Reed Canarygrass Monitoring Program
2020 Year-End Field Report: Irely Creek

Project Background

The Reed Canarygrass Monitoring Program (RCMP) goals are to observe and quantify the effects of an invasive grass, *Phalaris arundinacea* (*PHARU*) on water quality and ecosystem function in small coastal streams of the Olympic Peninsula. *PHARU* threatens aquatic ecosystems with its ability to rapidly colonize streams and wetlands via seed, rhizome or vegetative fragments[1]. The species acts as an 'ecosystem engineer' by creating dense, sod-forming monocultures[2,3].

The program's focal metrics are air and stream temperature, dissolved oxygen, flow velocity, sediment size class, light availability, riparian plant diversity and species percent cover. Regularly scheduled sampling occurs from spring through autumn, as field conditions safely and reasonably allows. Beginning in winter 2020, the program intends to collect temperature data year-round.

Irely Creek, located within the Big Creek drainage of the upper Quinault watershed (WRIA 21), was established as a study site in June 2020. Monitoring data and results are reported in the *2020 Irely Creek RCMP Results Report*, available at www.10000yearsinstitute.org.

In 2018, *PHARU* in the Irely Creek study reach was treated by 10,000 Years Institute (10KYI) with herbicide and by removing propagules (seeds, inflorescence, and fragments of stem and rhizome).

Installation of Irely Creek Monitoring Equipment

Crew: Marina Hein, Breyanna Waldsmith, Miguel Rodriguez, Jill Silver
Installation: *June 25 and 26, 2020*; Instrumentation: *July 1 and 15, 2020.*

Investigations into candidate streams for the RCMP were conducted throughout the winter of 2019/2020. Irely Creek flows through an 876.2 acre HUC-12[4] watershed in Olympic National Park wilderness, and was chosen as a prime candidate for this research. A research permit for the RCMP was granted by the National Park Service (NPS) in early June 2020. The permit allows monitoring within a 700-meter reach of Irely Creek (Figure 1). On June 26, the research team began installing ten cross-stream transects at equidistant 197-feet (60-meter) intervals along the approved reach (Figure 1, Appendix A).

[1] Lavergne, S., and Molofsky, J. "Reed Canary Grass (Phalaris arundinacea as a Biological Model in the Study of Plant Invasions." *Critical Reviews in Plant Sciences*, 23(5), (2004) 417.
[2] Crooks, Jeffrey A. "Characterizing ecosystem-level consequences of biological invasions: the role of ecosystem engineers." *OIKOS*. 97 (2002): 153-166.
[3] Apfelbaum, Steven. "Ecology and Control of Reed Canary Grass (Phalaris Arundinacea L.)." *Natural Areas Journal*. 7 (1987).
[4] Hydrologic Unit Code 12 (HUC-12) is the smallest classification available from Washington Department of Ecology.

