- LiDAR data processing
  - Extract pole, span, and fall-in tree geospatial information from LiDAR database
- Import processed data into Excel spreadsheet
  - Determine Tree–Span–Pole associations based on the LiDAR geospatial info
  - **Tree strike threat**: Calculate number of fall-in trees in each span that can touch the line
 - **Trees within 6 ft**: Calculate number of fall-in trees in each span that are within 6 ft from the line
  - Rank and color code the spans in each category based on the number of trees in each span
- Output results to Google Earth for visualization
  - For each circuit, span, pole, and tree results are output to separate KMZ files such that they are shown as different layers in Google Earth

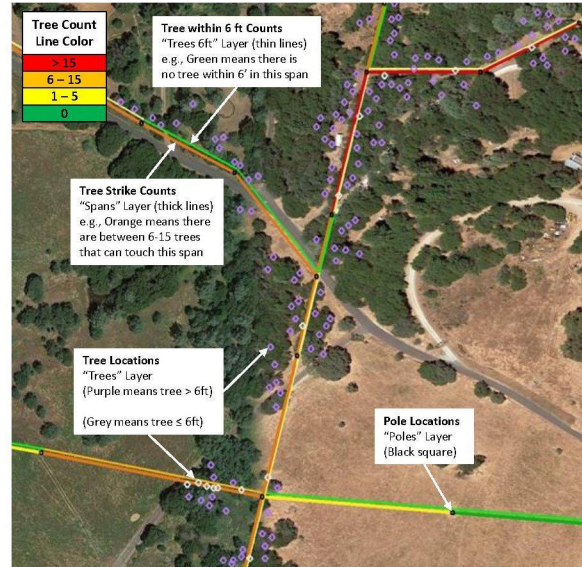| **LiDAR DATA PROCESSING** Extract geospatial info. Of pole, span, and fall-in trees from LiDAR database | → | **SPREADSHEET CALCULATION** Determine object associations Calculate tree strike threat Count trees ≤ 6 ft Span ranking and color coding | → | **RESULT VISUALIZATION** Output results to KMZ files for visualization in Google Earth |
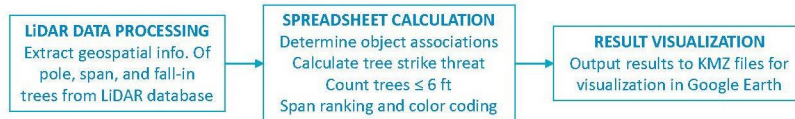
Assumptions for Non-Hardened System

- Tree-Span relationship is tagged in LiDAR (see figure)
- All fall-in trees have potential to strike the span regardless of wind speed and wind direction
- Tree strike failure is counted as true when a tree is tagged as fall-in with non-zero Overstrike
- Spans are ranked based on the number of fall-in trees in each span

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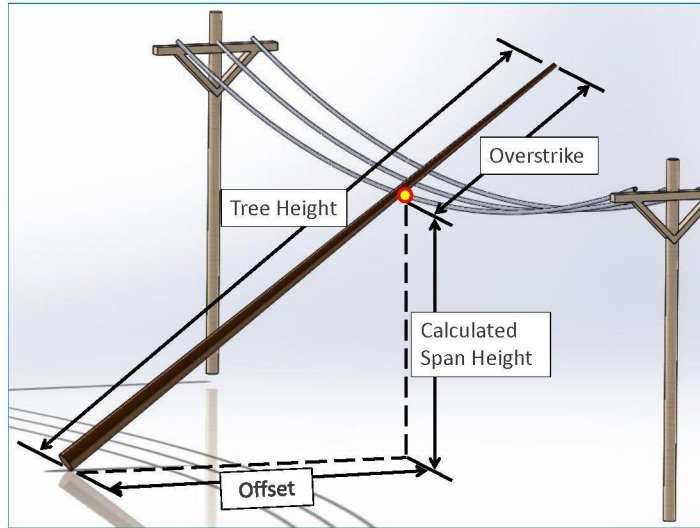
Definition of KMZ Layer Symbols and Line Colors

