**20.FW.WA.1:** **NCASI Funding Request**: Staff Time

**Title: Technical Support on Forest Watershed issues**

**Project Duration: Continuous**

**Collaborators:**

**Contact:** Ashley Coble (acoble@ncasi.org)

**NCASI Funding Request:**

**External Funding:**

**Relevance/Value to Members:**

Regulatory issues associated with forest management and water quality have serious implications for forest management and wood supplies in the United States. Examples include, unachievable water quality criteria, EPA revisions to stormwater regulations and agency guidance for defining Waters of the United States and listing of threatened and endangered species. NCASI will continue to monitor regulatory and scientific developments related to these issues and provide technical support to member companies and their associations as needed. Issues anticipated to be of particularly high priority during FY2023-24 include the following: (1) Water quantity (low and peak flows) (2) Herbicides (3) Threatened and endangered species (4) Waters of the United States (WOTUS) (5) Water quality of severely burned and salvaged watersheds

**Objectives:**

Provide technical support to Members on important watershed issues

**Summary of Recent Accomplishments:**

- Participate in advisory board for Elliot State forest riparian group
- Participated as invited participant in low flow and stream temperature workshop at H.J. Andrews
- Participated in food web modelling workshop with Washington DNR, USFS, USGS, and U. Alaska at Olympic Experimental State Forest and toured sites planned for riparian manipulation
- Provide information related to VELMA, DHSVM, and low flow concerns to multiple Members, groups
- Engaged in discussions with state and federal agencies on development of new stream permanence layers

**Recent Presentations of Results and Products:**

**20.FW.WA.2** **NCASI Funding Request:** $1,000

**Title: Mica Creek Nutrient Analyses Technical Support**

**Project Duration: Long-term 1990-Current**

**Collaborators:** Tim Link (University of Idaho)

**Contact:** Ashley Coble

**External Funding:** Ongoing support of field data collection provided by PotlatchDeltic and the State of Idaho, in collaboration with the University of Idaho

**Relevance/Value to Members:**

Mica Creek provides the only long-term dataset on nutrient responses to forest harvest on private land, and this dataset is invaluable for addressing questions regarding how forest harvest affects solute fluxes downstream. In 1990, Potlatch Corporation and numerous cooperators initiated a forest watershed study in northern Idaho to assess the effectiveness of the Idaho forest practice rules in protecting water quality. The study is ongoing and provides a perspective on seasonal and long-term trends in regard to forest practices. Mica Creek has received funding from the state of Idaho and occurs as a line item in the state's budget. This task provides staff time for analyses of nutrients for the studies in the Mica Creek. NCASI has been conducting nutrient analyses of runoff from Mica Creek at the laboratory in Gainesville. Monthly samplings from seven sites in the Mica Creek Watershed are being analyzed for orthophosphate, nitrate/nitrite, ammonium, and total nitrogen. If orthophosphate concentrations above 0.04 mg/L are noted, the samples are also analyzed for total phosphorus. In addition to these analyses, field duplicates and additional quality control analyses are being conducted with each set of samples collected.

**Objectives:**

Evaluate long-term responses of nitrogen and phosphorus concentrations in response to past and ongoing forest harvesting activities

**Summary of Recent Accomplishments:**

**Recent Presentations of Results and Products:**

Gravelle, J. A., Ice, G., Link, T. E., & Cook, D. L. (2009). Nutrient concentration dynamics in an inland Pacific Northwest watershed before and after timber harvest. Forest Ecology and Management, 257(8), 1663-1675.

Deval, C., Brooks, E. S., Gravelle, J. A., Link, T. E., Dobre, M., & Elliot, W. J. (2021). Long-term response in nutrient load from commercial forest management operations in a mountainous watershed. Forest Ecology and Management, 494, 119312.

