Oregon 1953 – 2020, overlaid with 2020 survey locations. (1:2300k)

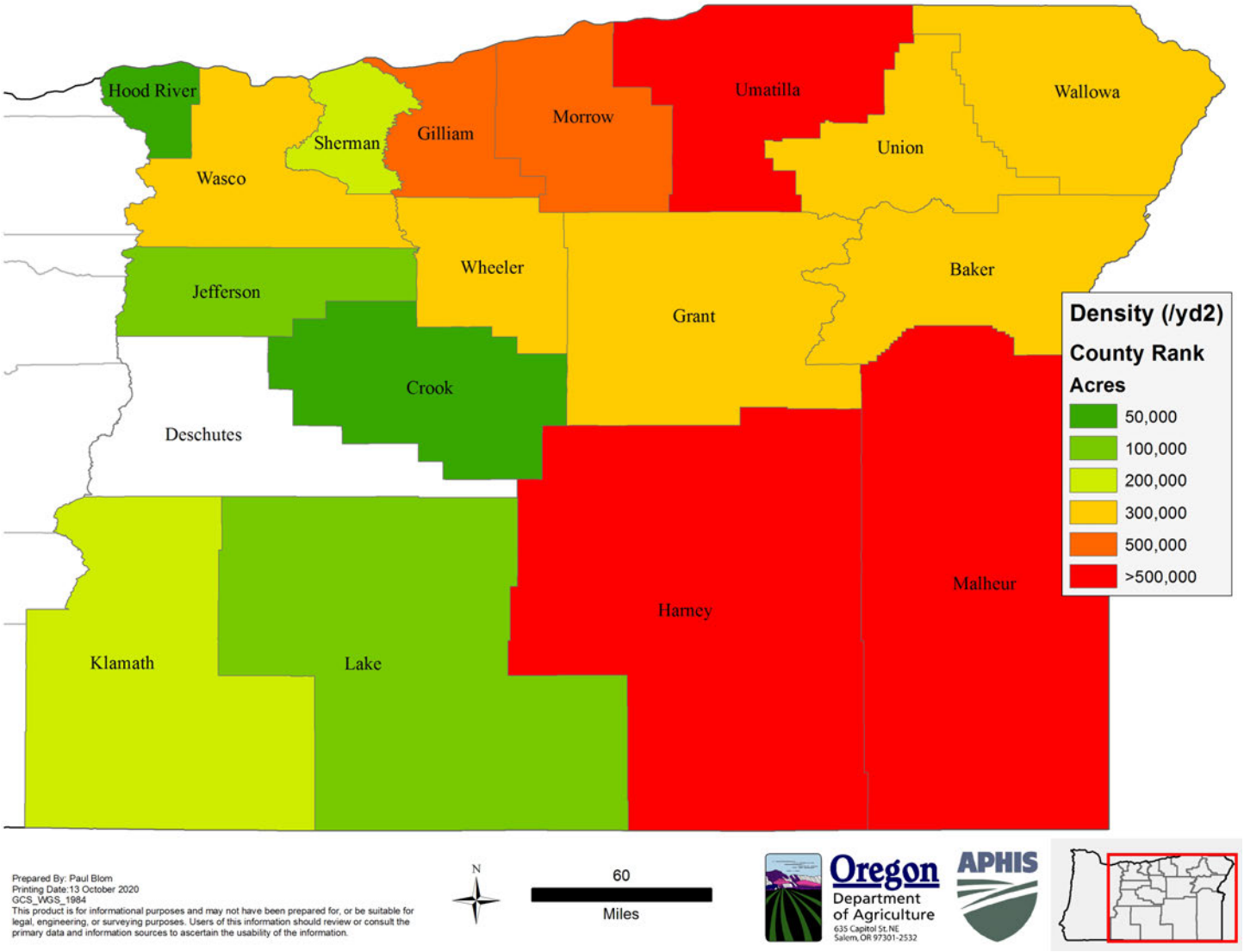

Figure 6. 2020 Grasshopper survey locations superimposed on Oregon counties ranked by economically infested acreage. (1:2400k)

Table 3. Surveyed area (ac) density estimates 2020 summarized by economic classification within a county.

	Economic Classes Summed by County				Economic Classes as % within County		
County	Economic	Non-Economic	No GH	Totals	Economic	Non-Economic	No GH
Baker	281,393	99,131	18,791	399,315	70.5	24.8	4.7
Crook	12,557	131,806	137,956	282,318	4.4	46.7	48.9
Deschutes	0	64,882	96,369	161,250	0.0	40.2	59.8
Gilliam	357,749	60,649	8	418,405	85.5	14.5	0.0
Grant	270,948	73,965	17,624	362,536	74.7	20.4	4.9
Harney	585,657	162,151	180,140	927,948	63.1	17.5	19.4
Hood River	30,433	0	0	30,433	100.0	0.0	0.0
Jackson	0	12,564	0	12,564	0.0	100.0	0.0
Jefferson	82,042	60,883	64,905	207,830	39.5	29.3	31.2
Klamath	153,857	326,448	145,278	625,582	24.6	52.2	23.2
Lake	96,175	264,708	300,796	661,678	14.5	40.0	45.5
Malheur	711,990	227,702	106,722	1,046,414	68.0	21.8	10.2
Morrow	462,461	80,478	13,021	555,960	83.2	14.5	2.3
Sherman	171,288	50,987	109	222,384	77.0	22.9	0.0
Umatilla	653,943	171,384	7,674	833,001	78.5	20.6	0.9
Union	236,101	100,855	15,905	352,861	66.9	28.6	4.5
Wallowa	211,580	59,445	0	271,024	78.1	21.9	0.0
Wasco	239,824	22,515	7,699	270,038	88.8	8.3	2.9
Wheeler	246,267	66,729	5,237	318,234	77.4	21.0	1.6
Totals	4,804,265	2,037,277	1,118,233	7,959,776	60.4	25.6	14.0

Table 4. The number of grasshopper stops by Density Category (/yd^2) and Dominant Life Stage encountered across the entire season.

		Dominant Developmental Stage						
Density	Totals	Egg	1	2	3	4	5	Adult
0	206							
1 – 3	215	0	10	24	16	13	9	143
4 – 7	205	0	20	29	39	12	14	91
8 – 15	264	0	15	36	79	30	7	97
16 – 25	156	0	6	21	59	13	5	52
26 – 50	169	0	7	29	58	10	4	61
> 50	221	0	8	40	62	22	3	86
	1436	0	66	179	313	100	42	530
Percentages:		0	5.4	14.6	25.4	8.1	3.4	43.1

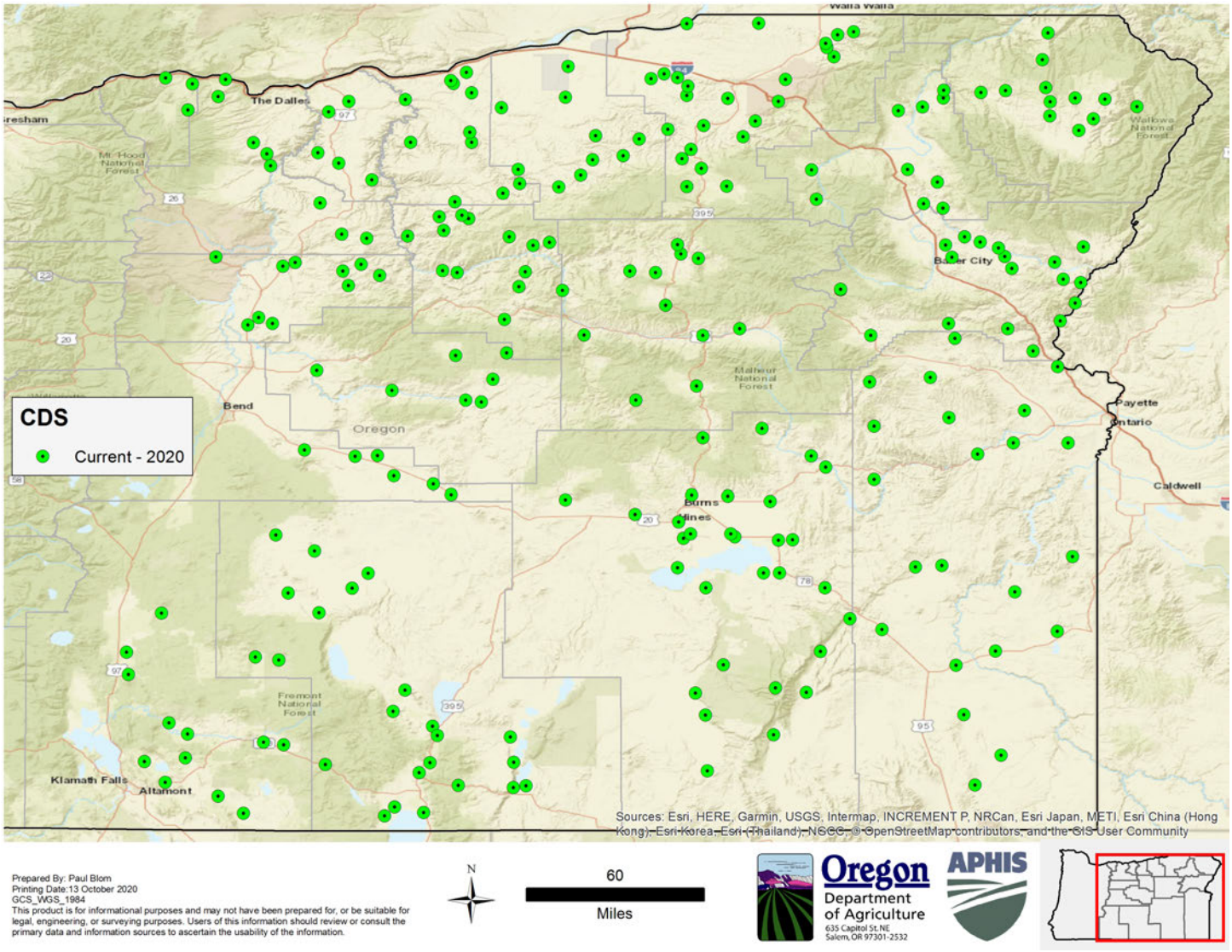

Figure 7. Common Data Sites current locations. (1:2400k)

Table 5. The 237 grasshopper survey stops at the **Common Data Sites** showing Density Category (/yd^2) by Dominant Developmental Stage over the entire Season.

		Dominant Developmental Stage						
Density	Totals	Egg	1	2	3	4	5	Adult
0	48							
1 – 3	40	0	0	0	0	0	1	39
4 – 7	24	0	0	1	1	0	0	22
8 – 15	39	0	0	1	9	0	0	29
16 – 25	23	0	0	1	9	2	0	11
26 – 50	29	0	0	0	7	1	1	20
> 50	34	0	0	0	0	0	0	34
	237	0	0	3	26	3	2	155
Percentages:		0	0	1.6	13.8	1.6	1.1	82.0

A Closer Look

While grasshopper populations have declined for eastern Oregon collectively, some local areas are undergoing very problematic levels (Fig. 2). In the following section we zoom in on 9 areas to give a little closer picture of where the densities were found. Local managers and owners may wish to use these maps to put early season scouting into their 2021 plans.

1-Klamath Marsh National Wildlife Refuge in Klamath County.

Grasshopper densities from pasture along western border of the refuge.

