Reed Canarygrass Research Program

2021 Findings and Results: Wilson Creek

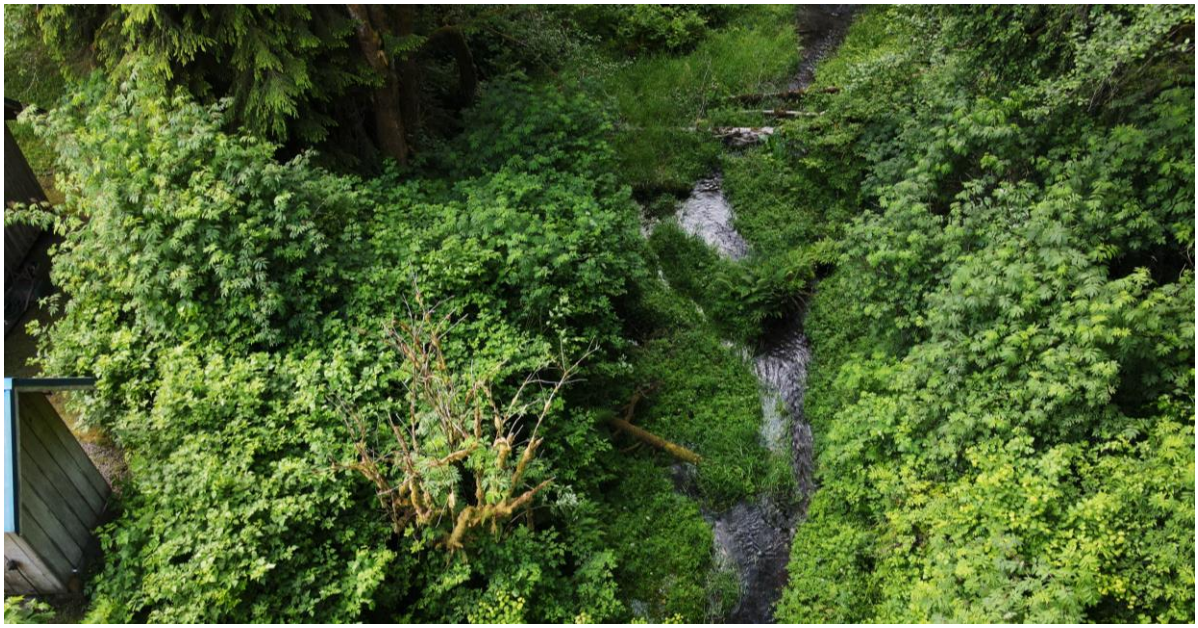
10,000 Years Institute

November 2021

Project Coordinator – Celia Thurman

Research Assistants – Lara Hakam, Onyx Yskamp, Miguel Rodriguez

Field Technicians – Seth Miles, Mathew Nichols



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Overview

The Reed Canarygrass Research Program (RCRP) goals are to observe and quantify the effects of an invasive grass, *Phalaris arundinacea* (reed canarygrass; RCG) on water quality and ecosystem function in small coastal streams of the Olympic Peninsula. RCG threatens aquatic ecosystems with its ability to rapidly colonize streams and wetlands via seed, rhizome, or vegetative fragments. The species acts as an 'ecosystem engineer' by creating dense, sod-forming monocultures. [1,2]

Data collected in the field consists of stream and air temperature, dissolved oxygen (DO), photosynthetic active radiation (PAR), canopy cover, vegetative character, stream velocity, and substrate composition. Regularly scheduled sampling occurred from spring to late fall as field conditions allowed. Temperature data is collected year-round. The data summarized in this report was collected between April 21 and November 2, 2021.

The RCRP is currently collecting data in two streams: Wilson Creek and Irely Creek. Wilson Creek, a tributary to the Bogachiel River within the Quillayute watershed (WRIA 20), was the focus of the original pilot study in 2019 and is in its third year of data collection. Monitoring data and results are reported for both streams, available at www.10000yearsinstitute.org.

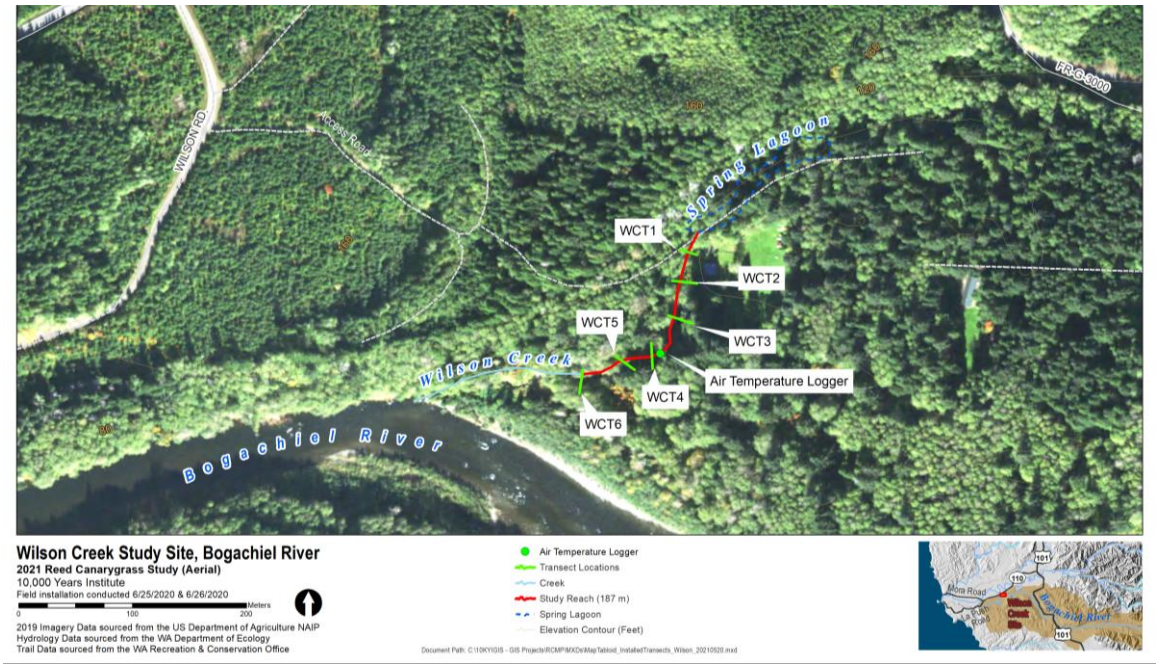

Figure 4. The Wilson Creek study reach is emphasized in red and the six cross-stream transects are marked in green.