- Tree strike threat color coding
  - Thick red lines: Spans that have more than 15 fall-in trees that can touch the line
  - Thick orange lines: Spans that have 6 to 15 fall-in trees that can touch the line
  - Thick yellow lines: Spans that have 1 to 5 fall-in trees that can touch the line
  - Thick green lines: Spans that have zero fall-in tree that can touch the line

- Tree distance color coding
  - Thin red lines: Spans that have more than 15 fall-in trees within 6 ft of the line
  - Thin orange lines: Spans that have 6 to 15 fall-in trees within 6 ft of the line
  - Thin yellow lines: Spans that have 1 to 5 fall-in trees within 6 ft of the line
  - Thin green lines: Spans that have zero 15 fall-in tree within 6 ft of the line

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Tree Count Line Color	
> 15	(red)
6 – 15	(orange)
1 – 5	(yellow)
0	(green)

Tree within 6 ft Counts
"Trees 6ft" Layer (thin lines)
e.g., Green means there is no tree within 6' in this span

Tree Strike Counts
"Spans" Layer (thick lines)
e.g., Orange means there are between 6-15 trees that can touch this span

Tree Locations
"Trees" Layer
(Purple means tree > 6ft)
(Grey means tree ≤ 6ft)

Pole Locations
"Poles" Layer
(Black square)

4

- Tree strike threat calculation
  - Tree counts that can touch the non-hardened line
- Residual risk calculation

$$= \frac{No.\ of\ Spans\ in\ Threat\ Level}{Total\ Spans} \times Weight\ Factor$$

Keswick 1101

Threat Level	Trees Touching Non-Hardened (No. of spans)	Linear Span Length (miles)	Tree Strike Residual Risk	
			Weight Factor	Non-Hardened
High (15+ trees)	17	1.04	1	0.014
Medium (5-15 trees)	133	6.04	0.75	0.079
Low (1-5 trees)	459	19.36	0.50	0.182
None	650	24.84	0	0.000
Total:	1,259	51.28		0.275

Konocti 1102

Threat Level	Trees Touching Non-Hardened (No. of spans)	Linear Span Length (miles)	Tree Strike Residual Risk	
			Weight Factor	Non-Hardened
High (15+ trees)	540	28.01	1	0.208
Medium (5-15 trees)	629	30.78	0.75	0.182
Low (1-5 trees)	775	36.46	0.50	0.150
None	647	29.90	0	0.000
Total:	2,591	125.15		0.540

Mariposa 2102

Threat Level	Trees Touching Non-Hardened (No. of spans)	Linear Span Length (miles)	Tree Strike Residual Risk	
			Weight Factor	Non-Hardened
High (15+ trees)	110	7.99	1	0.024
Medium (5-15 trees)	1,063	61.44	0.75	0.174
Low (1-5 trees)	2,382	123.21	0.50	0.260
None	1,032	52.18	0	0.000
Total:	4,587	244.82		0.457

Upper Lake 1101

Threat Level	Trees Touching Non-Hardened (No. of spans)	Linear Span Length (miles)	Tree Strike Residual Risk	
			Weight Factor	Non-Hardened
High (15+ trees)	75	4.76	1	0.087
Medium (5-15 trees)	228	13.30	0.75	0.199
Low (1-5 trees)	333	18.44	0.50	0.194
None	223	11.10	0	0.000
Total:	859	47.61		0.480

RESULTS 2/2

- Tree strike threat calculation
  - Tree counts that can touch the non-hardened line
- Residual risk calculation

$$= \frac{No.\ of\ Spans\ in\ Threat\ Level}{Total\ Spans} \times Weight\ Factor$$

Bucks Creek 1101

Threat Level	Trees Touching Non-Hardened (No. of spans)	Linear Span Length (miles)	Tree Strike Residual Risk	
			Weight Factor	Non-Hardened
High (15+ trees)	13	0.74	1	0.078
Medium (5-15 trees)	51	2.35	0.75	0.229
Low (1-5 trees)	60	2.36	0.50	0.180
None	43	1.78	0	0.000
Total:	167	7.23		0.487

Middletown 1102

| Threat Level	Trees Touching Non-Hardened (No. of spans)	Linear Span Length (miles)	Tree Strike Residual Risk	
			Weight Factor	Non-Hardened
High (15+ trees)	4	0.34	1	0.005
Medium (5-15 trees)	47	2.61	0.75	0.042
Low (1-5 trees)	325	14.39	0.50	0.192
None	471	19.61	0	0.000
Total:	847	36.95		0.238

