Welcome back from lunch!

We continue our discussions

General Ecological Hypotheses and Flow Recommendations

....unfortunately, we have to leave pretty river pictures for a while.

General Flow-Ecology Hypotheses

- 1. Species richness will peak at intermediate levels of flow variability.
  - a. Too many low-flows will extirpate riverine biota due to a cascade of flow-induced effects on water quality, connectivity, biotic interactions (i.e., predation and competition).
  - b. Too many high-flows will extirpate some riverine biota through sheer-stress effects and habitat loss.
  - c. An "intermediate" level of flow variability will increase riverine species richness by creating habitat features and limiting competition.
- 2. Low and high flow effects will be mediated by the spatial proximity and abundance of flow refugia and organismal vagility.
- * 3. Behavioral, phenotypic, and physiological species traits will predict organismal and population sensitivity to flow regimes.

General Hypotheses, cont.

- 4. The mechanisms of flow-effects will vary across spatial and temporal scales.
  - a. Spatial
    - i. At local-scales (i.e., within 1-10 mile-long river reaches), flows affect riverine biota primarily through physiological and behavioral pathways (e.g. low DO or poor visibility).
    - ii. At regional-scales (i.e., more than 10 mile-long river reaches), flows affect riverine biota primarily through recruitment and metapopulation dynamics (e.g., variable year classes).
  - b. Temporal
    - i. Over short time periods (i.e., hours-days), flows affect riverine biota primarily through physiological and behavioral pathways (e.g., fatigue, sheer stress).
    - ii. Over long time periods (i.e., years-decades), flows affect riverine biota primarily through habitat-forming processes (e.g., substrate organization and mesohabitat structure).

Tables 12 and 13 of the Workshop Background Report relate our flow hypotheses to flow needs of each ecological indicator group. Your input on these tables is an important part of the breakout work-sessions this afternoon and tomorrow.

Table 12. Flow component needs for nontidal large rivers (Monocacy R., Opequon R., Potomac R. mainstem).

Biota	Flow Component			Reference
	High Flow Events	Mid-Range Flows	Low Flows	
Group A fish (large-bodied, long-lived, late maturation, migratory, flow-velocity generalist) e.g., American eel	Sep-Feb – provides one of several cues for out-migration of adult eel (silver eels) (Flow Statistics 15-# events Winter, 16-# events Spring)	Dec-Apr - one of several cues for upriver migrations of juvenile eel (elvers) (Flow Statistic 9-# events Fall)	Sept-Feb - Out-migration delayed if prolonged. (Flow Statistics 7-duration events Fall, and 8-duration events Summer)	• High flows trigger adult eel out-migrations (Smogor et al. 1995). • Migrating eels may delay migration when velocities are too low or too high (Greene et al 2009).
Group B1 fish (Alosid, medium-sized, migratory, moderate flow-velocity specialization, e.g., blueback herring, alewife, American shad	Mar-Jun – provides one of several cues for upriver migrations of adults to nontidal spawning grounds Mar-Aug - high flow pulses not too numerous or too strong to cause loss of larvae and young-of-year class August-November- High flow are one emigration trigger. (Flow Statistics 13-2 yr R.I. event, 15- # events Winter, 16-# events Spring, and 18- # events Fall)	Mar-Jun – provide adults with access to natal spawning streams (Flow Statistics 9- Monthly Q_{90} flow, 10- Monthly Q_{50} flow, and 11- Monthly Q_{10} flow)		•High flows in summer limit recruitment success. (Jenkins and Burkholder 1994) • Cues for emigration include high flows (Greene et al 2009).
Group B2 fish (non-Alosid, small home range, medium-sized, moderate flow-velocity specialization), e.g., smallmouth bass, shorthead redhorse, redbreast sunfish	Dec - Mar – Extreme flows during dormancy period displace and cause energy consumption. (Flow Statistic 12- Annual Q_{10} flow)	May - Oct – stable flows best for developing young (Flow Statistics 9- Monthly Q_{90} flow, 10- Monthly Q_{50} flow, and 11- Monthly Q_{10} flow)	Jun-Oct – Competition, increase exposure of young to predators. (Flow Statistics 2-Annual Q_{90} flow, 3- $_7Q_{10}$ flow, 5-# events Summer, 6- # events Fall, 7- duration events Summer, 8- duration events Fall)	• Availability and persistence of shallow-slow water habitats were directly correlated with fish abundance, particularly percids, catostomids and cypriids (Bowen et al 1998) • Strongest smallmouth bass year class observed when June flows within 40% of long-term mean. Smith et al 2005 • Juveniles and adults directly compete for refuge (Rashleigh and Grossman 2005)

