Instructions for breakout groups

Workshop goal and outcomes

Goal: Determine environmental flow needs for segments of the mainstem Potomac and selected large tributaries

Workshop process: Use expert input to refine initial draft flow-ecology hypotheses, statistics, and recommendations from the draft report during breakout group sessions

Expected outcome: A set of flow hypotheses and measurable flow statistics for the Potomac River and major tributaries that can be refined using an adaptive management approach

Environmental flow terms

Ecological Indicators – species sensitive to flow and grouped by taxa, life history strategies, and flow needs

Environmental Flow Components – types of flow events that represent the full spectrum of river flows and are required for ecological function: small and large floods, high flow pulses, mid-range flows, low flows, and drought flows

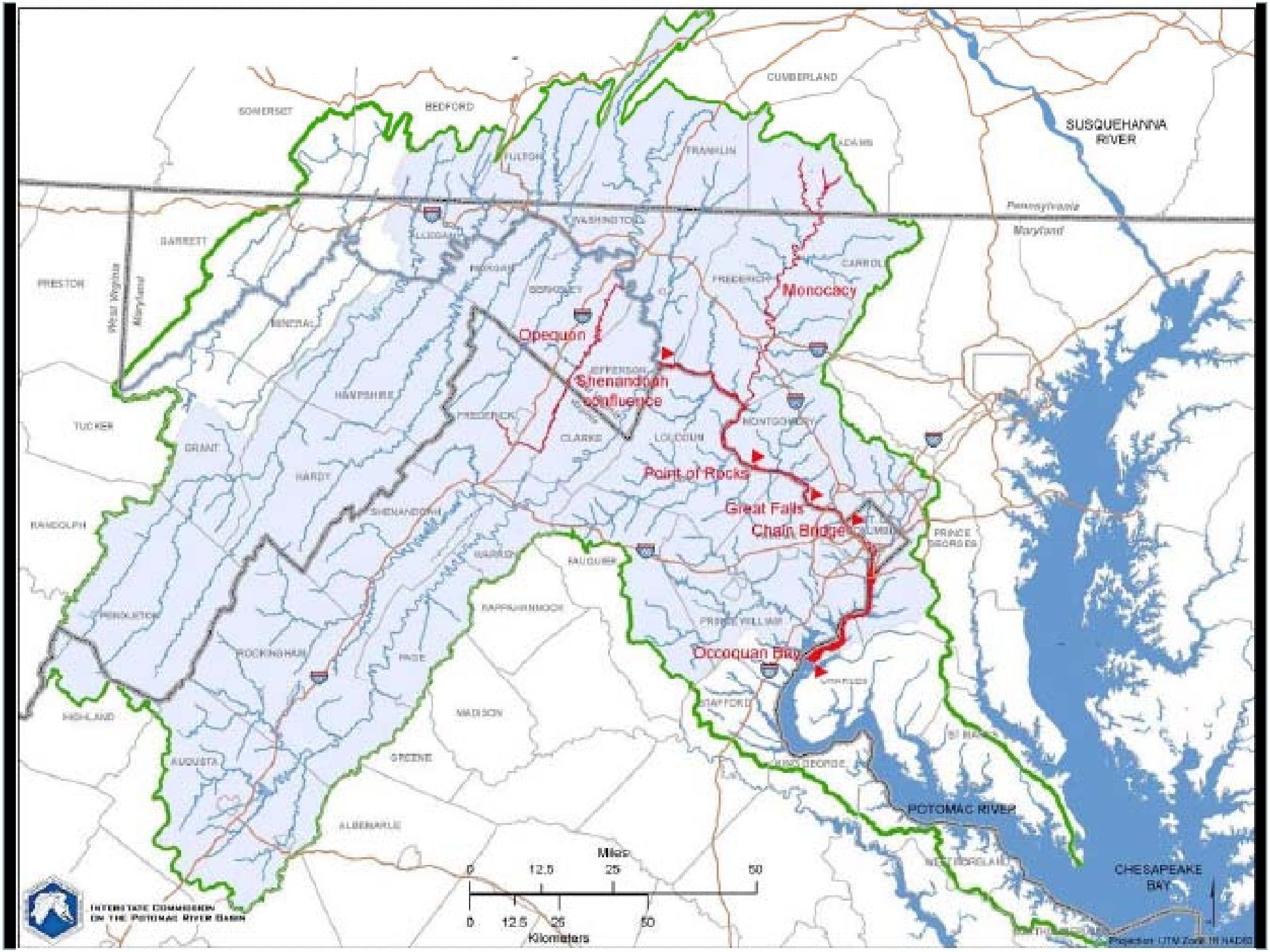
Environmental Flow Needs – the quality, quantity and timing of water flows required to maintain the components, functions, processes and resilience of aquatic ecosystems

Defining environmental flow needs

Flow hypothesis – a testable explanation for a suspected or observed relationship between river flow and the needs and tolerances of species and communities

Flow statistic – measurement of the magnitude, duration, frequency, timing, or rate of change of environmental flow components.

