

# The Sound of Science: Acoustic Monitoring and Occupancy Modeling of Songbirds in the Olympic Experimental State Forest

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## Background

Intensely managed forests can truncate habitat window, decrease area, or fragment home ranges for birds and other species

In the Olympic Experimental State Forest, DNR aims to integrate ecological health and timber production, requiring understanding species response to forest management techniques

Passive acoustic monitoring is an efficient method to observe soundscape DNR placed recording devices in the OESF across 4 forest stages to collect acoustic data



Figure 1. Acoustic recording unit affixed to a tree



Figure 2. Study area. Survey regions in orange. Olympic Experimental State Forest

Do Pacific-slope Flycatcher and Orange-crowned Warbler occupy forest stage areas in the OESF according to known habitat associations?

## Internship & Methods

Process surveys by viewing spectrograms and listening to audio in Audacity software. Validate and annotate target species vocalizations, aircraft, and rain events

Model occupancy of Pacific-slope Flycatcher & Orange-crowned Warbler using variables of occupancy: strata, time period, and detection probability: aircraft, rain, Julian day

Literature review investigating habitat associations for Pacific-slope Flycatcher and Orange-crowned Warbler

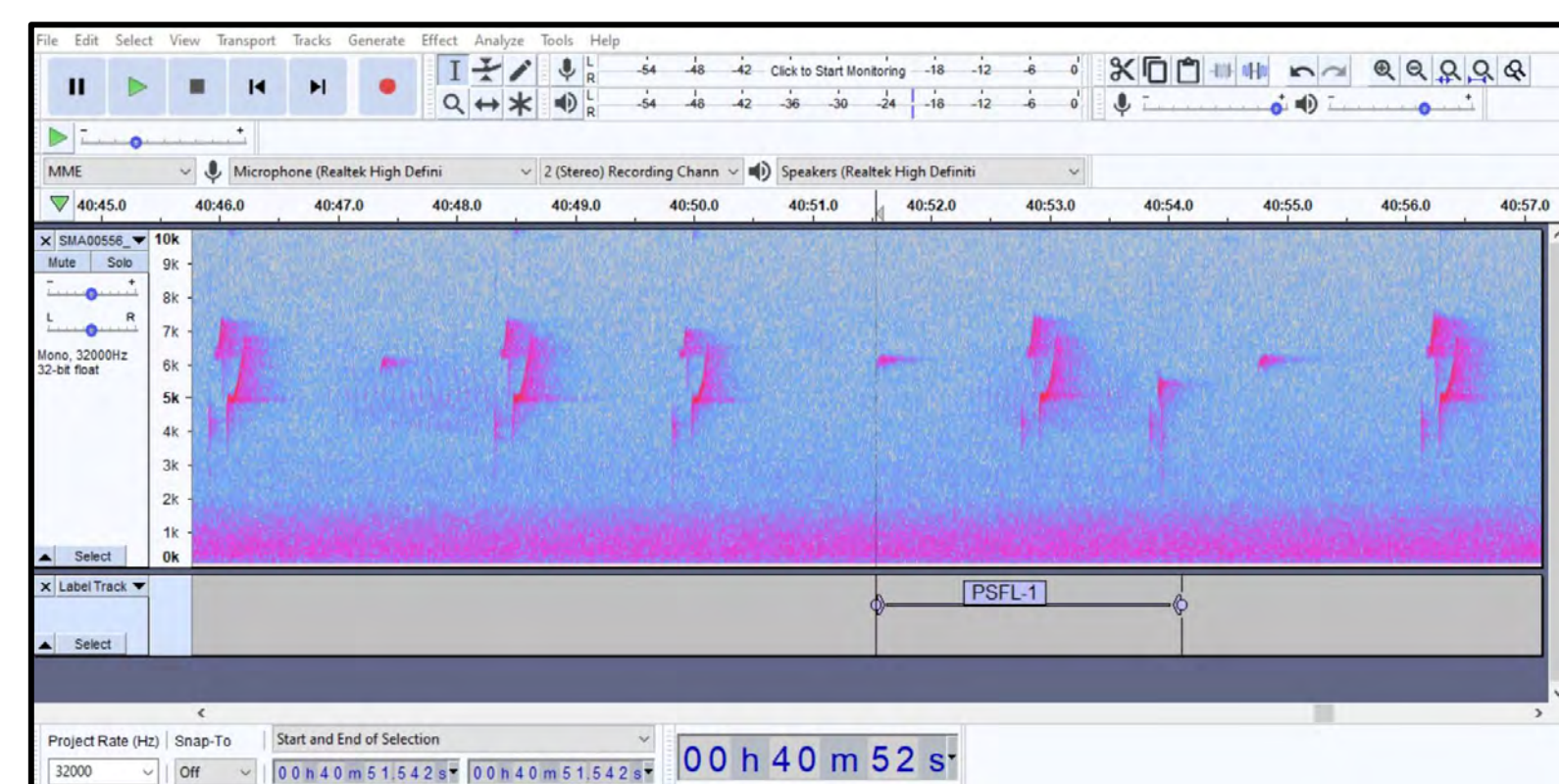


Figure 3. Spectrogram view of survey in Audacity showing 3-syllable song of Pacific-slope Flycatcher

When monitoring presence or absence, species may go undetected despite being present. **Occupancy models** help account for imperfect detection

Data from **86 stations** and **4 repeat** surveys per station

## Results



Figure 4. Pacific-slope Flycatcher

Known habitat association: mature forest: mixed conifer & deciduous canopy, large snags, riparian areas

Naïve occupancy 70%  
 Model occ estimate 71%  
 Detection probability 65%

Strata strong predictor of occ.  
 Rain had slight negative effect on detection probability  
 Aircraft & Julian day had slight positive effect on detection probability