[1] [JCNWCB] Jefferson County Noxious Weed Control Board. (n.d). **Best Management Practice: Reed Canarygrass (Phalaris arundinacea).** *Jefferson County Noxious Weed Control Program*. 26 Oct 2021.

[2] Maurer D. A., Lindig-Cisneros R., Werner K. J., Kercher S., Miller R., and Zedler J. B. (2003). **The replacement of wetland vegetation by reed canarygrass (Phalaris arundinacea)**. *Ecological Restoration, 21* (2), 116-119. http://www.jstor.org/stable/43442677. Accessed Feb. 15 2018.

Site Conditions and Site Visits

Crew: Celia Thurman, Miguel Rodriguez, Mathew Nichols, Seth Miles, Onyx Yskamp, Lara Hakam
Site Visits: April 21, May 5, May 20, June 16, July 7, July 19, August 3, August 13, August 24, September 15, October 1, October 11, and October 29.

The conditions of Wilson Creek have remained sufficient for most sampling purposes throughout 2021. Thirteen bi-monthly sampling visits were made to the site this year. Each visit generally consisted of sampling field temperature, dissolved oxygen (DO), flow velocity, and photosynthetic active radiation (PAR) or canopy coverage. These measurements were collected in six locations throughout the reach, at each of the cross-stream riparian transects.

- Temperature data was uploaded once per month from the HOBO Pendant™ data loggers throughout our field season (*Figure 6*). The equipment remains in Wilson Creek for data collection throughout winter 2021-2022.
- Dissolved oxygen was collected using an optical meter (Hanna Instruments Model 98198) near each temperature logger (*Figure 5*).
- Flow velocity was measured near each transect, in areas of sufficient depth and minimal flow interference (e.g. avoiding downed wood or sharp channel bends). A Swoffer flow meter (Model 3000) was used to calculate depth and flow velocity (ft/s) at numerous intervals across the stream (*Figure 11*). After ten transects were successfully completed, a replicate measurement was collected for quality assurance purposes.
- Light availability was quantified using an Apogee MQ-200™ meter to detect PAR along each riparian transect. This metric was collected at ten equidistant locations along each transect.
- In October 2021, the protocol for estimating canopy cover was changed from measuring PAR to taking hemisphere photos. This protocol will be fully standardized and developed by the 2022 field season.[3]

[3] Andis, A. Z. (2020). "Smartphone hemispherical photography". **A. Z. Andis: Ecology, Evolution, and Conservation**. Web. Accessed 10 Nov 2021. URL: http://www.azandisresearch.com/2020/12/16/smartphone-hemispherical-photography/

Figure 5. Collecting dissolved oxygen data at WCT01.

Figure 6. Downloading temperature data from the in-stream logger at WCT02.

The distribution of reed canarygrass in 2021 throughout Wilson Creek is widespread, with encroachment into the stream's active channel being particularly evident in Transects 2, 5, and 6 (*Figure 7)*. Large woody debris (LWD), combined with the aggressive colonization of RCG, affected representative flow velocity measurements at these three transects, as did summer drought impacts.

Low rates of precipitation during the late summer resulted in very low discharge levels at Wilson Creek, most prominently in September and October. Despite low rainfall, the study reach maintained surface flow due to the steady supply of water from the upstream pond and groundwater inputs.

Figure 7. Looking downstream at Wilson Creek Transect 2 *(left)* and Wilson Creek Transect 5 *(right)* where reed canarygrass is encroaching the stream and constricting stream flow.

Stream and Air Temperatures

Stream and air temperature data were collected at each monitoring point by HOBO Pendant™ temperature loggers between January 1 and November 2, 2021 and summarized by a thermograph.

Differences in sample size for each logger have occurred due to:

- Timing - Deployment date and time of day, vary slightly for each temperature logger.
- Environmental conditions - Data was deleted from the stream temperature logs if the streamflow dropped so that thermographs were exposed to the air and were no longer collecting water temperature data.
- Equipment error - There were a few instances when water loggers stopped working or required replacement.

These differences are reflected by blank space in the thermographs in *Appendix A*. The logger at WCT02 stopped working on October 11 and the logger at WCT04 stopped working on September 26. Both were replaced on November 2. The logger at WCT05 started recording on March 26. Minimum, maximum, and average water and air temperature are summarized below for the time period between the January 1 and the last site visit of the season on November 2, 2021 *(Figure 8, Table 1*).