Flow Recommendations

Great Falls, September 9, 2010

10 Key points that shaped the team's flow recommendations.

•1) The Potomac River has only minimal flow regulation, and that only at very low flows. There are no dams regulating flow on Opequon Creek or Monocacy River. Thus, high and mid range flow magnitude, and frequency and duration of events, are not subject to operational management.

•2) Except for low flows from Great Falls to Little Falls, the observed distribution of flows appears to be the result of weather, climate, and land use factors.

•3) Evidence suggests that there have been changes in flow distributions over the past 100 years but additional analysis is required to determine the roles of climate, land use, or other factors, in those changes.

•4) Intra- and inter-annual variability in flows is high.

•5) For aquatic species, no studies were found in the literature that provided directly applicable quantitative measures of flow needs for large rivers. Instead, flow needs were expressed as velocity requirements at the individual organism scale, which cannot be converted to river flow values. These requirements could not be translated to stream discharge values. The literature and expert judgment did provide qualitative descriptions of flow needs.

•6) No documented evidence of species impairment due to flow management was found in Potomac large rivers.

10 Key points that shaped the team's flow recommendations, continued.

*7) Low flows in the Great Falls to Little Falls reach are lower than they would otherwise be due to drinking water withdrawals at, and above, Great Falls. A 100 mgd (155 cfs) minimum flow-by at Little Falls and 300 mgd (464 cfs) from Great Falls to Little Falls recommendation has been observed since the early 1980s. During that time flows have rarely been that low. In 2002, when flows were approaching these levels, field observations did not identify any stressed communities and there did not seem to be a significant loss of habitat in these reaches. Additional study is needed to detect any potential subtle effects.

•8) The flow "needs" of most freshwater species in the tidal fresh river segment are typically a reflection of their salinity preferences and tolerances. High river flows can benefit taxa and life stages that prefer freshwater while low flows can benefit taxa and life stages that prefer salt water.

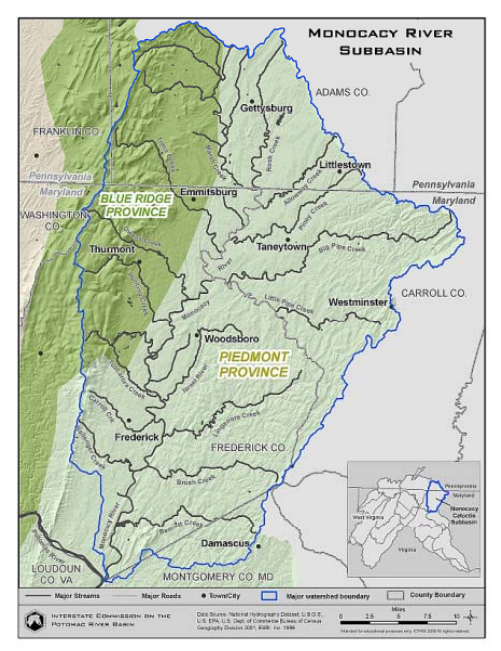
•9) Eutrophication and sedimentation of the tidal Potomac River have significantly changed many estuarine flow-ecology relationships. The flow needs identified for tidal fresh biota do not consider the very significant confounding influence of the tidal fresh Potomac River's poor water quality. Nor do they consider the flow needs of higher salinity taxa such as oysters, young-of-year menhaden, and older, resident striped bass.