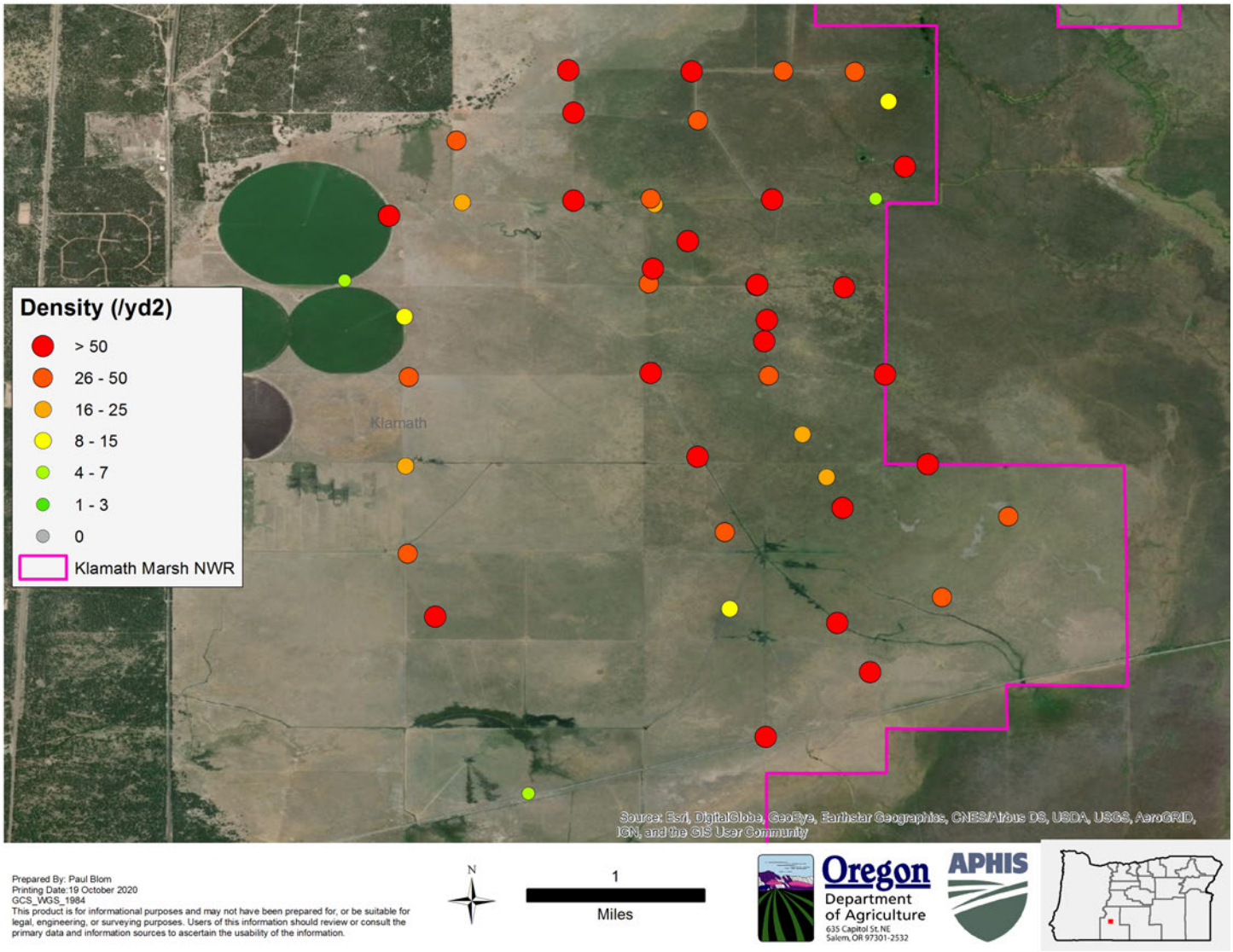

Figure 8. Grasshopper classified densities (GH/yd^2) at survey locations in pasture along western border of the Klamath Marsh National Wildlife Refuge in Klamath County. (1:40k)

2-Swan Lake Valley, Klamath County.

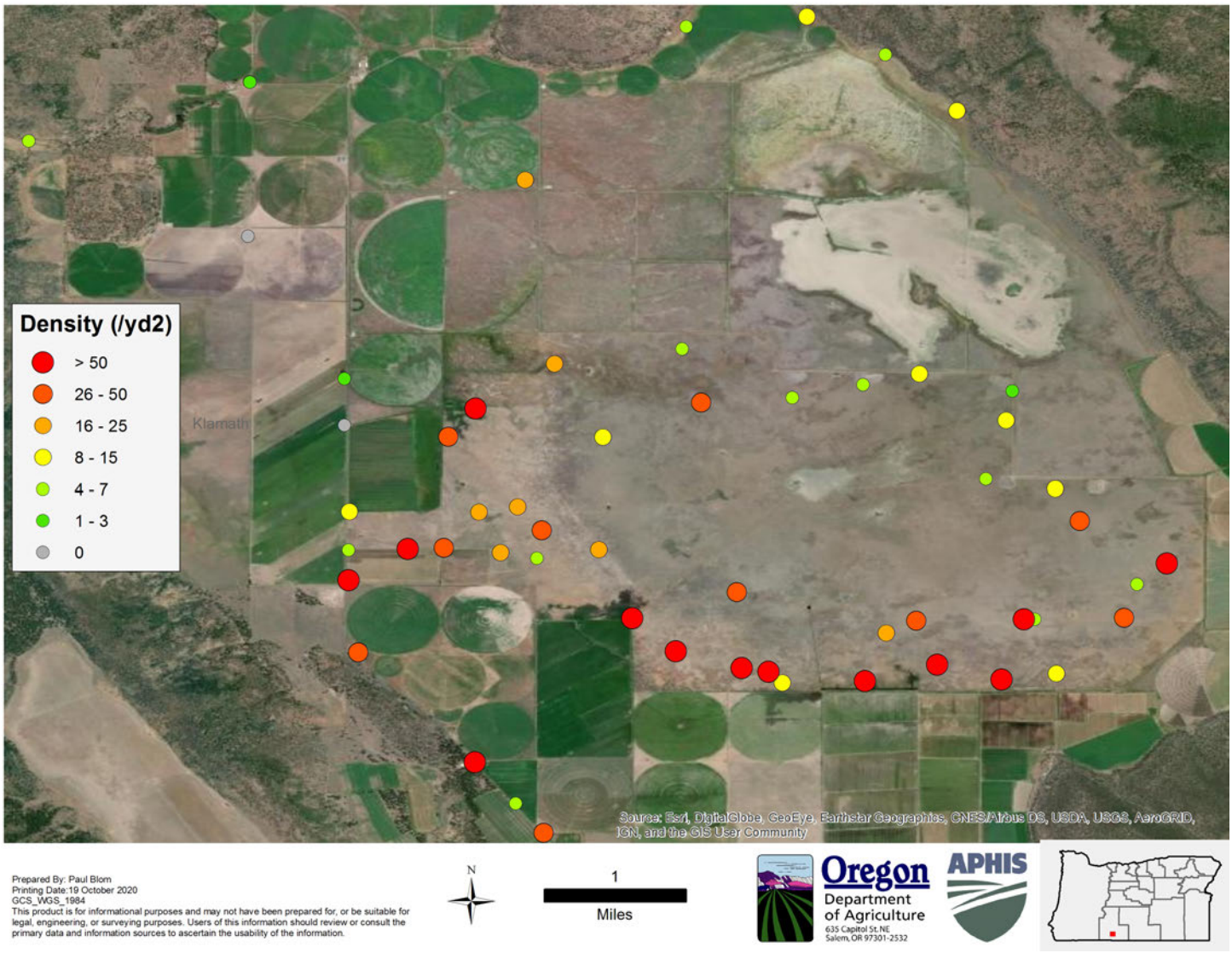

Figure 9. Grasshopper classified densities (GH/yd^2) in the Swan Lake Valley of Klamath County. (1:50k)

3-Drews Valley, Lake County.

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

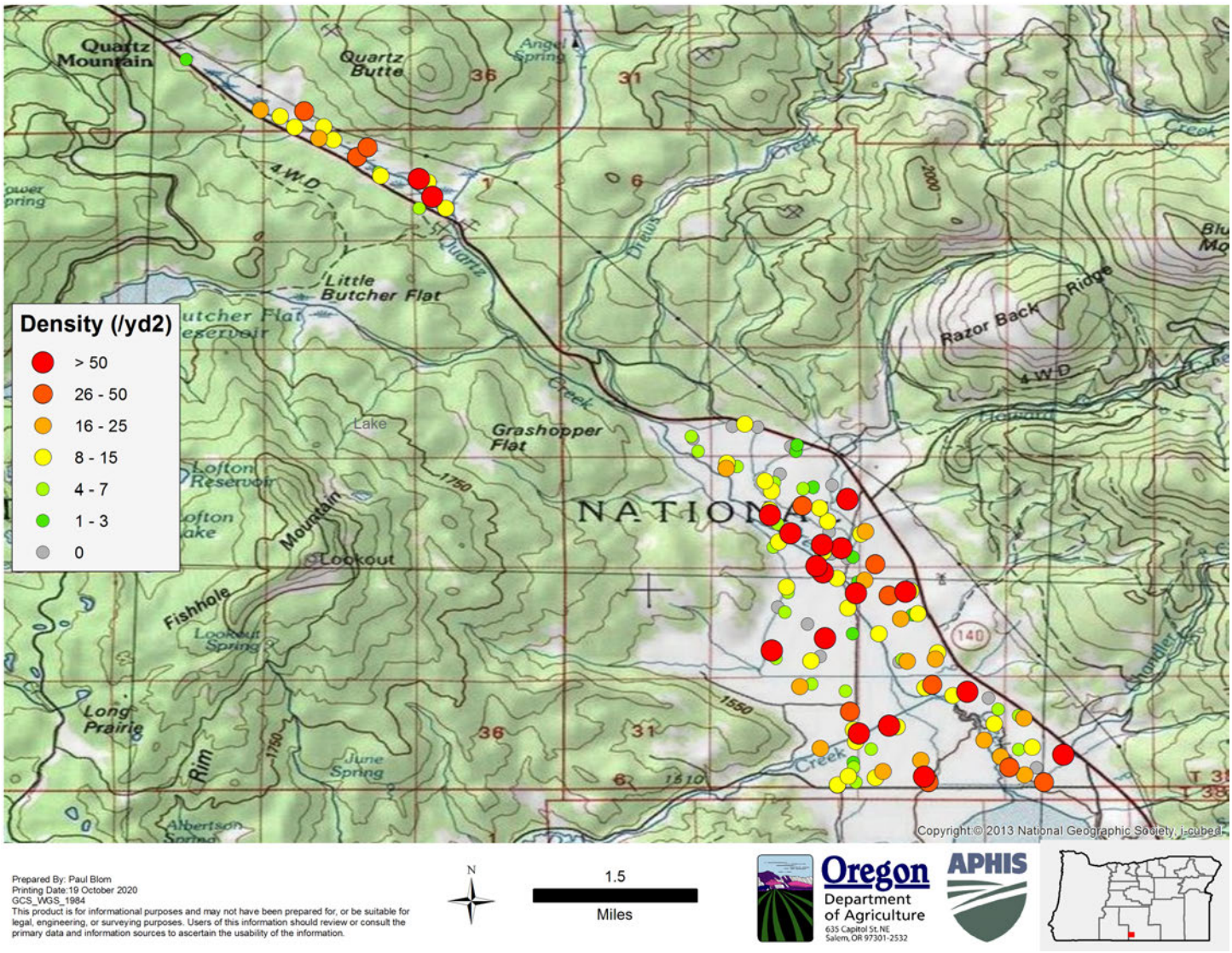

Figure 10. Grasshopper survey classified densities (GH/yd^2) at locations northwest of Lakeview, Drews Valley, Lake County. (1:65k)

4-Fields, Harney County.

Grasshopper densities reach extremely high levels in and around the Pueblo Valley south of Fields, OR. Our Salem ODA taxonomist gave the following summary from samples viewed in late June and early July: "The richest sample [had] 14 species … of which 8 are considered severe pests. … The Valley Grasshopper (*Odaleonotus enigma*) was the most abundant species, occurring in 11/14 samples. Big-headed Grasshoppers (*Aulocara elliotti*) occurred in 10/14 samples."

Table 6. The number of grasshopper stops by Density Category (/yd^2) and Dominant Life Stage encountered across the entire season visualized in Fig. 11.