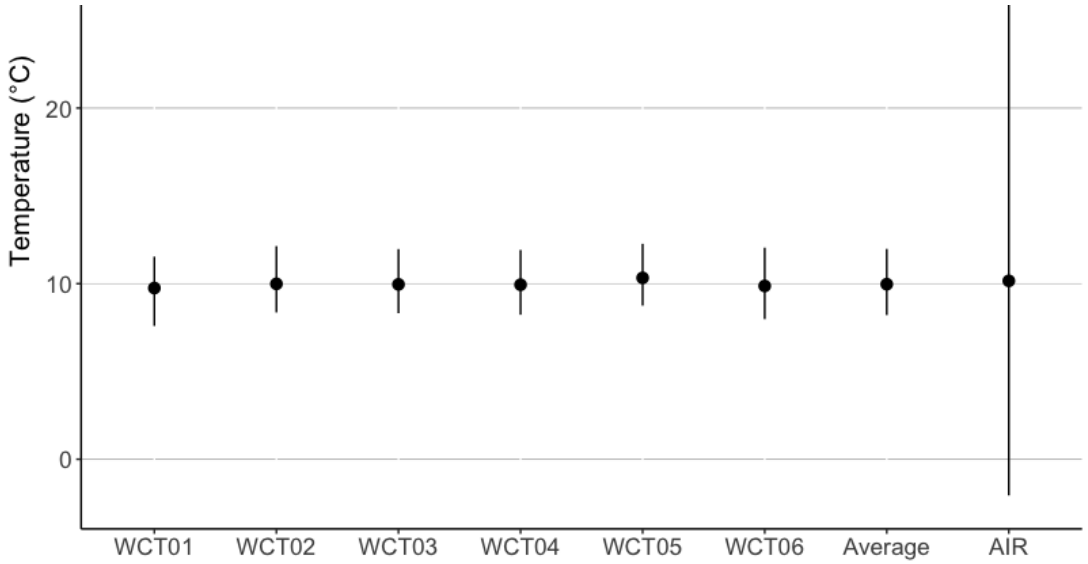

Figure 8. Minimum, maximum, and average stream temperature (°C) for each Wilson Creek Transect (WCT). Points represent water temperature averages, while lines represent the range of minimum and maximum for each transect. "Average" is the average water temperature, minimum, and maximum between all six transects.

Transect	Min Temp. (°C)	Max Temp (°C)	Ave. Temp. (°C)	Std. Dev.	Sample Size (n)	Std. Error
Average	8.21	11.98	9.97	0.54	24455	0.003
WCT01	7.93	11.54	9.81	0.60	21993	0.004
WCT02	8.36	12.14	9.99	0.61	20407	0.004
WCT03	8.32	11.97	9.96	0.23	20787	0.002
WCT04	8.23	11.92	9.94	0.60	19357	0.004

WCT05	8.75	12.27	10.33	0.57	15917	0.005
WCT06	7.98	12.05	9.87	0.63	21987	0.004
AIR	-2.06	36.08	10.16	5.46	21990	0.04

Table 1. Summarized stream and air temperature data (°C) for each Wilson Creek Transect (WCT).

Dissolved Oxygen

Dissolved oxygen (mg/L) was measured and summarized for the seasonal minimum, maximum, and average at each location where data was collected (*Figure 9, Table 2*). Each channel location was sampled thirteen times (*n=13*) between April 21 and October 29, 2021.

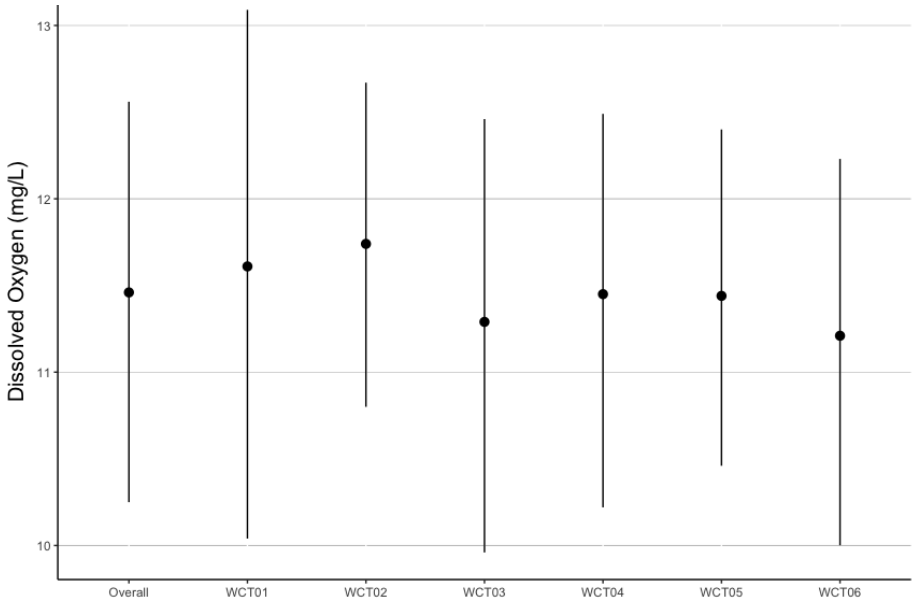

Figure 9. Minimum, maximum, and average dissolved oxygen measurements for each Wilson Creek Transect (WCT) within the study reach. Points on the chart represent averages, while lines represent the range of minimum and maximum for each transect.

Transect	Min. DO (mg/L)	Max. DO (mg/L)	Avg. DO (mg/L)	Std. Dev.	Sample Size (n)	Std. Error
Overall	10.25	12.56	11.46	0.74	13	0.206
WCT01	10.04	13.09	11.61	0.87	13	0.241
WCT02	10.80	12.67	11.74	0.66	13	0.183
WCT03	9.96	12.46	11.29	0.80	13	0.222
WCT04	10.22	12.49	11.45	0.76	13	0.211
WCT05	10.46	12.40	11.44	0.65	13	0.180
WCT06	10.00	12.23	11.21	0.72	13	0.200

Table 2. Summarized dissolved oxygen data (in mg/L) for each Wilson Creek Transect (WCT) within the study reach.

Flow Velocity

Flow velocity (ft/s) was measured during each site visit at 13 to 20 intervals across the stream at each transect (*Figure 10)*. Measurements were collected and averaged to obtain an accurate and representative of stream flow (*Figure 10, Appendix C).* Each transect location was sampled between five and eight times throughout the 2021 season, when the water level was deep enough to submerge the sampling equipment, and the stream was wide enough to get a full sample set of 13-20 measurements. The noticeable gap in collected data is due to the low flow conditions of late-summer drought.