Figure 6. Orange-crowned Warbler

Known habitat association: early-seral forest with abundant deciduous shrub layer

Naïve occupancy 10%  
 Model occ estimate 11%  
 Detection probability 53%

Strata strong predictor of occ.  
 Aircraft slight positive effect on detection probability  
 Julian day and rain had slight negative effect

### PACIFIC-SLOPE FLYCATCHER OBSERVATIONS BY FOREST STAGE



Figure 5. Bar graph illustrating PSFL detection (presence) at each forest stage

Table 1. Top 5 best-fit models for Pacific-slope Flycatcher

Model	ΔAIC	AICw	K
$\Psi(\text{STRATA}, \text{PERIOD}), P(\text{Aircraft}, \text{Rain}, \text{JulianDay})$	0.00	.9983	9
$\Psi(\cdot), P(\text{Aircraft}, \text{Rain}, \text{JulianDay})$	12.83	.0016	5
$\Psi(\text{STRATA}), P(\text{Rain})$	22.02	0	6
$\Psi(\cdot), P(\text{Rain})$	27.24	0	3
$\Psi(\cdot), P(\text{Aircraft}, \text{Rain})$	27.93	0	4

### ORANGE-CROWNED WARBLER OBSERVATIONS BY FOREST STAGE



Figure 7. Bar graph illustrating OCWA detection (presence) at each forest stage

Table 2. Top 5 best-fit models for Orange-crowned Warbler

Model	ΔAIC	AICw	K
$\Psi(\text{STRATA}), P(\cdot)$	0.00	.3642	5
$\Psi(\text{STRATA}), P(\text{Aircraft})$	1.4	.1809	6
$\Psi(\text{STRATA}, \text{PERIOD}), P(\cdot)$	1.62	.162	6
$\Psi(\text{STRATA}), P(\text{Rain})$	1.82	.1466	6
$\Psi(\text{STRATA}), P(\text{JulianDay})$	2.0	.134	6

## Takeaways

Forest stage is important variable in predicting site occupancy

Rain and aircraft events had some effect on detection probability

Use of forest management areas by these two species consistent with expected habitat associations

Pacific-slope Flycatcher observations were higher than Orange-crowned Warbler



Figure 8. Early seral near forest edge, OESF



Figure 9. Recently thinned area, OESF

## Significance

Acoustic monitoring is effective method for observing songbirds in the OESF

Future occupancy modeling may investigate species use at finer site-level scales

With many songbird populations declining, forest management is an opportunity to enhance and protect ecosystem health and wildlife habitat