Wetlands are a prevalent landform on the Kenai Peninsula, Alaska and provide critical support habitat for the world-class salmon runs that make this region famous. Streams in the Kenai Lowlands, the western coast of the Peninsula, support over a quarter million juvenile salmonids (Walker et al, 2007). Ancient glaciers formed the flat, pitted landscape of the Kenai Lowlands and today, 41% of the land is classified as wetlands and of that, 54% is peatlands (Reeve and Gracz, 2008). Peatlands serve as important ecological resources, were large historical sinks in the global carbon cycle (Gorham, 1991), are a source of nutrients and dissolved organic carbon to aquatic habitats, (Valett et al, 1996) and play a vital role in maintaining groundwater recharge to the numerous salmon streams that bisect this landscape. The two main rivers in the region, the Anchor River and Ninilchik River, receive 60-70% of their summer stream flow from groundwater, some of which moves through peatlands (Nelson and Johnson, 1981). Groundwater baseflow allows for thermal regulation of stream temperature (Poole and Berman, 2008). During the warm summer months when runoff is low and air temperatures are high, discharge to streams from peatlands helps maintain cooler water by contributing to higher stream stage. (Sinkrot and Gulliver, 2000). Cool in-stream temperature has been identified as a critical factor in salmon survival (Ritcher and Kolmes, 2005). As atmospheric temperature rises stream temperatures may surpass the habitable limit for salmon. Consequently, the importance of peatland habitat in stream thermal regulation has gained increased attention.
The Kenai Peninsula population continues to grow; the national census reported a ten-year growth rate of 11.5% (US Census). With this influx of people comes new infrastructure to make more remote areas of the Kenai accessible. Numerous roads now bisect wetlands and salmon streams. Despite its critical and documented contribution to salmon habitat, very little is known about shallow groundwater flow in peatlands in Kenai Lowlands. No study to date has looked at what impacts roadways might have on the quality of peatland habitat with respect to the hydrologic regime. Only a few such published studies exist for any habitat settings. Shallow groundwater movement under roads in forested slope settings was disrupted for 5-10m on either side of the road (Kahklen and Moll, 1999). For road and canal systems in a low relief coastal area of North Carolina roads impeded the movement of surface and subsurface water (Ferrell et al, 2007). For peatlands on the Kenai, impacts may be exaggerated due to the compressibility of peat. In personal communication with EPA research, Phil North, visual evidence exists that some road sites over peatlands on the Peninsula show altered vegetation and increased erosion of the peatland and road due to surface runoff. The extent to which this is happening has yet to be documented. As development on the Kenai Peninsula increases, the risk of altering groundwater flow and permanently damaging these landscapes is concerning.

Scope of Work

The goal of this study is to understand roadway impacts on groundwater movement through peatlands and the implications for salmon habitat. This will be accomplished by methods designed to address the following objectives.

1) Quantify basic hydraulic and water chemistry parameters upgradient and downgradient from the road crossing
2) Relate stream discharge at the study site to variability in groundwater flow
4) Monitor water level and stream flow response to precipitation
5) Create a numerical groundwater model of the shallow flow regime
6) Briefly assess groundwater levels and chemistry at a dozen other crossings of various type/configuration
6) Quantify the extent of impacts due to a road crossing
7) Model possible mitigation options
8) Increase local interest in groundwater issues at the college level through student involvement and educational materials

II. Technical Requirements

The following outlines tasks and research methodology to be performed by Megan Haserodt to meet the objectives listed above.

Methodology

Two potential sites have already been identified: Stariski Creek at Sergeant Avenue and Unnamed Creek at Bridge Access Road. Additional sites will be considered based on local researcher knowledge. Preference will be given to wetlands draining into tributaries of the Anchor River and Ninilchik River where some previous groundwater research has occurred, thermal imaging is available and where risk for development is greatest. Final selection criteria will include the following:

- Presence of a road traversing peatland habitat connected to a salmon stream
- Safe, easy access
- Observed differences in runoff patterns and vegetation near the road crossing which are possibly indicative of altered hydrologic conditions

An array of monitoring wells will be installed in the peatland on both sides of the road. Methods for installing and sampling monitoring wells will be similar to those described in the United States Forest Service Paper, “A Monitoring System for Measuring Effects of Roads on Groundwater: Equipment and Installation” (1997). These methods were created to assess the impact of roadways in forested regions
but many of the concepts are applicable to a peatland setting. Pressure transducers will be deployed in each well to provide continuous water level records over the field season. These data will be downloaded bi-weekly during the summer. Slug tests will be done to determine the hydraulic conductivity of peatland sediments. Water samples from the wells will be regularly tested for conductivity, pH, dissolved iron, dissolved oxygen and redox indicator species. A single set of samples will be collected for isotope analysis to determine the age of the groundwater and help delineate flow paths.

For stream stage monitoring a slotted PVC pipe stilling well outfitted with a pressure transducer will be installed in the stream. A rating curve, relating stage to flow, will be constructed using discharge measurements taken on a flow meter. Air and water temperature loggers will be deployed and allowed to run throughout the summer. Seepage meter measurements will be used to identify or confirm gaining and losing areas of the streambed and to quantify groundwater fluxes to and from the stream at selected locations. A nearby rain gage will be used to monitor precipitation.

Ecological surveys will be conducted to assess differences in the vegetation composition and robustness above and below the road crossing site. Wetland boundaries will be delineated using LiDAR, satellite imagery, and a field survey. Hydrostratigraphic characterization of the peatland will be accomplished by examining sediments recovered through hand augering and other coring techniques as feasible at the selected site.

An abridged hydrologic, chemical and ecological study will be conducted at a dozen other peatland crossings to assess impacts over a range of crossing configurations and types. The parameters assessed will be chosen based on data obtained from the heavily instrumented site.

The field data will be interpreted to develop a conceptual model of groundwater flow in the system and as calibration targets for a numerical model of groundwater flow using the USGS code MODFLOW. This model will be used both to test and refine understanding of the current conditions at the field site and to simulate potential effects of mitigation strategies that might alter drainage and flow beneath the roadbed or elsewhere in the system.

III. Deliverables/Schedule
Preparatory work has already begun and will continue through Spring 2013. This will include continued literature review for refinement of methods, discussion of site selection, planning the field campaign and equipment preparation.

Late May-Mid June (2013): Reconnaissance trip to top sites and site selection, initial installment of equipment, analysis of initial data
Late June – Late August (2013): Additional field instrumentation installed; field measurements conducted
Late October (2013): Field equipment removed
Late August (2013) – Late April (2014): Analysis of data, model construction
December (2013): Preliminary data report submitted
Early May (2014) – Early June (2014): Second round of field measurements to adjust for observations noted from data taken in 2013
Early June (2014): Data presentation in Alaska to interested parties (is so desired)
August (2014) – Submission of final report refinement of groundwater model, completion of educational materials

IV. References

Gorham, E., 1991. Northern peatlands: Role in the global carbon cycle and probable response to


