Effects of Uncertainties in Channel Flow-Stage Relationships on Watershed Area of Suitable Habitat, Bear River, UT

Todd Brown, Utah State University

Research Mentor: Dr. David E. Rosenberg, Ayman Alafifi; Utah State University

Abstract

How much water do we use and where do we use it to benefit both humans and the environment? Managing any river system requires an understanding of its ecology and hydrology. The Watershed Area of Suitable Habitat (WASH) system model is created to understand both. The WASH model recommends flow to increase suitable riverine, floodplain, and wetland areas and can help identify sites within a basin for restoration. This is going to help benefit the environment by allocating water for environmental users and also determining the quantity and the times of water needed for restoration purposes at different locations along the Bear River. In 2012, 2013, and 2015, the Bear River Fellows conducted multi-day river trips on the Bear River to collect water surface level, stream flow, water pressure, river bank bed topology, and riparian zone data using an Acoustic Doppler Current Profiler (ADCP), Garmin GPS, and HOBO pressure transducers at three sites. We collected these hydrologic and ecological data at 3 different sites; the Cub River site, the confluence of the Cub and Bear River, and the Morton site. I organized and compared data for river width, stage, and flow from year to year taking into account the human and the data collection instrument errors. I determined the change in river width from 2013 to 2015 and also determined the stage and flow relationship of the river at different times. The stage-flow relationship is important in the WASH model because it takes into account riverine, floodplain and wetland suitability. In order to measure this, the WASH model looks at cutthroat trout's needed depth, cottonwood trees lateral connectivity, and three different bird species' need river depth. Thus, a change in river depth can effect these species. The relationship is a linear relationship showing the higher the stage, the more flow. I also took into consideration the possible error; helping make the model more precise. After finding the different stage and flow relationships for multiple transects I ran the WASH model using the different values. The results showed that if we apply a minor change to the slope of the stage vs. flow in the WASH model, we will get different results for the area suitable for habitat. This research is helping protect the environment by considering riverine suitability, floodplain suitability, and wetland suitability throughout the year. When the slope of the stage-flow relationship moved from .0139 to .0151 there was a change in area suitable for habitat from 5,048,195 meters to 5,048,229; 34 meters of available suitable habitat.

Research Methods

1. Collect water surface level, stream flow, water pressure, river bank bed topology, and riparian zone data using an ADCP, Transom Survey equipment, Garmin GPS, and a HOBO pressure transducer in 2012, 2013, and 2015
2. Organized all the transects taken in 2012, 2013, and 2015 using the ADCP for flow and stage measurements.
3. The WASH model before used one line of the average slope for the stage-flow relationship. I determined the residual of our measurements of stage and flow against the line of best fit calculating in the error when collecting the data
4. Used the fitted flow-stage relationship to run the WASH model for an initial base case
5. Ran the WASH model for six alternative scenarios with modified flow-stage relationships that each took into account a random transect taken for each of the different times data was collected.

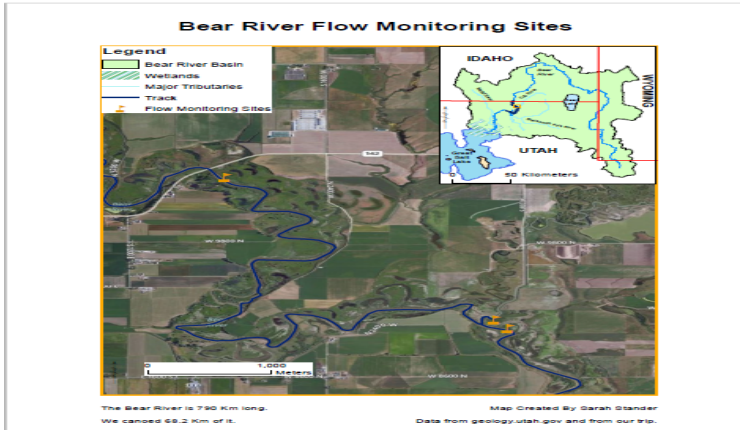

Figure 1. Work sites along the lower Bear River showing the Morton, Confluence, and Cub River

Results

In order to take into account all of the different transect and not take an average reading, I made an excel listing of all of the transects with their respective flow and stage. Once finding the data, I then was able to calculate the slope for each transect throughout the years starting with November 17th, 2012 through August 21st, 2015. The graph shows that at each day, we took multiple transects for each site; each point is one of those multiple transects taken. Every time I run the excel sheet, a new set up data points will be calculated; the graph above being one of them. All of the slopes being different from the other.

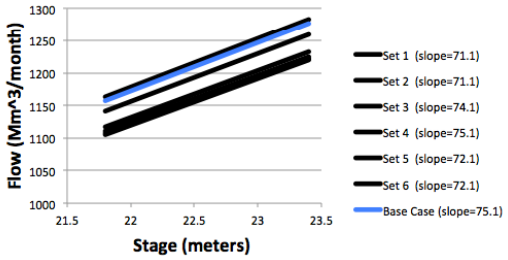

Fig.2 Shows in blue the current slope being used in the model and in black the slopes from the random transects

Results Cont.

When first calibrating the stage-flow relationship in the WASH model, we used the 'Confluence Rating Curves' to calculate the relationship. As I started to organize the data and go over every transect, I noticed that there were slight errors in each transect. The red line shows the slope of the line currently being used in the WASH model to determine suitable habitat. The black lines show what the random transects produced as what the stage and flow relationship is. When adding in the error to the WASH model, we can make the model more precise.

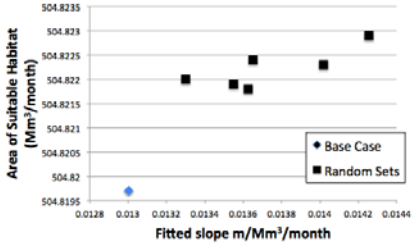

Fig.3 Shows that when you change the slopes in the WASH model, the area suitable for habitat also changes

After running the WASH model with the change in slope and intercept, we received a new reading for the area suitable for habitat. This shows us that even a minor change in slope can provide a change in area for habitat.
I started with the assumption that the flow and stage would have a significant change on the WASH model. My assumption was incorrect, the results showed that changes in the flow and stage would provide a difference in area suitable for habitat; but not a significant difference.

Why Does This Matter?

- Characterized effect of error for an individual measurement at a specific location on watershed area of suitable habitat for an entire watershed.
- Can apply to other locations within the watershed (e.g. Cub River, Morton Site).
- Can identify effects on water allocations to improve habitat for fish, vegetation, and bird species.

Toddkay.94@gmail.com

iFELLOWS UNDERGRADUATE RESEARCH PROGRAM

http://iutahepscor.org