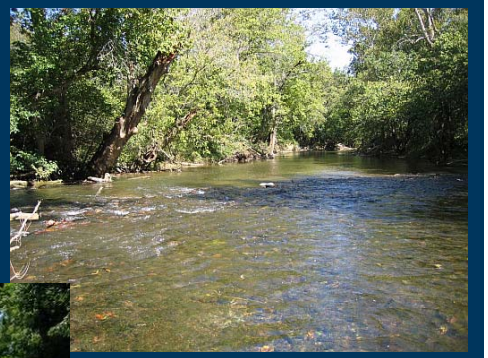
•10) Future impacts on flow from climate change are uncertain but studies have suggested that impacts in the middle Atlantic region of the U.S. will be lower in magnitude than elsewhere and may result in both higher precipitation and higher temperatures.

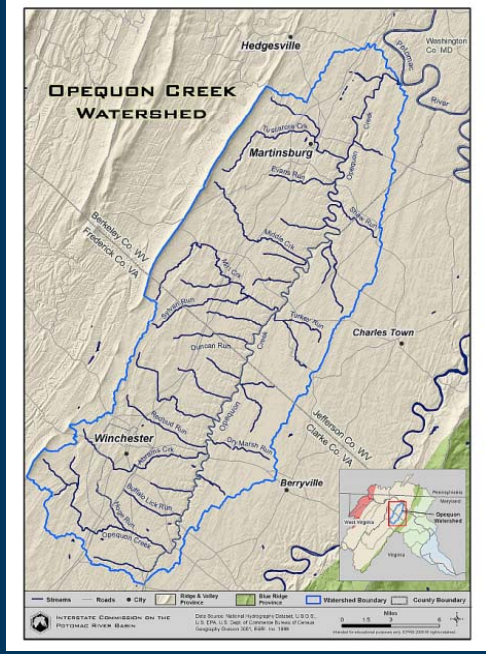
DRAFT Flow Recommendations, continued

6. **Low Flows - Monocacy River and Opequon Creek:**

Current low flow statistics be maintained and withdrawal volumes not be allowed to push flows below those observed in 1999 and 2002.







Extreme low flows in these watersheds are similar, on a flow per square mile drainage area basis, to those found in other watersheds with similar geology and healthy biological communities. Thus, it is unlikely that any observed biological stress is the result of human caused changes in flow conditions. The recommendation is precautionary.

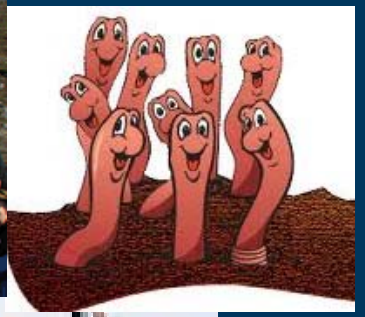
US Army Corps of Engineers

The Nature Conservancy

Enough Talking Heads

On to Breakout Groups!

BREAK ON THROUGH,
BREAK ON THROUGH…….



DRAFT Large-River Flow Recommendations

(From Report pages 76-77)

We start with a general flow recommendation…

based upon A) our evaluation of flow statistics which indicate the Potomac's flow components are not abnormal, and B) no overtly flow-stressed biotic communities were identified,

1. Maintain current flow characteristics.

It is reasonable to expect that maintaining these flows will continue to support biotic communities (other factors such as water quality aside).

DRAFT Flow Recommendations, continued

Then we flow into slightly more specifics;

2. **Extreme floods: There are no operational mechanisms for controlling floods.** In the long term, land use changes such as increases in impervious surface and reduction in forest cover will increase peak flows.

   Recommendation: **Where possible, impervious surface cover should be reduced and vegetative cover increased to reduce extreme floods.**

3. **Small Floods: There were no observed major problems in this flow component.**

   Recommendation: Maintain current conditions.

DRAFT Flow Recommendations, continued

Most specifically, when Potomac flows get low….

Low Flows – recommendations are provided for each of the 6 study sections:

4. Potomac mainstem from Harpers Ferry to Point of Rocks:

This river section benefits from slightly augmented flows during low flow due to water quality and water supply releases from Jennings Randolph and Savage River reservoirs. There are no discernable problems in this reach = **Maintain**