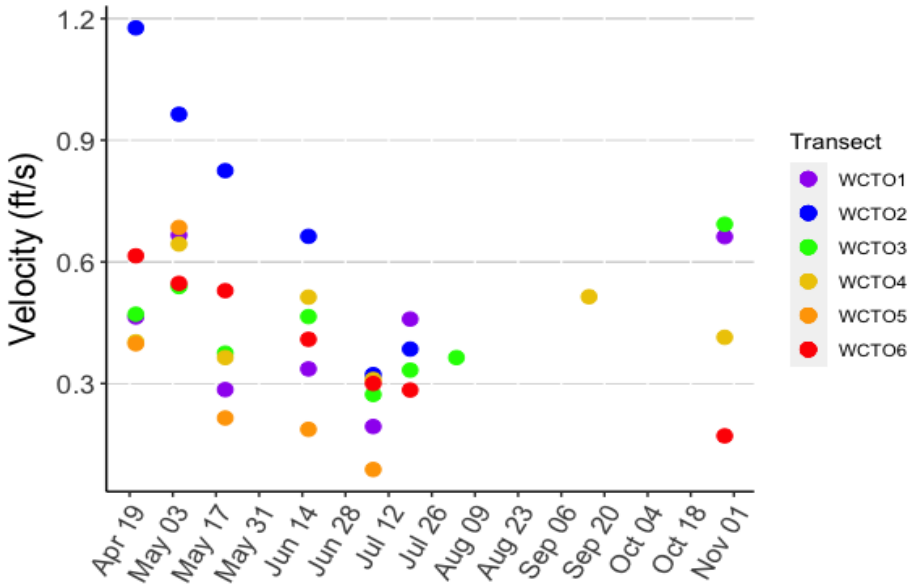

Figure 10. Average flow velocity (ft/s) at each Wilson Creek Transect. Appendix C depicts each transect separately.

Figure 11. Measuring flow velocity at WCT03.

Photosynthetic Active Radiation and Canopy Cover

PAR was measured (µmol m^{-2} s^{-1}) at ten equidistant intervals along each cross-stream transect to quantify riparian solar radiation. PAR measurements were averaged at each transect for each site visit, creating a daily average. These averages were then combined for each transect, representing a total seasonal average (*Figure 12).*

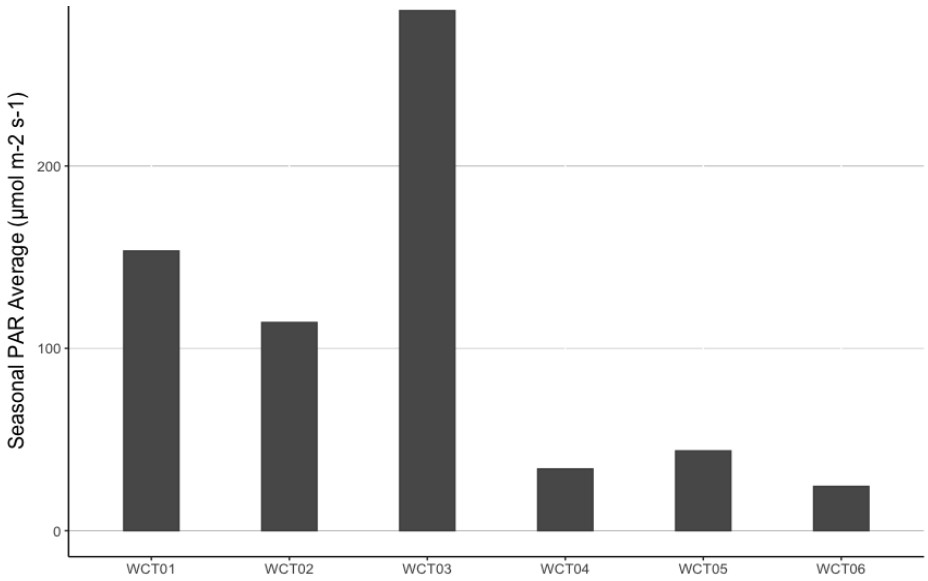

Figure 12. Photosynthetic active radiation (PAR) seasonal average indicating amount of solar radiation along each riparian transect at Wilson Creek.

PAR measurements are highly dependent on weather conditions and provide more information about sunlight intensity at a specific time than overall canopy structure. Starting on October 1, 2021, the protocol for estimating canopy cover was changed and PAR collection was replaced by canopy cover measurements using hemispherical photos (*Figure 13a*). These are taken using the spherical panorama function available on most cameras and then transformed into black and white binary images (*Figure 13b).* From here, the number of dark pixels (canopy) and the number of white pixels (open sky) are extracted to obtain an estimate of canopy coverage (as a percentage). This method is more accurate and more precise than previous methodology. A standardized methodology is under development, and results will be available in 2022.

Figure 13a. A hemisphere photo in color after it is transformed from the 360° photo taken in the field at Wilson Creek Transect 1.

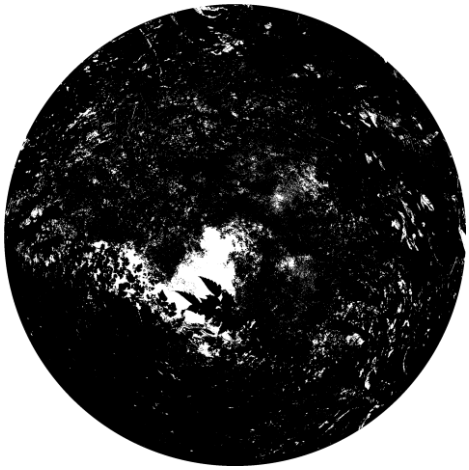

Figure 13b. A binary hemisphere photo where open areas are represented as white pixels and canopy cover as black pixels at Wilson Creek Transect 1.

Vegetation Survey

Crew: Celia Thurman, Miguel Rodriguez, Seth Miles, Raena Anderson
Site Visits: July 6 and 7

The 2021 Wilson Creek vegetation survey revealed a total species richness of 40 species within the Wilson Creek study reach (Appendix B). Percent cover of reed canarygrass was estimated for each of the ten quadrats along each transect of the vegetation survey, with 60 quadrats total in the whole reach (*Figure 15*). There appeared to be no significant correlation between *RCG* percent cover and species richness at this site (*Figure 14*).

