2.5 – Workshop: Formulating EFM Relationships

This workshop focuses on developing EFM relationships to investigate links between hydrology and ecology. Develop a relationship for each of the following ecological concerns.

1. Sacramento Splittail is a threatened species of fish. Splittail populations have declined as floodplain areas, critical to Splittail spawning, were turned into agricultural lands. Splittail spawn in shallow vegetated floodplain areas between **February and May**. Eggs require **sustained high flows for approximately 21 to 28 days** before hatching. Splittail reach adulthood in their first or second year and have a lifespan of approximately 6 years. Scientists say that good spawning conditions do not need to occur every year – it would be sufficient if there were good conditions in **25% of <u>years</u>**, so that, on average, each adult would have a chance to spawn in their lifespan. Propose an EFM relationship (with hypothesis) to be an indicator of Splittail spawning. *Hint: Flow <u>duration</u> considers percentage of time; flow <u>frequency</u> considers percentage of years.*

Season: *% Exceedance (<u>frequency</u> or <u>duration</u>):*
Duration (in days) and settings: *Hypothesis:*
1) mins, medians, maxs, or means
2) min, median, max, or mean

2. A study for shad and striped bass showed that fish mortality occurred in winter and spring, **January through May,** due to a chronic lack of habitat. Mortalities began to occur when generally poor conditions persisted for **two weeks**. Habitat shortages for these fish occur at low flows. Scientists said that these chronic conditions are best represented by **average low flows** and that, since these fish are in the river each winter, using a **typical <u>year</u> (median conditions)** would be a good indicator. The study showed that suitable habitat is proportional to increasing low flows (i.e., higher low flows create more habitat) until those low flows exceed 10,000-cfs. Propose an EFM relationship (with hypothesis) to be an indicator of habitat for shad and striped bass. *Hint: The curve option in hypothesis tracking might be useful for this relationship - consider a step linear curve with three points - a start (based on fish being fish), an inflection (based on the narrative above), and an end (to make sure EFM is not asked to extrapolate).*

Season: *% Exceedance (frequency or duration):*
Duration (in days) and settings: *Hypothesis:*
1) mins, medians, maxs, or means
2) min, median, max, or mean

3. Reservoirs tend to reduce high flows and increase low flows, which creates a more stable flow regime. In these regulated systems, communities of benthic macroinvertebrates often have reduced biodiversity because the few species that thrive in the more stable flow conditions out compete all of the others. **Flooding** initiates a return to more natural conditions which encourages the community to rebound to its original biodiversity. Scientists said that the **timing is not important**, but the high flows should **occur once every two years, on average**. Propose an EFM relationship (with hypothesis) to be an indicator of benthic macroinvertebrate biodiversity. *Hint: EFM relationships can be very simple.*

Season: *% Exceedance (frequency or duration):*
Duration (in days) and settings: *Hypothesis:*
1) mins, medians, maxs, or means
2) min, median, max, or mean

4. This excerpt describes flow conditions needed for protection of the shoals spider lily, which is an endangered plant species endemic to the Savannah Basin:

"**June and July** flows need to be held above **2,700 cfs** to limit deer grazing on the spider lily (which are not known to enter the shoals when river edges are wetted)."

Propose an EFM relationship (with hypothesis) to be an indicator of protection for the lily. *Hint: Flow duration considers percentage of time; flow frequency considers percentage of years. Does it sound like these plants need protection for a % of years or for a % of time during all years? Hypothesis curve might be handy again - consider three points. Duration settings are not pertinent for flow duration relationships.*

Season:
Duration (in days) and settings: 1-day
1) mins, medians, maxs, or means
2) min, median, max, or mean

% Exceedance (frequency or duration):
Hypothesis:

5. Water exchange between river and wetland areas has also been noted as a key component of wetland health. With frequent exchange, water quality in the wetlands remains good, but with isolation, dissolved oxygen levels drop, wetland areas become anoxic, and aquatic species die. This is only an issue in the warm summer months, **mid-May to mid-September**. A hydraulic engineer on your team has determined that flows of 6,000-cfs and higher allow water exchange in your project area and a biologist, familiar with the region, suggests that active exchange for approximately **30% of the time** (in summer) will lead to healthy conditions. Propose an EFM relationship (with hypothesis) to be an indicator of water exchange. *Hint: Flow duration considers percentage of time; flow frequency considers percentage of years. Duration settings are not pertinent for flow duration relationships.*

Season:
Duration (in days) and settings: 1-day
1) mins, medians, maxs, or means
2) min, median, max, or mean

% Exceedance (frequency or duration):
Hypothesis:

5. Extra credit: Propose another relationship for scenario #5 that uses EFM's reverse lookup feature. Reverse lookup relationships follow the same process as other relationships, except instead of specifying a % exceedance and having EFM compute the corresponding flow the user specifies a flow and EFM computes the corresponding % exceedance. *Hint: EFM still needs to know whether it's a flow frequency or a flow duration relationship – then just specify a reverse lookup flow instead of a percentage.*

Season:
Duration (in days) and settings: 1-day
1) mins, medians, maxs, or means
2) min, median, max, or mean

% Exceedance (frequency or duration)
Reverse lookup (flow, cfs):
Hypothesis: