



# Potential for Pine Sawfly (*Neodiprion Autumnalis*) Defoliation of Ponderosa Pine Forests in Elbert County, CO, in 2015

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## INTRODUCTION

The pine sawfly *Neodiprion autumnalis* is the most widely distributed of the sawflies that feed on ponderosa pine (*Pinus ponderosa*) in western North America. It is known to occur throughout the western U.S. and Mexico (Ciesla and Smith 2011). In Colorado, this species has been relatively abundant in ponderosa pine forests in portions of Elbert, Douglas and El Paso counties for a number of years. These rather homogenous, open forests comprise the easternmost limits of the distribution of ponderosa pine in the state. Local residents have reported seeing colonies of sawfly larvae and pockets of light to moderate defoliation in these forests for at least 16 years. However, an outbreak of this sawfly causing heavy defoliation on about 7,400 acres of pine forests, primarily in Elbert County, occurred in 2014 (Ciesla et al. 2014, State of Colorado 2015).

Many residents in these areas are concerned about the potential impacts on the health of native pines in 2015 and beyond. In response to this concern, the Colorado State Forest Service designed and conducted a special survey to predict the potential for pine sawfly defoliation in 2015. The objectives of this survey were to:

1. Predict future defoliation by *N. autumnalis* in 2015, based on numbers of egg-infested pine needles
2. Relate observed numbers of egg-infested needles to subsequent defoliation

This report addresses Objective 1: prediction of potential for defoliation in 2015.

## METHODS

Adults of *N. autumnalis* are present in the fall (September/October). Females deposit eggs singly in slits on needles of ponderosa pine (Fig. 1), where they overwinter in the egg stage. Prediction of 2015 defoliation was, therefore, based on counts of egg-infested needles during the overwintering period. A number of egg survey techniques designed to predict defoliation by pine sawflies are reported in the literature (Connola et al. 1959, Tostowaryk and McLeod 1972). However, a formalized egg survey method for *N. autumnalis* has not yet been developed. The design used for this survey is based on a sequential sampling technique described by Connola et al. (1959) for the pine sawfly *N. nanulus*, in red pine (*P. resinosa*) plantations in New York state. The survey team based their prediction on the cumulative number of egg-infested needles found on branch tips of 15 cm in length.

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Figure 1 – *Neodiprion autumnalis* egg slits, or niches, on ponderosa pine needles.

The design of this egg survey to predict defoliation by *N. autumnalis* in Colorado was as follows:

**Sample Points** – Each sample point consisted of 10 dominant/co-dominant ponderosa pines. Two branch tips were taken at or near mid-crown from each sample tree using pole pruners (Fig. 2). The number of sample points established on a property varied according to the forested area of the property as follows:

- Small lots < 2 acres – 1-2 sample points
- 10- to 50-acre lots – 5 sample points
- >50-acre lots – 6-10 sample points

**Sample Unit** – Ponderosa pine branch tips, each 15 cm (5.91 inches) in length.

**Attribute** – Cumulative number of egg-infested needles on 20 individual 15 cm branch tips.

**Defoliation Rating** – Intensity of defoliation was estimated for each sample tree using a six-class system (Fig. 3). This rating system was adapted from the Hawksworth six-class system used for rating intensity of dwarf mistletoe (*Arceuthobium* spp.) infection (Hawksworth 1977). An adaptation of this system was used successfully for rating intensity of defoliation by the pine processionary caterpillar (*Thaumetopoea wilkinsonii*) on a Mediterranean pine (*Pinus brutia*) on the island of Cyprus (Ciesla et al. 2011). Each sample

tree in this survey was rated for 2014 defoliation and will again be rated for 2015 defoliation during July/August 2015.



Figure 2 – Sampling ponderosa pines with pole pruners to count the number of egg-infested needles on 15 cm branch tips.

Figure 3 – System used to rate intensity of defoliation by the pine sawfly *Neodiprion autumnalis* in Elbert County, Colo., 2014-2015.