**20.FW.WA.5:** **NCASI Funding Request**: $92,000 + staff time

**Title: Cumulative effects of post-fire riparian forest management on aquatic ecosystems across fire severity and ownerships: an evaluation of recovery (ERWC framework)**

**Project Duration: Long-term 2021-2025, then every 5 years**

**Collaborators:** Brooke Penaluna (USFS)

**Contact:** Ashley Coble (acoble@ncasi.org)

**External Funding:**

**Relevance/Value to Members:**

Natural disturbance regimes are inherently variable, containing both disturbance events, such as fire, floods, landslides, or debris flows, followed by a period of renewal where habitat and biological complexities are created and sustained (Reeves et al. 1995; Penaluna et al. 2018). Fire frequency and intensity are expected to increase in many forested regions globally due to changing climate, less persistent snowpack, and anthropogenic influence such as novel ignition sources in densely forested areas. Riparian areas are expected to be resilient to natural disturbance with durations of recovery ranging from 1 to 10 years, but post-fire salvage logging may influence these trajectories. Retaining legacies leads to greater recruitment of in-stream large wood, organic matter, or may provide habitat for some terrestrial or aquatic species. Alternatively, active post-fire management may return riparian areas towards desired future conditions in shorter timescales. Post-fire riparian management strategies can include salvage logging of dead trees within riparian areas and re-planting to re-establish vegetation more rapidly, thereby enhancing rooting strength and soil stability adjacent to streams and providing shade for thermal recovery. We used a stratified random sampling design to identify 24 watersheds that vary in pre-fire stand age and fire extent and quantified physical characteristics, chemical, and biological characteristics. We will monitor these watersheds annually as they recover from fire to understand post-fire trajectories and the role of riparian management (using post-hoc analysis). This effort pairs with 21.FW.WA.1 assessing freshwater biodiversity and study 22.FW.WB.1 assessing vegetation community regrowth.

**Objectives:**

1. Quantify the cumulative effects of forest management following wildfire on aquatic ecosystems across land ownership
2. Quantify the effects of fire on riparian zones and aquatic ecosystems and their recovery over time across land ownership
3. Evaluate the consequences of salvage logging and replanting within the riparian zone on aquatic ecosystems

**Summary of Recent Accomplishments:**

- See Progress Report

**Recent Presentations of Results and Products:**

Coble, A.A., Penaluna, B.E., Six, L.J., Verschuyl, J. Forested streams, fire, and large wood: ecosystem responses to fire severity and forest stand age. In review, Journal of Applied Ecology

See Progress report for more information

**20.FW.WA.6** **NCASI Funding Request**: $82,000 + staff time

**Title:** Assessing the effects of alternative riparian management practices on aquatic food webs and water quality [Riparian alternatives]

**Project Duration: Mid-term 2018-2025**

**Collaborators:** Dana Warren (OSU)

**Contact:** Ashley Coble

**External Funding:** $56,859 OSU FWHMF

**Relevance/Value to Members:**

Best management practices in the Pacific Northwest require the retention of continuous streamside buffers to protect aquatic habitat and maintain cold-water habitat for native salmonids. Fixed-width buffers are typically applied due to ease of implementation although some states allow deviation from these standard buffers. However, uncertainty in their outcomes on regulatory standards (e.g., stream temperature) may reduce widespread implementation of alternative riparian management practices. Riparian alternatives, such as canopy gaps, thinning within riparian buffers, or variable retention buffers, may alleviate light limitation in localized sections of the stream that disproportionately contribute to in-stream primary productivity and support stream food webs. We propose to evaluate effectiveness of various alternative riparian management strategies on food web responses and ecosystem function across watersheds. Broad-scale replication of five alternative riparian buffer configurations will be implemented across Oregon to create a gradient of light availability on the stream channel including: uncut unit, standard fixed-width buffer, current practice, variable retention buffer, and canopy gaps (n = 6 for each treatment). Ultimately, the results from this study will inform alternative riparian management strategies by providing a scientific basis for the effects of these approaches on aquatic productivity, fish, and physico-chemical characteristics subject to regulation (e.g., temperature).

**Objectives:**

To determine how water quality and stream biota respond to three alternative riparian management options (buffer gaps, thinning, and variable retention) relative to standard fixed-width buffers and to a wholly unharvested unit.

1. Quantify bottom-up factors, including algal standing stocks, primary production, and macroinvertebrate abundances, that may affect growth, abundance, and overall production of fish and salamanders in headwater streams
2. Quantify the short-term (<3 yr) responses of fish and salamander abundance, total biomass, and summer growth across prescription alternatives.

