Regional equations for streams in forested watersheds in the Pacific Northwest

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Introduction and Objectives

The objective of this project was to determine and evaluate equations capable of estimating width, depth, discharge, and sediment load of stream channels in the Pacific Northwest in order to predict and monitor the effects of logging on water quality. This study is necessary as suspended sediment is currently amongst the largest pollutants in North American waters. Large amounts of suspended sediment entering Pacific Northwest channels have contributed to changes in channel morphology and a significant decrease in salmonid and macroinvertebrate populations.

Data collected from around 400 sites across the Pacific Northwest was compiled to determine both a general equation and more specific equations for each physiographic province of the Pacific Northwest. These regional equations are capable of predicting characteristics, e.g., bankfull width and depth, from bankfull discharge and drainage area (Fig. 1).

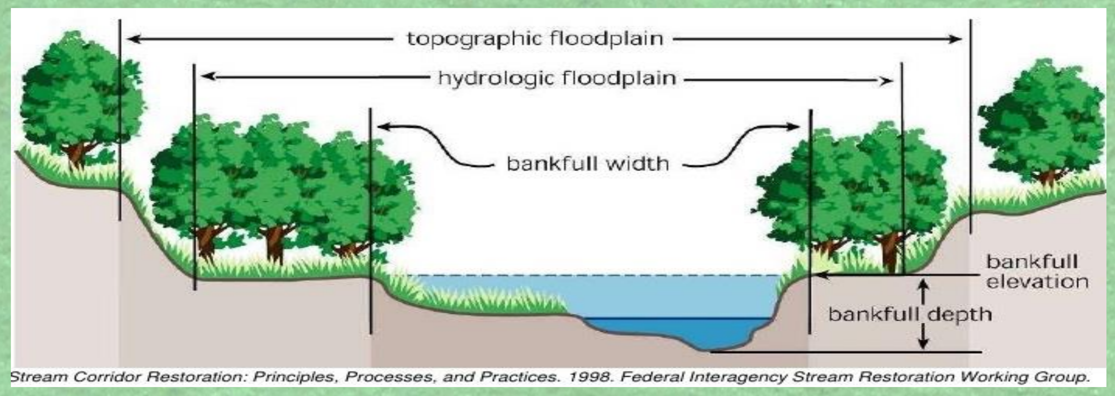


Figure 2: depiction of stream channel parameters used.

Dimensionless W = $\frac{g^{\frac{1}{5}}W}{Q^{\frac{2}{5}}}$	Dimensionless D = $\frac{g^{\frac{1}{5}}D}{Q^{\frac{2}{5}}}$	Dimensionless Q = $\frac{Q}{\sqrt{gD_{s50}}D^2{}_{s50}}$

Figure 3: dimensionless forms used.