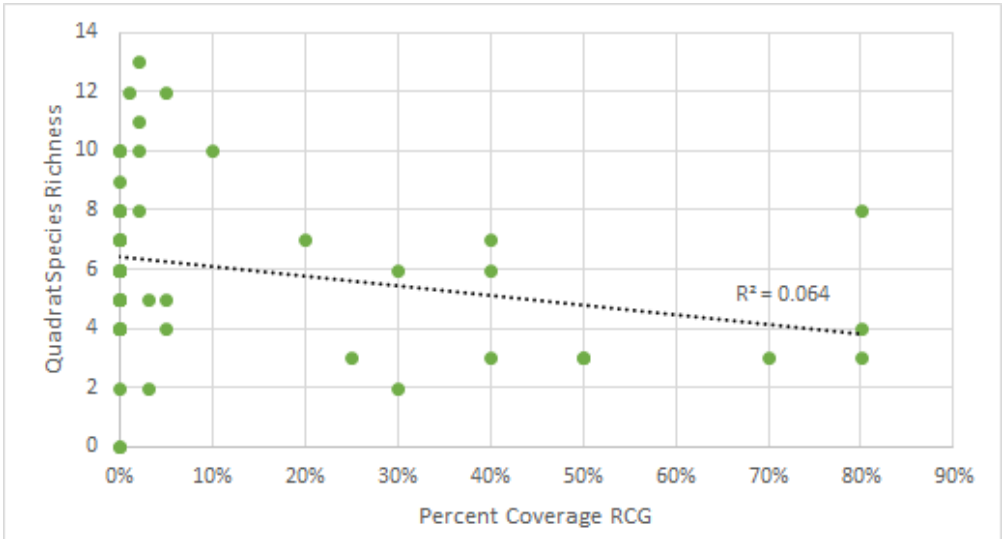

Figure 14. Estimated percent cover of *Phalaris arundinacea* compared to species richness of each quadrat measured during the 2021 Wilson Creek vegetation survey (R^2= 0.064, p= 0.051, p<0.05).

Figure 15. A vegetation sampling quadrat on the bank of Wilson Creek Transect 6 that had high RCG coverage and low species richness.

Figure 16. *Luzula parviflora*, small-flowered woodrush, growing at Wilson Creek Transect 3.

Wolman Pebble Count

Crew: Celia Thurman, Seth Miles, Aaron Bennett, Miguel Rodriguez, Lara Hakam
Site Visits: April 21, November 2

Pebble counts were conducted at each transect at the beginning and end of the 2021 field season (*Figure 17*). Data collection was conducted near a 'riffle' or 'run' geomorphic habitat unit. The D_{50} (50^{th} percentile measurement) of each sample was determined to represent general substrate composition (*Table 3*).

Transect	April 14, 2021		November 2, 2021	
	D_{50} Size Range	**Size Class**	**D_{50} Size Range**	**Size Class**
WCT01	33-64 mm	Very Coarse Gravel	33-64 mm	Very Coarse Gravel
WCT02	17-32 mm	Coarse Gravel	5-8 mm	Fine Gravel
WCT03	Fines (0-2 mm)	Sand	Fines (0-2 mm)	Sand
WCT04	Fines (0-2 mm)	Sand	Fines (0-2 mm)	Sand
WCT05	Fines (0-2 mm)	Sand	Fines (0-2 mm)	Sand
WCT06	Fines (0-2 mm)	Sand	Fines (0-2 mm)	Sand

Table 3. D_{50} size range and general size class for each Wilson Creek Transect (WCT) pebble count conducted within the study reach.

Figure 17. Collecting sediment for the April pebble count at WCT06.

Thank You

We appreciate your interest and support for this project. The impacts of invasive reed canarygrass on Pacific Northwest cold water ecosystems require further investigation. We appreciate the opportunity to initiate this research. Please contact us if you have questions about or recommendations for the Reed Canarygrass Research Program, or the work of 10,000 Years Institute:

Celia Thurman, Project Coordinator: cthurman@10000yearsinstitute.org

Jill Silver, Executive Director: jsilver@10000yearsinstitute.org

References

Andis, A. Z. 2020. “Smartphone hemispherical photography”. A. Z. Andis: Ecology, Evolution, and Conservation. http://www.azandisresearch.com/2020/12/16/smartphone-hemispherical-photography/

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Dunham, J., Chandler, G., Rieman, B., and Martin., D. 2005. “Measuring stream temperature with digital data loggers: a user’s guide”. Gen. Tech. Rep. RMRS-GTR-150WWW. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. https://www.fs.fed.us/rm/pubs/rmrs_gtr150.pdf

[JCNWCB] Jefferson County Noxious Weed Control Board. N.d. “Best Management Practice: Reed Canarygrass (Phalaris arundinacea)”. *Jefferson County Noxious Weed Control Program*. https://www.co.jefferson.wa.us/DocumentCenter/View/2959/Reed-Canarygrass

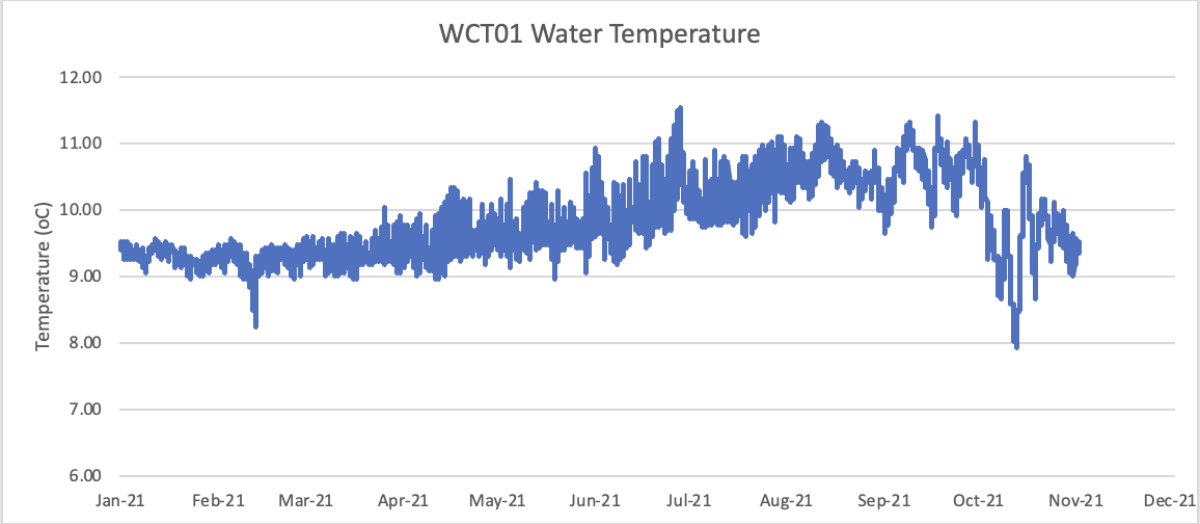
Lavergne, S., and Molofsky, J. 2004. “Reed Canary Grass (Phalaris arundinacea as a Biological Model in the Study of Plant Invasions).” Critical Reviews in Plant Sciences, 23(5), 415-429. https://doi.org/10.1080/07352680490505934.