**Summary of Recent Accomplishments:**

See progress report for full details

**Recent Presentations of Results and Products:**

Sanders, A, A.A. Coble, A.G. Swartz, M. River, P. James, and D.R. Warren. 2022. Effects of fire and smoke on water temperature and dissolved oxygen in headwater streams. Freshwater Science, https://doi.org/10.1086/722632

**20.FW.WA.8:** **NCASI Funding Request**: Staff time only

**Title: A review of the effects of riparian forest management on aquatic biota and their habitats**

**Project Duration: 1-2 years**

**Collaborators:** Dana Warren (OSU)

**Contact:** Ashley Coble (acoble@ncasi.org)

**External Funding:** N/A

**Relevance/Value to Members:**

Modifications to riparian buffers are not often implemented, but implementation of riparian alternatives has the potential to enhance basal resources available for aquatic biota resulting in increases in abundance or biomass. To complement our experimental approach of manipulating riparian buffers to assess its effects on stream food webs (20.FW.WA.6, described above), we are conducting a literature review focused on better understanding how different riparian management strategies may affect aquatic habitat characteristics and biota. The review will focus on studies of riparian thinning, gap creation as either manipulation or natural disturbance, and variable retention buffers. We will identify studies that have focused on responses of temperature, light, periphyton biomass, macroinvertebrates, and fish.

**Objectives:**

Review the literature to understand how different riparian management strategies may affect aquatic habitat characteristics and biota.

**Summary of Recent Accomplishments:**

**Recent Presentations of Results and Products:**

**21.FW.WA.1:** **NCASI Funding Request:** Staff time only

**Title: Assessing freshwater biodiversity across a watershed scale gradient of management intensity (ERWC framework)**

**Project Duration: 2022-2025**

**Collaborators:** Brooke Penaluna (USFS), Jessica Homyack (Weyerhaeuser), Tiffany Garcia (OSU)

**Contact:** Ashley Coble

**External Funding:** $54,000 SFI

**Relevance/Value to Members:**

Protecting biodiversity is a primary objective of sustainable forest management, which relies on best management practices to protect aquatic ecosystems. BMP effectiveness monitoring from state regulatory agencies, private forest landowners, and third-party certification programs remain heavily focused on using water quality and fish habitat monitoring as a proxy for the protection of biota (Warrington et al. 2017). Traditional methods to quantify macroinvertebrates and fish require intensive field measurement and taxonomic expertise, but water collected for environmental DNA (eDNA) can be used to determine presence or absence of fish, macroinvertebrates, or amphibians across a large spatial distribution of sites (e.g., Coble et al. 2018). Environmental DNA allows for determination of biodiversity in locations with Endangered Species Act (ESA) listed species, without obtaining a federal permit as is required for electrofishing. Incorporating eDNA into our spatial sampling framework (20.FW.WA.5) will allow us to obtain biotic information from ESA sites where permits have not been obtained (submitted federal permit application, including post-fire sampling) or where take is limited. Results from this study will determine whether biological diversity varies across a gradient of area-weighted stand age and to elucidate which landscape or management factors are the most influential predictors of biological diversity in forested streams.

**Objectives:**

Complete eDNA analysis from 30 watersheds, including 24 post-fire streams in Oregon's Cascades and 6 reference watersheds in Washington.

**Summary of Recent Accomplishments:**

**Recent Presentations of Results and Products:**

**21.FW.WA.6:** **NCASI Funding Request:** Staff time only

**Title: Evaluating the fish response to adjacent forest harvest at Hinkle Creek watershed, Oregon**

**Project Duration:** 1- 2 years

**Collaborators:** Dana Warren (OSU)

**Contact:** Ashley Coble

**External Funding:** N/A

**Relevance/Value to Members:**

Riparian management practices in the Pacific Northwest seek to protect aquatic physical-chemical properties as a strategy to protect salmonids. To date, few paired watershed studies have examined the response of fish to an adjacent forest harvest, and of the three Oregon paired watershed studies only the response to the first phase of the Alsea Watershed Revisited documents such a change. In Hinkle Creek watershed, the downstream response of fish to an upstream harvest has been published (Bateman et al. 2016), but the fish response to harvest in adjacent forest stands has not been analyzed or published. Dr. Coble will continue to work collaboratively with the original principal investigator in this study, Douglas Bateman, and with Oregon State University faculty, Dana Warren and Ivan Arismendi, to synthesize, draft, and submit a peer-reviewed publication. This will inform task 22.FW.WA.3. No funding is requested, and successful completion of this paper is dependent on collaborators volunteering their time and effort to this project.