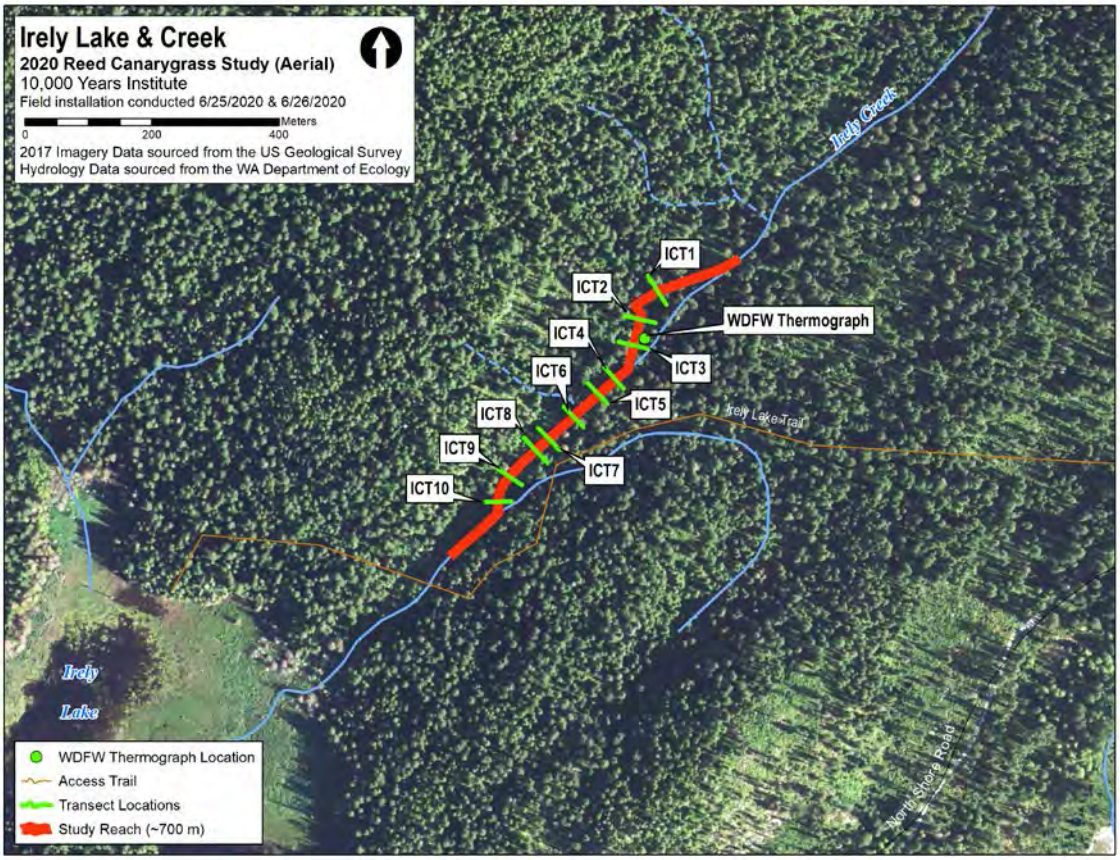

Figure 1. Location of Reed Canarygrass Monitoring Program (RCMP) transects and temperature loggers at the Irely Creek study area. The approved reach for the study is emphasized in red. Irely Creek is located in Olympic National Park, and flows into Irely Lake.

Transects were installed perpendicular to the direction of flow, marked with wooden stakes located 30-feet from each bank on either side of the wetted stream channel (Figure 2a). Stakes were augmented with red biodegradable flagging in areas where installations were difficult to see (Figure 2c). As requested by NPS, flagging was not used in proximity to trails or publically-accessible areas.

HOBO Pendant™ temperature loggers were deployed in-stream along each transect (Figure 2b, Figure 3a). These temperature loggers were set to collect measurements (°C) at 20-minute intervals. Due to multiple channels or off-channel habitat, additional water temperature loggers were installed in Transects 4 through 8 (ICT4, ICT5 ICT6, ICT7 and ICT8).

On July 1, water temperature loggers were deployed only at ICT1 through ICT5 and at the furthest downstream transect, ICT10. The remaining thermographs were deployed by July 15. Two air temperature loggers were deployed in trees near ICT3 and ICT7.

Figure 2a. *(left)* Example of either left bank or right bank transect demarcations in Irely Creek.
Figure 2b. *(center)* Example of original temperature logger installation (at ICT2), including rebar, crab bait cage and HOBO Pendant™ temperature logger. (This location is far from view of hiking trail.)
Figure 2c. *(right)* Example of biodegradable flagging, attached to rebar for temperature logger.

Updates were made to the housing of the water temperature loggers on October 7, to ensure durability and continued operation throughout winter 2020/2021. The temperature loggers were reinstalled in a 2" section of 1.5" diameter PVC pipe, and weighted with a half brick (Figure 3b). This design is modeled after the Olympic Experimental State Forest's (OESF) T-3 Stream Temperature Study[5,6,7].

