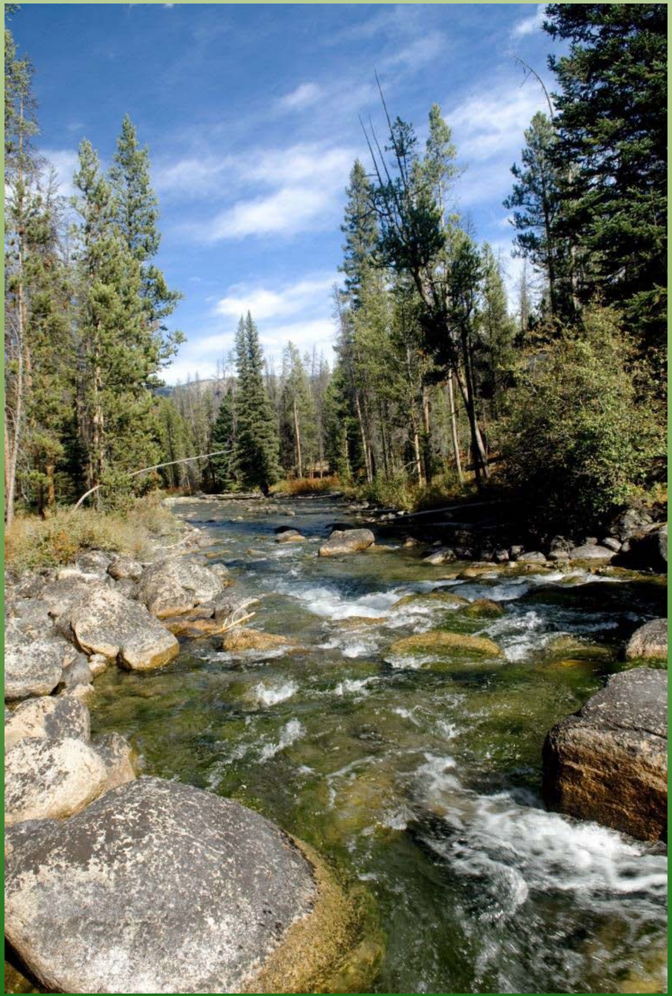
Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration



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Presentation Overview

- What the Draft Technical Report "Is" and What "It Is Not"
- Why the Report Was Developed
- Environmental Flow (or EWater) Support in the Literature
- Quick Overview of applicable CWA programs
- Technical Non-Prescriptive Framework for Quantifying Flow Targets to Protect Aquatic Life
- Climate Change

What Is the Draft Technical Report?

- EPA and USGS jointly developed this draft technical report to serve as a source of information for states, tribes and territories about:
  - The natural flow regime and the potential effects of flow alteration on aquatic life;
  - Examples of CWA tools that states have used to support the natural flow regime and maintain healthy aquatic biota; and
  - A flexible, nonprescriptive framework that water quality managers might consider if they are interested in quantifying targets for flow regime components that are protective of aquatic life.

What the Draft Technical Report Is Not

The Report is Not:

- A law or regulation
- A set of binding legal requirements
- A substitute for applicable statutes or regulations, which are always controlling; or
- A substitute for, or constraint on, state and Tribal discretion to act on a case-by-case basis

Why Did EPA-USGS Develop the Draft Technical Report?

- To serve as a technical and informational resource to water-resource managers who face real challenges today
  - They must balance needs of growing human population with protection of natural hydrologic regimes and aquatic life
- Expected changes to historic hydrologic conditions as a result of climate change further complicate water-resource management challenges

The Draft Technical Report Has Three Main Sections

1. Environmental Flow (or EWater) Support in the Literature
2. Overview of applicable CWA programs, with state and Tribe examples
3. Technical Non-Prescriptive Framework for Quantifying Flow Targets to Protect Aquatic Life

Streamflow is inextricably linked to the vitality of rivers

- Flow variability shapes the physical, chemical and biological attributes and functioning of riverine systems
  - Channel form and habitat complexity
  - Life-history patterns
  - Lateral and longitudinal connectivity
  - Resistance to species invasions
- At the same time, human societies modify natural flow regimes to provide dependable ecological services, water supply, and protection from floods and droughts

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Supporting Documentation Emphasizing the Connection between Streamflow & Ecology

The Question

How much water does a river need?

(Freshwater Biology 1997)

BRIAN D. RICHTER*
Biohydrology Program, The Nature Conservancy, PO Box 430, Hayden, Colorado 81639, U.S.A.

JEFFREY V. BAUMGARTNER, ROBERT WIGINGTON
The Nature Conservancy, 2060 Broadway, Suite 230, Boulder, Colorado 80302, U.S.A.

DAVID P. BRAUN
The Nature Conservancy, 1815 N. Lynn St, Arlington, Virginia 22209, U.S.A.

The Natural Flow Regime

(BioScience 1997)

A paradigm for river conservation and restoration

N. LeRoy Poff, J. David Allan, Mark B. Bain, James R. Karr, Karen L. Prestegaard, Brian D. Richter, Richard E. Sparks, and Julie C. Stromberg

(Ecological Applications 2006)

THE CHALLENGE OF PROVIDING ENVIRONMENTAL FLOW RULES TO SUSTAIN RIVER ECOSYSTEMS

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Freshwater Biology (2009) doi:10.1111/j.1365-2427.2009.02204.x

The ecological limits of hydrologic alteration (ELOHA): a new framework for developing regional environmental flow standards

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SUMMARY

1. The flow regime is a primary determinant of the structure and function of aquatic and riparian ecosystems for streams and rivers. Hydrologic alteration has impaired riverine ecosystems on a global scale, and the pace and intensity of human development greatly exceeds the ability of scientists to assess the effects on a river-by-river basis. Current scientific understanding of hydrologic controls on riverine ecosystems and experience gained from individual river studies support development of environmental flow standards at the regional scale.
2. This paper presents a consensus view from a group of international scientists on a new framework for assessing environmental flow needs for many streams and rivers simultaneously to foster development and implementation of environmental flow standards at the regional scale. This framework, the ecological limits of hydrologic alteration (ELOHA), is a synthesis of a number of existing hydrologic techniques and environmental flow methods that are currently being used to various degrees and that can support comprehensive regional flow management. The flexible approach allows