**Objectives:**

Complete a peer reviewed publication summarizing fish data collected pre- and post-harvest as part of the original Hinkle Creek paired watershed study.

**Summary of Recent Accomplishments:**

**Recent Presentations of Results and Products:**

**22.FW.WA.3** **NCASI Funding Request**: $15,000

**Title: Comparing wildfire and forest management effects on water quality and fish in headwater ecosystems**

**Project Duration: Mid-term 2021-2024**

**Collaborators:** Kevin Bladon (OSU), Dana Warren (OSU)

**Contact:** Ashley Coble

**External Funding:** $50,000 (OFIC), other parameters measured at Hinkle are funded by OSU, NASA

**Relevance/Value to Members:**

The 2020 Oregon wildfires burned more than ~1.19M acres (~481K ha) of forest land. Given that fires of the magnitude observed in 2020 are projected to continue to occur across the Western US, it is critical to quantify the effects from the current wildfires to enable informed policy and forest and water management decisions in the future. The Archie Creek fire in the southern Cascades burned both the north and south fork of Hinkle Creek, which were control and treatment watersheds, respectively, in the contemporary Hinkle Creek paired watershed study (HCPWS). Hinkle Creek is uniquely suited to directly evaluate the relative effects of wildfire versus contemporary forest harvest on water quality and biota by leveraging 10 years of pre-fire data (4 years pre-harvest, 6 years post-harvest) that includes discharge (Surfleet and Skaugset 2013), stream temperature (Kibler et al. 2013), stream chemistry (Meininger 2012), suspended sediment, amphibian (Leuthold et al. 2012), and fish (Bateman et al. 2016 – prior NCASI funded work). Drs. Kevin Bladon and Dana Warren (OSU) propose to measure stream temperature, turbidity, and fish population responses in the first four years following the 2020 stand replacing wildfire and will compare these responses with pre- and post-harvest responses.

**Objectives:**

O1. Quantify the effects of wildfire on key physical water quality parameters that describe aquatic habitat, such as turbidity and stream temperature.

O2. Quantify changes in fish abundance and biomass throughout the river network in the first summer after the year, and over at least two additional years of post-fire recovery.

O3. Compare and contrast effects of the 2020 fires to effects of 2005-06 timber harvest on physical water quality and fish at Hinkle Creek.

O4. Quantify supporting data such as canopy closure, air temperature, photosynthetically active radiation, large wood, and primary productivity to improve understanding of the processes driving observed changes in physical water quality and fish responses.

**Summary of Recent Accomplishments:**

- Peer-reviewed publication on the first summer response of temperature and fish following fire

**Recent Presentations of Results and Products**:

Warren, DR., Roon, D., Swartz, A., and Bladon, K.D. 2022. Cold-water fish persist in a stream system with elevated summer temperatures after a severe wildfire. Ecosphere. 13(9): e4233. doi: 10.1002/ecs2.4233.

See Progress Report for full details of presentations

**22.FW.WA.5** **NCASI Funding Request**: $4,000

**Title: Post-fire suspended sediment monitoring of Gate Creek watershed (McKenzie River)**

**Project Duration: Mid-term 2021-2025**

**Collaborators:** Mark River (Weyerhaeuser), Dana Warren (OSU), Peter James (Weyerhaeuser)

**Contact:** Ashley Coble

**External Funding:** Leverages Weyerhaeuser field support & equipment, OSU lab facilities for processing samples

**Relevance/Value to Members:**

Post-fire changes in stream chemistry are most pronounced in the first few storm events following a forest fire. Increases in suspended sediment during storm events have important implications for aquatic habitat, debris flow hazards, and downstream drinking water. Water quality characterized by elevated turbidity, high dissolved organic carbon (DOC) and nitrogen (N) concentrations and altered carbon composition (e.g. increased aromaticity) can affect efficiencies of water supply treatment downstream. The September-October Holiday Farm fire had a disproportionate effect on Gate Creek watershed burning 100% of the watershed with large-scale tree mortality and devastation to riparian areas. USGS hazard risk assessments have identified this watershed as high risk, particularly if large storm events occur this winter and spring. Immediate monitoring of suspended sediment and stream chemistry to capture winter and spring storm events will provide critical data to understand sediment export throughout the drainage and will be beneficial in supporting post-fire stream food web monitoring to build upon 4 years of pre-fire data from three sub-basins within Gate Creek (Dr. Warren will seek NSF funding). This task seeks funding to cover 1 week of support for 2 crew members to sample for large woody debris, macroinvertebrates, substrate characteristics, light, and discharge. Additionally, funding will cover macroinvertebrate identification and other consumable costs associated with laboratory analysis. Dr. Coble will allocate time to draft a peer-reviewed manuscript using the first year of data on total suspended solids, turbidity, nutrient, and carbon concentrations.