		Dominant Developmental Stage						
Density	Totals	Egg	1	2	3	4	5	Adult
0	6							
1 – 3	4	0	1	3	0	0	0	0
4 – 7	1	0	0	0	1	0	0	0
8 – 15	10	0	2	4	4	0	0	0
16 – 25	5	0	0	3	1	0	0	1
26 – 50	8	0	0	5	3	0	0	0
> 50	54	0	4	19	17	9	0	5
	88	0	7	34	26	9	0	6
Percentages:		0	8.5	41.5	31.7	11	0	7.3

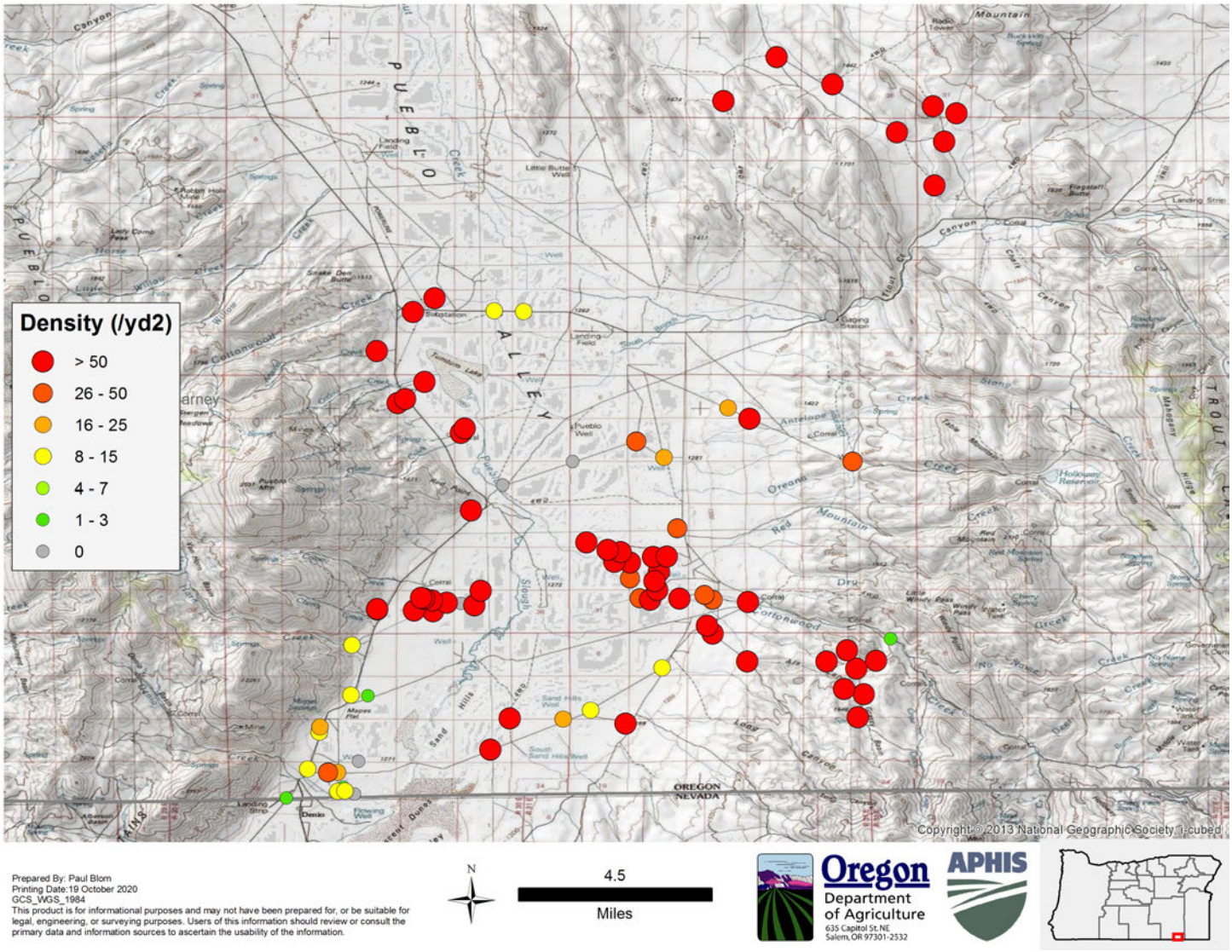

Figure 11. Grasshopper classified densities (GH/yd^2) in the region south-southeast of Fields, down to the Nevada border. (1:165k)

5-East of Steens Mountain, Harney and Malheur Counties.

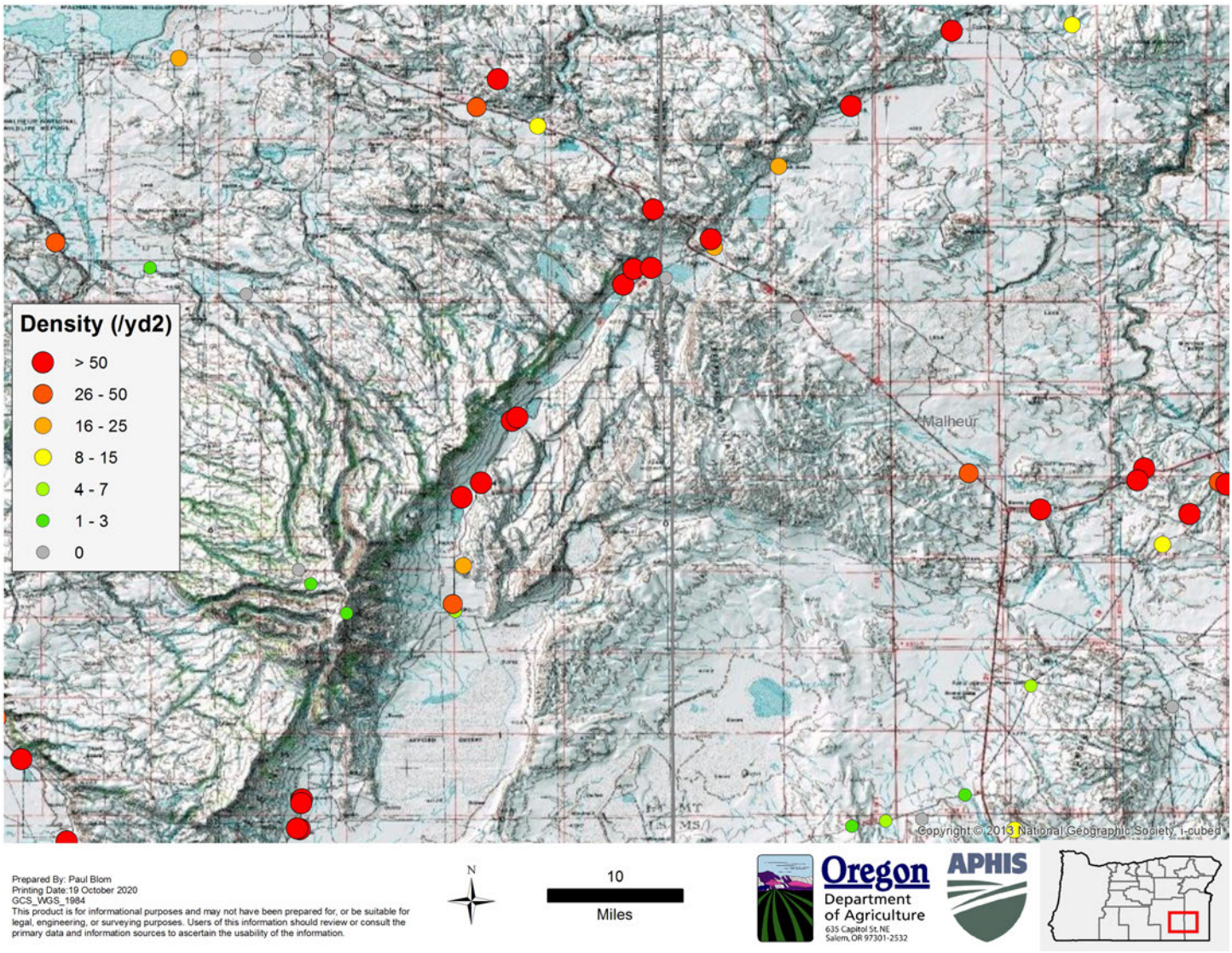

Figure 12. Grasshopper classified densities (GH/yd^2) east of Steens Mountain and to the northeast. (1:525k)

6-Burns Junction – Rome, Malheur County.

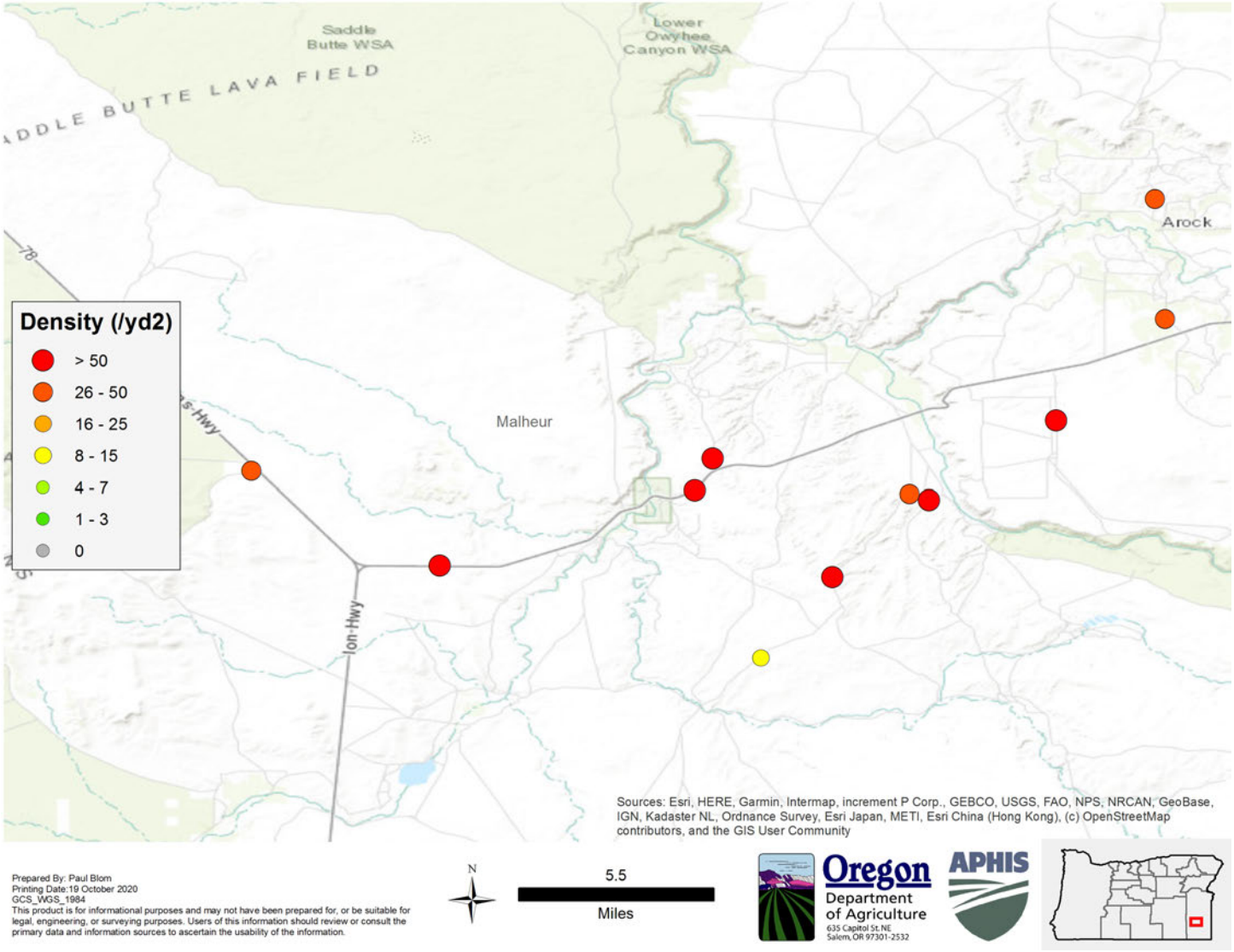

Figure 13. Grasshopper classified densities (GH/yd^2) and area estimations from the region around Rome, west to Burns Junction. (1:200k)

7-Jordan Valley Region and North, Malheur County.

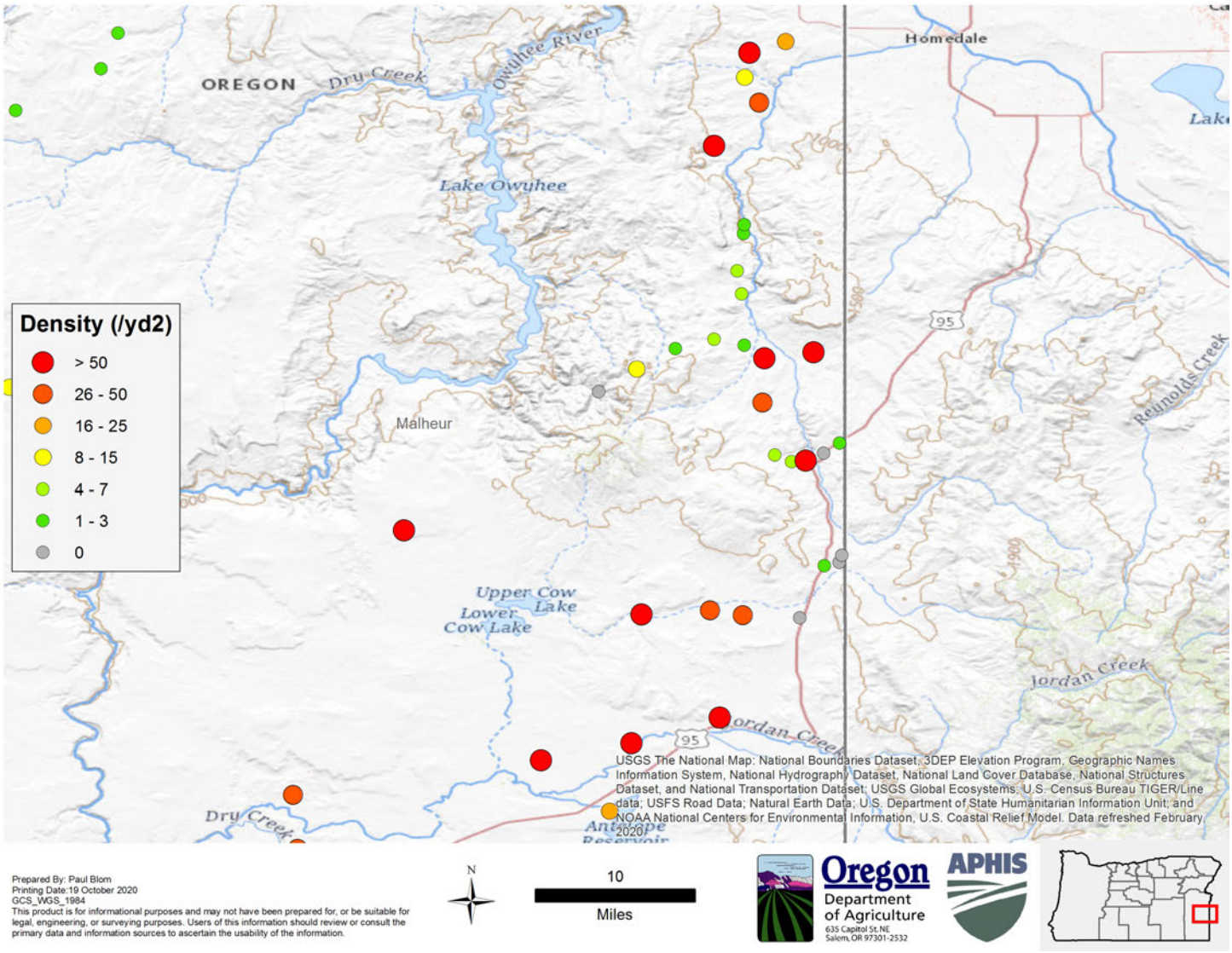

Figure 14. Grasshopper classified densities (GH/yd^2) and area estimations in the Jordan Valley region and north, Malheur County. (1:445k)

8-Northern Baker – SE Union Counties.