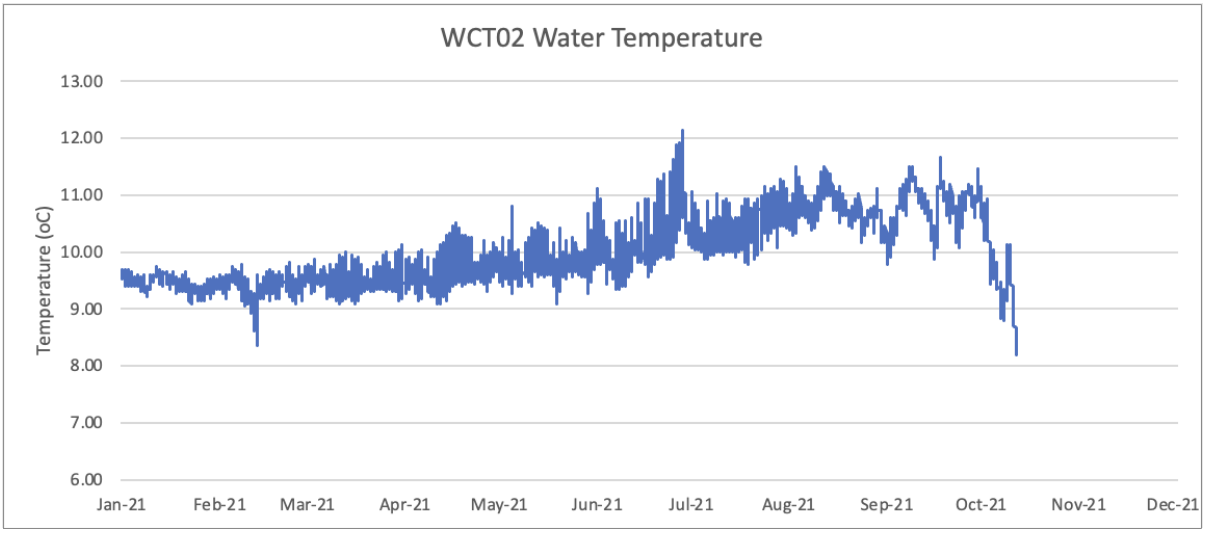
Maurer, D. A., Lindig-Cisneros, R., Werne,r K. J., Kercher, S., Mille,r R., and Zedler, J. B. 2003. “The replacement of wetland vegetation by reed canarygrass (*Phalaris arundinacea)”. Ecological Restoration, 21* (2), 116-119. http://www.jstor.org/stable/43442677.

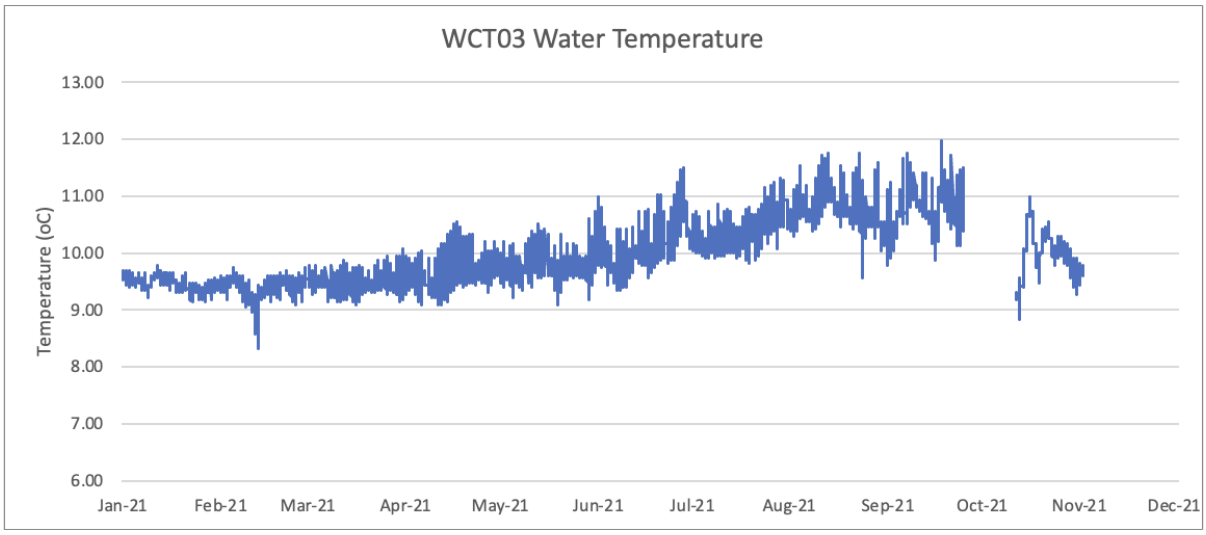
Minkova, T., and Foster, A. 2017. “Status and Trends Monitoring of Riparian and Aquatic Habitat in the Olympic Experimental State Forest: Monitoring Protocols”. Washington State Department of Natural Resources, Forest Resources Division, Olympia, WA. (7) 7-8. https://www.dnr.wa.gov/publications/lm_oesf_2017_monitoring_protocol.pdf.