Pine Sawfly Defoliation Rating		
Instructions		Example
Step 1 – Divide live crown into thirds		This third is undamaged = 0
Step 2 – Rate each crown level for defoliation as follows		This third has some noticeable defoliation = 1
0 = No visible defoliation		
1 = Noticeable defoliation		
		This third has most or all of the older foliage removed = 2
2 = Most or all of older foliage removed		
Step 3 – Add ratings for each third for a tree rating		0 + 1 + 2 = defoliation rating of 3
Step 4 – Average tree ratings for a plot or stand rating		Range of values = 0 - 6

*Decision Rule* – Since the relationship of cumulative egg-infested needles to subsequent defoliation by *N. autumnalis* has not yet been developed, prediction for this survey was based on the sequential sampling plan developed by Connola et al. (1959). According to this plan, cumulative counts of egg-infested needles on 20 separate 15 cm branch samples predict the following:

<u>Cumulative number of egg-infested needles</u>	<u>Predicted defoliation</u>
≤ 14	None to light
15-41	Unable to make a prediction, continue sampling
≥ 42	Moderate to heavy

For purposes of the 2014-15 *N. autumnalis* egg survey in Colorado, the following decision criteria were used, adapted from Connola et al. (1959):

<u>Cumulative number of egg-infested needles</u>	<u>Predicted defoliation</u>
≤ 14	None to light (Defoliation ratings of 0-3)
15-41	Moderate (Defoliation ratings of 3.1-4.5)
≥ 42	Severe (Defoliation ratings of 4.6-6.0)

These values are subject to change in the future, based on the development of a quantifiable relationship between egg counts and defoliation in the outbreak area in Colorado.

*Eggs Per Needle* – An estimate of the average number of eggs per egg-infested needle was obtained by randomly selecting 129 egg-infested needles and counting the number of egg slits, or niches, per needle in the field.

*Development of a Prediction Model* – A prediction model, based on simple linear regression using 2014-2015 egg counts (x) vs. 2015 defoliation intensity (y) will be computed when sample trees are rated for 2015 defoliation. If necessary, a multiple regression model using egg counts (x<sub>1</sub>) and previous year's defoliation intensity (x<sub>2</sub>) to predict defoliation (y) will be developed.

## RESULTS AND DISCUSSION

Egg surveys were conducted on 22 October 2014, 10 November 2014 and 6-9 April 2015. A total of 66 sample points on 18 properties were established, all in Elbert County. A total of 49 of these sample points on 11 properties were located south and east of Kiowa, many in the areas most heavily impacted by the 2014 outbreak. Seventeen sample points on seven properties were located north and west of Kiowa, where localized defoliation was noted in 2014 and several concerned landowners requested that their properties be included in the survey (Figs. 4 and 5).