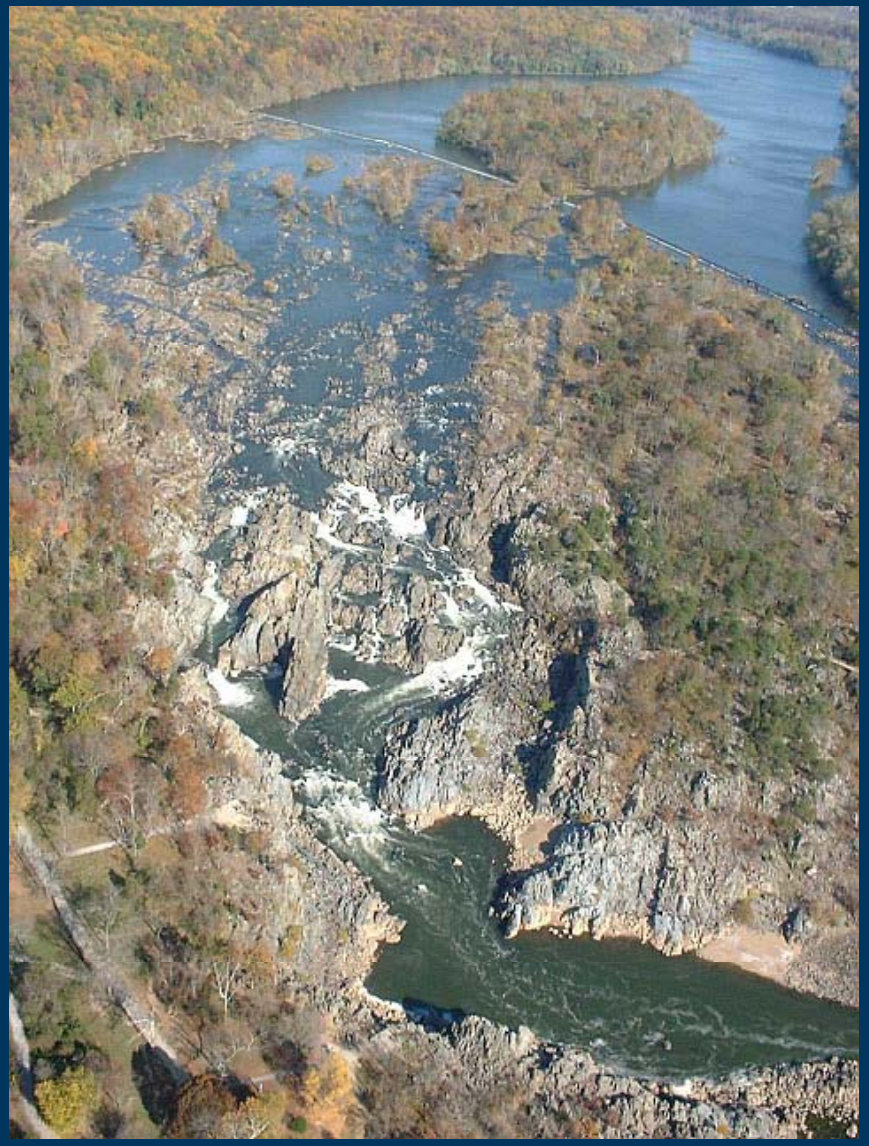
DRAFT Flow Recommendations, continued

5. Point of Rocks to Great Falls:

There are large consumptive withdrawals in this section including the Dickerson power station and metropolitan Washington area water utilities. All currently provide augmentation during low flow conditions.

A) withdrawals should be managed so that Potomac river flows do not fall below those experienced in the 1999 and 2002 droughts.

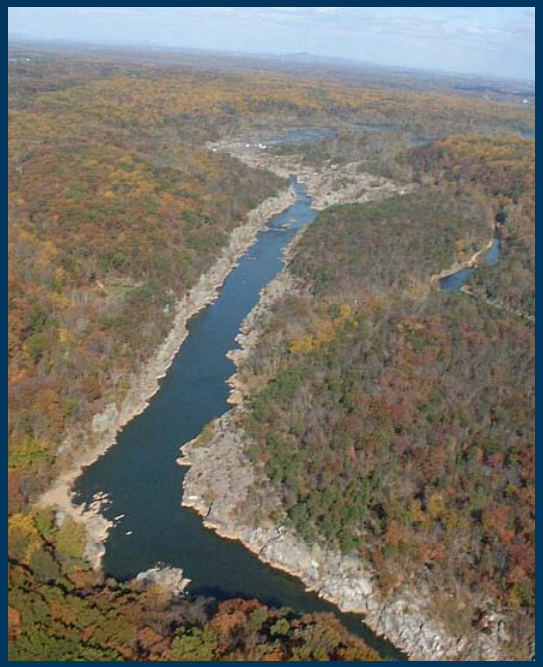
B) a gage should be installed to measure low flow levels at the Great Falls weir.