The RCMP installation technique differs from the T-3 stream temperature study methods in one critical way; the PVC pipe in our study is attached to rebar. The decision to use rebar was made due to the lack of stable 'natural' mounting locations, and so the original placement locations could remain precise.

As a precaution to reduce the spread of *PHARU* to areas outside of the selected study reach, reed canarygrass inflorescence and/or seed was clipped from the plants, collected, bagged, and removed from the study reach during the installation day. Three 30-gallon kraft paper yard waste bags were filled three-quarters full of inflorescence/seed material, weighing approximately 50 pounds, and were counted, totaling 4,741 seed heads. The removal of seeds in 2020 will not eliminate regrowth from the seedbank or other propagules within the study reach but will prevent further spread via seed.

[5] Minkova, T. and A. Foster (eds.). "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, 2017.
[6] Bilhimer, D., A. Stohr, W. Ward (eds.) "Standard Operating Procedures for continuous temperature monitoring of fresh water rivers and streams conducted in a Total Maximum Daily Load (TMDL) project for stream temperature, version 3.0". *Washington Department of Ecology*, Environmental Assessment Program. Olympia, WA. 2013.
[7] Dunham, J., G. Chandler, B. Rieman, D. Martin. "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. 2005.

Figure 3a. *(left)* Original housing for the HOBO Pendant™ temperature logger consisted of a crab bait cage attached to rebar by several exterior use zip-ties. **Figure 3b.** *(right)* Updated housing consists of a 2" PVC pipe covering for the temperature logger and a half brick to weight the system. The system is attached to rebar via tar-coated parachute cord. These updates were implemented on October 7, 2020.

Site Conditions and Site Visits

Crew: Breyanna Waldsmith, Miguel Rodriguez, Mathew Nichols, Ashley Baltrusitus
Site Visits: *July 2-3, 15, and 29-30, August 10-11, and 25-26, September 8-9, and 21, October 6-7 and 21-22, November 6-7.*

Site visits consisted of sampling field temperature, dissolved oxygen (DO) flow velocity, and photosynthetic active radiation (PAR) at each of the ten transects.

- Temperature data was uploaded once per month from the HOBO Pendant™ data loggers throughout summer. The equipment remains in Irely Creek for data collection throughout winter 2020/2021.
- Dissolved oxygen was collected using an optical meter (Hanna Instruments Model 98198) near each temperature logger.
- Flow velocity was measured near each transect, in areas of sufficient depth and minimal flow interference (e.g. downed wood or sharp curves in the stream). A Swoffer flow meter (Model 3000) was used to calculate depth and flow velocity (ft/s) at numerous intervals across the stream (Figure 4). 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.

Figure 4. Field technician Miguel Rodriguez sampling flow in Irely Creek using a Swoffer flow meter (Model 3000) on July 3, 2020.

Nine bi-monthly site visits were completed in Irely Creek throughout summer 2020. A tenth visit was attempted on July 15, but only four transects could be completed because of transportation issues.

The site conditions at Irely Creek were affected by two significant factors in 2020; beaver activity and summer low flows. Since original scouting of the study reach in 2019, the site has been significantly altered by beaver activity and dam construction. During installation of the monitoring equipment, a five-foot high beaver dam was discovered spanning the creek for approximately 200 feet. The dam had impounded flow, creating a pond approximately 200-feet long, affecting Transect 6 (ICT6) (Figure 5a,b). Outflow from the beaver dam spreads laterally into several diffuse and braided channels affecting Transect 7 (ICT7).

Figure 5a. *(left)* Upstream view of the large beaver dam, as seen from the Irely Creek Transect 7 (ICT7) primary channel. Photo was taken on June 25, 2020. **Figure 5b.** *(right*) Downstream view of beaver dam from ponded area between ICT6 and ICT7. *Phalaris arundinacea* (*PHARU*) can be seen in the foreground along a log submerged in the pond, densely established along the dam, with native vegetation in the background outflow area. This photo from June 25, 2020, covers approximately one-third of the beaver dam's lateral width.