### Pine Sawfly Survey South: Elbert County, CO. 2015

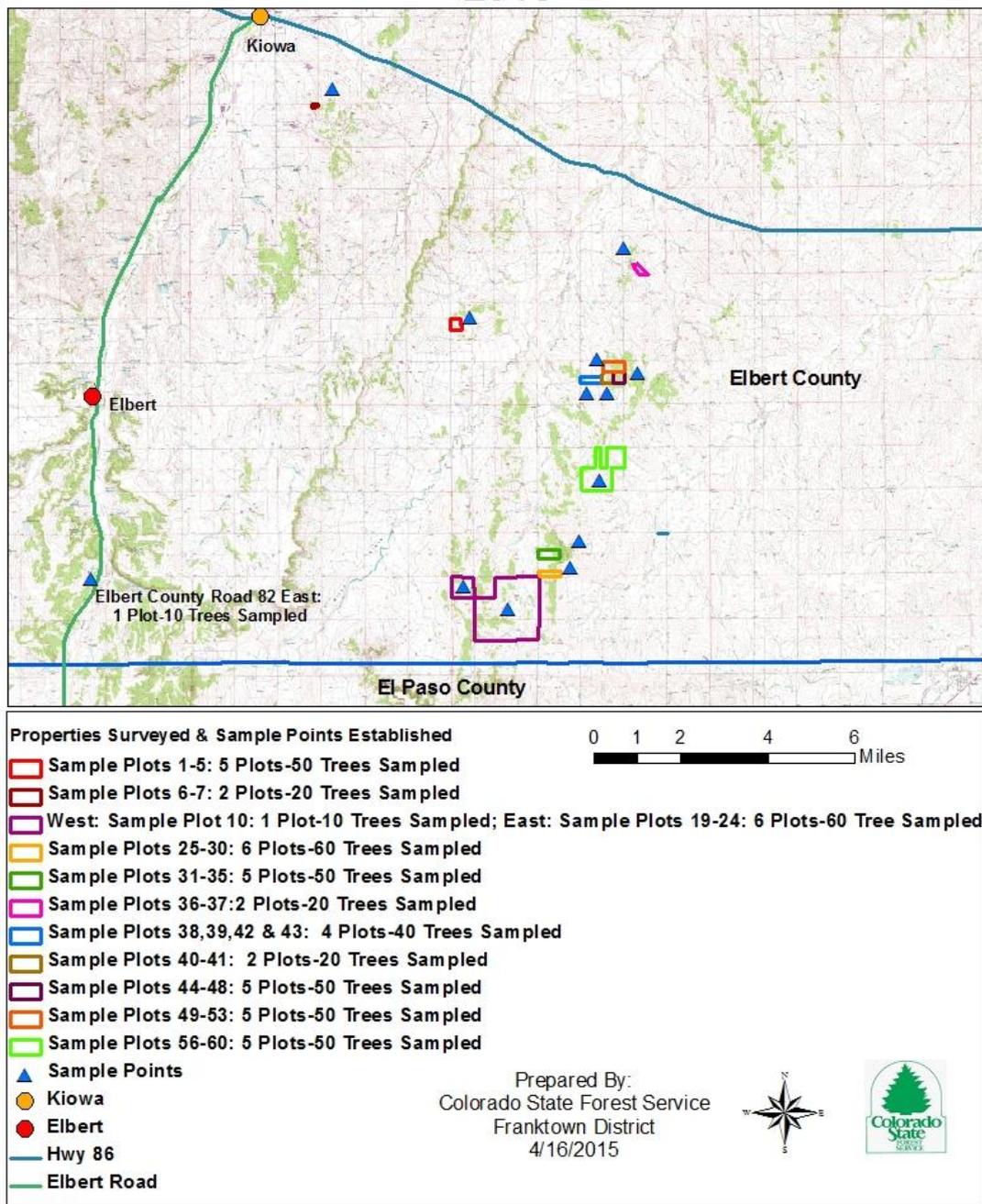


Figure 4 – Location of properties south and east of Kiowa, Colo., included in the 2014-2015 pine sawfly egg survey.