Appendix A

Stream temperature summaries for each Wilson Creek Transect (WCT) temperature logger location, followed by air temperature, spanning from January 1, 2021 through November 2, 2021.






WCT03 Water Temperature
Temperature (oC)
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
Jan-21
Feb-21
Mar-21
Apr-21
May-21
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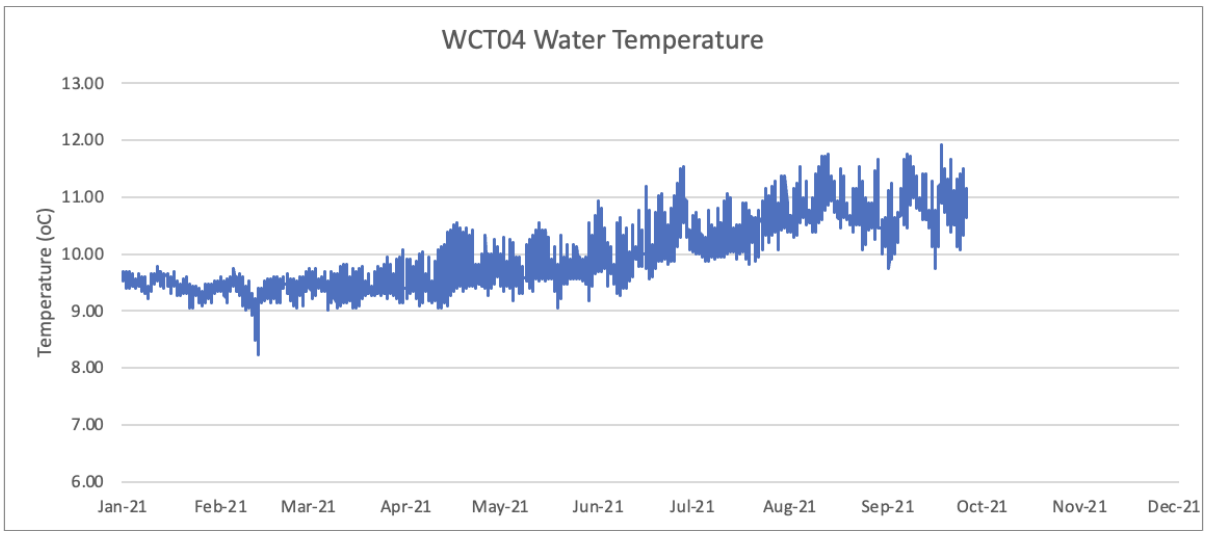
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21


WCT04 Water Temperature
Temperature (oC)
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
Jan-21
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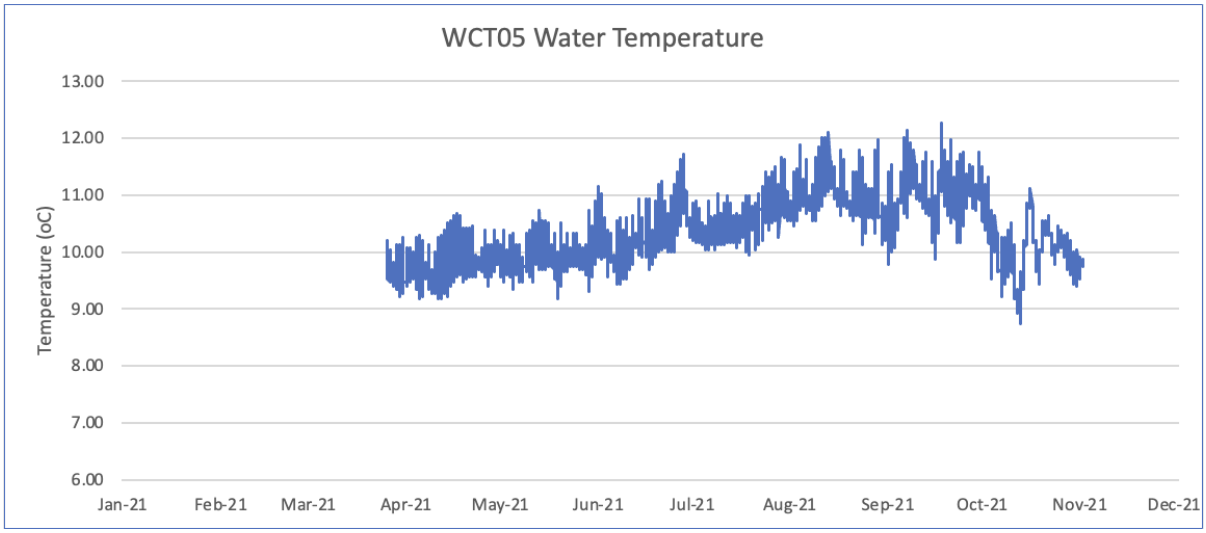
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21


WCT05 Water Temperature
Temperature (oC)
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
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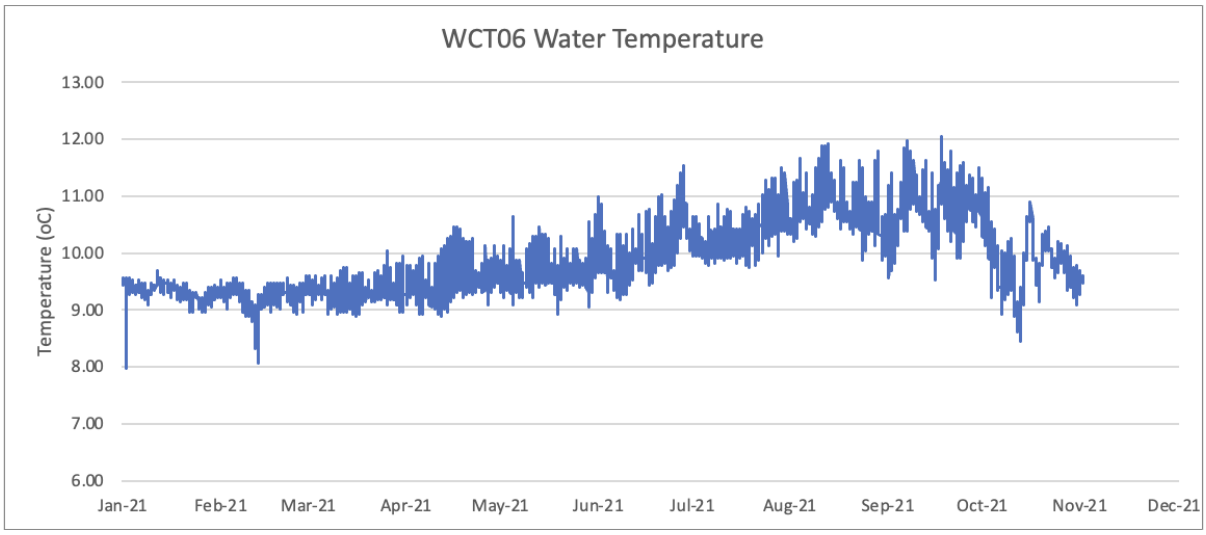
Nov-21
Dec-21