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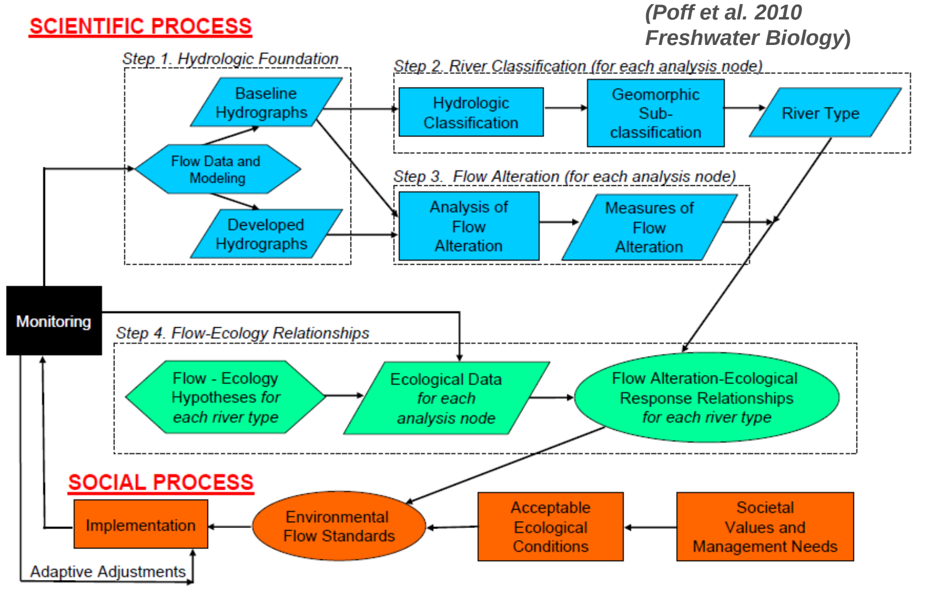
1

ELOHA Flow Chart



Hydrologic (flow) alteration

Effects of flow alteration is well documented in the lit

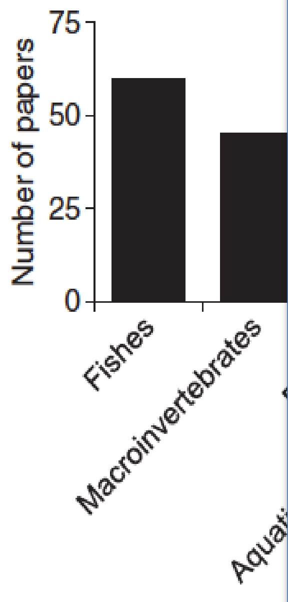


Fig. 1 The number of pa

Poff & Zimmerr

Freshwater B

Freshwater Biology (2013) 58, 2439–2451

SPECIAL REVIEW

Squeezing the most out of existin re-analysis of published evidence altered flows

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MICHAEL J. STEWARDSON[†], JULIE K. H. ZIMMERMAN
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[†]Department of Infrastructure Engineering, The University of Melbourne,
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[§]Department of Biology, Colorado State University, Fort Collins, CO, U.S

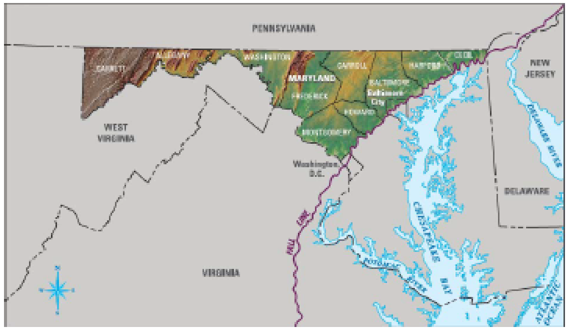
SUMMARY

1. Human-induced changes in river flow regime
case studies have identified negative ecological
regimes (e.g. magnitude, timing), there have bee

Webb et al. 2014. F

ECOLOGICAL RESPONSES TO FLOW ALTERATION:
A LITERATURE REVIEW WITHIN THE CONTEXT OF THE
MARYLAND HYDROECOLOGICAL INTEGRITY ASSESSMENT.

A CONTRIBUTION TO THE COMPREHENSIVE ASSESSMENT OF WATER SUPPLY IN THE REGION UNDERLAIN BY FRACTURED ROCK IN MARYLAND.



Maryland Department of Natural Resources
Resource Assessment Service
Monitoring and Non-Tidal Assessment Division
RAS-MANTA-AIM-13-01

MARYLAND DEPARTMENT OF NATURAL RESOURCES

Ashton, M.J. 2012.