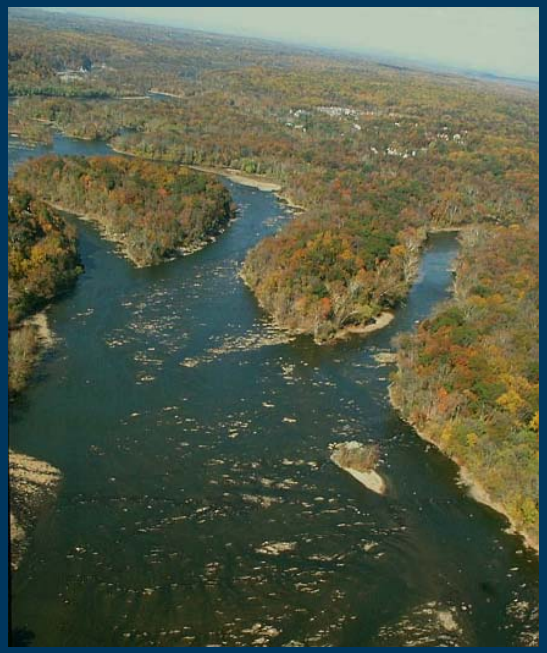


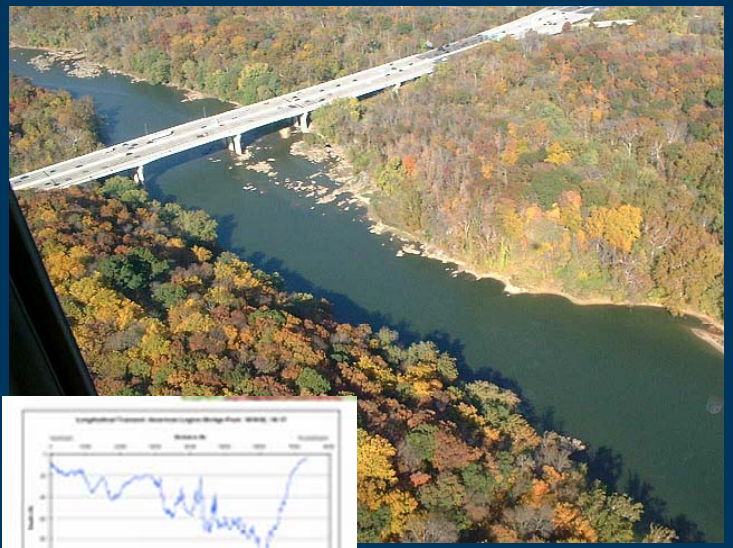
DRAFT Flow Recommendations, continued

6. Great Falls to Little Falls:

Maintain the current recommended 300 mgd (465 cfs) minimum flow.







Although not a requirement, water utilities have managed their operations to always exceed this target. During the 1999 and 2002 droughts, when flows approached this low level, there were no overt observed ecological stresses in this section. However, further research is warranted.

DRAFT Flow Recommendations, continued

7. Low Flows - Little Falls to Chain Bridge (tidal river)

a) maintain the 100 mgd minimum flow-by, and

b) maintain the variability in extreme low flows observed in 1999 and 2002. This could be done, for example, by allowing only single day dips in flow to 100 mgd, but maintain weekly average flows of 200 mgd and at least one peak of 300 mgd every two weeks.

No overt ecological stresses were observed in this section during the 1999 and 2002 droughts, but there is a definite need to better understand impacts here. In past droughts, even at extreme low flows, there has been some variability in daily flows with flows generally several hundred mgd higher than the 100 mgd minimum.

DRAFT Flow Recommendations, continued

8. Low Flows - Chain Bridge to Occoquan Bay:

Maintain current conditions.

Water quality is the major determinant of biological health, not freshwater flow. Species groups will adjust to accommodate flow changes.