## Pine Sawfly Survey North: Elbert County, CO. 2015

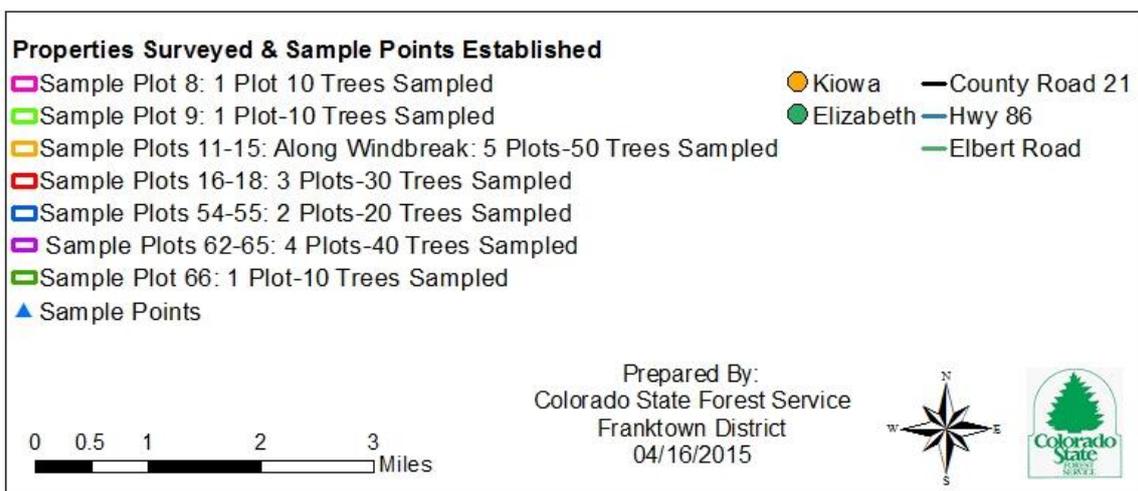
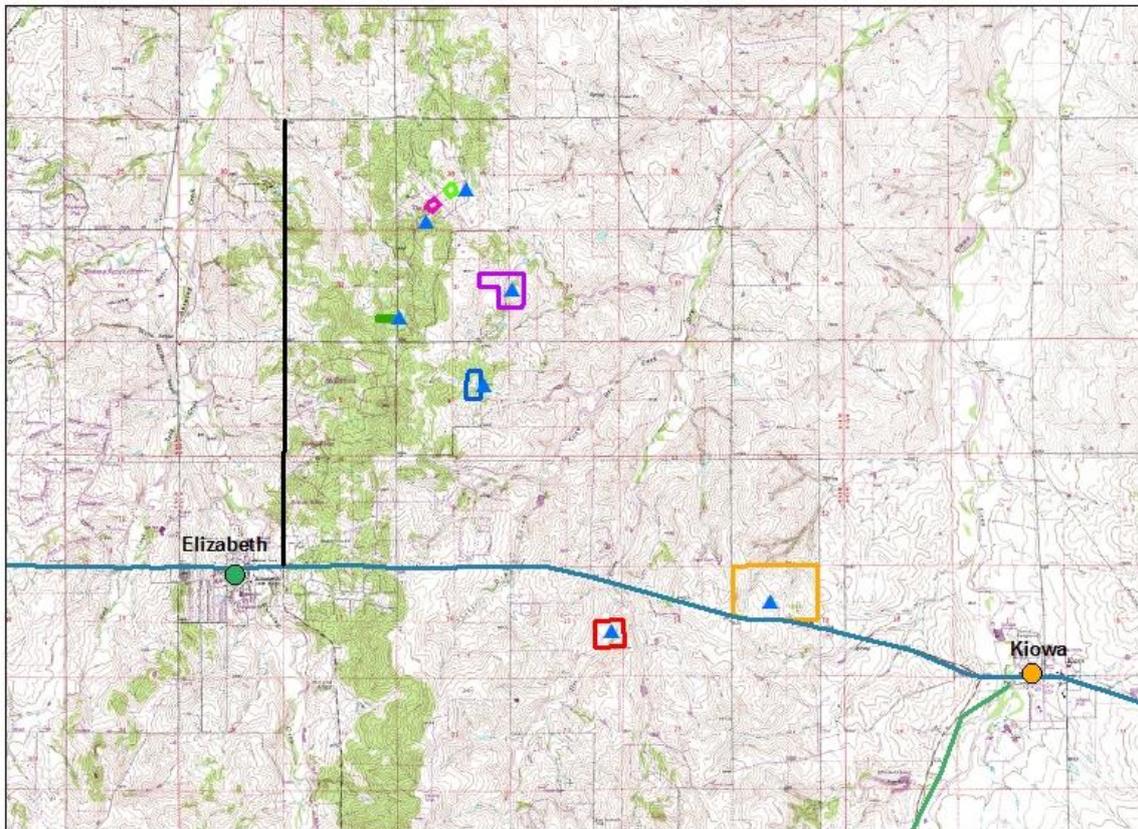


Figure 5 – Location of properties north and west of Kiowa, Colo., included in the 2014-2015 pine sawfly egg survey.