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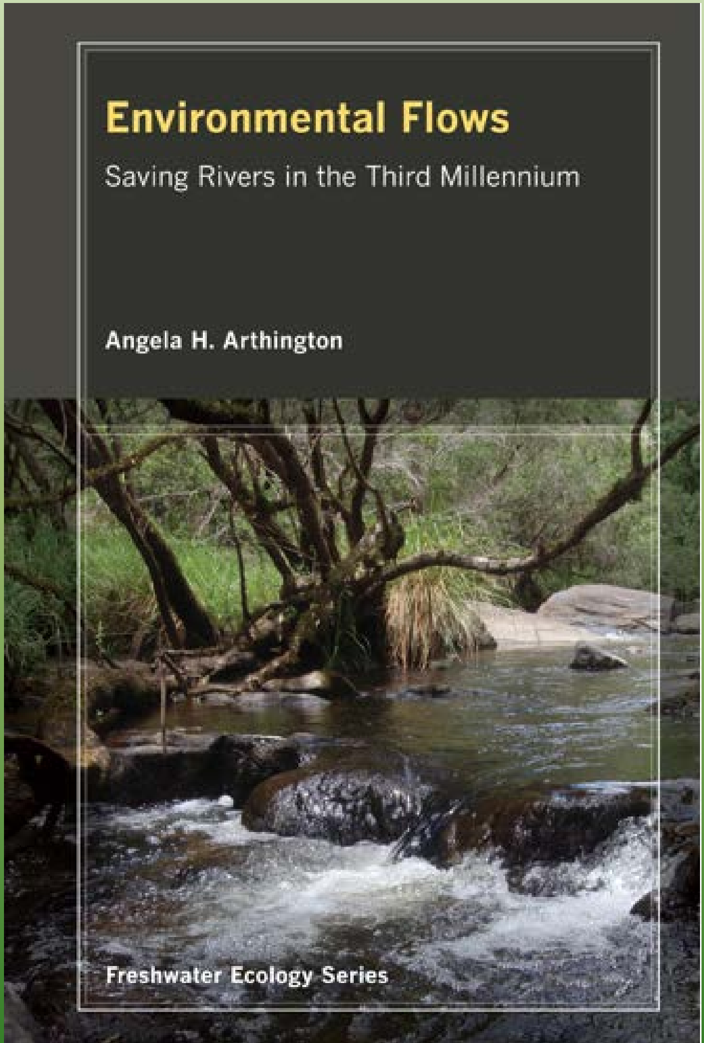
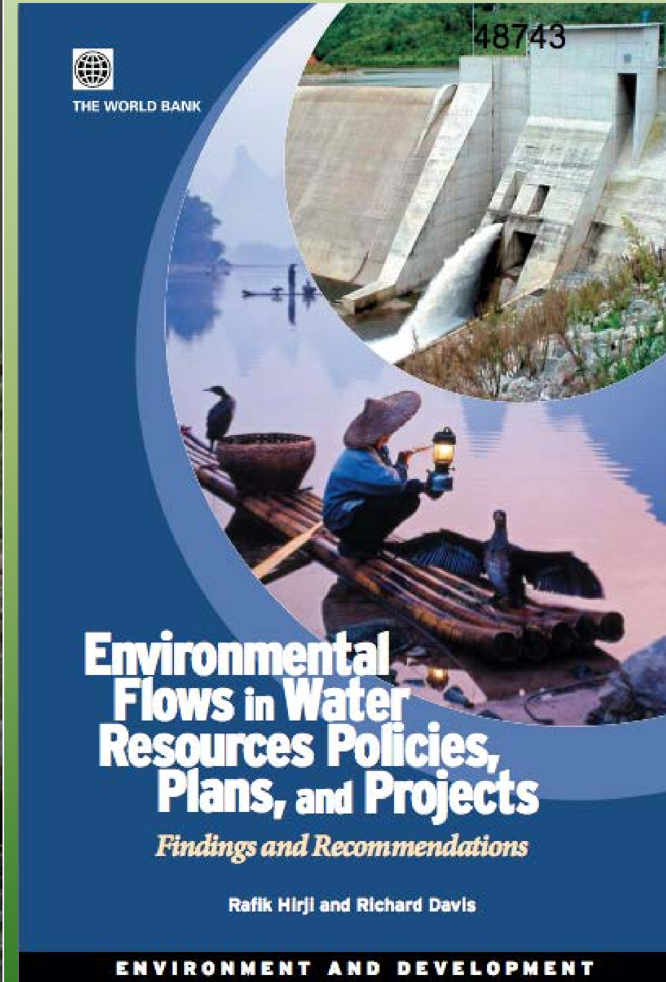
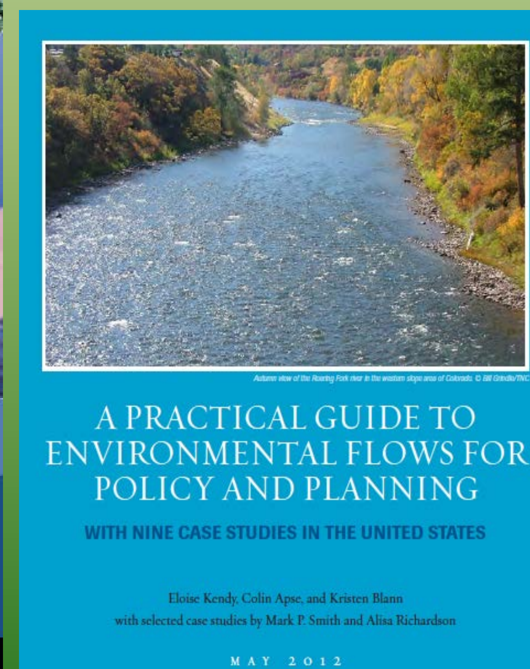
The Science and Practice for Achieving Environmental Flows



Arthington 2012



Hirji and Davis 2012



Kendy et al. 2012

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Natural Flow Regime

The first main section (pages 15-39) describes the scientific principles of the natural flow regime and presents a general conceptual model of the effects of flow alteration on aquatic life. The document discusses the following sources of flow alteration:

- Dams & Impoundments
- Diversions
- Groundwater withdrawals
- Effluents and artificial inputs
- Land-cover alteration
- Climate change
- Physical, chemical, and geomorphological effects

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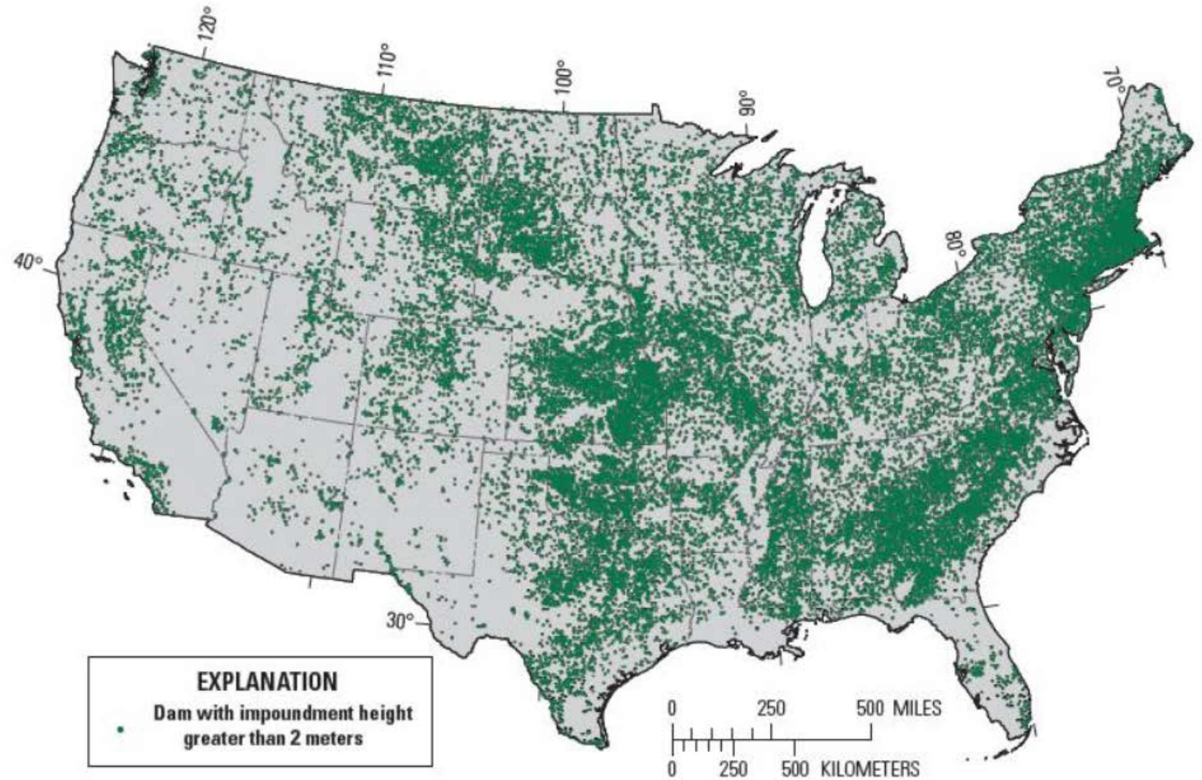
One example – Dams in the conterminous United States