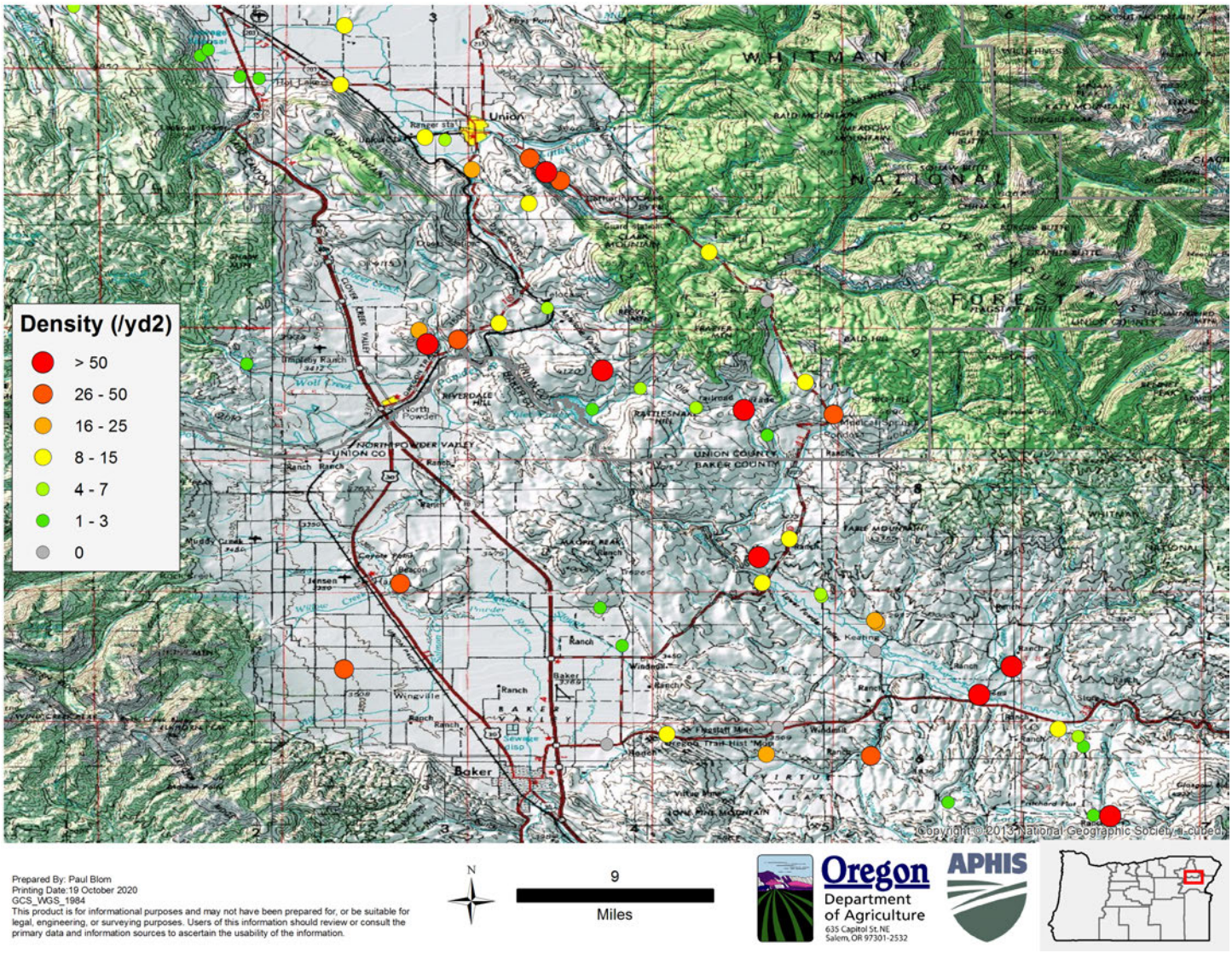

Figure 15. Grasshopper classified densities (GH/yd^2) and area estimations in the region of northern Baker County and southeast Union County. (1:325k)

9-Northwestern Eastern Oregon.

Not to be left out the northern tier of eastern Oregon had more than its share of very high grasshopper densities during 2020. The northwestern area of this region is depicted below.

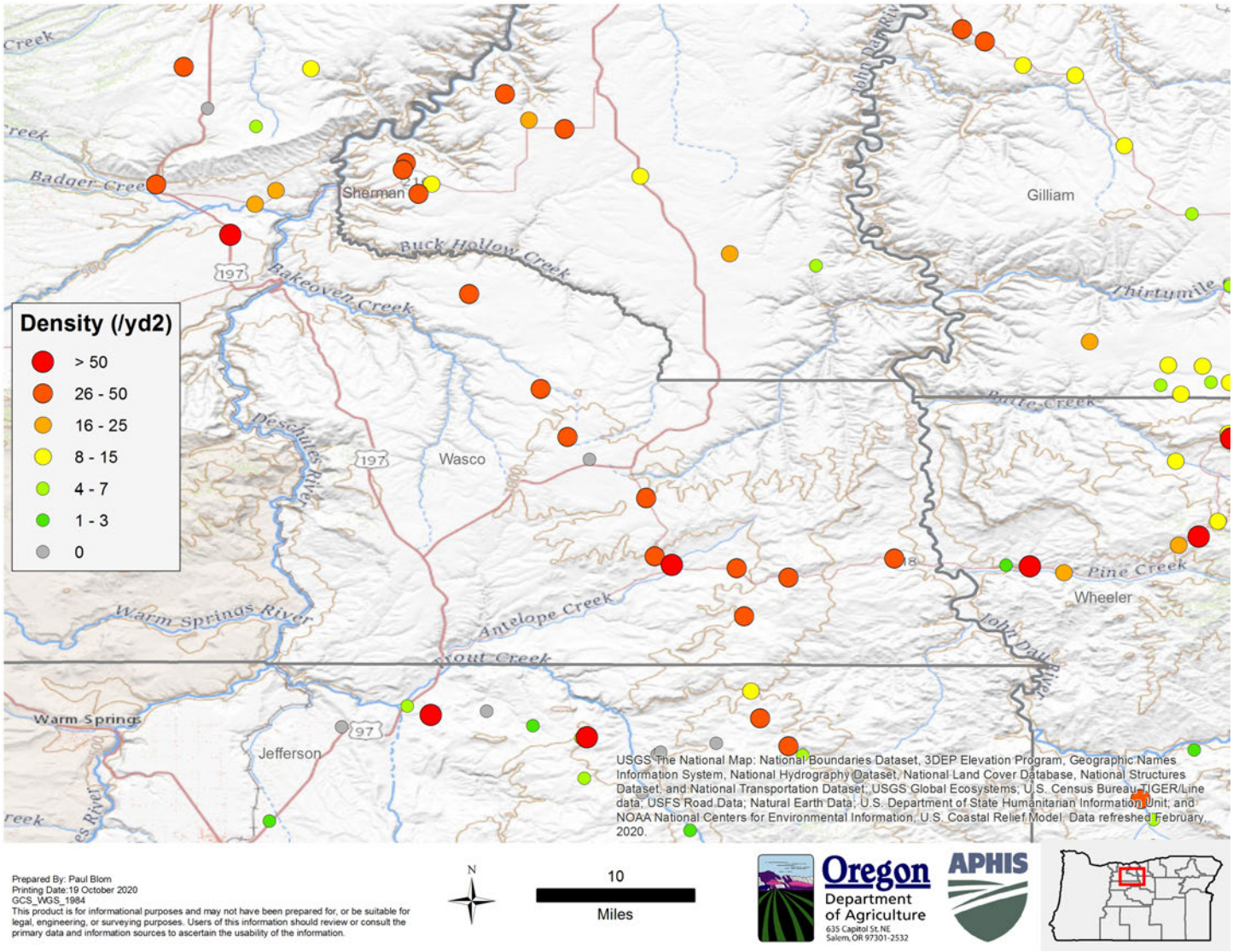

Figure 16. Grasshopper classified densities (GH/yd^2) and area estimations at locations in Gilliam, Jefferson, Sherman, Wasco, and Wheeler Counties. (1:450k)

Tribal Lands

The grasshopper survey intersected tribal holdings at several locations across eastern Oregon (~135,864 ac; 54,982 ha), including the Umatilla and Warm Springs Reservations (Fig. 17). Area estimates on the Umatilla and Warm Springs Reservations contained both Economic and Non-economic densities (Table 7).

The largest area including survey density estimates occurred on the Confederated Tribes of the Umatilla Indian Reservation (Fig. 18), followed by acreage on the Confederated Tribes of the Warm Springs Reservation (Fig. 19).

Table 7. 2020 grasshopper survey area estimates intersecting with eastern Oregon tribal lands.

	Economic		Non-Economic		No Grasshoppers	
	Acres	Hectares	Acres	Hectares	Acres	Hectares
Burns Reservation	0	0	0	0	0	0
Ft McDermitt Reservation	0	0	0	0	0	0
Umatilla Reservation	129,409	52,370	36,594	14,809	5,582	2,259
Warm Springs Reservation	37,674	15,246	0	0	1,554	629
Other*	6,372	2,578	323	131	2,482	1,004
TOTALS	173,455	70,194	36,917	14,940	9,618	3,892
Grand Total	219,990	89,026				