Middletown 1103

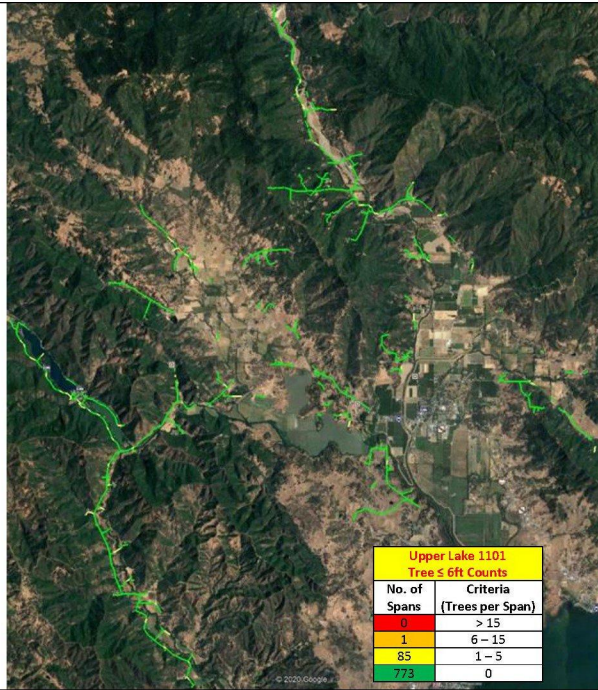| Threat Level	Trees Touching Non-Hardened (No. of spans)	Linear Span Length (miles)	Tree Strike Residual Risk	
			Weight Factor	Non-Hardened
High (15+ trees)	15	1.44	1	0.045
Medium (5-15 trees)	60	4.33	0.75	0.136
Low (1-5 trees)	115	7.11	0.50	0.174
None	141	8.54	0	0.000
Total:	331	21.43		0.355

Upper Lake 1101

- * - Spans.kmz
- Based on 2019 LiDAR
- Trees that can touch the line
  - 75 spans have more than 15 trees in each span that can strike
  - 228 spans have 6 – 15 trees in each span that can strike
  - 333 spans have 1 – 5 trees in each span that can strike
  - 223 spans have zero tree in each span that can strike
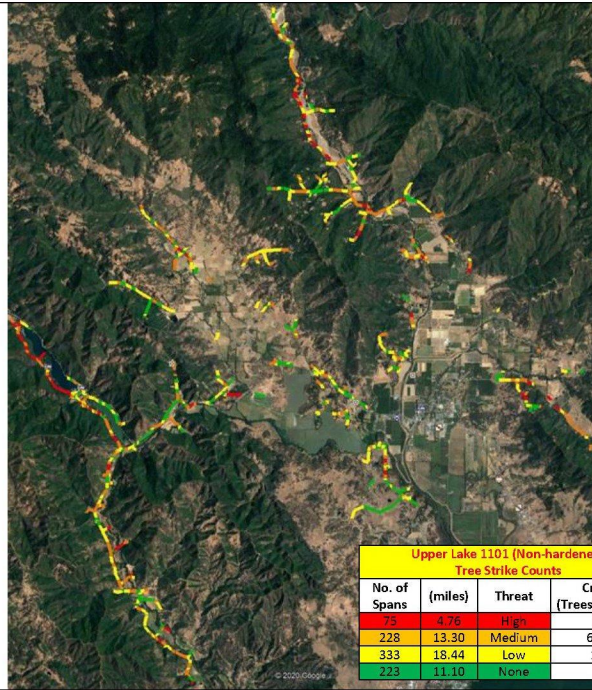
Upper Lake 1101 (Non-hardened) Tree Strike Counts			
No. of Spans	(miles)	Threat	Criteria (Trees per Span)
75	4.76	High	> 15
228	13.30	Medium	6 – 15
333	18.44	Low	1 – 5
223	11.10	None	0

- * - Trees 6ft.kmz
- Trees that are within 6 ft of line
  - 0 span have more than 15 trees in each span that are within 6 ft
  - 1 span have 6 – 15 trees in each span that are within 6 ft
  - 85 spans have 1 – 5 trees in each span that are within 6 ft
  - 773 spans have zero tree in each span that are within 6 ft