As of 2013, more than 87,000 dams were represented in the U.S. National Inventory of Dams (NID)



Base from U.S. Census Bureau cartographic boundary file, 2013, 1:500,000
Albers Equal-Area Conic projection
Standard parallels 29°30'N and 45°30'N
Central meridian 96°00'W

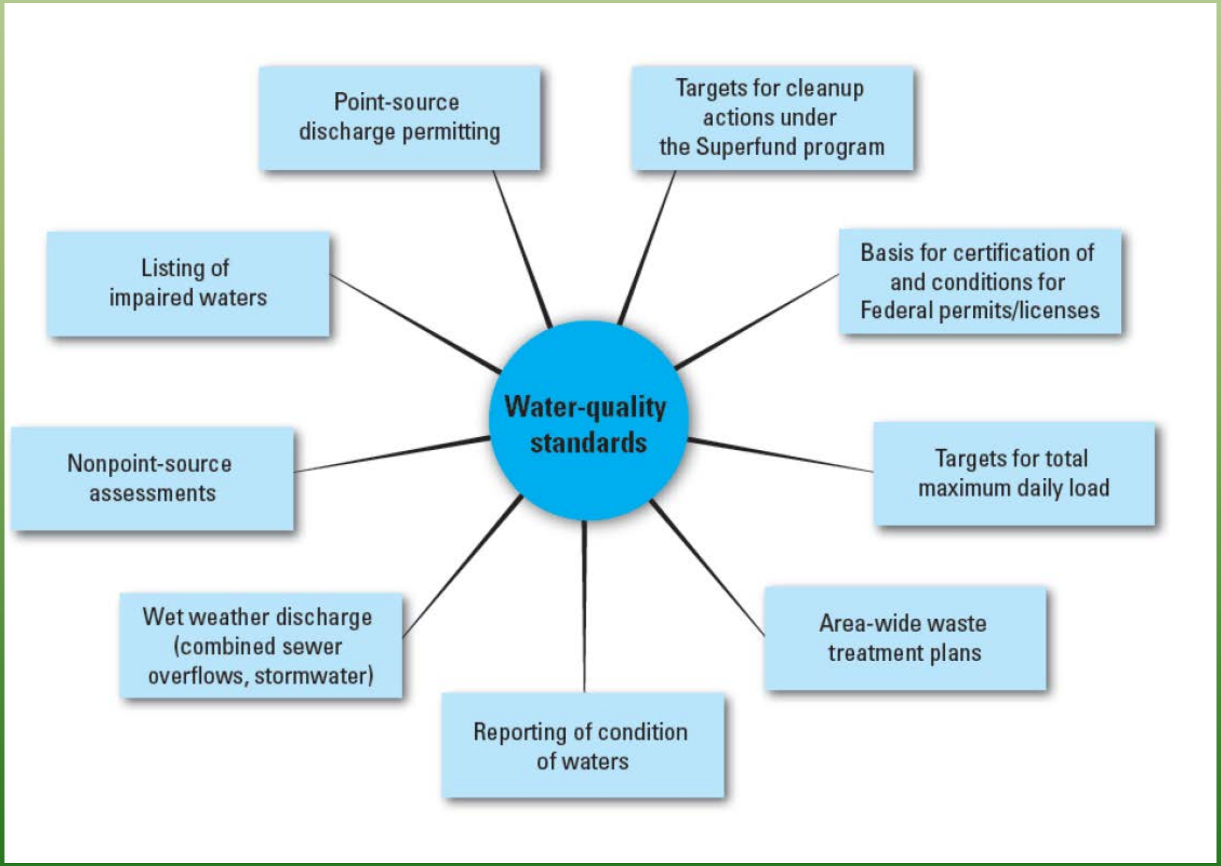
CWA Program Descriptions

The second main section (pages 39-64) discusses CWA tools that states have used (citing examples) to address the effect of flow regime change on aquatic life. They include:

- Water quality standards (WQS) (Section 5.1),
- Monitoring and assessment of water bodies (Section 5.2),
- Total Maximum Daily Load (TMDL) development (Section 5.3),
- Clean Water Act (CWA) 401 certifications (Section 5.4),
- CWA Section 404 permits (Section 5.5)4, and
- CWA Section 402 National Pollutant Elimination Discharge System (NPDES) permits (Section 5.6).

Water quality management programs based on water quality standards under the Clean Water Act

Schematic illustrating WQS Programs



States that have Adopted Narrative Criteria

- New Hampshire – “surface water quantity shall be maintained at levels adequate to protect existing and designated uses”.
- Rhode Island – “For activities that will likely cause or contribute to flow alterations, streamflow conditions must be adequate to support existing and designated uses.”
- Vermont – Changes from natural flow regime shall not cause the natural flow regime to be diminished, in aggregate, by more than 5% of 7Q10 at any time;”
- New York – Class N fresh surface waters … “There shall be no alteration to flow that will impair the waters for their best usages.”
- Virginia – “Man-made alterations in stream flow shall not contravene designated uses including protection of the propagation and growth of aquatic life.”
- Kentucky – Section 4. “Aquatic Life. …Applies for the protection of productive warm water aquatic communities…. c) Flow shall not be altered to a degree which will adversely affect the aquatic community.”
- Tennessee – Subsection (o) Flow –“Stream or other waterbody flows shall support the fish and aquatic life criteria.”
- Missouri –“Waters shall be free from physical, chemical, or hydrologic changes that would impair the natural biological community.”