The cumulative number of egg-infested needles per sample point ranged from 0 to 205. Thirty-four of the sample points had 14 or fewer egg-infested needles, suggesting that defoliation in 2015 would be none to light. Of the 34 points, 18 had no observed egg-infested needles. Nineteen sample points had between 15 and 41 egg-infested needles, indicating a prediction for moderate defoliation in 2015, and 13 sample points had 42 or more egg-infested needles, indicating that predicted defoliation for 2015 would be severe (Fig. 6). Five of the sample points with “severe” predictions had more than 100 egg-infested needles on the sample branch tips (Fig. 6). Individual sample point data and predictions are provided in Tables 1 and 2.

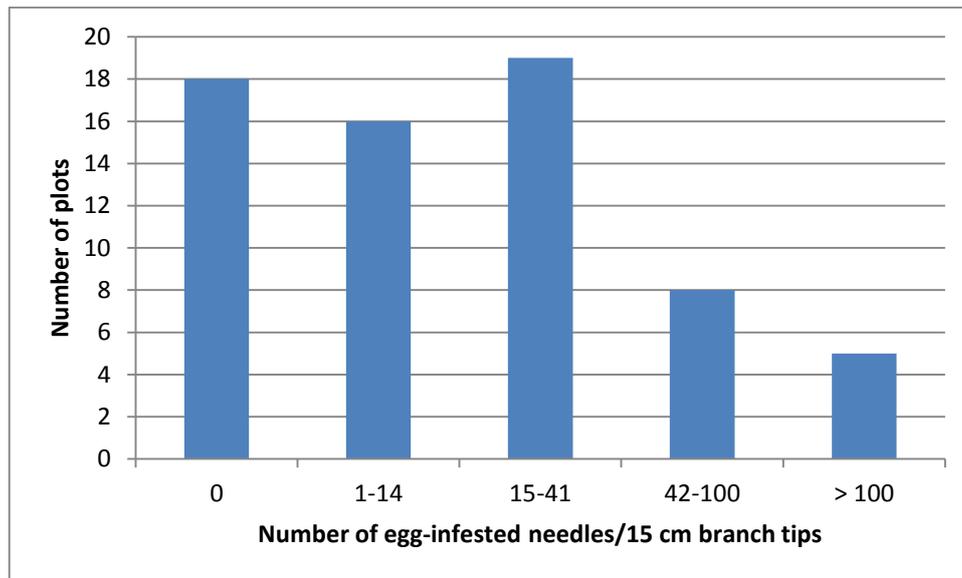


Figure 6 – Distribution of sample points by number of egg-infested needles on branch tips.

The number of eggs per egg-infested needle averaged 19.33 ( $n = 129$ , S.D. = 3.99, range = 4-50) (Fig. 7). Needles with smaller numbers of eggs per egg-infested needle tended to be those that had suffered some feeding damage in 2014.