During much of the summer, the beaver dam directed a significant portion of Irely Creek's streamflow onto the nearby Irely Lake trail (Figure 6). Water quality parameters could not be collected from the trail due to the NPS request to separate study activities from visitor view. Substantial stream discharge was visible on the hiking trail, including a 1-foot deep pool. Cutthroat trout and Coho fry were observed along the inundated section of the trail. The trail remained inundated until early August and flows returned to the trail in early October.

Figure 6. Irely Creek overflowing onto the Olympic National Park Irely Lake hiking trail. Photo captured on October 6, 2020.

By August 25, beaver activity had moved further downstream. A smaller dam approximately 2.5-feet high and 12-feet wide was discovered 328 feet (100m) below the study reach (Figure 7). This new activity led to ponding in the furthest downstream transect of the study reach, Transect 10 (ICT10).

Figure 7. View of the beaver dam discovered 328-feet (100m) downstream of the study reach. This dam caused ponding, affecting Irely Creek Transect 10 (ICT10) from late August through October. Photo was taken downstream of the dam, facing upstream, on August 26, 2020.

Seasonably low precipitation in August caused a considerable drop in stream discharge by late summer. By August 10, the creek was no longer flowing along the hiking trail. The low discharge eventually resulted in the upper reach of the creek (upstream of ICT6) to dry out completely. By September 8, the upper half of the study reach had become reduced to disconnected puddles, preventing adequate flow velocity measurements (Figure 8a). These low flow events are likely an annual trend in mid- to late-summer for Irely Creek, and it is expected that the occurrence of dry channel segments will be especially prominent during drought years. These drought events result in the deposition of *PHARU* stem fragments and rhizomes, expanding invaded area (Figure 8b).

Figure 8a. *(left)* Discharge has fallen at Transect 7 where velocity is often measured. Photo taken on August 25, 2020. **Figure 8b.** *(right)* Reed canarygrass (*Phalaris arundinacea)* observed spreading into the dry streambed of Irely Creek during late summer low-flows. Photo taken on September 9, 2020.

Vegetation Survey and Wolman Pebble Count

Crew: Marina Hein, Breyanna Waldsmith, Miguel Rodriguez
Vegetation Survey: *July 8, 9, 14 and 15*
Wolman Pebble Count: *July 30 and August 10*

The annual vegetation survey took place over four days at Irely Creek. The survey was conducted in July, the most optimal time for grasses to be in florets, and therefore, most easily identified. A square, 1-meter quadrat was placed at ten equal intervals along each riparian (cross-stream) transect, similar to the methodology in which PAR is measured (Figure 9). Each plant found rooted within the quadrat was identified to species level, and percent cover was visually estimated and recorded. Species richness of the Irely Creek study reach equals 69 species (Appendix B).

Figure 9. Examples of the 1-square meter quadrat placement during the Irely Creek vegetation survey. To the left is an example of the diverse riparian vegetative character found in the area, and to the right is an area invaded heavily by *Phalaris arundinacea*.

Wolman pebble counts were conducted at each transect to characterize dominant sediment size classes, and to track changes over time. Due to Covid-19 safety and health considerations in spring, the pebble count was delayed until July 30, as the project start was pushed further into the year and more time-sensitive sampling was completed first.

While the standard operating procedures (SOPs) dictate that pebble counts be conducted twice annually, only one count could be conducted in 2020. Preferably, pebble counts would take place in spring to early summer, and again in late summer to fall. This year, the RCMP found that one pebble count was sufficient, as repeating the count only one or two months later would likely not have impact on sediment character. Considering available resources, the RCMP may consider making this change permanent.

Continuing Work

To prevent additional *PHARU* expansion in the watershed, treatment in the study reach will continue with removal of propagules. Application of herbicide outside the study reach is planned through 2022 in partnership with the ONP Exotic Vegetation Management Team.