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

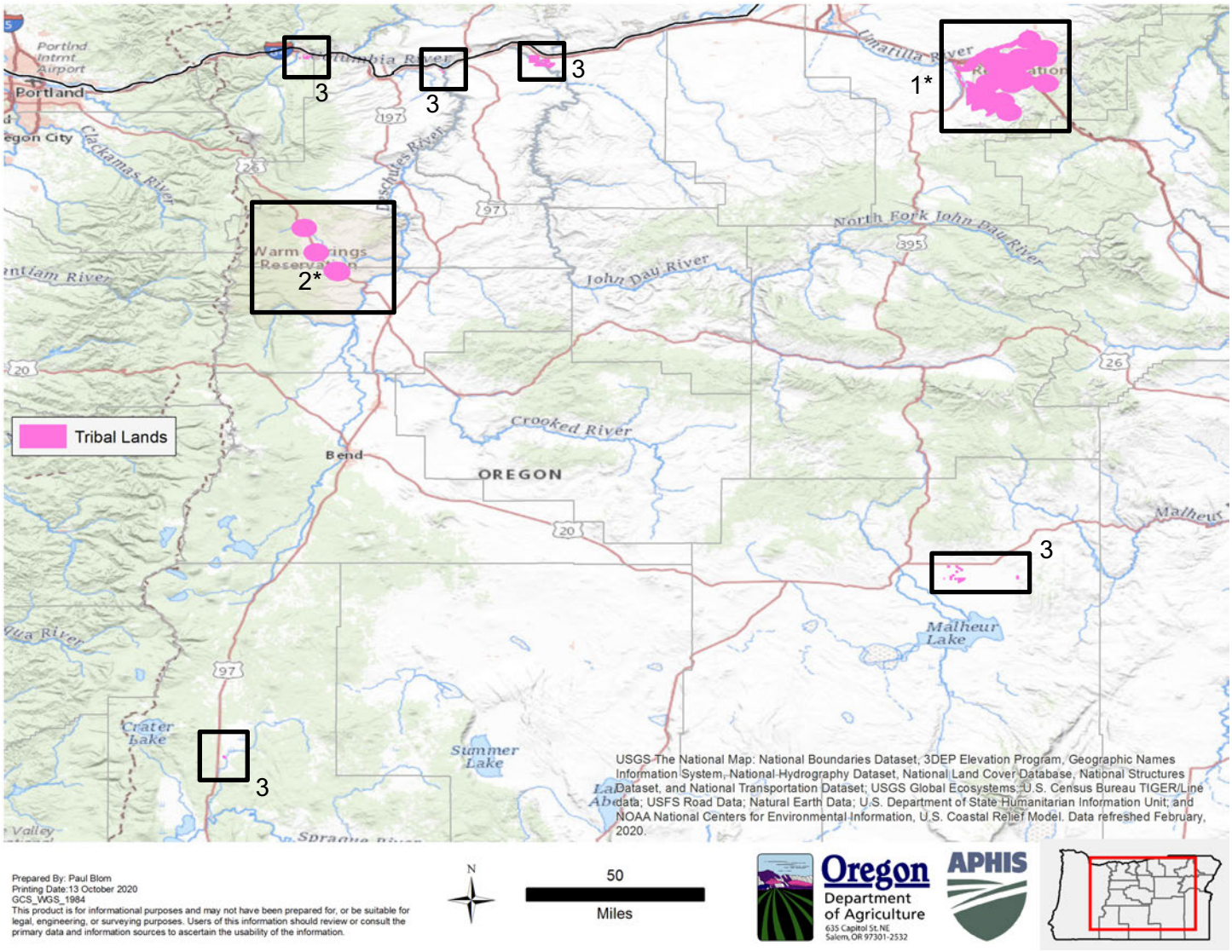

Figure 17. 2020 grasshopper survey areas intersecting tribal lands. Superimposed rectangles indicate the six geographic areas where this occurred. Black rectangles with an asterisk indicate areas given a closer examination below. 1=CTUIR, 171,585 ac; 2=Warm Springs, 39,228 ac; 3=Other, 9,177 ac. (1:2000k)

A Closer Look

1-CTUIR Area, Umatilla County.

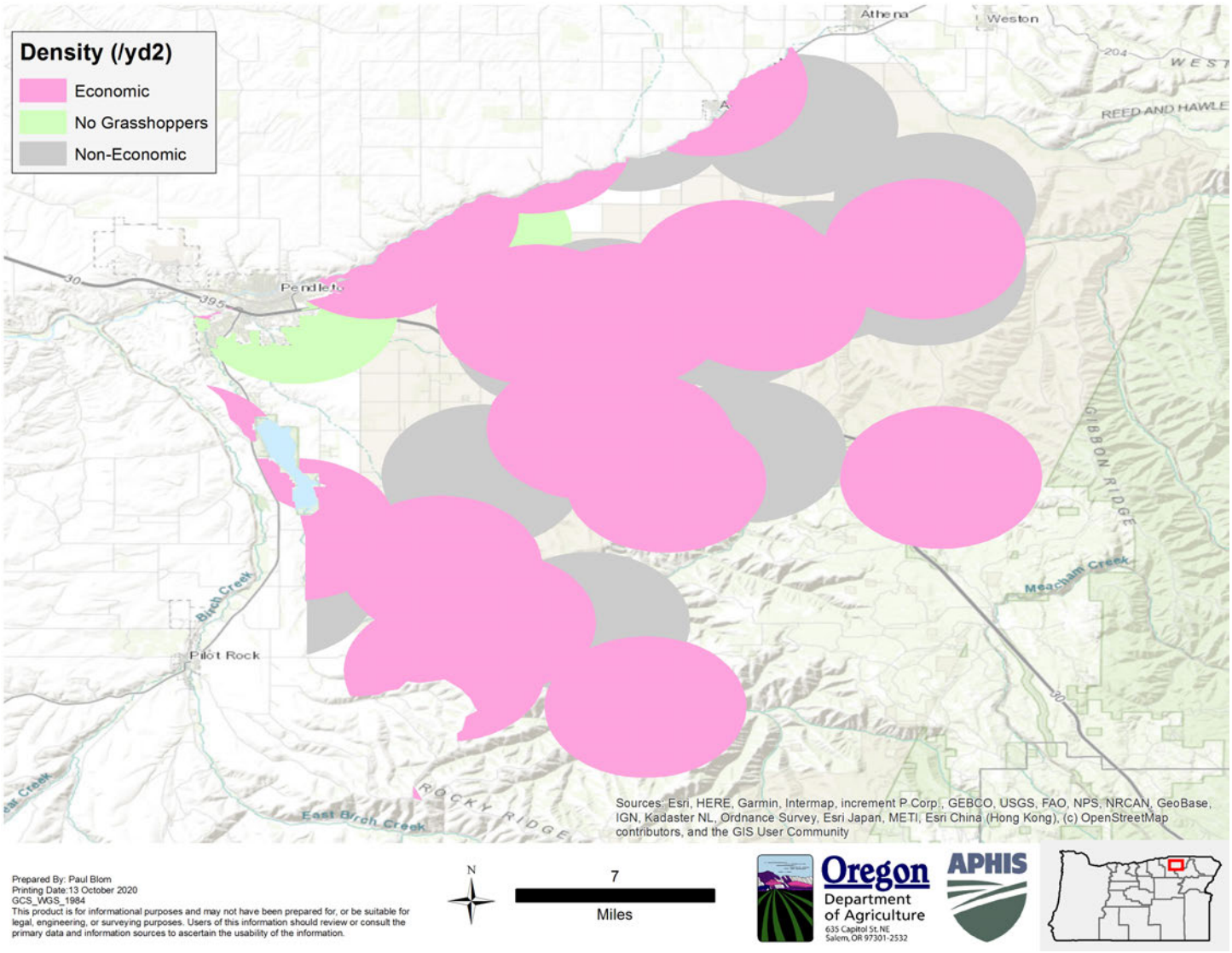

Figure 18. Grasshopper survey areas of economic density intersecting tribal land on the Confederated Tribes of the Umatilla Indian Reservation. Economic density: ≥8 grasshoppers per square yard. (1:250k)

2-Warm Springs Area, Jefferson and Wasco Counties.

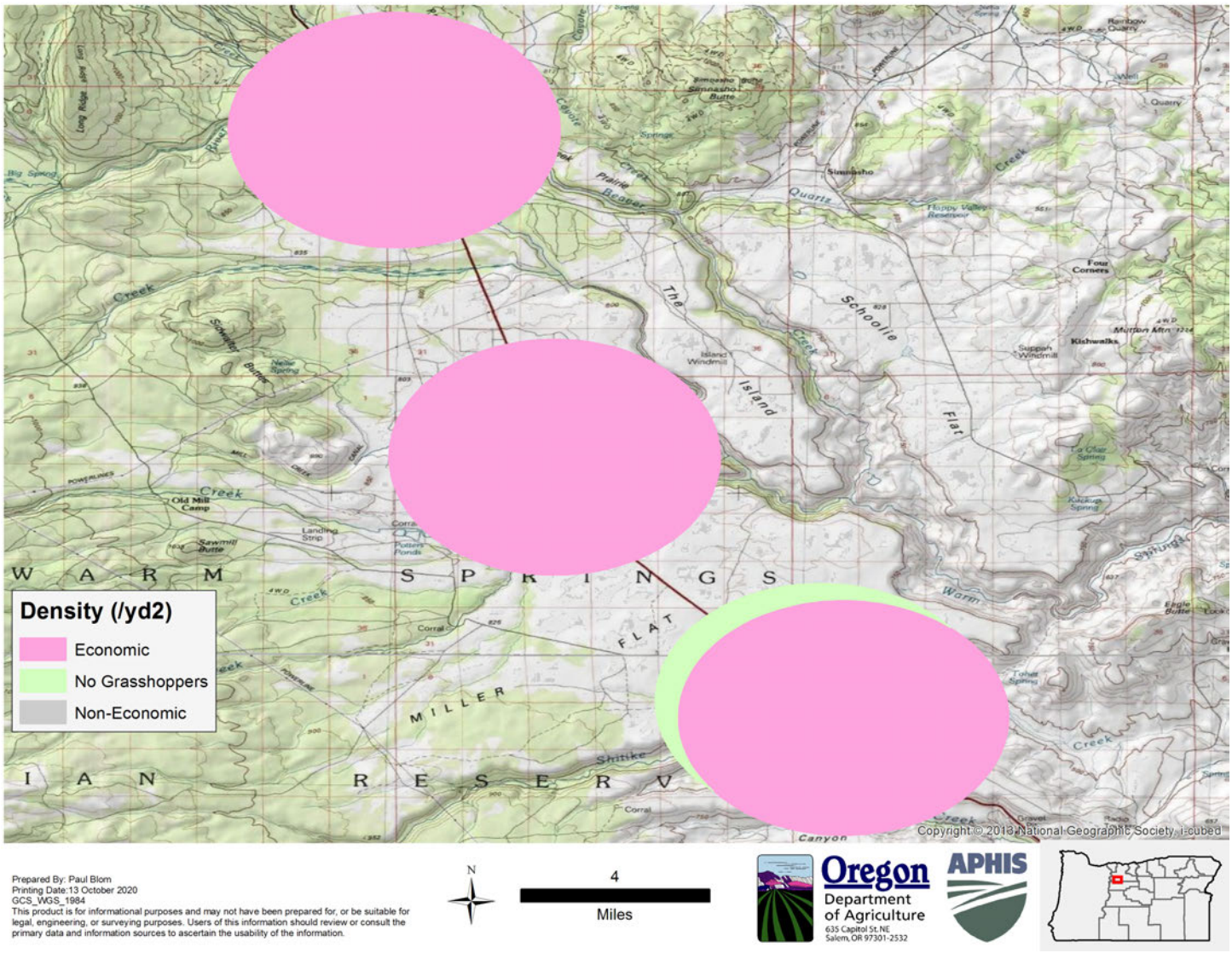

Figure 19. Grasshopper survey areas of economic density intersecting tribal land on the Confederated Tribes of the Warm Springs Indian Reservation. Economic density: ≥8 grasshoppers per square yard. (1:150k)

Mormon Crickets

In 2020, though greatly reduced, the outbreak population of 2018 which overran Jordan Valley (central Malheur County) and surrounding areas is still evident. Though our survey only encountered significant numbers to the north of Jordan Valley in the Succor Creek area, others reported sightings and issues around that 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 though there was some in-town emergence from the 2017 incursion.

While complexities of 2020 prevented us from providing our normal support for Robert Srygley (USDA, ARS, Sidney, MT), he continued his research on Mormon cricket egg development and delayed hatch ('hedge betting') in the Arlington and Blalock Canyon area. 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 8. The number of Mormon cricket stops by Density Category (/yd^2) and Dominant Life Stage encountered across the entire season.

