Project Title: Seward Old-Growth Forest Hemlock Survey & Youth Training

Investigators: (Name, affiliation, email)
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Project Summary (500 words max):

Western Hemlocks (Tsuga heterophylla) in the old-growth forest at Seward Park appear to be diseased and dying at higher than historical and background rates. WSU plant pathologist Marianne Elliott, UW ecologist Tim Billo, and forest steward Paul Shannon toured the forest on April 9th 2021, formulating the hemlock survey here proposed.

The mortality and decline of Seward Park hemlocks we observed is not an isolated event. Western Red Cedar decline is a focus of Joseph Hulbert's WSU Forest Watch project. Broad regional decline of multiple species is described in a recent Nature article (Stanke et al, 2021)[1] in which decades of USFS Forest Inventory and Analysis (FIA) data are complemented by the authors' Forest Stability Index (FSI). The proposed Seward Hemlock survey is inspired by, will adopt methods from, and offer results to both of these projects.

Environmental decline is not our only concern. The last year has focused our minds, and the minds of many, on the historical roots and present day persistence of racism and systematic inequity in the United States and in our own community. This problem takes many forms, including high incarceration rates and social immobility - the "new Jim Crow"[2]. It is manifest in in the low number of young people of color in science and engineering educational programs and in STEM professions.

As a minor but not inconsequential effort to contribute on both of these fronts, The Friends of Seward Park (FoSP) has joined with CHOOSE 180[3] - a King County jail diversion program for at-risk youth - securing a $4500 Department of Neighborhoods grant[4] to employ at-risk youth for four to six weeks this summer. 90% of the grant funds will be used for youth wages. We will train them in methods of forest monitoring and data analysis, and introduce them to the natural history of the rare remnant PNW lowland early old-growth forest found at Seward Park. Four to six young adults will be hired, supervised by FoSP board member and Green Seattle Partnership forest steward Paul Shannon, advised by plant pathologist Elliott and ecologist Billo, with the advice and consent of Seattle Parks plant ecologists.

Site Selection (500 words max):

The USFS Forest Inventory and Analysis Program[5], and some Green Seattle Partnership long- term monitoring[6] projects use small randomly placed circular plots for their surveys. The FIA protocol combines four subplots within a larger circle, totaling 1/6 of an acre, sometimes also containing micro-plots[6]. Some GSP plots at Seward employ small radius circles. Transects have been used also.

Our goals overlap with, but also extend beyond these projects, leading us to select a relatively large (4.6 acre, 1.8 hectare) site, roughly oval in shape, at the center of the forest, bounded by the sqebeqsed and Windfall trails:

The three project goals:

1. Establish a hemlock demographic baseline in a hemlock-rich area containing a large number of both healthy and diseased trees.
2. Obtain affected plant tissue for analysis by Marianne Elliot from short, easily-reached hemlock boughs.
3. Offer a mostly intact, heterogeneous and ecologically rich forest area, of tractable study size, in which students can learn many aspects of the natural history of an old-growth PNW lowland forest, as they acquire competence in some methods of field biology and data analysis.

The selected site meets all three criteria. It is 4.6 acres (1.8 hectare), mostly flat, bounded neatly and unambiguously by two established trails. This centrally located forest region is somewhat isolated from edge effects and high traffic user impacts, thereby possibly reducing a multitude of confounding variables that might affect the dynamics of the forest. The survey should give us a reliable, if conservative, estimate of the extent of disease in Seward Park's hemlocks. Furthermore, the peninsula-wide sword fern die-off has thus far had a low impact in this area (2% mortality as of January 2019). Douglass squirrels, evergreen huckleberry, and large fallen Douglas firs identify it as a good and largely still healthy representative of the early old growth Puget lowland forest.

Sampling (and other related) Methods (500 words max):

Forest Inventory and Analysis (FIA) Phase 2 field data [7] will be collected. Since this is the first survey, relevant FIA-2 measures for all live, dead, and fallen hemlocks include:

1. DBH
2. Tree height
3. Gross tree damage (see Elliott-recommended protocol below for finer assay)
4. Stand characteristics: forest type, stand age, gross disturbance (i.e., wind damage). We will seek advice on the level of discrimination to apply.

As with site selection, our survey and sampling methods will be shaped by the nature of our workforce. Young adults from CHOOSE 180 will likely be scientifically naive at the start of the project. This modest disadvantage is offset by our generous schedule: the DoN grant provides funding for at least 4 weeks, 16 hours per week, for 2-4 youths.