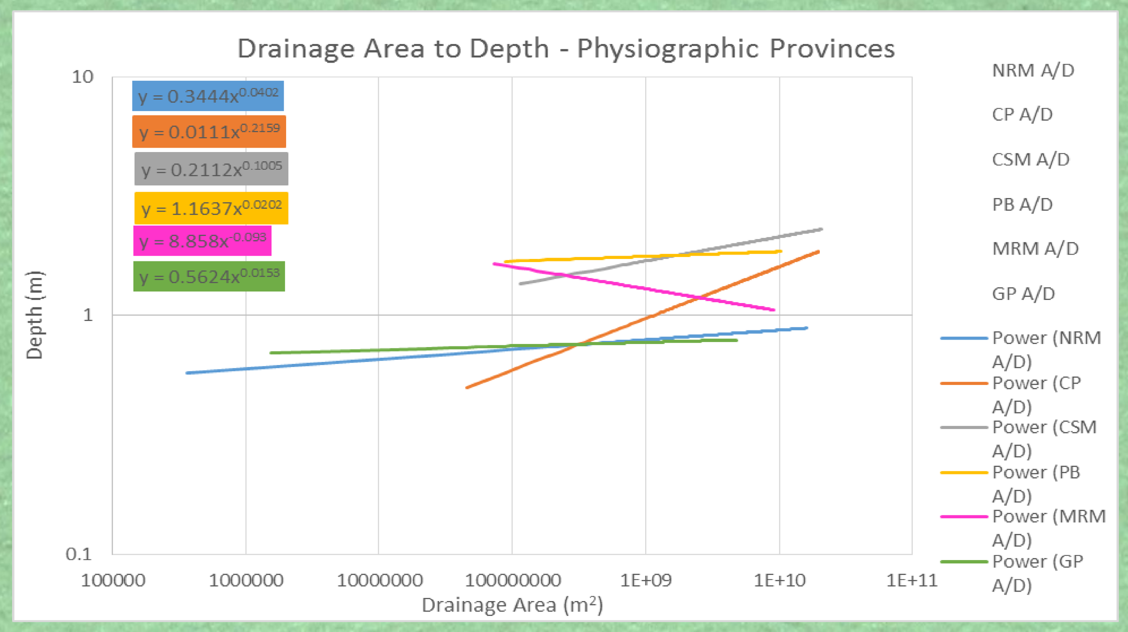
Methodology

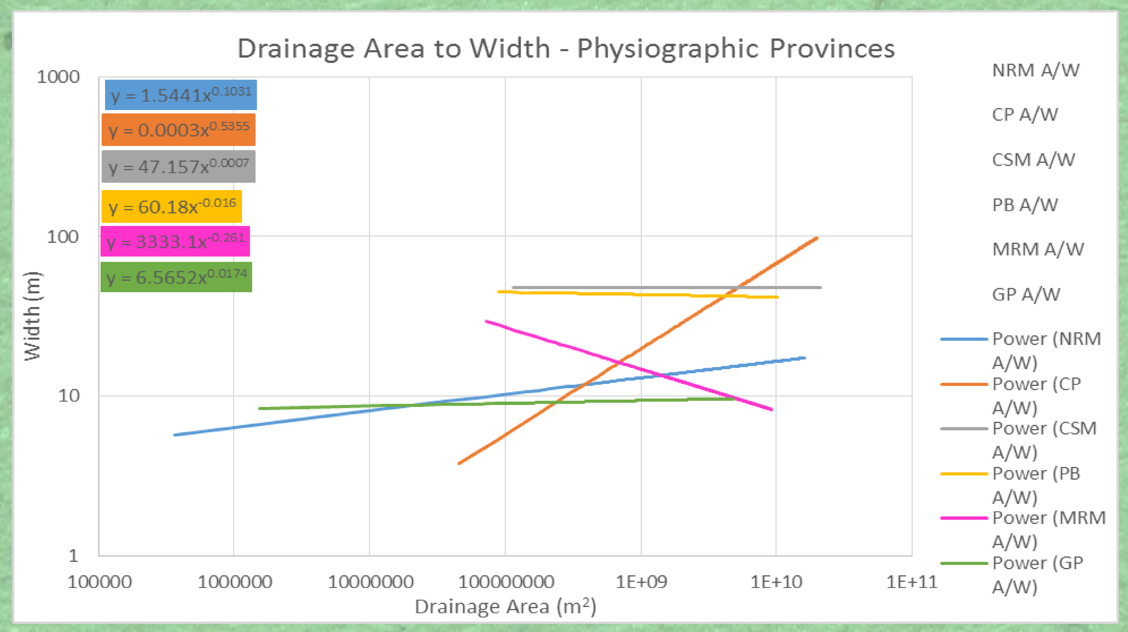
Bankfull width, depth, discharge, drainage area, slope, grain size and other data was collated from several different publications (Fig. 2) and rendered dimensionless (Fig. 3). After data collection, both discharge and drainage area were plotted against channel slope, bankfull depth, and bankfull width on a logarithmic scale and fitted with a trendline that serves as a general predictor for stream behavior in the Pacific Northwest (Fig. 4).

Each site was plotted on Google Earth and their physiographic provinces were determined. The sites were then separated by physiographic province and each data set was plotted again to generate more specific equations (Figs. 5 and 6). Specific equations are more useful as they take into account the climate, elevation, and other factors of each province that can attribute to different stream characteristics (Figs. 7 and 8). The Analysis of Covariance (ANCOVA) statistical test was then used to determine if the physiographic province equations were statistically different from the original Pacific Northwest general equations.

$$W,D = a(Q,A,L)^b$$

Figure 1: hydraulic geometry equation form.





