**Discharge – Precipitation Data**

Hypothesis: Change in the suitability of freshwater habitats used for spawning, rearing and migration has contributed to declines in Chinook salmon stocks.

Do environmental forcing variables such as flow explain trends in Chinook salmon?

Regionally downscaled estimates of monthly total precipitation (mm) 1980-2009 at a 771 x 771 meter spatial resolution were summarized for exploration. Downscaling process utilizes PRISM climatological datasets (http://ckan.snap.uaf.edu/dataset/historical-monthly-and-derived-precipitation-products-771m-cru-ts).

Literature search resulted in several hypothesis’ regarding flow or discharge effects on Chinook populations specific to life-cycle events (Schindler et al. 2013, Neuswanger et al. 2015):

1. Maximum flood peak during the spawning and incubation period (20 July – 25 Oct)
2. Maximum flood peak during the summer growing season (26 Apr – 30 Sept)
3. Flashiness during the critical emergence period (15 May – 15 June)
4. Flashiness during the summer growing season (26 Apr – 30 Sept)

Because precipitation is not well constrained, for lack of available data, climate model bias and prediction errors are amplified. We do not assume that such models can accurately predict heavy rain events over a short temporal scale, which are the likely driver of flashy flow conditions. Instead, we use estimates to correlate anomalous precipitation patterns to chinook life history stages. Here we investigate the use of precipitation as a proxy for discharge (Pandzic et al. 1997) at both seasonal and monthly time scales. Seasonal and monthly averages were first calculated within GIS and then extracted for each fish model location.

Following the list of possible discharge effects from above I have provided the following for analysis and data exploration using precipitation as a surrogate and exploring anomalies in space and time:

1. High flows effects on spawning and incubation period (fall and winter metrics):

**ASO\_max** - Maximum monthly precipitation for period August, September, October

**SON\_avg**  - Average precipitation over three month period (September, October, and November)

**SON\_max** - Maximum monthly precipitation for period September, October, November

**DJF\_max** - Maximum monthly precipitation for period December, January, February –

**\*\***I would be wary to use this one….precip estimates do not differentiate between rain and snow during winter months…however we may be able to get at this on a decadal time step

1. High flow effects during summer growing season (summer metrics):

**MJJAS\_max** – Maximum monthly precipitation for period May, June, July, August, September

**MJJAS\_avg** – Average precipitation over five month period (May - September)

**JA\_avg** - Average precipitation over two month period (July and August)

1. High flows during critical emergence period (spring metrics):

**MJ\_avg –** Average precipitation over two month period (May and June)

**MJ\_max** – Maximum monthly precipitation for period May and June

I produced some plots (pdf files) to look for anomalies across sites with commonalities in time. A couple metrics show distinct spikes which are common across all sites and select years and may be worth exploring:

ASO\_max

MJJAS\_max

MJ\_max

SON\_avg

MJJAS\_avg

Neuswanger, J. R., M. S. Wipfli, M. J. Evenson, N. F. Hughes, A. E. Rosenberger, and B. Jonsson. 2015. Low productivity of Chinook salmon strongly correlates with high summer stream discharge in two Alaskan rivers in the Yukon drainage. Canadian Journal of Fisheries & Aquatic Sciences **72**:1125-1137.

Pandzic, K., K. Cesarec, and B. Grgic. 1997. An analysis of the relationship between precipitation and discharge fields over a karstic river basin. International Journal of Climatology **17**:891-901.

Schindler, D. W., C. Krueger, P. Bisson, M. Bradford, B. Clark, J. Conitz, K. Howard, M. Jones, J. Murphy, K. Myers, M. Scheuerell, E. Volk, and J. Winton. 2013. Arctic-Yukon-Kuskokwim Chinook Salmon research action plan: evidence of decline of chinook salmon populations and recommendations for future research.