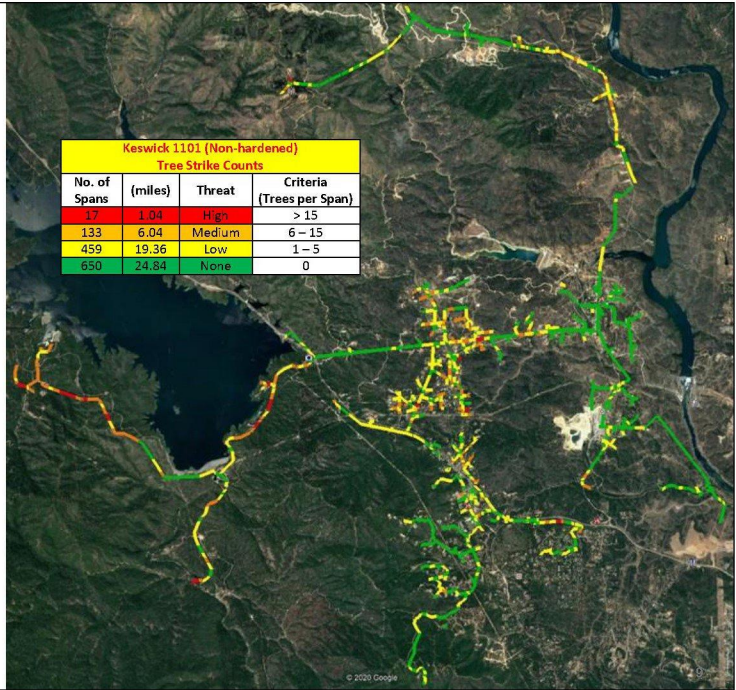| Upper Lake 1101 Tree ≤ 6ft Counts	
No. of Spans	Criteria (Trees per Span)
0	> 15
1	6 – 15
85	1 – 5
773	0

Keswick 1101

- * - Spans.kmz
- Based on 2019 LiDAR
- Trees that can touch the line
  - 17 spans have more than 15 trees in each span that can strike
  - 133 spans have 6 – 15 trees in each span that can strike
  - 459 spans have 1 – 5 trees in each span that can strike
  - 650 spans have zero tree in each span that can strike

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Keswick 1101 (Non-hardened) Tree Strike Counts			
No. of Spans	(miles)	Threat	Criteria (Trees per Span)
17	1.04	High	> 15
133	6.04	Medium	6 – 15
459	19.36	Low	1 – 5
650	24.84	None	0

- * - Trees 6ft.kmz
- Trees that are within 6 ft of line
  - 0 span have more than 15 trees
    in each span that are within 6 ft
  - 0 span have 6 – 15 trees
    in each span that are within 6 ft
  - 8 spans have 1 – 5 trees
    in each span that are within 6 ft
  - 1,251 spans have zero tree
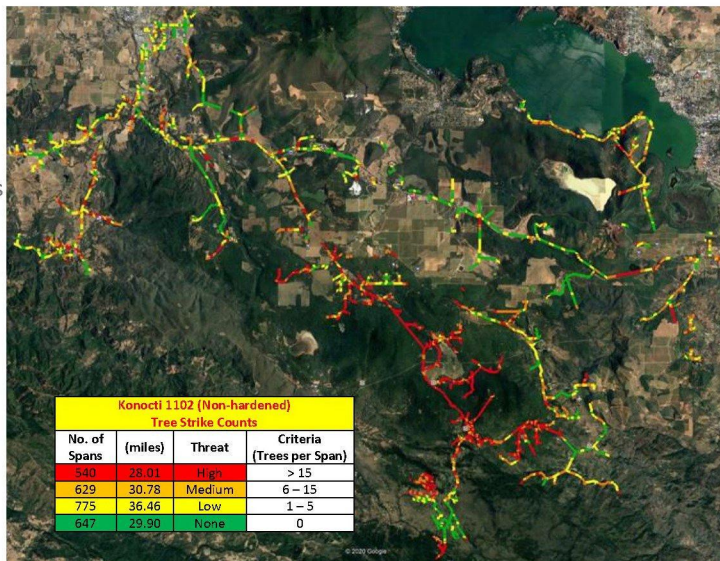   in each span that are within 6 ft
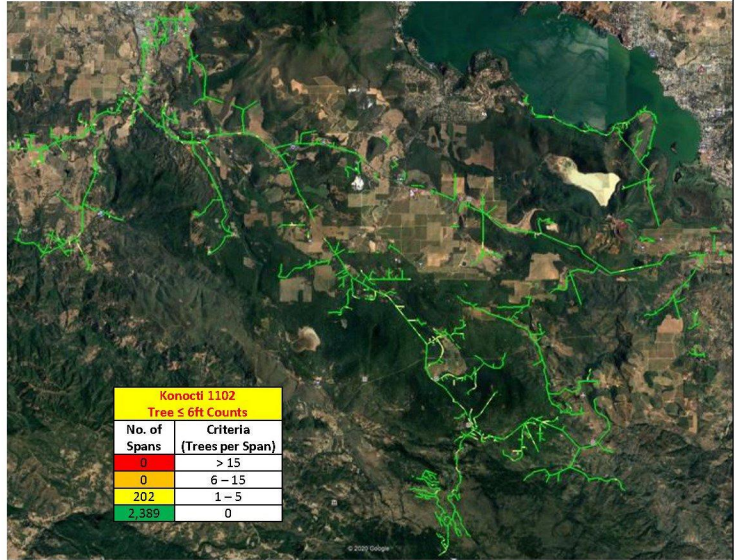
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No. of Spans	Criteria (Trees per Span)
0	> 15
0	6 – 15
8	1 – 5
1,251	0
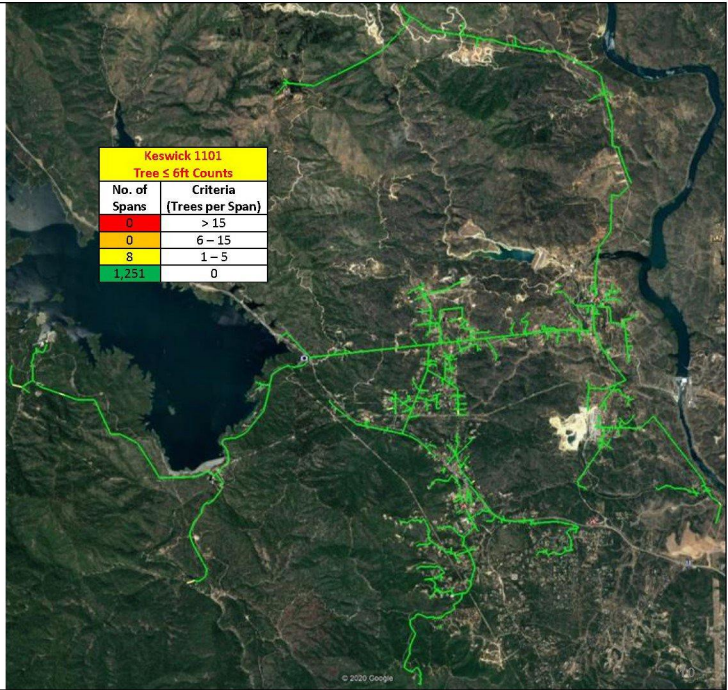
Keswick 1101
Tree ≤ 6ft Counts

Konocti 1102

- * - Spans.kmz
- Based on 2019 LiDAR
- Trees that can touch the line
  - 540 spans have more than 15 trees in each span that can strike
  - 629 spans have 6 – 15 trees in each span that can strike
  - 775 spans have 1 – 5 trees in each span that can strike
  - 647 spans have zero tree in each span that can strike

Konocti 1102 (Non-hardened)
Tree Strike Counts

No. of Spans	(miles)	Threat	Criteria (Trees per Span)
540	28.01	High	> 15
629	30.78	Medium	6 – 15
775	36.46	Low	1 – 5
647	29.90	None	0