**Objectives:** Quantify stream sediment concentrations and fluxes from multiple tributaries within a drinking water source area adversely affected by recent fires.

**Summary of Recent Accomplishments:**

- Full year of sediment concentration collected and used to calibrate turbidity sensors
- Weyerhaeuser is now maintaining turbidity sensors and level loggers
- Summer field sampling of physical, chemical, and biological parameters completed in first 2 summers post-fire

**Recent Presentations of Results and Products:** Manuscript in preparation

**22.FW.WA.8** **NCASI Funding Request**: Staff time

**Title: Effects of the forest products industry on macroinvertebrate assemblages along the river continuum**

**Project Duration:** Mid-term

**Collaborators:** Camille Flinders (NCASI), Renee Ragsdale (NCASI)

**Contact:** Ashley Coble (acoble@ncasi.org)

**External Funding:** N/A

**Relevance/Value to Members:**

Macroinvertebrate assemblages are commonly used as biological indicators of water quality, particularly in response to anthropogenic activities, and NCASI has evaluated their response to mill effluent in four river networks throughout the United States (Flinders et al. 2009, 2015). Further upstream, NCASI has monitored macroinvertebrate assemblages on private, state, and federal forest land to evaluate their response to forest stand age distribution and forest harvest (20.FW.WA.5, 20.FW.WA.6). Traditional ecological theory posits shifts in species assemblages as river networks transition from headwaters to larger streams, and eventually mainstem rivers. However, integrating anthropogenic land use, including the forest products industry, into this framework is currently lacking. We propose to allocate staff time to assess the suitability of existing NCASI datasets to address the question of "how do macroinvertebrate assemblages vary throughout a river network in the context of the entire forest products supply chain"? Currently we are compiling datasets (publicly available and NCASI) within the McKenzie and Willamette basins that are upstream of the long-term receiving water study sites. If any additional macroinvertebrate datasets are available from Member Companies in this region to incorporate, please let us know.

**Objectives:** Elucidate how macroinvertebrate assemblages vary throughout a river network in the context of the entire forest products supply chain

**Summary of Recent Accomplishments:**

**Recent Presentations of Results and Products:**

**23.FW.WA.2** **NCASI Funding Request**: $27,000 + staff time

**Title: Ground-truthing streamflow duration classification across privately managed forests**

**Project Duration: Immediate 2022-2023**

**Collaborators:** Jason Dunham (USGS) & Emily Heaston (USGS): provided training and assistance

**Contact:** Ashley Coble

**External Funding:** $9,000 (WFPA)

**Relevance/Value to Members:**

Forested stream definitions are a primary determinant of the degree of protection surface waters receive during forest management by determining allocation of buffers and their widths. As state and federal regulators consider (or re-consider) levels of protection to achieve water quality objectives, proposed changes are expected to focus on protections of the smallest forested streams (Kampf et al. 2021), which often do not require forested buffers. Federal researchers are actively developing tools to improve streamflow designations, but the majority of data informing modeling efforts in the western U.S. are derived from federal land. Federal and privately managed forestland often differentiate by biophysical factors such as elevation and gradient, which are identified as important determinates of streamflow duration (Jaeger et al. 2018). Privately managed forests may become regulated on the results of these models, in which private land is underrepresented. We propose to provide funding to support one or two field teams verify streamflow regime across private forested lands. Data will be collected following USGS protocols using high resolution GPS devices and will work to inform USGS and USFS modeling efforts on streamflow duration during summer low flow.

**Objectives:**

Increase observations of streamflow classification during low flow months on privately managed forest in Oregon and Washington. Populating this database with field observations will improve future modeling efforts that may be used to define riparian buffer presence or widths during forest management activities.

**Summary of Recent Accomplishments:**

1 season of field data collected already. See progress report for additional details.

**Recent Presentations of Results and Products:**