Figures 5 and 6: graphs comparing width and depth to drainage area in each physiographic province.

Figures 7 and 8: images comparing physical characteristics of two streams in different physiographic provinces.

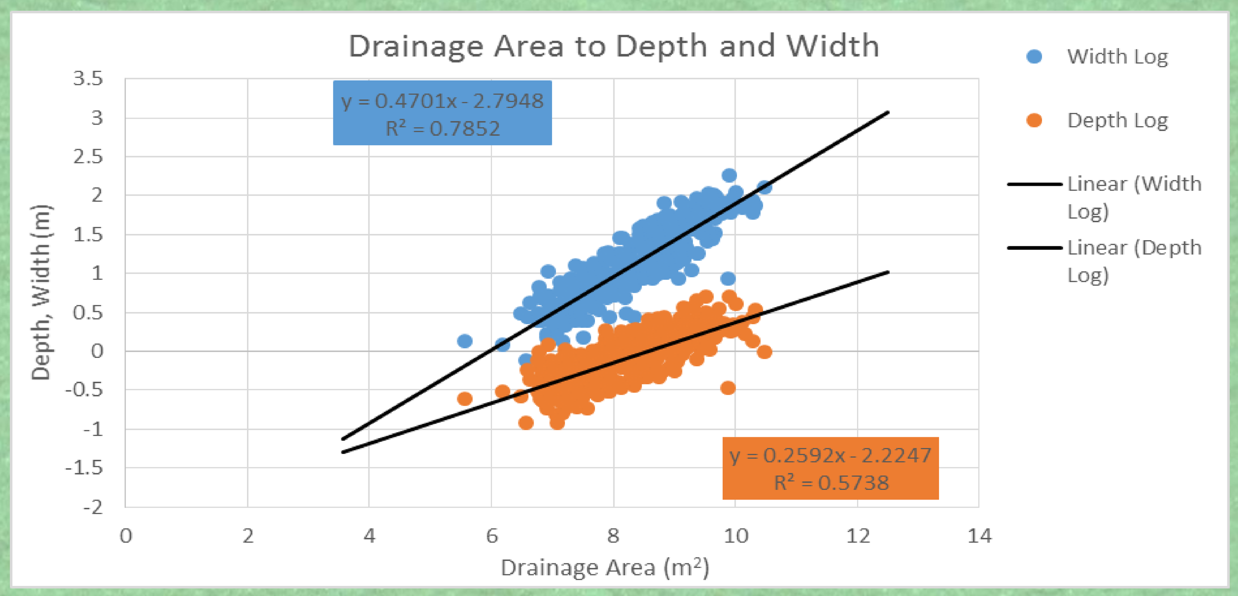


Figure 4: graph comparing change in depth and width with drainage area.

Results and Discussion

Separate equations were obtained for bankfull discharge and drainage area to width, depth, and slope for the Pacific Northwest. Equations for bankfull discharge and drainage area to width and depth were also calculated for the six physiographic provinces of the Pacific Northwest. Of the twenty equations tested, all equations were determined to be statistically different from the general Pacific Northwest equations. From the calculated p-values, depth and drainage area seemed to change the least with geographic provinces.

Now, it is possible to accurately anticipate and minimize the effects of logging on streams systematically by implementing the use of drainage area or discharge to predict changes in suspended sediment load.

Future Work

General and specific equations have been developed for watersheds in the Pacific Northwest. Now, it is possible to use the equations to determine the effects of logging and increased sediment transport on aquatic ecosystems. Attempts can be made to reduce sediment load in order to preserve and improve water quality of channels. In the future, precipitation, climate and additional site data will be collected and assimilated into each equation in order to render them more useful and accurate. Likewise, generating discharge equations for the Middle Rocky Mountains province and Grand Plains province would be useful.

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NARA

Northwest Advanced Renewables Alliance

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