We will therefore use a slow-paced, staged methodology with careful instruction at each stage, and including these activities:

- Species identification
- Temporary tree flagging
- DBH and height measurement of approximately 80 trees, all sizes, dead and alive (FIA protocol: tree height, DBH, all trees > 1 inch.
- Health assessment via needle distribution (crown, middle, base) adapting (per Marianne Elliott) the Dwarf Mistletoe Rating system (DMR), substituting defoliation for mistletoe infection[8].
- Close observation, measurement and photography of selected affected needles and twigs, with guidance from Marianne Elliott, leading to sample collection and laboratory analysis at WSU Puyallup, from which insights into causality may emerge.
- As youth interest and aptitude permits, time will be devoted to statistical analysis of the emerging data, uploading photos and measurements to Forest Watch iNaturalist, and mapping.
- Small side projects in traditional forest stewardship may be included as well to break the routine. Subject to GSP stewardship event permission processes, we may address social trail closing, ivy removal, watering, and documenting a representative sample of the recent (spring 2021) contractor restoration planting.

Data Analysis (300 words max):

Weekly FIA-style “trees per acre/hectare” (TPA, TPH) summary statistics on all observed trees, supporting QC on data thus far collected in the field. Spatial analysis of the distribution of live/dead, healthy/affected trees, and their sizes will be run as the data accumulates, looking for patterns which may offer insight into decline processes. Full dataset analyses (summary statistics and spatial distribution) will occur at the project’s conclusion.

Data Management (100 words max):

Incremental storage of tabular data on my Institute of Systems Biology computers systems, from which it can be easily exported in any number of formats and to any location (such as Seattle Parks computers).
Photos will accumulate on my Apple cloud storage account.

Project Timeline (100 words max):

- Mid-June 2021: CHOOSE 180 workers selected
- Late June: work begins with an introduction to the forest and elementary data analysis
- Week 1: species identification learned, hemlocks get temporary landscape pin flags
- Week 2: DBH measurements, initial health assessment
- Week 3: Clinometry-based tree height estimation, detailed health assessment via crown/middle/base needle distributions
- Week 4: Close observation, measurement and photography of selected affected needles and twigs, adapting (per Marianne Elliott) the Dwarf Mistletoe Rating system (DMR), substituting defoliation for mistletoe infection[9].
- Ongoing: As youth interest and aptitude permits, statistical, graphical and map-based exploration of the accumulating data, uploading photos and data to iNaturalist
- Ongoing: small side projects in traditional forest stewardship, managed via GSP CEDAR events.

Project Participants:

- Paul Shannon, bioinformatican, GSP volunteer forest steward
- 2-4 youth from the CHOOSE 180 program
- CHOOSE 180 managers on call as needed
- Marianne Elliott and Tim Billo: scientific advisors

Loan of Equipment from Seattle Parks (if available)

1. 4 GSP orange vests
2. 2 Clinometers (UW also a possibility)
3. 2 DBH tapes (ditto)

Are any of the investigators volunteers?

Yes___X_____ No_____

If Yes, please contact Lisa.Ciecko@seattle.gov to complete a Volunteer registration form

Budget

Expense	Details	Type	Cost
Wages (from DoN grant)	**2-6 youths, Seattle minimum wage, 4 days per week, 4 hours per day, until the budget is exhaused**	**Labor**	$3650
GPS (grant match donation)	**For tree geolocation**	**Capital**	**0**
Consulting	**Tim Billo**		**$500**
Grant Management, Fiscal Sponsor Fee	**Insurance etc, required by DoN grant, provided by the Seattle Parks Foundation**		**$360**
Total:			**$ 4500**

Deliverables (100 words max):

At the conclusion of the study we will produce and archive per-acre and per-hectare (TPA and TPH) statistics following the data schema of the US Forest Service Forest Inventory and Analysis Project. FoSP github repositories, Forest Watch iNaturalist web site, and Seattle Parks archives will be used.

These data will provide a baseline for future repeat surveys of the plot, as well as other possible surveys at Seward. We will attempt to apply the forest stability index (FSI) proposed by Stanke et al, to track change over time. Other metrics will be considered.

Finally, with sufficient youth interest, we will submit a research note to *Douglasia*[10], the journal of the Washington Native Plant Society. Such a submission would be a fitting capstone to the CHOOSE 180 youths' summer.

Literature Cited (optional):

1. Stanke, Hunter, et al. "Over half of western United States' most abundant tree species in decline." *Nature Communications* 12.1 (2021): 1-11.
2. Alexander, Michelle, Penny Holmes, and Alice Green. "The new Jim Crow: Mass incarceration in the age of Colorblindness" (2012).
3. https://choose180.org
4. https://www.seattle.gov/neighborhoods/programs-and-services/neighborhood-matching-fund/
5. https://www.fia.fs.fed.us/
6. https://www.greenseattle.org/gsp-long-term-monitoring-tells-a-story-of-improving-forest- health/
7. https://www.fia.fs.fed.us/library/fact-sheets/data-collections/Sampling%20and%20Plot%20Design.pdf
8. https://www.fia.fs.fed.us/library/fact-sheets/data-collections/Phase2_3.pdf
9. https://forestpathology.org/parasitic-plants/dwarf-mistletoe/ecology/
10. https://www.wnps.org/douglasia