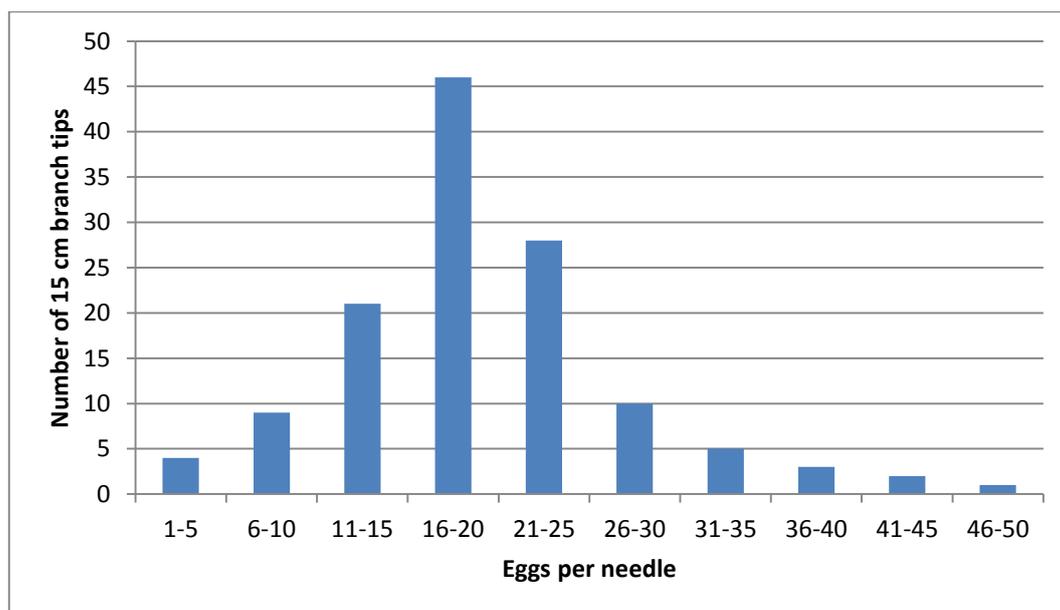
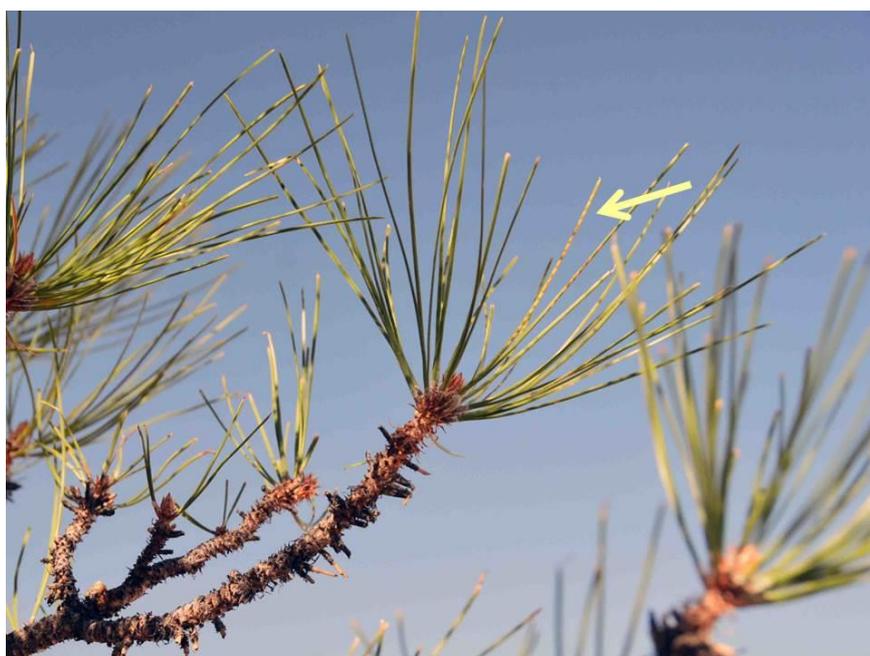


Figure 7 – Frequency distribution of the number of *Neodiprion autumnalis* eggs per needle.

It was initially believed that there would be few, if any, egg-infested needles on trees that suffered nearly complete defoliation in 2014, simply because virtually all of the needles had been fed upon. However, new needles were produced by trees heavily defoliated in 2014, which provided some sites for egg deposition by female sawflies during their September/October flight period (Fig. 8).