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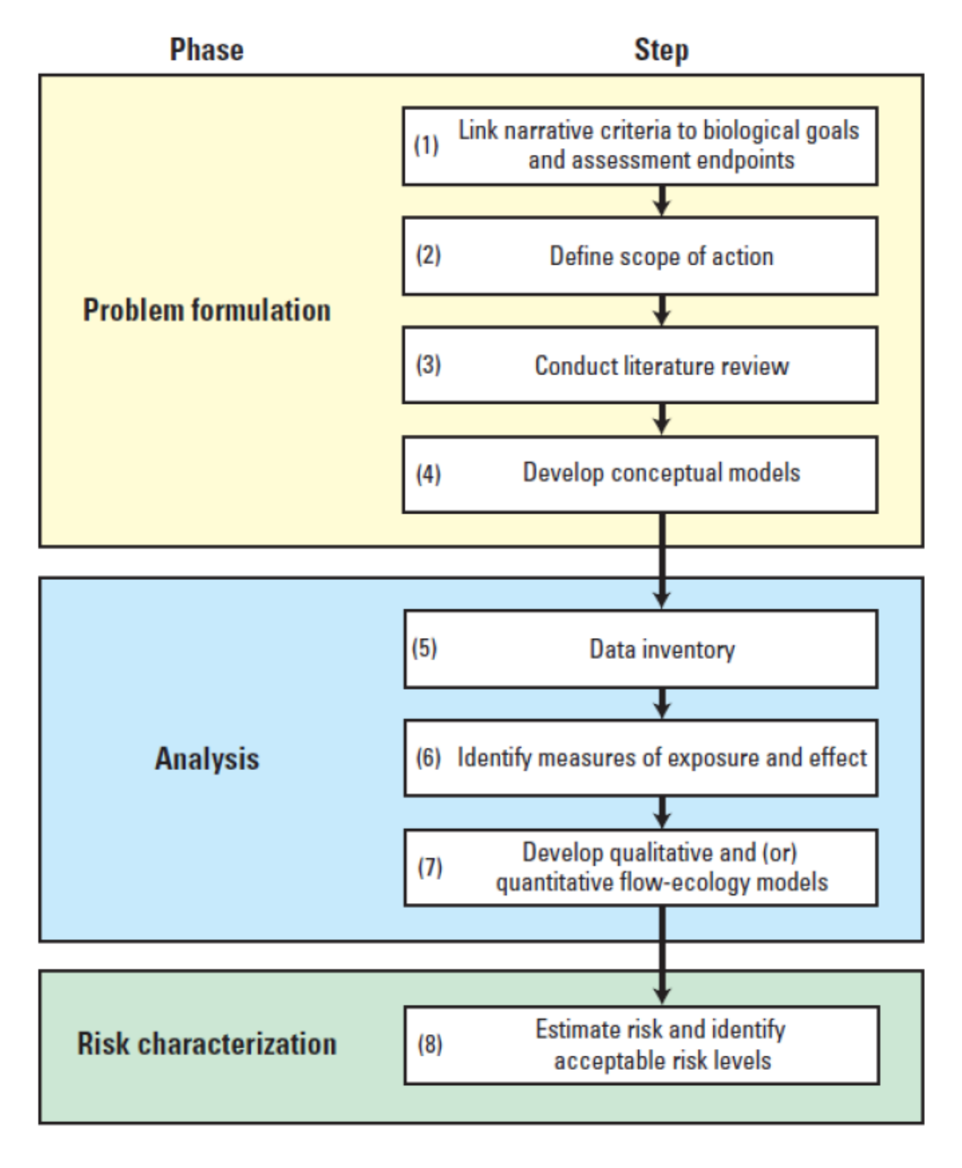
Non-Prescriptive Framework

The third main section (pages 65-91) discusses a non-prescriptive framework for quantifying flow targets to protect aquatic life and includes three primary phases:

1. Problem Formulation Phase
2. Analysis Phase and
3. Risk Characterization Phase



Problem Formulation Phase

Consist of 4 steps:

Step 1. Link narratives based on existing biological criteria to protect aquatic life designated uses

Step 2. Define the scope (spatial extent of the project - stream, basin, etc.)

Step 3. Conduct a literature review to provide a foundation of understanding in support of the natural flow regime

Step 4. Develop a diagram (conceptual diagram) that accompanies the narrative

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Step 1. Link narrative criteria to biological goals and assessment endpoints

Narrative flow criteria are generally composed of (1) a description of the resource to be protected and the protection goal, and (2) statements describing the flow condition needed to be maintained to achieve the protection goal.

- A biological goal is a specific type of management goal that focuses on the biological characteristics of an aquatic system, such as fish or macroinvertebrate populations.
- The assessment endpoints specify which biological attributes are used to evaluate whether goals are met. For example, if the biological goal was to “maintain a cold-water fishery,” assessment endpoints could include spawning success rate and adult abundance for one or more cold-water fish species.

Step 2. Define scope of action: identify target streams

Target streams – flow targets can be quantified for a single stream, all streams within a geographic area (for example, a catchment, province or a state), or a subset of streams that satisfy a set of selection criteria.

- As recommended in ELOHA (Poff et al. 2009) – it is advantageous to classify target streams according to their natural flow, geomorphic properties, temperature regimes, and other attributes to help identify groups of streams with similar characteristics.
- However, stream classification is not a requirement for successful development of quantitative flow targets.

Step 3. Conduct literature review

A review of existing literature provides a foundation for understanding how the natural flow regime supports aquatic life and the biological effects of flow alteration in target streams.

- Should identify the most important aspects of flow regimes that are vital to support aquatic life and connections between flow variables and ecological response.
- Can help to identify data gaps that could be filled through subsequent studies or additional monitoring.
- Can help identify a reference point for characterizing the types and sources of flow alteration in target streams.

Step 4. Develop a [Simple] Conceptual Model

Model reflects the hierarchy and linkages between streamflow alteration and the survival, growth and reproduction of aquatic life.

