Combining the Concepts of Eco-deficit and Sustainability Boundaries

Ecological Flow Science Advisory Board
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Eco-Deficit/Surplus

- Vogel et al. 2007
- Create a median flow duration curve of unaltered flows on an annual (seasonal, monthly) basis
- Do the same for altered flows
- Difference between the curves is termed “eco-surplus” or “eco-deficit”
  - It is really median flow surplus or deficit
- The focus is on changes in flow magnitude
  - Monthly curves also reflect aspects of timing
  - Duration, frequency and rate of change are not fully considered
Example of Eco-Difference
Flow Duration Curve - January
Tar River at Rocky Mount

- Unaltered
- Altered

Eco-Deficit

Eco-Surplus
Example of Eco-Difference
Flow Duration Curve - January
Tar River at Rocky Mount

Change due to reservoir storage and release

Eco-Deficit

Eco-Surplus
Example of Eco-Difference
Flow Duration Curve - January
Tar River at Rocky Mount

- **Unaltered**
- **Altered**

Change due to withdrawal

Eco-Deficit

Flow (cfs)

Exceedence Probability

0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Eco-Deficit/Surplus

- “Eco-difference” is absolute value of “eco-surplus” or “eco-deficit”
- When calculated on an overall percentage basis, eco-difference gives measure of relative change from the unaltered condition
Example of Eco-Difference
Flow Duration Curve - January
Tar River at Rocky Mount

- Unaltered
- Altered
- Eco-Difference

Exceedence Probability

Flow (cfs)
Example of Eco-Difference
Flow Duration Curve - January
Tar River at Rocky Mount

Overall Eco-Difference = 22%

Eco-Deficit

Eco-Surplus
Sustainability Boundaries

- Richter et al. 2011
- Presumptive standard concept
- Deviation from inflow on a daily basis
  - Moderate protection: ±11-20%
  - High protection: ±0-10%
- Maintains inter- and intra-annual flow variability
Combining Concepts

- Median flow duration curves – because based on multiple data points, one can create a band of variability around the median
  - This is similar to the sustainability boundary
  - The width of the band should consider biological and management aspects
  - In following example, using 15%

- The Susquehanna Basin report (TNC 2010) used a similar approach
Example of Eco-Difference
Flow Duration Curve - January
Tar River at Rocky Mount

Exceedence Probability

Flow (cfs)
Use as a Planning Tool

Various ways to “trip the red flag”

1. Compare median altered to median unaltered (no band)
   - If eco-difference >15%
   - This is comparing the overall difference between median FDCs
   - It does not trip if certain parts of the FDC exceed the threshold
Example of Eco-Difference
Flow Duration Curve - January
Tar River at Rocky Mount

Overall Eco-Difference = 22%
Use as a Planning Tool

Various ways to “trip the red flag”

2. Compare median altered FDC to the unaltered with band
   - If any part outside of band
   - This is more stringent than option 1
Example of Eco-Difference
Flow Duration Curve - January
Tar River at Rocky Mount

Altered flow is within Unaltered flow boundary
Example of Eco-Difference
Flow Duration Curve - January
Tar River at Rocky Mount

Altered flow is outside of Unaltered flow boundary