Upon receiving a renewed research permit, we plan to begin the 2021 field sampling in March or April, as conditions safely and reasonably allow.

Thank You

We appreciate your interest and support for this project. The impacts of invasive reed canarygrass on Pacific Northwest cold water ecosystems requires further investigation. We appreciate the opportunity to initiate this research. Please contact us if you have questions about or recommendations for the Reed Canarygrass Monitoring Program, or the work of 10,000 Years Institute: research@10000yearsinstitute.org

Bibliography

Apfelbaum, Steven. 1987. "Ecology and Control of Reed Canary Grass (Phalaris Arundinacea L.)." *Natural Areas Journal*. 7.

Bilhimer, D., A. Stohr, W. Ward (ed.) 2013. "Standard Operating Procedures for continuous temperature monitoring of fresh water rivers and streams conducted in a Total Maximum Daily Load (TMDL) project for stream temperature, version 3.0". *Washington Department of Ecology*, Environmental Assessment Program. Olympia, WA. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.309.8122&rep=rep1&type=pdf.

Crooks, Jeffrey A. 2002. "Characterizing ecosystem-level consequences of biological invasions: the role of ecosystem engineers." *OIKOS*. 97. 153-166.

Dunham, J., G. Chandler, B. Rieman, D. Martin. 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

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.

Martinez, Adriana E. 2017. "Sensitivity of Modeled Channel Hydraulic Variables to Invasive and Native Riparian Vegetation." *Applied Geospatial Research*. 8(4). https://doi.org/10.4018/IJAGR.2017100104.

Minkova, T. and A. Foster (Eds.). 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

Coordinates of installed study materials for the RCMP. (Collected by Breyanna Waldsmith for 10KYI on July 30, 2020. Map Datum & Spheroid: WGS 84)

Transect	Installation Type	Installation Purpose	Lattitude (N)	Longitude (W)
ICT01	wooden stake	right bank transect demarcation	47.57227	-123.66348
ICT01	wooden stake	left bank transect demarcation	47.57206	-123.66348
ICT01	rebar	water temperature logger	47.57206	-123.66331
ICT02	wooden stake	right bank transect demarcation	47.57169	-123.66362
ICT02	wooden stake	left bank transect demarcation	47.57176	-123.66343
ICT02	rebar	water temperature logger	47.57174	-123.66360
ICT03	wooden stake	right bank transect demarcation	47.57136	-123.66382
ICT03	wooden stake	left bank transect demarcation	47.57137	-123.66378
ICT03	rebar	water temperature logger	47.57114	-123.66405
ICT03	crab cage (3.5"x6")	air temperature logger	47.57134	-123.66388
ICT04	wooden stake	right bank transect demarcation	47.57113	-123.66462
ICT04	wooden stake	left bank transect demarcation	47.57108	-123.66441
ICT04	rebar	water temperature logger (1/2)	47.57096	-123.66445
ICT04	rebar	water temperature logger (2/2)	47.57116	-123.66447
ICT05	wooden stake	right bank transect demarcation	47.57059	-123.66454
ICT05	wooden stake	left bank transect demarcation	47.57073	-123.66547
ICT05	rebar	water temperature logger	47.57073	-123.66547
ICT06	wooden stake	right bank transect demarcation	47.57066	-123.66536
ICT06	wooden stake	left bank transect demarcation	47.57011	-123.66472
ICT06	rebar	water temperature logger (1/3)	47.57029	-123.66517
ICT06	rebar	water temperature logger (2/3)	47.57037	-123.66474
ICT06	rebar	water temperature logger (3/3)	47.57069	-123.66537
ICT07	wooden stake	right bank transect demarcation	47.57027	-123.66595
ICT07	wooden stake	left bank transect demarcation	47.57018	-123.66548
ICT07	rebar	water temperature logger (1/2)	47.57003	-123.66556
ICT07	rebar	water temperature logger (2/2)	47.57006	-123.66589
ICT07	crab cage (3.5"x6")	air temperature logger	47.57006	-123.66544
ICT08	wooden stake	right bank transect demarcation	47.57001	-123.66613
ICT08	wooden stake	left bank transect demarcation	47.57022	-123.66656
ICT08	rebar	water temperature logger (1/2)	47.56991	-123.66595
ICT08	rebar	water temperature logger (2/2)	47.56898	-123.66805
ICT09	wooden stake	right bank transect demarcation	47.56949	-123.66650
ICT09	wooden stake	left bank transect demarcation	47.56925	-123.66627
ICT09	rebar	water temperature logger	47.56953	-123.66641
ICT10	wooden stake	right bank transect demarcation	47.56908	-123.66882
ICT10	wooden stake	left bank transect demarcation	47.56908	-123.66656
ICT10	rebar	water temperature logger	47.56907	-123.66680