WCT06 Water Temperature
Temperature (oC)
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12.00
11.00
10.00
9.00
8.00
7.00
6.00
Jan-21
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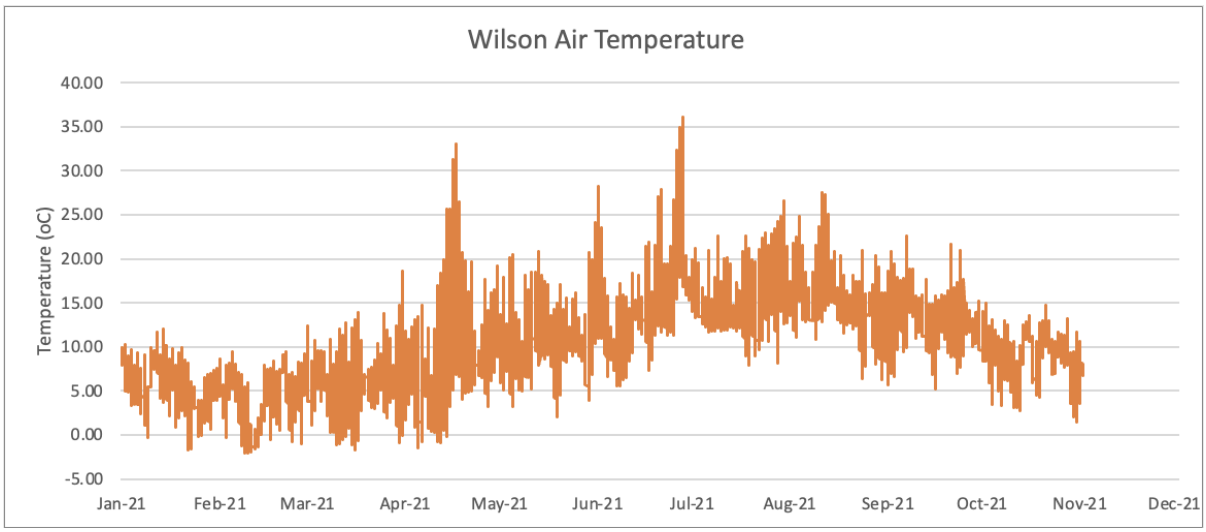
Oct-21
Nov-21
Dec-21


Wilson Air Temperature
Temperature (oC)
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
-5.00
Jan-21
Feb-21
Mar-21
Apr-21
May-21
Jun-21
Jul-21
Aug-21
Sep-21
Oct-21
Nov-21
Dec-21

Appendix B

Plant species list for the Wilson Creek 2021 vegetation survey. Updated November 3, 2021.

- *Acer circinatum* (Vine maple)
- *Adiantum pedatum* (Western maidenhair fern)
- *Athyrium filix-femina* (Lady fern)
- *Blechnum spicant* (Deer fern)
- *Bromus sitchensis* (Alaska brome)
- *Bromus vulgaris* (Columbia brome)
- *Callitriche heterophylla* (Water starwort)
- *Cardamine hirsute* (Hairy bittercress)
- *Cardamine nuttallii* (Nuttall's toothwort)
- *Carex leptopoda* (Slender-footed sedge)
- *Chrysosplenium glechomaefolium* (Pacific golden saxifrage)
- *Corydalis scouleri* (Scouler's corydalis)
- *Epilobium ciliatum* (Fringed willow herb)
- *Equisetum hyemale* (Scouring rush)
- *Galium aparine* (Cleavers)
- *Galium triflorum* (Fragrant bedstraw)
- *Hydrophyllum tenuipes* (Pacific waterleaf)
- *Lonicera involucrata* (Black twinberry)
- *Luzula parviflora* (Small-flowered woodrush)
- *Lysichiton americanus* (Skunk cabbage)
- *Mitella ovalis* (Oval-leaf bishop's cap)
- *Montia parvifolia* (Small-leaved blinks)
- *Oemaleria cerasiformis* (Oso berry)
- *Oenanthe sarmentosa* (Water parsley)
- *Osmorhiza berteroi* (Mountain sweet cicely)
- *Oxalis oregana* (Redwood sorrel)
- *Phalaris arundinacea* (Reed canarygrass)
- *Pleuropogon refractus* (Nodding semaphore grass)
- *Polypodium glycyrrhiza* (Licorice fern)
- *Polystichum munitum* (Western sword fern)
- *Ranunculus repens* (Creeping buttercup)
- *Ribes bracteosum* (Stink currant)
- *Rubus parviflorus* (Thimbleberry)
- *Rubus spectabilis* (Salmonberry)
- *Rubus ursinus* (Trailing blackberry)
- *Sambucus racemose* (Red elderberry)
- *Stachys mexicana* (Mexican hedge nettle)
- *Symphoricarpos albus* (Snowberry)
- *Tolmiea menziesii* (Piggyback plant)
- *Viola glabella* (Stream violet)

Appendix C

Stream flow velocity averages collected at each site visit in 2021. There is one figure for each Wilson Creek Transect (WCT).