		Dominant Developmental Stage								
Density	Totals	Egg	1	2	3	4	5	6	7	Adult
0	1479									
1 – 2	29	0	2	9	5	8	2	2	0	1
3	15	0	2	7	0	1	5	0	0	0
4 – 6	20	0	1	6	4	3	4	2	0	0
7 – 10	26	0	2	2	6	9	5	2	0	0
11 – 25	17	0	1	3	4	4	4	1	0	0
> 25	11	0	0	0	1	2	8	0	0	0
	1597	0	8	27	20	27	28	7	0	1
Percentages:		0	6.8	22.9	16.9	22.9	23.7	5.9	0	0.8

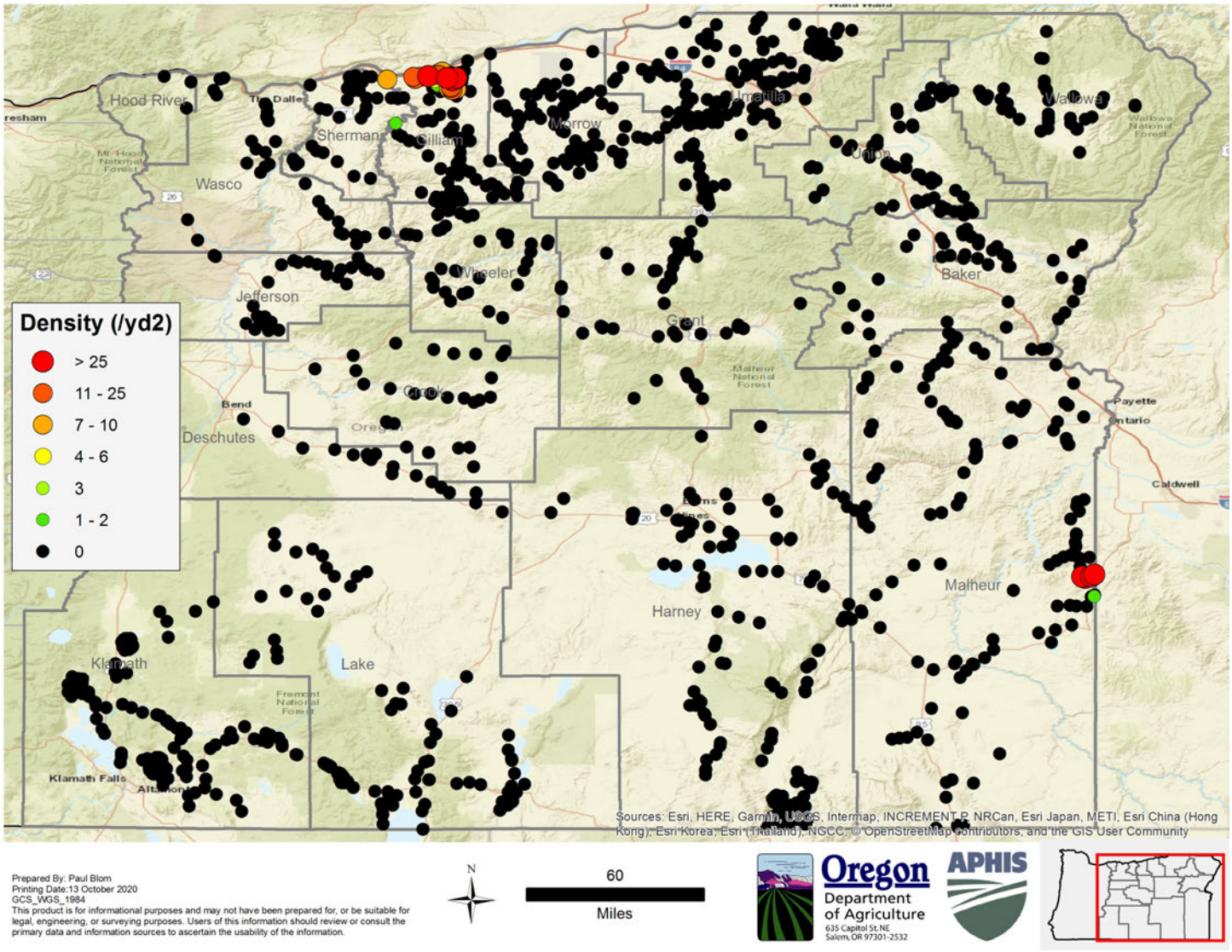

Figure 20. Locations surveyed for Mormon crickets (*Anabrus* sp.) in eastern Oregon classified by density (/yd^2). (1:2400k)

A Closer Look

1-Arlington Area, Gilliam County.

Table 9. The number of Mormon cricket stops by Density Category (/yd^2) and Dominant Life Stage from the area depicted in the following figure across the entire season.

Density	Totals	Dominant Developmental Stage								
		Egg	1	2	3	4	5	6	7	Adult
0	63									
1 – 2	28	0	2	9	5	8	1	2	0	1
3	15	0	2	7	0	1	5	0	0	0
4 – 6	20	0	1	6	4	3	4	2	0	0
7 – 10	26	0	2	2	6	9	5	2	0	0
11 – 25	17	0	1	3	4	4	4	1	0	0
> 25	7	0	0	0	1	1	5	0	0	0
	176	0	8	27	20	26	24	7	0	1
Percentages:		0	7.1	23.9	17.7	23	21.2	6.2	0	0.9

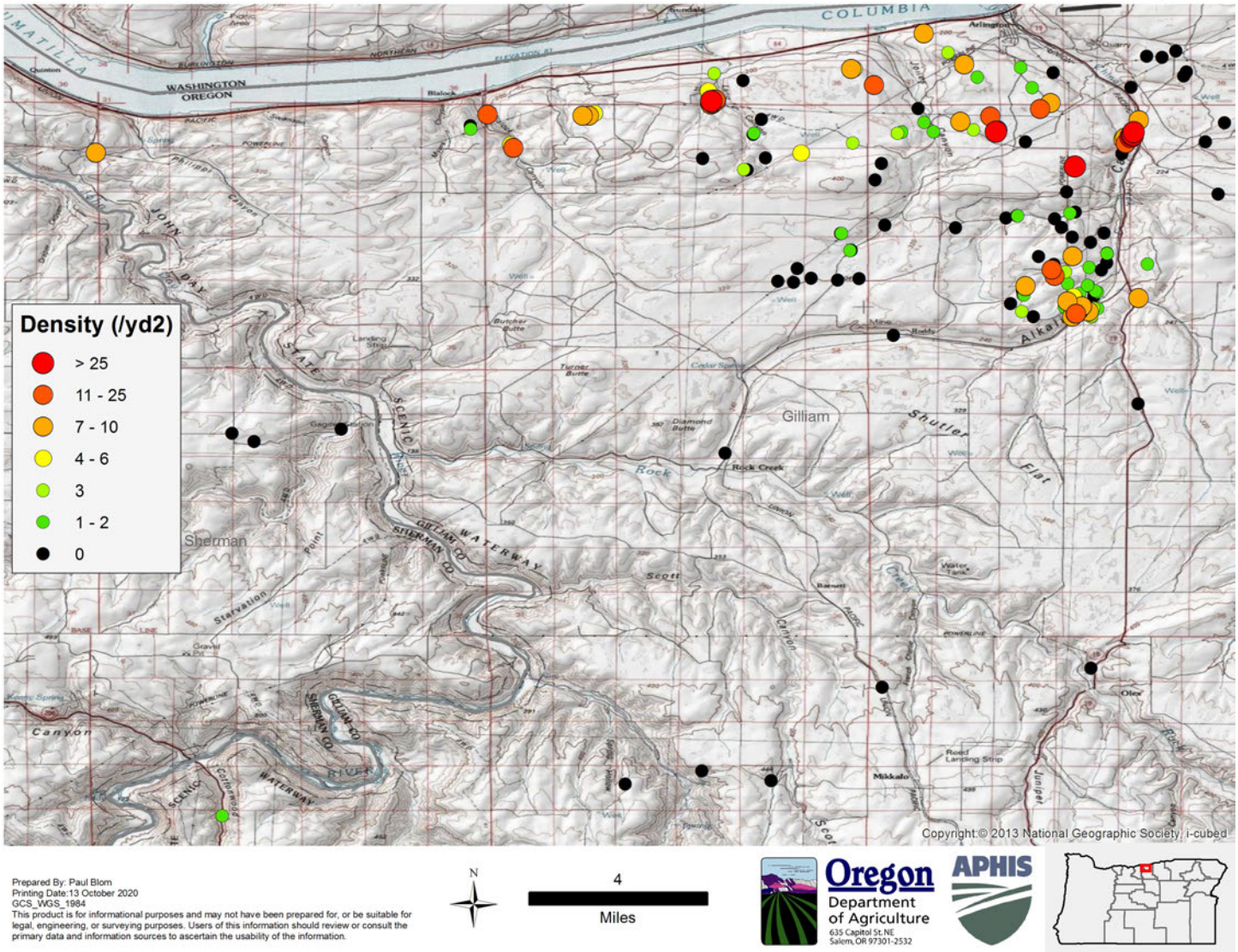

Figure 21. 2020 Mormon cricket survey results in the Arlington - Blalock Canyon area. (1:160k)

2-Jordon Valley Area, Malheur County.

Table 10. The number of Mormon cricket stops by Density Category (/yd^2) and Dominant Life Stage from the area depicted in the following figure across the entire season.

		Dominant Developmental Stage								
Density	Totals	Egg	1	2	3	4	5	6	7	Adult
0	10									
1 – 2	1	0	0	0	0	0	1	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4 – 6	0	0	0	0	0	0	0	0	0	0
7 – 10	0	0	0	0	0	0	0	0	0	0
11 – 25	0	0	0	0	0	0	0	0	0	0
> 25	4	0	0	0	0	1	3	0	0	0
	15	0	0	0	0	1	4	0	0	0
Percentages:		0	0	0	0	20	80	0	0	0

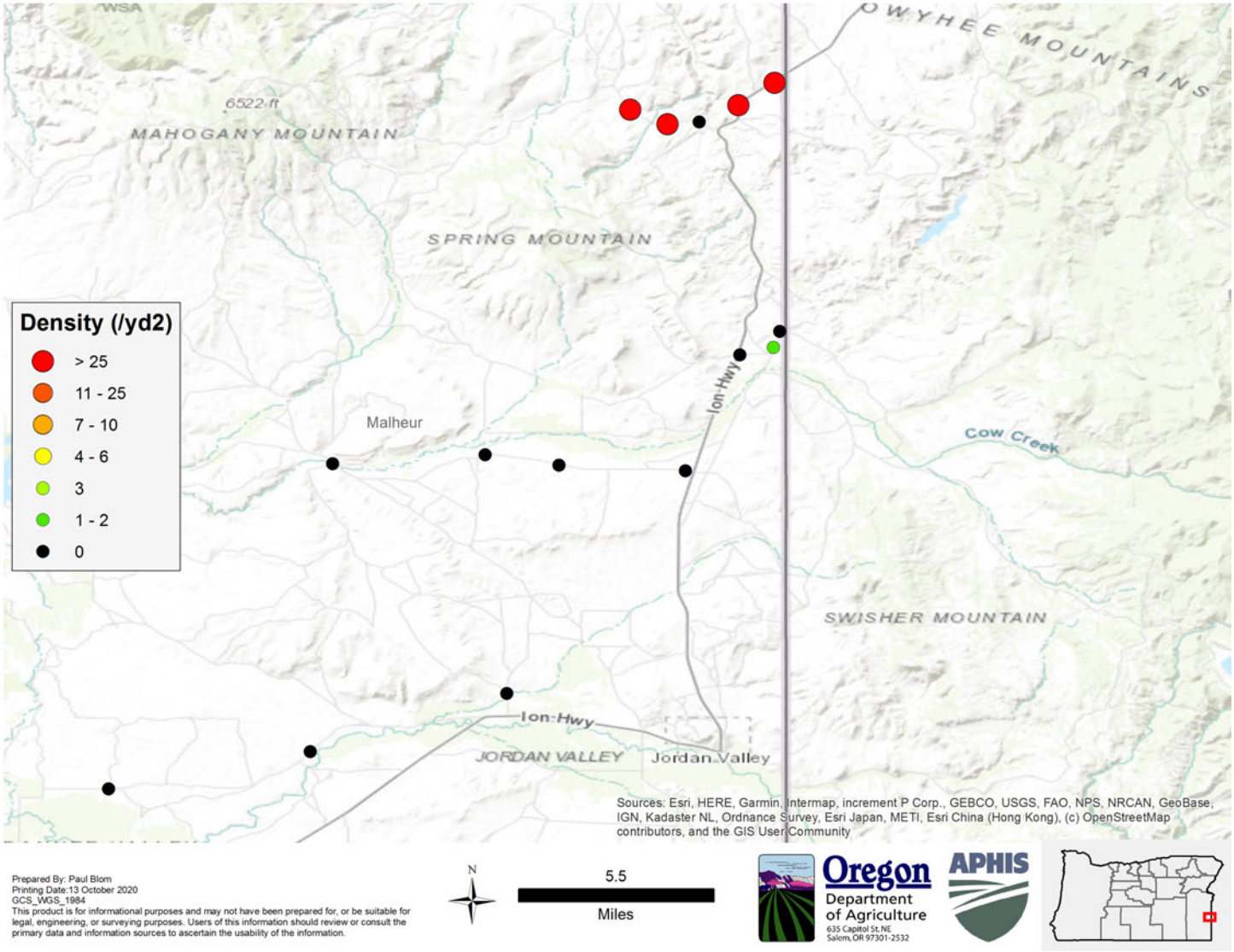

Figure 22. 2020 Mormon cricket survey results in the Jordon Valley area. (1:200k)

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 be have economically significant populations.

During 2020 a total of **1,601** sampling locations were visited, **501** during the nymphal grasshopper survey period and **935** 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 810 locations (60% of all sampled sites) that were estimated to have densities of ≥8 grasshoppers / yd^2. Land managers located within or near regions of high density should focus on early detection (hatch) in 2021. If early 2021 populations appear to be of significant density it is both fiscally and environmentally advantageous to intervene early in the grasshopper 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 NW Wallowa County. In the last few years significant populations have plagued the Arlington and Jordon Valley area. Both may be on the decline now though only time will tell. Certainly, Arlington and vicinity continues to have had less pressure this past season, a trend likely encouraged by the coordinated management efforts of local city, county and private interests.

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.