Appendix B

Plant species list for the 2020 Irely Creek vegetation survey. (Last update 11/30/2020*)*

Acer circinatum (vine maple)
Acer macrophyllum (bigleaf maple)
Achlys triphylla (vanilla leaf)
Adiantum pedatum (maidenhair fern)
Agrostis capillaris (colonial bentgrass)
Angelica genuflexa (kneeling angelica)
Athyrium filix-femina (lady fern)
Blechnum spicant (deer fern)
*Boykinia occidentalis (*coast boykinia)
Bromus sitchensis (Alaska brome)
Bromus vulgaris (Columbia brome)
Carex rossii (Ross' sedge)
Cardamine angulata (angled bittercress)
Circae alpina (enchanter's nightshade)
Claytonia sibirica (Siberian miner's lettuce)
Elymus hirsitus (hairy wildrye)
Epilobium ciliatum (Watson willowherb)
Equisetum arvense (common horsetail)
Equisetum telmateia (giant horsetail)
Erythranthe moschatus (musk monkeyflower)
Galium aparine (cleavers)
Galium triflorum (sweet-smelling bedstraw)
Galium trifidum (small bedstraw)
Gaultheria shallon (salal)
Glyceria elata (tall mannagrass)
Holcus lanatus (velvet grass)
Lactuca muralis (wall lettuce)
Luzula parviflora (small-flowered woodrush)
Lysochiton americanus (western skunk cabbage)
Maianthemum dilatatum (false lily-of-the-valley)
Melica harfordii (Harford's melic)
Mitella pentandra (five-stamen miterwort)
Moehringia macrophylla (bigleaf sandwort)
Mosses, lichens, and other bryophytes
Nepeta glechoma (creeping charlie)
Oenanthe sarmentosa (water parsley)
Oxalis oregana (wood sorrel)
Petasites palmatus (Arctic sweet coltsfoot)
Phalarus arundinacea (reed canarygrass)
Picea sitchensis (sitka spruce)
Polystichum munitum (sword fern)
Prunella vulgaris (self-heal)
Pteridium aquilinum (bracken fern)
Ranunculus repens (creeping buttercup)
Rhamnus purshiana (cascara)
Ribes bracteosum (stink currant)
Rubus laciniatus (cutleaf blackberry)
Rubus spectabilis (salmonberry)
Rubus ursinus (trailing blackberry)
Rumex occidentalis (Western dock)
Sambucus racemosa (red elderberry)
Scirpus microcarpus (small-flowered bulrush)
Sisyrinchium angustifolium (blue-eyed grass)
Stachys mexicana (Mexican hedge-nettle)
Stellaria crispa (crisp starwort)
Stellaria calycantha (northern starwort)
Tellima grandiflora (fringecup)
Tiarella trifoliata (three-leaf foamflower)
Thuja plicata (Western red cedar
Tolmiea menziesii (piggyback plant)
Tsuga heterophylla (Western hemlock)
Unidentified grass spp. (4)
Vaccinum ovalifolium (oval-leaved huckleberry)
Vaccinium parviflorum (red huckleberry)
Viburnum edule (highbush cranberry)
Viola palustris (marsh violet)