Summary of arguments and points for discussion – Reinthal – March 5, 2013

<u>As you decrease flow in Aravaipa, you increase the probability of extinction in fishery.</u>

1) Standard Instream Flow Incremental Model (IFIM) -

- Predicts changes in available habitat with changes in flow. The changes in habitat are extrapolated to changes fish species abundance and composition.
- Does not simulate ecological interactions. Criticized because does not account for predation, competition, prey availability (citation).

2) Habitat Suitability Index (HSI) –

- Bonar et al (2010) calculates habitat suitability indices for fish from Cherry Creek.

Bonar (pers. comm.) warns about using HIS from one creek to another – you need specific HIS for Aravaipa. This could be big argument because the study lists low depth as habitat. Need specific reasons why this info would be different in Araviapa.

- Also, information regarding spikedace and loach minnow HSI is not available. Can we determine HIS for spikedace and loachminnow based on literature?
- Other HSI work- Adult and juvenile roundtail chub (*Gila robusta*), razorback sucker (*Xyrauchen texanus*) in Fossil Creek, and adult roundtail chub in Wet Beaver Creek (Barrett and Maughan 1995).

3) Lower carrying capacity of the environment due to lower mean flow;

- Lower flow, decreases habitat area and results in a smaller population.
    - Both genetic and stochastic bottlenecks are more extreme. Inbreeding, General examples of bottlenecks, Genetics of effective population size – these open up an entirely new set of arguments.

4) Thermal tolerance;

- Both Lethal Tolerance/50% survival (LT50) and Critical Thermal Maximum (CTmax) Tolerance of spikedace and loach minnow known (Widmar; Corveth).
- Decrease flow, increase max temperature and increase probability of reaching CTmax. Riparian area is also crucial for keeping temperature in stream low due to shading; Loss of riparian and increase temperature.

5) Variability of flow important for populations (Eby et al);

- Periodic flooding and increased reproduction - Creates and maintains habitat variability necessary for the seven different species of fish
- 6) Alteration of habitat availability due to decreased flow – Riffle areas are of particular importance because this is spikedace and loach minnow habitat
    - Decrease habitat favored by spikedace and loach minnow
- Increase habitat favored by non-native red shiners and facilitates the spread.
    - Red shiners can compete with native fish for both space and food resources in Aravaipa (Marsh report and Cunningham et al.).

6) Can we determine maximum likelihood model or probabilistic model for how populations would change in response to changes in flow? New idea.

Other Areas - Questions?

1) Do we want to look at invertebrate flow responses?

- Decrease or loss of invertebrate species richness and abundance due to decreased flow and habitat variability.
    - Invertebrates are an important food resource for fish
    - Decrease of carrying capacity of habitat for invertebrates, less food resource for fish
    - Decrease or loss of functional feeding groups, in particular filter feeding invertebrates that rely of flow to forage. Once such filter feeding group is Simulidae, which is a preferred forage insect of spikedace.

2) Material that would be useful for the fishery argument

- Hydrology
    - Which areas will be affected first if flow's decrease? For example, will riffles quality or quantity decrease?
    - Down-cutting of canyon as a creator of variable habitats
    - Effects to flooding regime
    - Bed load transportation and sedimentation
    - Effects on temperature
- Riparian
    - Effects to allocthonous nutrient inputs
    - Effects to temperature

3) Other wildlife related arguments

- Mexican Spotted Owl or Willow Flycatcher - Endangered birds
    - Forrest owl that relies on riparian areas and canyons at lower elevations
    - Decreased riparian area due to flow decreases habitat
- Lowland leopard frog- State protected frog