Paul Blom, Oregon Department of Agriculture, Hermiston, OR, 503-508-1253, pblom@oda.state.or.us
Colin Park, USDA-APHIS-PPQ, Portland, OR, 503-730-7622, Colin.G.Park@usda.gov
October 2020

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: http://www.aphis.usda.gov/publications/plant_health/2016/fs-grasshoppers-mormon-crickets.pdf
Or visit our full program website:
www.aphis.usda.gov/aphis/ourfocus/planthealth/plant-pest-and-disease-programs/pests-and-diseases/grasshopper-mormon-cricket/ct_grasshopper_mormon_cricket

ARS resource page for grasshopper and Mormon Cricket:
http://www.sidney.ars.usda.gov/grasshopper/
https://www.oregon.gov/ODA/programs/IPPM/SurveyTreatment/Pages/GrasshoppersCrickets.aspx

Appendix 1. Estimate of the acreage with economic levels of grasshopper infestation (≥8 grasshoppers / yd2) based on the 2020 survey.

		Economic Classes Summed by Watershed			Economic Classes Summed by Count		
County	Watershed	Economic	Non-Economic	No Grasshoppers	Economic	Non-Economic	No Grasshoppers
Baker	Alder Creek-Pritchard Creek	5,434	565	0	281,393	99,131	18,791
	Baldock Slough-Powder River	11,252	14,525	5,442			
	Big Creek	4,696	2,290	0			
	Big Creek-Burnt River	12,182	132	0			
	Birch Creek-Snake River	4,502	2,611	0			
	Burnt River	29,629	5,791	0			
	Burnt River Canyon-Burnt River	1,362	13	0			
	Camp Creek	0	10,787	7,193			
	Clarks Creek-Burnt River	2,012	11,339	0			
	Eagle Creek	606	2,582	0			
	Love Creek-Powder River	15,668	11,565	0			
	Lower Powder River	18,535	920	0			
	Middle Willow Creek	0	0	681			
	North Fork Burnt River	24,549	884	0			
	North Powder River	26	4,280	0			
	Pine Creek	13,792	0	0			
	Rock Creek-Powder River	21,872	459	0			
	Rock Creek-Snake River	23,004	141	0			
	Ruckles Creek-Powder River	76,996	13,401	5,475			
	South Fork Burnt River	1,156	13,178	0			
	Upper Powder River	11,152	0	0			
	Upper Willow Creek	565	71	0			
	Wolf Creek-Powder River	2,401	3,597	0			
Crook	Bear Creek	12,557	6,772	296	12,557	131,806	137,956
	Camp Creek	0	4,122	3,080			
	Chimney Rock-Crooked River	0	0	1,516			
	Deep Creek	0	0	12,649			
	Horse Heaven Creek-Crooked River	0	17,393	23,645			
	Lower Beaver Creek	0	611	10,691			
	Lower Crooked Valley-Crooked River	0	0	11,880			
	Lower Dry River	0	0	191			
	Lower North Fork Crooked River	0	2,225	4,026			
	Lower Ochoco Creek	0	9,008	9,785			
	Lower South Fork Crooked River	0	2,185	32,613			
	Mill Creek	0	2,865	0			
	Paulina Creek	0	12,556	6,282			
	Prineville Reservoir-Crooked River	0	7,039	1,357			
	Upper Dry River	0	8,949	7,448			
	Upper North Fork Crooked River	0	24,945	4,568			
	Upper Ochoco Creek	0	12,556	0			
	Upper South Fork Crooked River	0	1,205	812			

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		Economic Classes Summed by Watershed			Economic Classes Summed by Count		
County	Watershed	Economic	Non-Economic	No Grasshoppers	Economic	Non-Economic	No Grasshoppers
Crook, continued							
	Watson Creek-Crooked River	0	19,375	6,873			
	Willow Creek	0	0	244			
Deschutes	Bear Creek	0	0	336	0	64,882	96,369
	Lower Dry River	0	242	3,818			
	Mayfield Pond-Central Oregon Canal	0	0	4,714			
	McKenzie Canyon-Deschutes River	0	0	4,024			
	Soldiers Cap	0	12,557	22,236			
	Upper Dry River	0	37,429	30,627			
	Upper South Fork Crooked River	0	14,654	30,613			
Gilliam	Butte Creek	16,086	588	0	357,749	60,649	8
	Clarno Rapids-John Day River	824	0	0			
	Eightmile Canyon	17,787	5,469	0			
	Ferry Canyon-John Day River	15,637	225	0			
	John Day River	12,002	0	8			
	Lower Lake Umatilla	43,545	9,629	0			
	Lower Rock Creek	73,336	12,751	0			
	Lower Willow Creek	2,609	5,485	0			
	Scott Canyon-John Day River	65,853	16,839	0			
	Thirtymile Creek	78,443	9,663	0			
	Upper Rock Creek	31,627	0	0			
Grant	Bear Creek	8,108	1,267	0	270,948	73,965	17,624
	Beech Creek	5,382	13,942	0			
	Big Creek-Middle Fork John Day River	21,579	59	0			
	Big Creek-North Fork John Day River	43	0	0			
	Bridge Creek-Middle Fork John Day River	0	0	12,542			
	Camp Creek-Middle Fork John Day River	0	0	9			
	Canyon Creek	0	683	164			
	Cottonwood Creek	25,565	4,042	0			
	Desolation Creek	1,381	0	0			
	Eight Mile Creek-Middle Fork John Day River	9,341	5,735	831			
	Fields Creek-John Day River	22,010	1,025	0			
	Grub Creek-John Day River	28,729	4,080	0			
	Headwaters Silvies River	16,289	13,359	3,951			
	John Day River-Johnson Creek	8,489	4,288	0			
	Kahler Creek-John Day River	875	0	0			
	Laycock Creek-John Day River	21,542	7,191	0			
	Long Creek	46,468	1,291	127			
	Lower North Fork John Day River	17,100	0	0			
	Lower South Fork John Day River	12	11,329	0			
	Middle South Fork John Day River	2,984	0	0			
	Potamus Creek-North Fork John Day River	16,247	0	0			

Appendix 1. Estimate of the acreage with economic levels of grasshopper infestation (≥8 grasshoppers / yd^2) based on the 2020 survey.

		Economic Classes Summed by Watershed			Economic Classes Summed by Count		
County	Watershed	Economic	Non-Economic	No Grasshoppers	Economic	Non-Economic	No Grasshoppers
Grant, continued							
	Rock Creek	0	778	0			
	Upper Middle John Day	0	4,886	0			
	Upper Silvies River	9,407	9	0			
	Upper South Fork John Day River	9,399	0	0			
Harney	Alvord Lake	83,258	260	12,335	585,657	162,151	180,140
	Big Alvord Creek	1,091	0	0			
	Big Alvord Creek	14,859	8,871	0			
	Chain Lakes-Sunset Valley	0	1,448	3,406			
	Cottonwood Creek-Frontal Pueblo Valley	85,675	1,259	0			
	Crane Creek	9,234	1,459	0			
	Griffin Creek-Upper Malheur River	2,263	14,006	0			
	Harney Lake-Malheur Lake	29,239	7,575	31,978			
	Headwaters Malheur River	0	0	118			
	Home Creek-Garrison Lake	25,862	265	0			
	Jackass Creek	0	2,149	0			
	Kiger Creek-Diamond Canal	202	14,690	14,396			
	Lower Donner und Blitzen River	25,847	1,311	0			
	Lower Silver Creek	1,843	3,657	0			
	Lower Silvies River	46,008	14,359	22,422			
	Malheur Gap	5,856	0	13,364			
	Malheur Slough	19,032	12,325	0			
	Middle Donner und Blitzen River	14,230	16,862	0			
	Middle Silver Creek	4,323	1,840	25,070			
	Middle Silvies River	3,745	0	0			
	North Basin	21,134	2,671	12,410			
	Otis Creek	0	688	0			
	Quail Creek	16,341	0	56			
	Riddle Creek	6	0	0			
	Rincon Creek	50	1,278	0			
	Sage Hen Creek	11,761	7,277	6,237			
	Shallow Lake-Slickey Lake	18,075	4,688	4,521			
	Skull Creek	18,323	0	1,270			
	Squaw Lake-Capehart Lake	0	0	5			
	Stinkingwater Creek	7,880	4,657	9,479			
	Summit Creek-Storehouse Canyon	38,729	0	0			
	Upper Donner und Blitzen River	3,733	10,575	2,060			
	Upper Silvies River	8,812	0	0			
	Upper South Fork Crooked River	0	0	136			
	Upper South Fork Malheur River	24,269	0	464			
	Walls Lake Reservoir	36,338	7,145	0			
	Warm Springs Reservoir-Upper Malheur River	5,041	20,835	7,707			

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		Economic Classes Summed by Watershed			Economic Classes Summed by Count		
County	Watershed	Economic	Non-Economic	No Grasshoppers	Economic	Non-Economic	No Grasshoppers
Harney, continued							
	Wheatgrass Lake	0	0	305			
	Willow Creek	2,599	0	0			
	Wolf Creek	0	0	12,401			
Hood River	East Fork Hood River	560	0	0	30,433	0	0
	Hood River	15,654	0	0			
	Mill Creek-Columbia River	19	0	0			
	Mosier Creek-Columbia River	14,200	0	0			
Jefferson	Antelope Creek	189	0	0	82,042	60,883	64,905
	Hay Creek	7,354	6,688	1,692			
	Juniper Butte-Crooked River	2,784	12,575	0			
	Lower Crooked Valley-Crooked River	2,847	0	3,209			
	Lower Trout Creek	7,414	7,412	2,615			
	Mud Springs Creek	0	9,786	7,201			
	Muddy Creek-John Day River	15,430	2,696	8,674			
	Potter Canyon-Deschutes River	62	1,088	1,141			
	Shitike Creek-Deschutes River	10,222	1,449	526			
	Upper Trout Creek	18,247	17,755	14,440			
	Willow Creek	17,491	1,435	25,407			
Klamath	Big Springs Creek-Klamath Marsh	11,011	0	0	153,857	326,448	145,278
	Crater Lake-Williamson River	16,238	1,301	8,440			
	Fishhole Creek	0	1,679	1,539			
	Gerber Reservoir-Miller Creek	0	3,702	963			
	Hog Creek-Williamsno River	20,740	24,725	7,811			
	Jack Creek-Williamson River	6,583	23,465	19,236			
	Jackson Creek-Williamson River	0	0	4,357			
	Lake Ewauna-Klamath River	312	1	0			
	Langell Valley-Lost River	0	11,478	31,482			
	Long Lake Valley-Upper Klamath Lake	2,232	21,150	1,227			
	Lower Sycan River	2,903	5,376	0			
	Mills Creek-Lost River	438	0	2,418			
	North Fork Sprague River	8,582	4,253	0			
	Rock Creek-Buck Creek	0	0	8,443			
	South Fork Sprague River	14,085	18,836	2,932			
	Sprague River	26,090	85,385	16,065			
	Swan Lake Valley	37,103	17,981	159			
	Wood River	0	50,330	4,450			
	Yonna Valley-Lost River	7,540	56,785	35,756			
Lake	Alkali Lake	0	0	41	96,175	264,708	300,796
	Anna River-Summer Lake	0	379	0			
	Buck Creek	0	0	918			
	Campbell Lake	0	0	11,530			

Appendix 1. Estimate of the acreage with economic levels of grasshopper infestation (≥8 grasshoppers / yd^2) based on the 2020 survey.

