**Introduction:**

Streams and their biota are ~~inherently~~ linked to riparian vegetation in forested systems. In the Pacific Northwest (PNW) region of North America, riparian forests have changed substantially in the past half century. After a legacy of heavy harvesting, riparian forest protections have created dense second-growth vegetation along streams. The dense vegetation in these regenerating forests decreases light availability and limits benthic primary production. Algae can have a disproportionate effect on higher trophic levels as an energy-dense food source, and a shift in this basal resource can have substantial effects on stream biota. To understand how aquatic food webs respond to an increase in light associated with canopy gaps, we investigate the response of macroinvertebrates and fish feeding to canopy-opening manipulations.

Earlier research has shown that relieving light limitation by clear-cutting riparian forests can result in an increase in stream primary and secondary productivity, but increases inlight also lead to increases in temperature and cutting to the stream edge can increase sediment loads. Given these negative impacts, clear cutting along streams is no longer a common practice in the Pacific Northwest—even in managed landscapes riparian buffers are left. In unmanaged forests, and in these riparian forest buffers, stands are in the early to mid-seral stages with dense homogenous canopy cover and low stream light (@Kaylor01). As forest stand development continues natural disturbances and individual tree mortality will increase canopy heterogeneity through the introduction of gaps. While studies on forest clearing at the reach level demonstrate a clear response in benthic primary producers, invertebrates, and fish to release from light limitation, the effects of localized light patches – that reflect a more realistic picture of future stream conditions in forested landscapes – have not been evaluated.

Why Algae is Important

Paragraph

~~Stream light availability is an important factor affecting aquatic food webs through its controls on stream primary production. In the PNW, stream algal production is highly light-limited, and an increase in light often enhances benthic algal growth, which in turn increases food availability for secondary consumers in the stream such as macroinvertebrates. Such changes in resource availability can cascade through trophic levels resulting in changes in selective pressures dependent on the relative abundance of resources.~~

~~Evidence of this – example?~~

Stream secondary production is dominated by aquatic macroinvertebrates, which obtain resources from both allocthonous litter originating outside the stream and autochthonous in-stream production. Sentence about disproportionate quality or representation of algae in bugs. Etc etc etc for a few sentences Macroinvertebrates play an important role in assimilating and transducing energy to higher trophic levels such as insectivorous fish and other vertebrate predators. Because macroinvertebrates play such a crucial role in mediating food web interactions, understanding their community dynamics can provide insight into broader ecosystem functioning.

In temperate systems diversity of community tends to be high, are a widely used (ubiquitous) metric for assessing changes in resource availability, etc. NMS, PCA, FFG, tools for community assessment.

Trout diet as function of macro’s, foraging, etc

With the application of a gap experiment we hypothesize that the macroinvertebrate community will change in response to authocthounous resource availability, and changes in community will be reflected in the foraging of trout.

Methods

*Study location*

The study consists of 5 reach pairs on five separate streams in the western Cascade Mountains of Oregon. Two of the reach pairs (W-100, W-113) are located on private Weyerhaeuser Co. land, and three (LOON, CHUCK, MCTE) are located on U.S. Forest Service land, one of which (MCTE) is situated in the HJ Andrews Experimental Forest. Stream reaches were 90 meters in length and treatment gaps were 40 to 60 meters in diameter situated approximately in the middle of treatment reaches. Reach pairs were spaced x meters apart to moderate any effects of the upstream reach on downstream conditions.

Sampling lasted two years with pre-treatment data gathered during summer 2017 and post-treatment data gathered during summer 2018. Canopy gaps were cut in the treatment reach during the winter of 2017-18 to permit adequate time for response to the canopy manipulation. The reach pair design with pre and post treatment years is intended to account for inherent environmental variation among streams and between years.

All of the streams are wadeable, fish-bearing streams with bankfull widths of 1-8 meters. Fish-bearing streams were purposefully selected to provide management-relevant results for protecting salmonids. Small streams were chosen for ease of sampling and to maximize the effect of a canopy opening manipulation since smaller streams can be more heavily shaded. The streams run through 40-60-year-old forests that had previously been harvested without leaving a riparian buffer. The result is a forest stand homogenous in age with a homogenous canopy structure, as defined by its early seral development stage. Stream-side vegetation predominantly consists of red alder (*Alnus rubra*) and douglas fir (*Pseudotsuga menzesii*) which provide shade and allocthonous carbon inputs to the streams.

*Data Collection*

Three benthic invertebrate samples were taken at each stream reach at meters 15, 45, and 75, or the closest area with non-boulder substrate. Samples were collected once per year over the course of one week using a Surber sampler with a .1 sq. meter sampling area. Substrate was disturbed to a depth of approximately 4 inches for one minute. Samples were elutridated and something to remove fine sediments and rocks. The remaining sample was then preserved in 95% ethanol for identification and enumeration in the lab.

Fish diets were collected during three-pass depletion of fish standing stock and were only taken from a subset of fish greater than 100 mm in length. Fish were gastrolavaged, and stomach contents were collected in filter paper and preserved in 95% ethanol for lab processing.

*Data Analysis*

All analyses were performed in PC-ORD 7 and R (Version 3.5) using the Vegan package.