Flow recommendation – recommended quantification of, or development of a range around, a flow statistic that is protective of one or more ecological indicator or function


SUSQUEHANNA RIVER
Pennsylvania
Maryland
Monocacy
Opequon
Shenandoah confluence
Point of Rocks
Great Falls
Chain Bridge
Occoquan Bay
POTOMAC RIVER
CHESAPEAKE BAY
CUMBERLAND
BEDFORD
SOMERSET
FRANKLIN
ADAMS
CARROLL
FREDERICK
WASHINGTON
BERKELEY
JEFFERSON
HAMPSHIRE
MORGAN
MINERAL
PRESTON
TUCKER
GRANT
HARDY
RANDOLPH
PENDLETON
ROCKINGHAM
HIGHLAND
AUGUSTA
GREENE
ALBEMARLE
MADISON
PAGE
SHENANDOAH
CLARKE
LOUDOUN
MONTGOMERY
HOWARD
PRINCE GEORGES
PRINCE WILLIAM
FAIRFAX
STAFFORD
Miles
0 12.5 25 50
0 12.5 25 50
Kilometers
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Developing flow hypotheses

A testable explanation for a suspected or observed relationship between river flow and the needs and tolerances of the river's species and communities

Who	Species or group of species
What	Flow magnitude or event
When	Month or season
Where	Habitat type or unit
Why / how	Ecological response

Fish: flow hypotheses

During spring, American shad require high flows as one of several cues for upriver migrations of adults to non-tidal spawning grounds.

Loss of high spring flows may delay emigration and spawning.

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Who What When Where Why/How

Choosing flow statistics ("what")

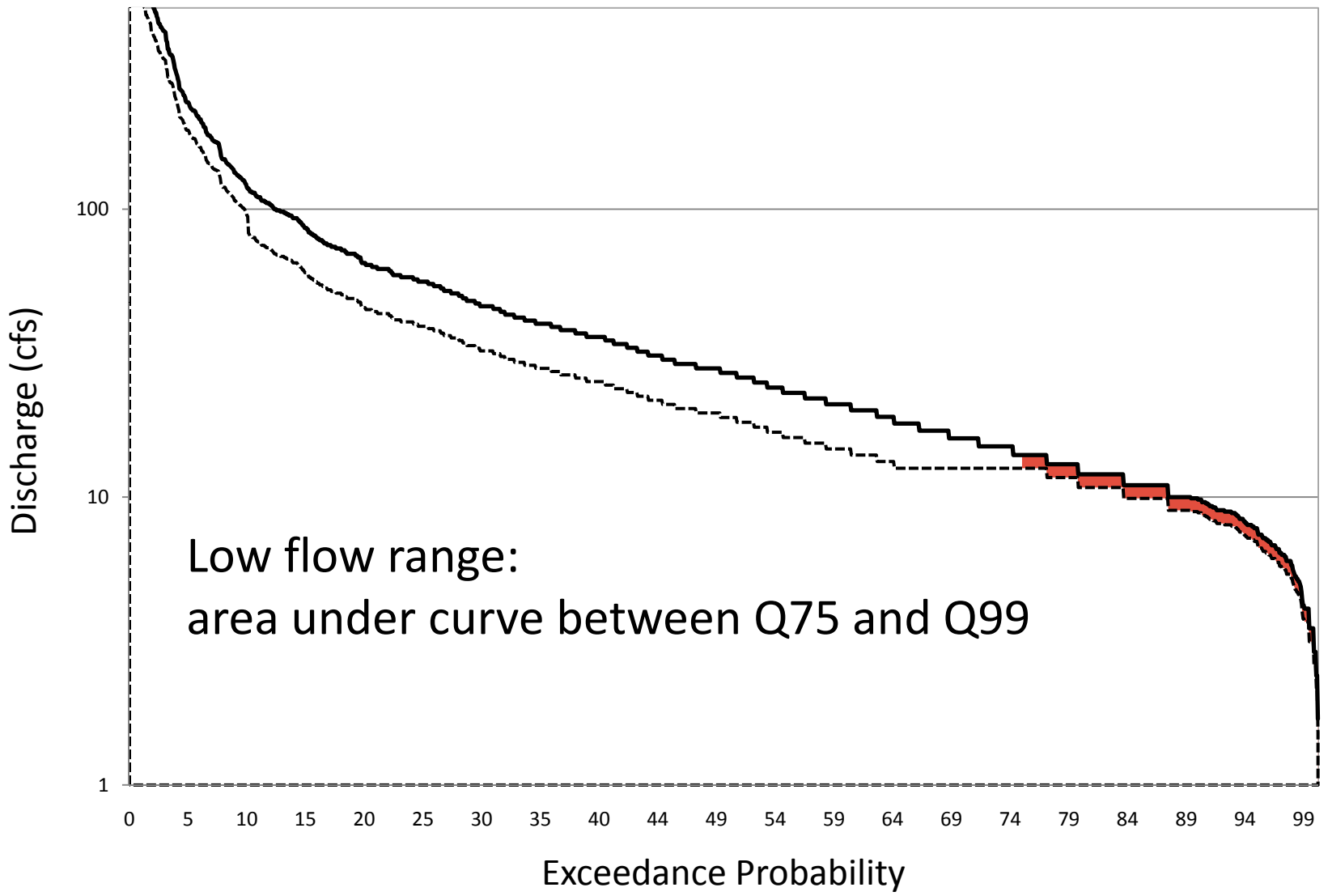
Measurements of the magnitude, duration, frequency, timing, or rate of change of environmental flow components. Statistics should:

- Represent natural variability in flow regime
- Be sensitive to change and have explainable behavior
- Be easy to calculate and be repeatable
- Have limited redundancy
- Have linkages to ecological responses
- Facilitate communication among scientists, managers
- Could be individual statistics or ranges of a flow duration curve

Statistics suggested by flow hypotheses

Flow Component	Flow statistic
High flows	Bankfull (2-yr RI) and large floods (10-yr RI)
	Magnitude of annual Q10 flow
	Frequency of high flow events, fall and winter
Seasonal flows	Magnitude of monthly Q10
	Magnitude of monthly Q50
	Magnitude of monthly Q90
Low flows	Magnitude of annual Q90
	7Q10 (7 day, 10 year) flow
	Duration of low flow events, summer and fall
	Low flow range (flow duration curve)

Flow Duration Curve



Developing flow recommendations from hypotheses (quantify "what")

Recommended quantification of, or development of a range around, a flow statistic that is protective of one or more ecological indicator or function

Who	Species or group of species
What	Flow statistic and recommended value or range
When	Month or season
Where	River, group of rivers, or river reach
Why/How	Ecological response

Example flow recommendations: Susquehanna River

Table 5.1 Flow recommendations for the Susquehanna River ecosystem.

Season	Flow Component	Flow Statistic	Flow Recommendations	
			Headwater streams < 50 sq mi	Streams and small rivers (50 – 200 sq mi)
Annual and Interannual Events	High Flows	Large flood	Maintain magnitude and frequency of annual Q0.05 (20-yr flood)	Same for all streams
		Small flood	Maintain magnitude and frequency of annual Q0.2 (5-yr flood)	Same for all streams
		Bankfull	Maintain magnitude and frequency of annual Q0.5 (Approx. 1 to 2-yr flood)	Same for all streams
All Months	High flows	Monthly Q10	<10% change to magnitude of monthly Q10	Same for all streams
	Seasonal flows	Monthly Median	Between 45th and 55th percentiles	Same for all streams
		Monthly Range	≤ 20% change to area under curve between Q10 and Q75	Same for all streams
	Low flows	Monthly Low Flow Range	No change to area under curve between Q75 and Q99	≤ 10% change to area under curve between Q75

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Maintain baseline conditions for individual flow statistics

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Ranges around individual statistics

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Area under a flow duration curve

Objectives for breakout sessions

- Review and refine flow-ecology hypotheses
- Review and refine proposed environmental flow statistics
- Identify emerging priority flow statistics that represent flow needs of multiple taxa by EFC and season
- Determine adequacy of current conditions to meet ecological needs
- Discuss approaches to determine protective hydrologic ranges around key flow statistics in order to support ecological functions

Breakout session agenda

- Review of breakout process and Q&A (5 min.)
- Review and refinement of flow hypotheses and statistics (45 min.)
- Identify flow statistics that represent the needs of multiple taxa by EFC, season and geography (20 min.)
- Discuss whether current flow conditions are adequate to support ecological functions? (20 min.)

Tables 12-13: flow needs of ecological indicators (pp 79-88)

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-m (Smogor et al. 1995). • Migrating eels may delay migrati velocities are too low or too high (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 recrui (Jenkins and Burkholder 1994) • Cues for emigration include high et al 2009).