- * - Trees 6ft.kmz
- Trees that are within 6 ft of line
  - 0 span have more than 15 trees
    in each span that are within 6 ft
  - 0 span have 6 – 15 trees
    in each span that are within 6 ft
  - 202 spans have 1 – 5 trees
    in each span that are within 6 ft
  - 2,389 spans have zero tree
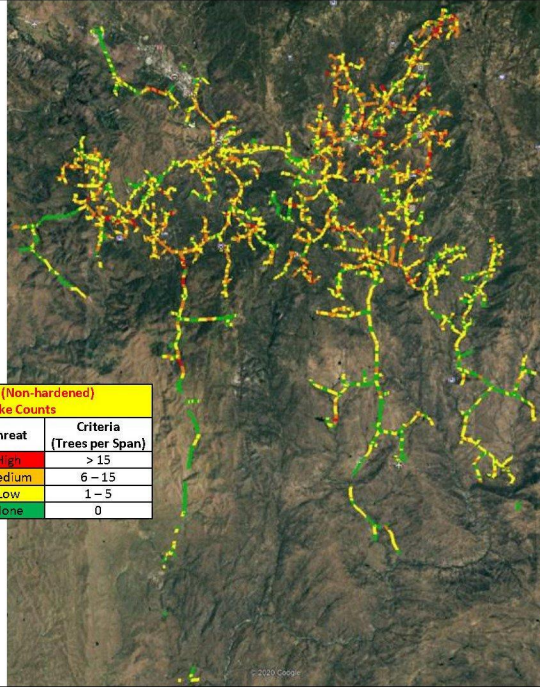   in each span that are within 6 ft

| Konocti 1102 Tree ≤ 6ft Counts	
No. of Spans	Criteria (Trees per Span)
0	> 15
0	6 – 15
202	1 – 5
2,389	0

Mariposa 2102

- * - Spans.kmz
- Based on 2019 LiDAR
- Trees that can touch the line
  - 110 spans have more than 15 trees in each span that can strike
  - 1,063 spans have 6 – 15 trees in each span that can strike
  - 2,382 spans have 1 – 5 trees in each span that can strike
  - 1,032 spans have zero tree in each span that can strike

Mariposa 2102 (Non-hardened)
Tree Strike Counts

No. of Spans	(miles)	Threat	Criteria (Trees per Span)
110	7.99	High	> 15
1,063	61.44	Medium	6 – 15
2,382	123.21	Low	1 – 5
1,032	52.18	None	0

- * - Trees 6ft.kmz
- Trees that are within 6 ft of line
  - 0 span have more than 15 trees
    in each span that are within 6 ft
  - 0 span have 6 – 15 trees
    in each span that are within 6 ft
  - 71 spans have 1 – 5 trees
    in each span that are within 6 ft
  - 4,516 spans have zero tree
    in each span that are within 6 ft

Mariposa 2102 Tree ≤ 6ft Counts	
No. of Spans	Criteria (Trees per Span)
0	> 15
0	6 – 15
71	1 – 5
4,516	0
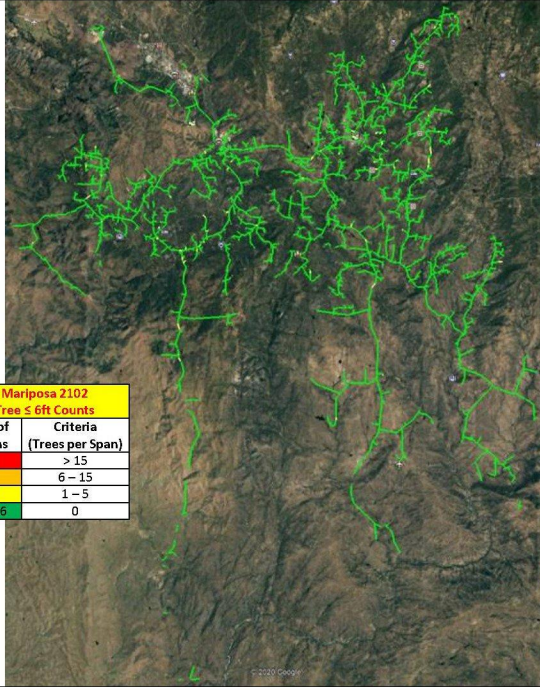
Bucks Creek 1101