This survey indicates that some pine stands in Elbert County may suffer another season of moderate to heavy defoliation. However, we note that the decision rules for predicting 2015 pine sawfly defoliation in Colorado are based on a sampling plan developed in New York state for different species of sawfly and pine, and this is the first known attempt to predict defoliation by the sawfly *N. autumnalis* in Elbert County, Colo. We also believe that previous year's defoliation may influence the number of egg-infested needles that could cause a given level of defoliation. Previously defoliated trees have a smaller complement of foliage available for the larvae. Therefore, the predictions presented in this report may be subject to error and must be considered merely a "best guess" based on available information. The authors hope that a sufficient number of the sample points will be left untreated during 2015 so that a relationship between egg counts and defoliation, specific to the pine sawfly *N. autumnalis* in Elbert and adjoining counties of Colorado, can be established.



*Figure 8 – New growth on a ponderosa pine following nearly complete defoliation of older needles by the pine sawfly *N. autumnalis*. Note the egg-infested needles on new growth (see arrow).*

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**Table 1**

Summary of egg-infested needles and predicted 2015 pine sawfly defoliation for areas south and east of Kiowa, Elbert County, Colo.

Sample Point Number	2014 defoliation rating	Number of egg-infested needles per 20 branch tips 15 cm in length	Predicted 2015 defoliation
1	2.6	63	Severe
2	1.7	135	Severe
3	2.1	192	Severe
4	1.8	61	Severe
5	2.2	25	Moderate
6	0.1	0	None to light
7	0.2	4	None to light
10	2.8	0	None to light
19	0.8	49	Severe
20	2.0	4	None to light
21	5.2	7	None to light
22	3.2	1	None to light
23	4.9	1	None to light
24	2.6	0	None to light
25	0.8	16	Moderate
26	2.6	7	None to light
27	1.1	16	Moderate
28	1.8	4	None to light
29	1.4	16	Moderate
30	3.4	0	None to light
31	3.6	2	None to light
32	5.5	36	Moderate
33	4.4	0	None to light
34	2.9	0	None to light
35	3.5	0	None to light
36	1.2	13	None to light
37	0.4	36	Moderate
38	5.1	43	Severe
39	2.8	17	Moderate
40	3.0	38	Moderate
41	3.2	52	Severe
42	4.0	69	Severe
43	1.6	9	None to light
44	2.2	13	None to light
45	1.2	3	None to light
46	2.5	10	None to light
47	2.3	23	Moderate
48	3.0	13	None to light
49	3.2	20	Moderate
50	5.4	15	Moderate

**Table 1 (Continued)**

Summary of egg-infested needles and predicted 2015 pine sawfly defoliation for areas south and east of Kiowa, Elbert County, Colo.

Sample Point Number	2014 defoliation rating	Number of egg-infested needles per 20 branch tips 15 cm in length	Predicted 2015 defoliation
51	5.7	36	Moderate
52	4.9	21	Moderate
53	3.4	20	Moderate
56	4.9	36	Moderate
57	4.6	16	Moderate
58	4.4	33	Moderate
59	4.7	21	Moderate
60	4.1	78	Severe
61	0.0	0	None to light

**Table 2**

Summary of egg-infested needles and predicted 2015 pine sawfly defoliation for areas north and west of Kiowa, Elbert County, Colo.

Sample Point Number	2014 defoliation rating	Number of egg-infested needles per 20 branch tips 15 cm in length	Predicted 2015 defoliation
8	0.1	0	None to light
9	0.0	1	None to light
11	0.7	49	Severe
12	0.0	15	Moderate
13	3.8	184	Severe
14	1.7	178	Severe
15	2.4	205	Severe
16	0.0	10	None to light
17	0.2	0	None to light
18	0.4	0	None to light
54	2.1	0	None to light
55	0.4	0	None to light
62	1.6	0	None to light
63	0.4	0	None to light
64	0.5	0	None to light
65	0.1	0	None to light
66	0.0	0	None to light

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