Land Use Change

↓

Alteration in Discharge Patterns

↓

Decreased Seasonal Flow Variability

↓

Reduced spawning success rate

Goal – Maintain a cold-water fishery

Change in YOY Density

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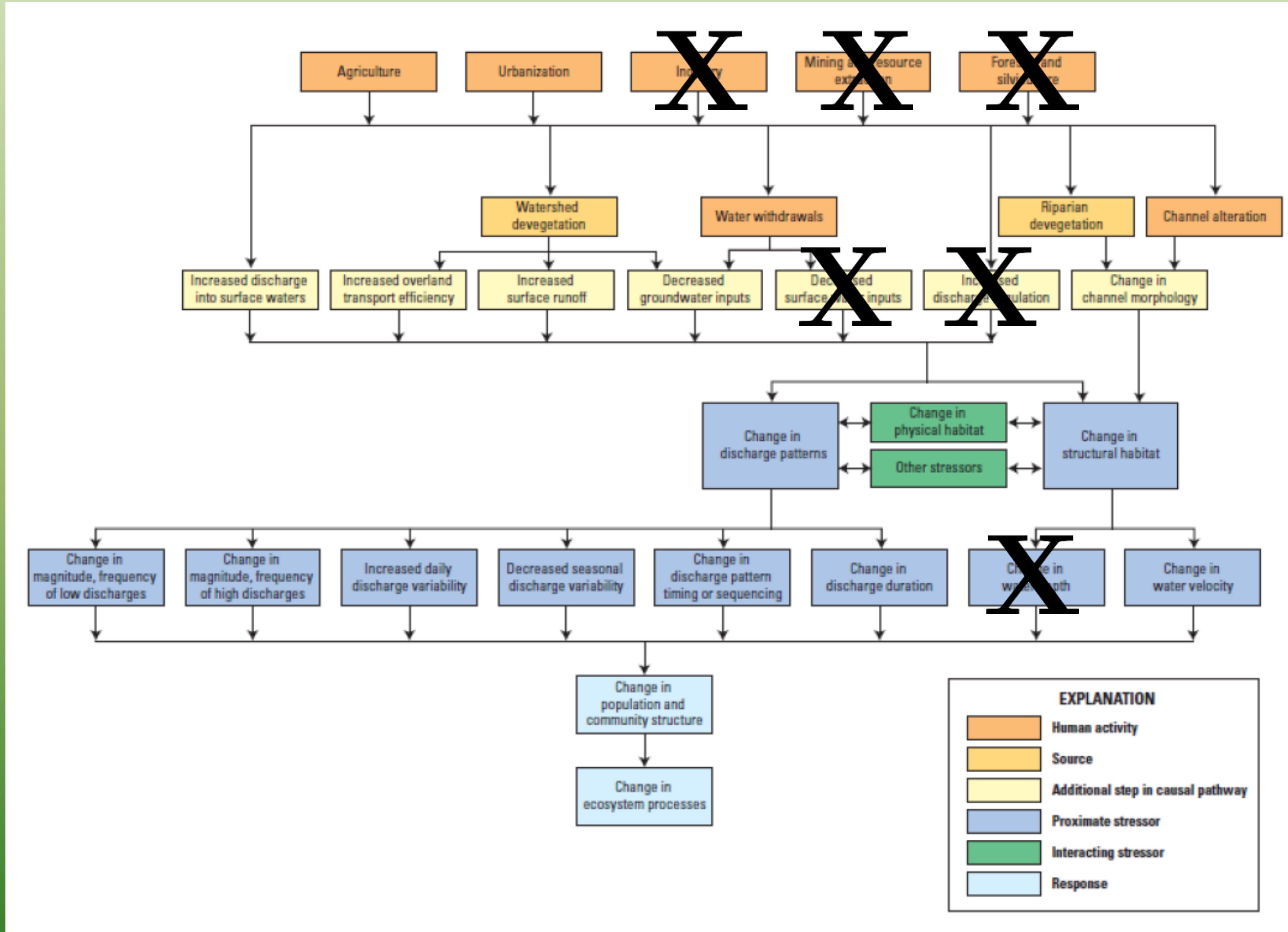
Step 4 – Detailed Conceptual Model



Example conceptual model: Modified from CADDIS Causal Analysis/Diagnosis Decision Information System

Analysis Phase

Consist of 3 steps:

Step 5. Data Inventory. Inventory, compile and review streamflow and ecological data.

Step 6. Identify Biological & Streamflow Indicators. Macroinvertebrate & flow metrics, life-history traits of fish etc.

Step 7. Develop qualitative or quantitative flow-ecology models. Stressor-response models.

Step 5 – Perform Data Inventory

Identify and aggregate streamflow and ecological data for target streams, basins or regions. Many state and federal resources are available!

- Streamflow data is available through the USGS National Water Information System database (http://waterdata.usgs.gov/nwis), STREAMStats (http://water.usgs.gov/osw/streamstats/)
- Biological data such as the EPA Wadeable Streams Assessment program (http://water.epa.gov/type/rsl/monitoring/streamsurvey/web_data.cfm), and the USGS BioData retrieval system (https://aquatic.biodata.usgs.gov/landing.action) are available online.

Step 6 – Identify Biological & Streamflow Indicators

Identify streamflow and biological indicators that can be used to analyze the relations between flow alteration and biological response.

- Biological indicators are various measures (or metrics) of diversity, richness, abundance, or specific life-history traits of fish, macroinvertebrates, and aquatic vegetation.
- Flow indicators characterize the magnitude, timing, frequency, duration, and rate of change of flow conditions.
- Available tools – e.g., Nature Conservancy IHA and USGS EflowStats "R" Package.