- * - Spans.kmz
- Based on 2019 LiDAR
- Trees that can touch the line
  - 13 spans have more than 15 trees in each span that can strike
  - 51 spans have 6 – 15 trees in each span that can strike
  - 60 spans have 1 – 5 trees in each span that can strike
  - 43 spans have zero tree in each span that can strike

Bucks Creek 1101 (Non-hardened) Tree Strike Counts			
No. of Spans	(miles)	Threat	Criteria (Trees per Span)
13	0.74	High	> 15
51	2.35	Medium	6 – 15
60	2.36	Low	1 – 5
43	1.78	None	0

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- * - Trees 6ft.kmz
- Trees that are within 6 ft of line
  - 0 span have more than 15 trees
    in each span that are within 6 ft
  - 0 span have 6 – 15 trees
    in each span that are within 6 ft
  - 4 spans have 1 – 5 trees
    in each span that are within 6 ft
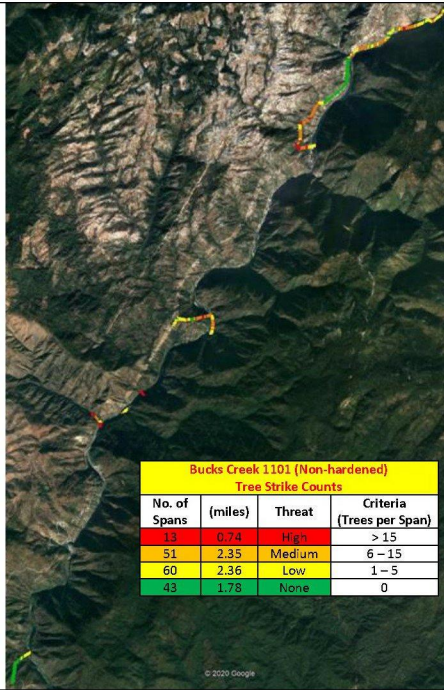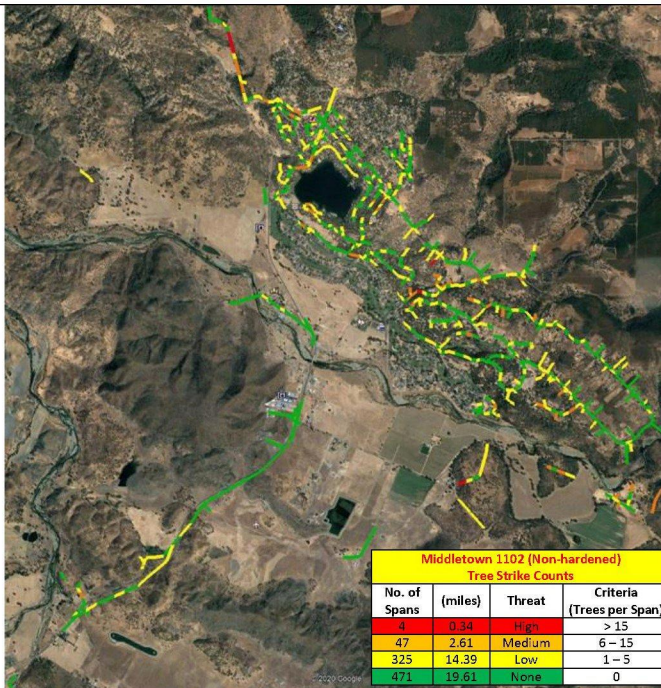 - 163 spans have zero tree
    in each span that are within 6 ft

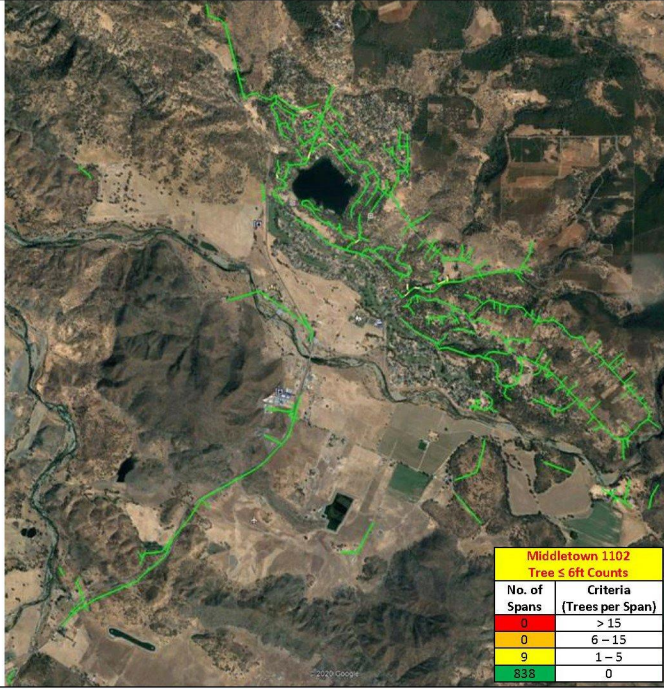| Bucks Creek 1101 Tree ≤ 6ft Counts	
No. of Spans	Criteria (Trees per Span)
0	> 15
0	6 – 15
4	1 – 5
163	0