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Table 14: Flow statistics (pp 89)

Flow category	Flow Statistics		
	Magnitude (cfs)	Frequency (#)	Duration (days)
Low flows (flow < Q_{90})	1. Annual 1 day min. flow 2. Annual Q_{90} flow 3. $_7Q_{10}$ (7 day, 10 year) flow	Median # of low flow events 4. Spring (Apr - Jun) 5. Summer (Jul - Sep) 6. Fall (Oct - Dec)	Median duration of low flow events 7. Summer (Jul - Sep) 8. Fall (Oct - Dec)
Mid-range flows (Q_{90} < flow < Q_{10})	9. Monthly Q_{90} flow 10. Monthly Q_{50} flow 11. Monthly Q_{10} flow		
High flows (> annual Q_{10}), Small Floods (>= 2 yr R.I. and < 10 yr R.I. event), and Large Floods (>= 10 yr R.I. event)	12. Annual Q_{10} flow 13. 2 yr Recurrence Interval (R.I.) event (approx. bank full) 14. 10 yr R.I. event (Large flood)	Median # of high flow events 15. Winter (Jan-Mar) 16. Spring (Apr - Jun) 17. Summer (Jul - Sep) 18. Fall (Oct - Dec)	Median duration of high flow events 19. Spring (Apr - Jun) 20. Summer (Jul - Sep)

Table 15: linking flow statistics back to biota

		Statistic	Group A fish	Group B1 fish	Group B2 fish	Group C fish	Benthic macroinv.	Mussels	Amphibians & reptiles	In-river vegetation	"Bar and bank" vegetation	Floodplain vegetation	Flood terrace vegetation	All biota	Tidal Fresh Phytoplankton	Tidal Fresh Zooplankton	Tidal Fresh Benthic Macroinv.	Tidal Fresh SAV	Atlantic Sturgeon	Shortnose Sturgeon	Striped Bass	White Perch	Count
Low Flows	1	Annual 1 day min. flow												X									1
	2	Annual Q90 flow			X	X	X	X		X				X	X								7
	3	7Q10 (7 day, 10 year) flow			X	X	X	X		X					X								6
	4	# events Spring (Apr - Jun)								X					X								2
	5	# events Summer (Jul - Sep)			X					X					X								3
	6	# events Fall (Oct - Dec)			X					X													2
	7	duration events Summer (Jul - Sep)	X		X					X					X	X	X	X					7
	8	duration events Fall (Oct - Dec)	X		X					X						X	X	X					6
Mid Flows	9	Monthly Q10 flow	X	X	X	X	X	X	X		X	X									X	X	11
	10	Monthly Q50 flow		X	X	X	X	X	X		X	X			X	X		X			X	X	13
	11	Monthly Q90 flow		X	X	X	X	X	X			X		X	X	X		X			X	X	13
High Flows	12	Annual Q10 flow			X		X	X		X	X	X		X	X	X	X	X	X	X	X	X	15
	13	2 yr Recurrence Interval (R.I.)		X		X	X	X	X	X	X	X		X	X	X	X	X	X	X			15
	14	10 yr R.I. event (Large flood)										X	X	X	X	X		X	X	X			8
	15	# events Winter (Jan-Mar)	X	X				X		X		X							X	X	X	X	9
	16	# events Spring (Apr - Jun)		X		X		X	X			X								X	X	X	8
	17	# events Summer (Jul - Sep)						X							X				X	X	X	X	6
	18	# events Fall (Oct - Dec)	X	X						X		X											4
	19	duration events Spring (Apr - Jun)				X				X													2
	20	duration events Summer (Jul - Sep)				X				X													2

Outcome for breakout sessions: emerging priority flow statistics

Season	Flow Component	Emerging Priority Flow Statistics	Taxa Affected (species or group(s), and associated key flow hypothesis

Breakout session agenda

- Review of breakout process and Q&A (5 min.)
- Review and refinement of flow hypotheses and statistics (45 min.)
- Identify flow statistics that represent the needs of multiple taxa by EFC, season and geography (20 min.)
- Discuss whether current flow conditions are adequate to support ecological functions? (20 min.)

Developing protective hydrologic ranges

Season	Flow Component	Emerging Priority Flow Statistics	Potential protective hydrologic ranges around key flow statistics	Taxa Affected (species or group(s), and associated key flow hypothesis

Outcome will also inform day 2 monitoring breakout session

Season	Flow Component (prioritize lows for starting the discussion)	Emerging Priority Flow Statistic to be monitored (our key outcome from Day 1)	Taxa Affected (species or group(s), and associated key flow hypothesis)	Key taxa, life cycle or process to be monitored [this will be filled in by workshop participants during the breakout discussion]	Priority Locations for Monitoring (reaches or sub-basins)	Other abiotic factors that require monitoring associated with this taxa or flow statistic (e.g., water quality, groundwater withdrawals)	Cost Resource neutral -- available through current monitoring; Requires $100s, $1000s, $10,000s, or $100,000s to accomplish?

Specific questions for consideration

- Do the flow hypotheses adequately represent the flow needs of the ecological indicators?
- Do the recommended flow statistics adequately represent the flow needs for each hypothesis?
- Should the flow duration curve approach be used to represent some flow needs?
- Are current conditions appropriate to use as a baseline for flow recommendations?
- What is the best way to develop protective hydrologic ranges around flow statistics in order to develop flow recommendations?