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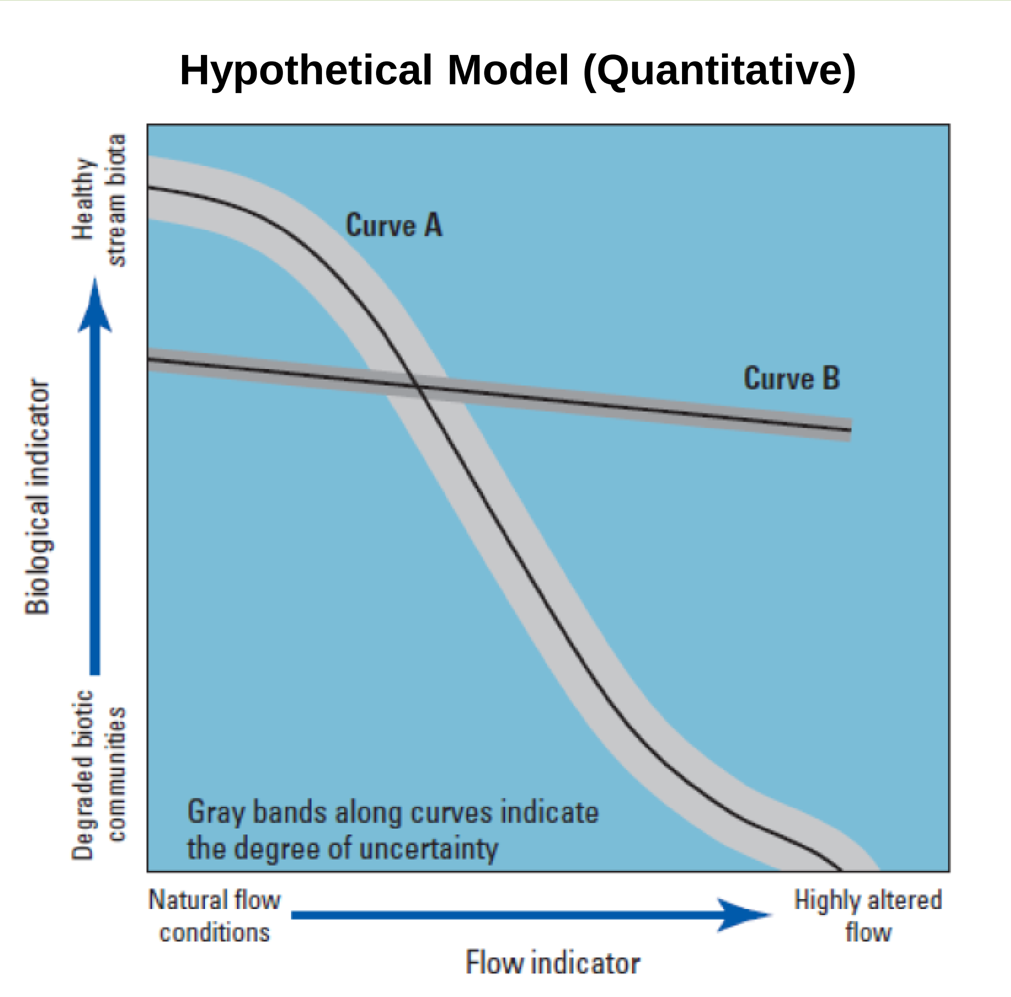
Step 7-Develop Qualitative or Quantitative Flow-Ecology Models

- A flow-ecology model is a specific type of stressor-response model.
- Describes the relation between a flow indicator and a biological indicator.
- Two hypothetical response curves are shown, linear and non-linear, developed using statistical methods.
- Used to predict the value of a biological indicator under a variety of flow conditions such as the percent change in fish diversity as a function of the percent change in annual peak flow magnitude.



Risk (Effects) Characterization Phase

Final Step: Lines between acceptable and unacceptable flow alteration can be used to determine select numeric flow targets.

- Effects characterization involves estimating effects levels that correspond to increasing magnitudes of a stressor.
- Effects estimates can be categorical (low, medium, high) or numeric (the probability of not meeting a certain biological condition).
- Effects estimation integrates quantitative or qualitative flow-ecology models, biological goals, and other available evidence.

Risk (Effects) Characterization Phase

- In cases where quantitative flow-ecology models are available, effects estimation may be centered on the numerical relations between flow and biological indicators and their uncertainty.
- When quantitative models are not available, effects estimates can be generated from qualitative flow-ecology models and any other lines of evidence.
- Effects estimation can be guided by threshold values or range of biological indicators, for example, an Index of Biotic Integrity score between 80 and 90.

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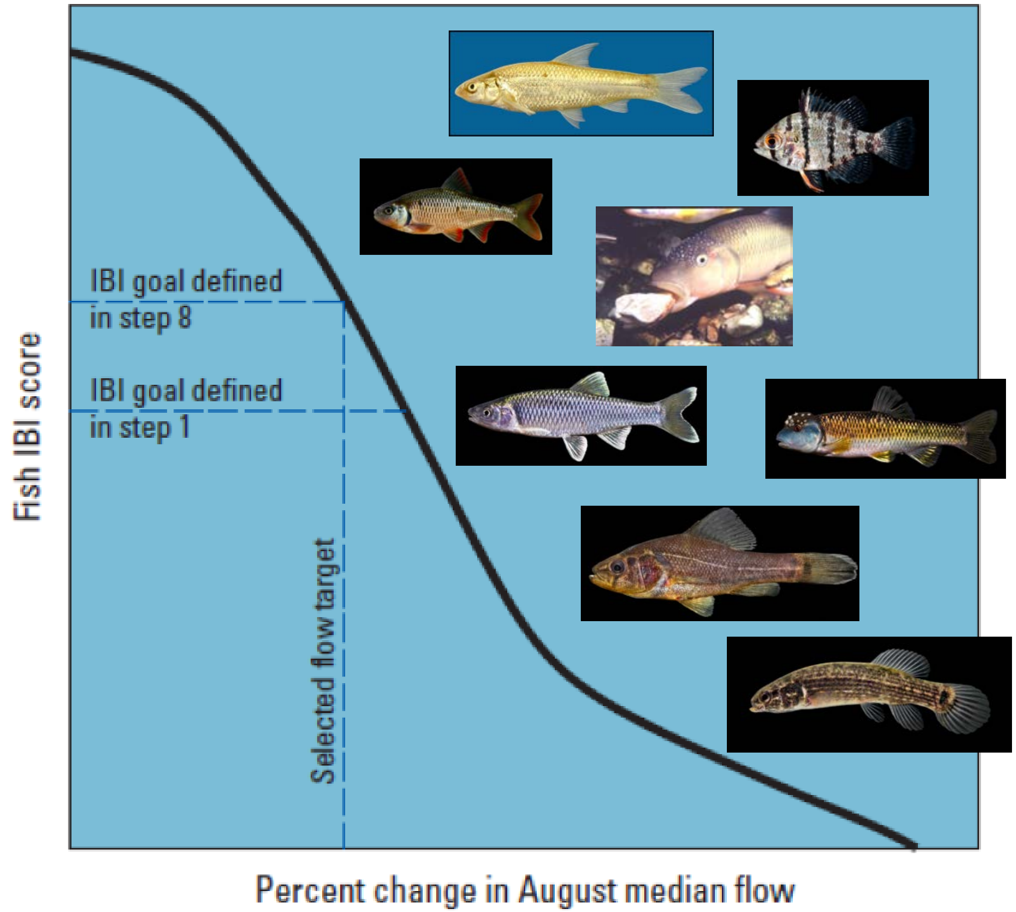
Example: Flow-Target Framework Using a Quantitative Flow-Ecology Model