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Middletown 1102

- * - Spans.kmz
- Based on 2019 LiDAR
- Trees that can touch the line
  - 4 spans have more than 15 trees in each span that can strike
  - 47 spans have 6 – 15 trees in each span that can strike
  - 325 spans have 1 – 5 trees in each span that can strike
  - 471 spans have zero tree in each span that can strike

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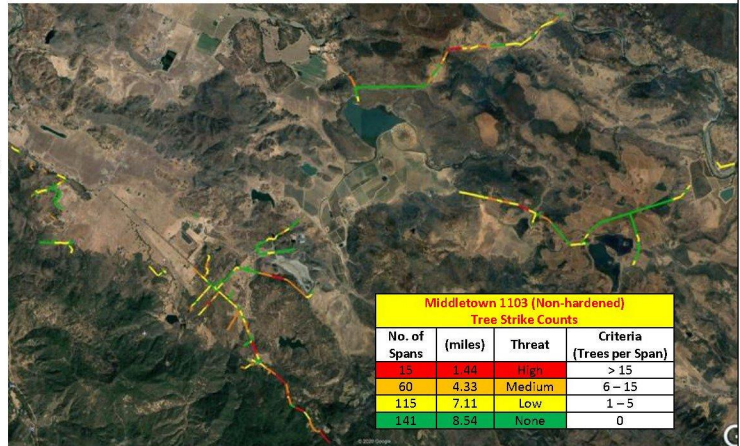| Middletown 1102 (Non-hardened) Tree Strike Counts			
No. of Spans	(miles)	Threat	Criteria (Trees per Span)
4	0.34	High	> 15
47	2.61	Medium	6 – 15
325	14.39	Low	1 – 5
471	19.61	None	0

- * - Trees 6ft.kmz
- Trees that are within 6 ft of line
  - 0 span have more than 15 trees
    in each span that are within 6 ft
  - 0 span have 6 – 15 trees
    in each span that are within 6 ft
  - 9 spans have 1 – 5 trees
    in each span that are within 6 ft
  - 838 spans have zero tree
    in each span that are within 6 ft

Middletown 1102
Tree ≤ 6ft Counts

No. of Spans	Criteria (Trees per Span)
0	> 15
0	6 – 15
9	1 – 5
838	0

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Middletown 1103

- * - Spans.kmz
- Based on 2019 LiDAR
- Trees that can touch the line
  - 15 spans have more than 15 trees in each span that can strike
  - 60 spans have 6 – 15 trees in each span that can strike
  - 115 spans have 1 – 5 trees in each span that can strike
  - 141 spans have zero tree in each span that can strike

Middletown 1103 (Non-hardened)
Tree Strike Counts

No. of Spans	(miles)	Threat	Criteria (Trees per Span)
15	1.44	High	> 15
60	4.33	Medium	6 – 15
115	7.11	Low	1 – 5
141	8.54	None	0

- * - Trees 6ft.kmz
- Trees that are within 6 ft of line
  - 0 span have more than 15 trees in each span that are within 6 ft
  - 0 span have 6 – 15 trees in each span that are within 6 ft
  - 5 spans have 1 – 5 trees in each span that are within 6 ft
  - 326 spans have zero tree in each span that are within 6 ft

Middletown 1103
Tree ≤ 6ft Counts

No. of Spans	Criteria (Trees per Span)
0	> 15
0	6 – 15
5	1 – 5
326	0