		Economic Classes Summed by Watershed			Economic Classes Summed by Count		
County	Watershed	Economic	Non-Economic	No Grasshoppers	Economic	Non-Economic	No Grasshoppers
Lake, continued							
	Christmas Lake Valley	0	0	201			
	Crooked Creek	0	17,445	9,237			
	Crump Lake	17,820	26,931	25,637			
	Deep Creek	20	32,285	13,153			
	Drews Creek	64,366	2,419	6,400			
	Dry Creek-Fort Rock Valley	0	0	5,092			
	Dry Creek-Frontal Goose Lake	394	11,346	3,682			
	Duncan Creek-Silver Lake	0	6,909	6,208			
	Fishhole Creek	75	0	0			
	Goose Lake	0	85	0			
	Honey Creek	0	1,258	624			
	Lower Chewaucan River	0	39,065	20,660			
	Middle Chewaucan River	0	966	0			
	Pine Lake-Devils Garden	0	0	11,980			
	Post Lake	0	3,884	2,082			
	Rabbit Creek	0	0	5,212			
	Rock Creek-Buck Creek	0	0	11,805			
	Sand Canyon-Lake Abert	0	1,443	15,227			
	Silver Creek	0	23,854	9,991			
	South Fork Sprague River	3,233	2,144	0			
	Sycan River at Sycan Marsh	0	12,479	23,027			
	Thomas Creek	6,090	15,811	38,820			
	Thorn Lake	0	36,077	67,642			
	Tired Horse Lake	0	0	85			
	Twentymile Creek	4,176	487	366			
	Upper South Fork Crooked River	0	9,257	10,842			
	Wheatgrass Lake	0	0	333			
	Willow Creek-Frontal Goose Lake	0	20,185	0			
Malheur	Antelope Creek	0	3,321	12,497	711,990	227,702	106,722
	Birch Creek-Snake River	1,033	8,611	0			
	Camp Creek	0	0	334			
	Clover Creek	9,889	19,190	4,281			
	Cottonwood Creek	15,565	18,196	0			
	Cow Creek	14,005	106	14,904			
	Crowley Creek	50,523	0	0			
	Dry Creek	10,510	0	0			
	Dry Creek-Jordan Creek	25,016	0	0			
	Hog Creek-Lower Malheur River	24,228	5	56			
	Hunter Creek-Lower Malheur River	2,487	0	0			
	Jackson Creek-Owyhee River	1,616	0	0			
	Jacobsen Gulch-Snake River	7,328	0	0			

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		Economic Classes Summed by Watershed			Economic Classes Summed by Count		
County	Watershed	Economic	Non-Economic	No Grasshoppers	Economic	Non-Economic	No Grasshoppers
Malheur, continued							
	Johnston Gulch Reservoir-Lower Malheur River	41,629	0	0			
	Jordan Creek-Sheep Spring Creek	41,419	0	2,744			
	Juniper Basin Creek-Upper Malheur River	20,444	986	0			
	Little Malheur River	18,417	771	0			
	Little Sandy Reservoir-Lower Malheur River	9,686	0	0			
	Locket Gulch-Snake River	4,097	0	0			
	Lower Bully Creek	15,178	3,974	0			
	Lower Cow Creek	13,222	0	0			
	Lower Crooked Creek	36,902	0	82			
	Lower North Fork Malheur River	6,538	18,217	0			
	Lower South Fork Malheur River	20,125	1,389	82			
	Lower Succor Creek	46,961	28,745	414			
	Lower Willow Creek	12,839	0	3,632			
	McDermitt Creek	11	0	0			
	Middle Willow Creek	13,659	12,629	25,410			
	Moores Hollow-Snake River	10,836	0	0			
	North Alkali Creek-Snake River	8,328	0	0			
	Oregon Canyon Creek	43,923	8,941	1,358			
	Quail Creek	15,087	0	3,852			
	Rattlesnake Creek	0	10,832	12,640			
	Ryegrass Creek-Owyhee River	0	0	10,738			
	Sand Hollow Creek	5,522	0	0			
	Sand Hollow Creek-Owyhee River	9,937	136	0			
	Skull Creek-Owyhee River	27,527	0	0			
	Three Fingers Gulch-Owyhee River	11,211	3,891	6,564			
	Twelvemile Creek-Coyote Lake	0	6,252	0			
	Upper Bully Creek	13,293	4,945	297			
	Upper Cow Creek	26,184	7,171	2,361			
	Upper Crooked Creek	12,569	30,103	2,650			
	Upper Dry Creek	2,610	22,492	0			
	Upper South Fork Malheur River	2,480	0	0			
	Upper Succor Creek	22,195	4,248	623			
	Upper Willow Creek	24,863	11,439	1,204			
	Warm Springs Reservoir-Upper Malheur River	9,113	1,113	0			
	West Tub Mountain Reservoir	2,986	0	0			
Morrow	Eightmile Canyon	47,027	7,571	0	462,461	80,478	13,021
	Juniper Canyon	64,918	12,720	0			
	Lower Butter Creek	32,991	3,859	41			
	Lower Lake Umatilla	0	5,005	0			
	Lower Rock Creek	15,977	0	0			
	Lower Willow Creek	27,001	19,923	0			

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		Economic Classes Summed by Watershed			Economic Classes Summed by Count		
County	Watershed	Economic	Non-Economic	No Grasshoppers	Economic	Non-Economic	No Grasshoppers
Morrow, continued							
	Middle Lake Umatilla	704	33	252			
	Middle Willow Creek	41,093	9,715	0			
	Rhea Creek	61,878	2,494	0			
	Sand Hollow	27,528	5,202	0			
	Sixmile Canyon	38,122	2,730	0			
	Upper Butter Creek	19,319	11,045	415			
	Upper Lake Umatilla	0	0	12,314			
	Upper Rock Creek	20,102	58	0			
	Upper Willow Creek	65,802	123	0			
Sherman	Buck Hollow Creek	26,317	0	0	171,288	50,987	109
	Cedar Island-Deschutes River	28,279	9,622	0			
	Ferry Canyon-John Day River	7,512	5,936	0			
	Grass Valley Canyon	43,590	11,702	0			
	John Day River	25,630	0	109			
	Lower Lake Umatilla	6,154	0	0			
	Pine Hollow	1,920	5,248	0			
	Scott Canyon-John Day River	1,353	4,207	0			
	Spanish Hollow-Columbia River	30,533	14,272	0			
Umatilla	Alkali Canyon-Umatilla River	76,515	10,937	0	653,943	171,384	7,674
	Big Creek-North Fork John Day River	576	0	0			
	Birch Creek	69,387	12,696	123			
	Cold Springs Canyon	56,190	16,992	0			
	Desolation Creek	0	0	0			
	Hunt Ditch-Umatilla River	10,598	13,830	0			
	Lower Butter Creek	12,752	3,655	0			
	Lower Camas Creek	69,701	5,515	0			
	Lower Lake Wallula	16,110	1,649	0			
	Lower Walla Walla River	8,287	7,457	0			
	McKay Creek	48,165	9,579	568			
	Meacham Creek	20	0	0			
	Middle Walla Walla River	14,063	3,289	0			
	Mission Creek-Umatilla River	70,441	13,448	4,358			
	Pine Creek	31,077	32,721	979			
	Potamus Creek-North Fork John Day River	1,747	0	0			
	Sand Hollow	840	492	0			
	Stage Gulch	21,323	9,538	0			
	Upper Butter Creek	56,056	3,372	0			
	Upper Camas Creek	0	4,862	0			
	Upper Walla Walla River	22,282	721	0			
	Wildhorse Creek	67,817	20,632	1,646			

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		Economic Classes Summed by Watershed			Economic Classes Summed by Count		
County	Watershed	Economic	Non-Economic	No Grasshoppers	Economic	Non-Economic	No Grasshoppers
Union	Beaver Creek-Grande Ronde River	7,860	17,563	0	236,101	100,855	15,905
	Big Creek	20,312	355	2,281			
	Cabin Creek-Grande Ronde River	19,051	9,906	0			
	Five Points Creek-Grande Ronde River	19,354	11,443	501			
	Indian Creek-Grande Ronde River	27,616	760	2,992			
	Ladd Creek	12,711	19,818	0			
	Lower Catherine Creek	10,633	586	0			
	Lower Wallowa River	1,844	0	0			
	Meadow Creek	10,861	663	0			
	Minam River	3,060	0	0			
	North Powder River	261	8,335	0			
	Rock Creek-Powder River	0	0	0			
	Upper Catherine Creek	40,238	1,370	5,074			
	Upper Grande Ronde River	17,496	9,435	0			
	Willow Creek	11,445	4,503	5,057			
	Wolf Creek-Powder River	33,358	16,118	0			
Wallowa	Bear Creek	2	1,703	0	211,580	59,445	0
	Chesnimnus Creek	7,333	1,785	0			
	Lostine River	5,929	1,884	0			
	Lower Big Sheep Creek	29,276	4,183	0			
	Lower Grande Ronde River	9,044	0	0			
	Lower Imnaha River	3,016	0	0			
	Lower Joseph Creek	3,052	0	0			
	Lower Wallowa River	22,068	12,463	0			
	Middle Imnaha River	6,108	0	0			
	Middle Wallowa River	28,834	12,784	0			
	Minam River	931	428	0			
	Mud Creek-Grande Ronde River	5,885	13,143	0			
	Upper Big Sheep Creek	855	0	0			
	Upper Joseph Creek	44,945	6,498	0			
	Upper Wallowa River	44,302	4,573	0			
Wasco	Antelope Creek	38,043	0	1,807	239,824	22,515	7,699
	Bakeoven Creek	22,502	0	96			
	Beaver Creek	6,941	0	0			
	Buck Hollow Creek	10,167	0	835			
	Cedar Island-Deschutes River	6,722	2,510	0			
	Clarno Rapids-John Day River	16,349	243	0			
	Eightmile Creek	15,819	0	0			
	Fifteenmile Creek	32,637	7,718	1,280			
	Hood River	10	0	0			
	Mill Creek	3,242	0	0			
	Mill Creek-Columbia River	8,718	1,733	0			

Appendix 1. Estimate of the acreage with economic levels of grasshopper infestation (≥8 grasshoppers / yd^2) based on the 2020 survey.

		Economic Classes Summed by Watershed			Economic Classes Summed by Count		
County	Watershed	Economic	Non-Economic	No Grasshoppers	Economic	Non-Economic	No Grasshoppers
Wasco, continued							
	Mosier Creek-Columbia River	15,563	7,300	0			
	Muddy Creek-John Day River	3,410	327	0			
	Pine Hollow	6,887	0	395			
	Shitike Creek-Deschutes River	2,346	0	1,024			
	Spanish Hollow-Columbia River	24	0	0			
	Tygh Creek	9,986	1,863	2,258			
	Upper Trout Creek	13	0	0			
	Warm Springs River	14,923	0	3			
	White Horse Rapids-Deschutes River	10,775	697	0			
	White River	14,747	122	0			
Wheeler	Bridge Creek	46,666	637	0	246,267	66,729	5,237
	Butte Creek	42,703	511	0			
	Clarno Rapids-John Day River	1,072	1,857	0			
	Deep Creek	0	0	2,489			
	John Day River-Johnson Creek	6,299	1,209	0			
	Kahler Creek-John Day River	51,325	29,848	2,351			
	Lower Beaver Creek	0	0	397			
	Mountain Creek	23,599	6,381	0			
	Muddy Creek-John Day River	25,182	1,006	0			
	Rock Creek	0	2,344	0			
	Service Creek-John Day River	33,593	22,805	0			
	Thirtymile Creek	15,827	0	0			
	Upper Middle John Day	0	131	0			
	Upper Rock Creek	2	0	0			
Totals for Economic Class		4,804,269	2,024,716	1,118,233			
Grand Total of Surveyed Acres		7,947,218					

Appendix 2. 2020 grasshopper survey area estimates intersecting with tribal lands by County and Reservation.

		Economic Classes Summed by Watershed			Economic Classes Summed by County		
County	Watershed	Economic	Non-Economic	No Grasshoppers	Economic	Non-Economic	No Grasshoppers
Gilliam	Burns Reservation	0	0	0	3,527	0	0
	FT McDermitt Reservation	0	0	0			
	Umatilla Reservation	0	0	0			
	Warm Springs Reservation	0	0	0			
	Other	3,527	0	0			
Harney	Burns Reservation	0	0	0	71	322	2,245
	FT McDermitt Reservation	0	0	0			
	Umatilla Reservation	0	0	0			
	Warm Springs Reservation	0	0	0			
	Other	71	322	2,245			
Hood River	Burns Reservation	0	0	0	623	0	0
	FT McDermitt Reservation	0	0	0			
	Umatilla Reservation	0	0	0			
	Warm Springs Reservation	0	0	0			
	Other	623	0	0			
Jefferson	Burns Reservation	0	0	0	10,222	0	526
	FT McDermitt Reservation	0	0	0			
	Umatilla Reservation	0	0	0			
	Warm Springs Reservation	10,222	0	526			
	Other	0	0	0			
Klamath	Burns Reservation	0	0	0	0	2	239
	FT McDermitt Reservation	0	0	0			
	Umatilla Reservation	0	0	0			
	Warm Springs Reservation	0	0	0			
	Other	0	2	239			
Sherman	Burns Reservation	0	0	0	1,983	0	0
	FT McDermitt Reservation	0	0	0			
	Umatilla Reservation	0	0	0			
	Warm Springs Reservation	0	0	0			
	Other	1,983	0	0			
Umatilla	Burns Reservation	0	0	0	129,409	36,594	5,582
	FT McDermitt Reservation	0	0	0			
	Umatilla Reservation	129,409	36,594	5,582			
	Warm Springs Reservation	0	0	0			
	Other	0	0	0			
Wasco	Burns Reservation	0	0	0	27,620	0	1,027
	FT McDermitt Reservation	0	0	0			
	Umatilla Reservation	0	0	0			
	Warm Springs Reservation	27,452	0	1,027			
	Other	168	0	0			
Totals for Economic Class		173,455	36,918	9,619			
Grand Total of Surveyed Acres		219,992					

Appendix 3. Methodology for Area Estimation.

1. Grasshopper and Mormon cricket density (count/yd^2) 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 [≥8/yd^2], Non-economic [1-7/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.).

Appendix 4. General Information about Maps in this Report.

These maps were prepared by Paul Blom 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.