- Example – fish response curve generated through regression modeling.
- This response curve depicts the relation between altered August median flow and fish-community condition (IBI, Index of Biotic Integrity).
- Follows framework steps in which endpoints are selected, data is aggregated, and models are developed for differing stream classes.
- Appropriate targets are then defined by stakeholders.

Hypothetical Model (Quantitative)



Climate – Change Vulnerability and the Flow Regime

Climate change will potentially increase the vulnerability of rivers and streams to flow alteration and affect the ecosystem services they provide

- There is much uncertainty about the future effect of climatically driven changes on streamflow
- Not all rivers and streams are equally vulnerable to the effects of climate change – exposure (rate of change), sensitivity (response), and adaptive capacity (how a system adjusts) are all continuums.

Conclusions

- Flow regime plays a central role in supporting healthy aquatic ecosystems.
- Alterations to the natural flow regime can contribute to the degradation of biological communities.
- Flow alteration can prevent water bodies from supporting aquatic life designated uses defined by state water quality standards.
- Water quality programs implemented to address the Clean Water Act (CWA) objectives support the natural flow regime.
- This technical report serves as a source of information for states, tribes, and territories that may want to proactively protect aquatic life from the adverse effects of flow alteration.

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Current Status

- The Draft Technical Report is currently undergoing public review
- At the request of commenters, EPA-USGS have extended the comment period an additional 45 days
- All comments must be submitted by June 17, 2016




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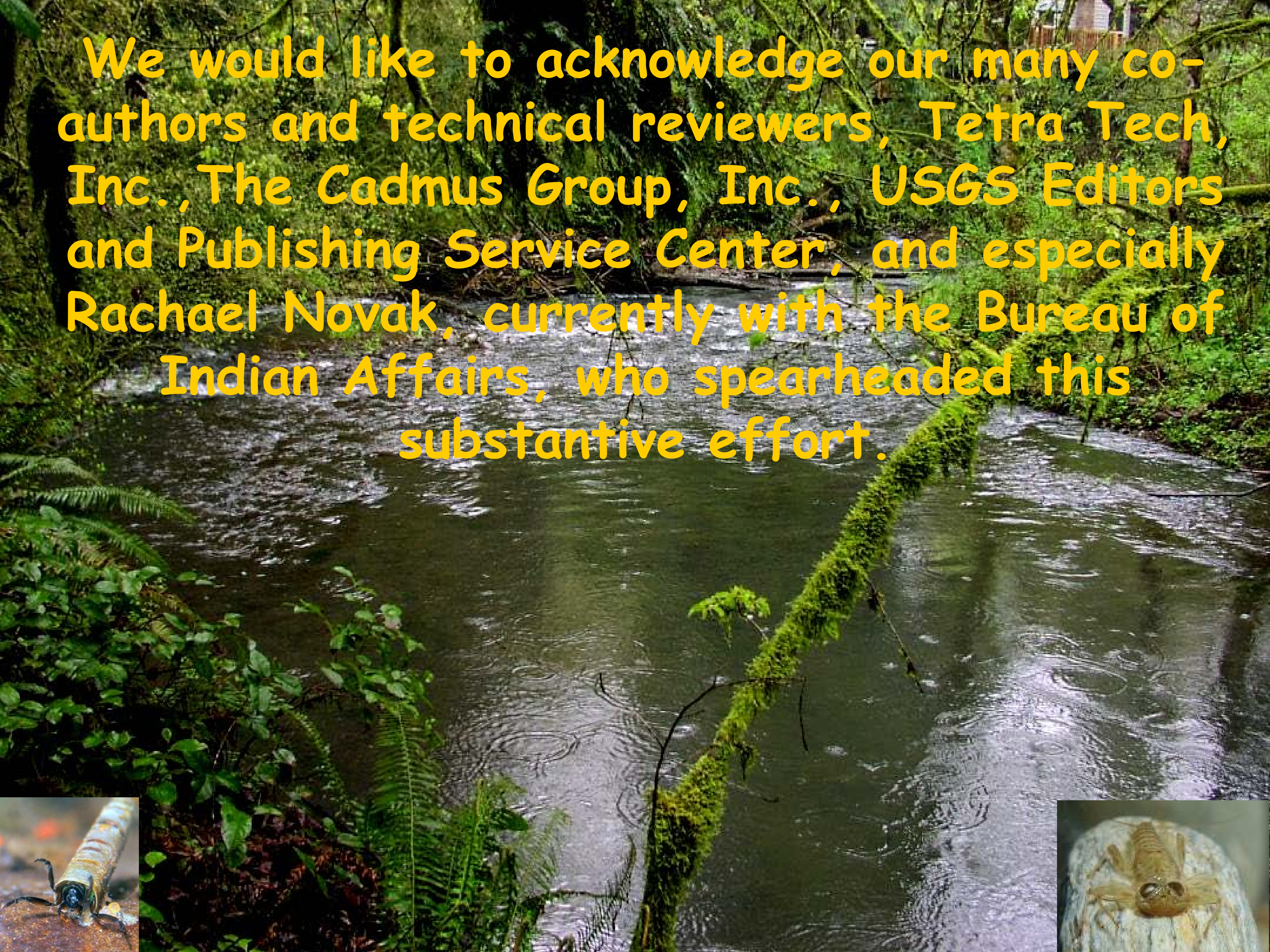
We would like to acknowledge our many co-authors and technical reviewers, Tetra Tech, Inc.,The Cadmus Group, Inc., USGS Editors and Publishing Service Center, and especially Rachael Novak, currently with the Bureau of Indian Affairs, who spearheaded this substantive effort.

The End

QUESTIONS?

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