Ecohydrology Research Vision

SCCWRP Commission Meeting
December 4, 2015
Roadmap for Today

• What is Ecohydrology?

• Why is Ecohydrology important?

• How does SCCWRP’s Ecohydrology research vision relate to policy and management decisions?

• What comes next?
What is Ecohydrology?

**Ecohydrology** is an interdisciplinary field studying the interactions between water and ecosystems.

The principles of Ecohydrology are expressed in three sequential components:

1. **Hydrological**: integration of hydrological and biological processes.
2. **Ecological**: ecosystem services and beneficial uses.
3. **Ecological engineering**: regulation of hydrological and ecological processes as a key management tool/approach.
Why Do We Care About Ecohydrology?

- Biological endpoints are increasingly used for ambient and compliance monitoring in streams
  - *Bio-integrity*
  - *Nutrient numeric endpoints*
  - *Hydromodification*
  - *Stormwater compliance monitoring*

- Instream biological communities are sensitive to changes in flow and physical structure of streams

- Improved understanding of the relationship between flow and biological assessment indicators will aid in development of management strategies

Datry 2012
Hydrology is an Integrator

If you can mitigate hydrologic alteration, you’ll solve a lot of other problems
Conceptual Model

Drivers

Land Use  Climate Change  Water Use

Effects

△ Hydrology
△ Physical Habitat
△ Ecosystem

Management Actions

Site Specific  Regional
BMP  LID  Source Control  Offsets

Streams
Wetlands
Estuaries
Drivers

What are the expected patterns in key hydrologic/ecosystem drivers?
✓ Tools to improve our ability to predict changes in drivers

How might we affect drivers to achieve ultimate desired outcomes?

• Land Use
  • Changes in land use patterns → largely done by others
  • Relationship between connected and disconnected impervious

• Climate Change
  • Downscaling global climate models → largely done by others
  • Statistical analysis of medium-scale (decadal) climate signals

• Water Use
  • Quantification of reduced flow due to changing water use practices
Effective Imperviousness

Key metric for use in hydromodification compliance

- Effective (disconnected) impervious cover is a better predictor of hydrologic change
- No local relationships to relate total to effective imperviousness
- Programs currently rely on single study from Maryland (Sutherland 2000)
- Lot’s of uncertainty for local use
Effects - Overview

**Hydrology**
- How do changes in key landscape drivers affect hydrology?

**Physical Habitat**
- What is the relationship between hydrologic change and physical habitat response?

**Ecosystem Response**
- How are key biological indicators or communities affected by changes in hydrology and physical habitat?

How might program and policies affect management at each of these levels (e.g. hydrologic targets vs. biological targets)
Effects - Hydrology

Past work focused on developing watershed models

• Modeling framework for many water quality programs (e.g. TMDL)
• SCCWRP land-use runoff coefficients still provide the foundation of most local models

Future research needs

• Update land use – runoff coefficients from 2002-05 studies
• Improved modeling of biologically meaningful flow metrics
• Statistical models
• Mechanistic models
• Surface-water groundwater interactions
• Long term effects of fire

Drivers → Effects → Management Actions
Modeling Biologically Meaningful Metrics

Which flow metrics should we manage toward?
Effects – Physical Habitat

**Past work**
- Robust research program on hydromodification has influenced stormwater management statewide

**Future research needs**
- Continued work on evaluation of *effectiveness of hydromodification management strategies* → feedback to improve assessment tools
- Improved ability to predict sediment yield
  - Potential compliance endpoint
- Predicting hydraulic responses in channels
  - PHAB metrics and assessment
  - Hydraulic modeling

**How do we gage “success” of hydromodification management?**

![Targeted field assessment for model calibration](image)
Past Focus: Hydromodification

How can we assess extent of impact?

*Hydromodification* = changes to the runoff hydrograph and sediment supply resulting from land use modifications.
SCCWRP Products Responded to Management Needs

- Classification system
- GIS screening tool
- Field susceptibility assessment
- Model selection guidance
- Management approaches
- Monitoring framework
Ongoing Implementation Support

- Technical advisory committees
- Stakeholder outreach
- Training and technical support
- Automated tools
Future Needs for Hydromodification Management

• **Assessment** – *setting appropriate targets based on anticipated effects*
  • Link hydromodification to biological endpoints / support causal assessment
  • Improve models for predicting physical habitat response
  • Inform flow criteria based on ecological endpoints

• **Management** – *what will be the most effective management strategies*
  • New management approaches, such as restoring stream processes
  • Use alternative compliance provisions to support more holistic management

• **Monitoring** – *improving the effectiveness of monitoring tools*
  • Use monitoring and retrospective analysis to inform causal assessment
  • Establish sentinel monitoring to better separate anthropogenic effects from natural variability
  • New monitoring technologies
  • Focused monitoring to provide data to improve model calibration
Management: Control of Critical Coarse Sediment Yield

- How can you map these areas?
- What type of BMPs are needed to protect sediment yield?
- How do you monitor/assess effectiveness?
- Resolving apparent conflicts between TMDLs and hydromodification

Drivers → Effects → Management Actions

22% of proposed development lies within highly productive GLUs

***SEDIMENT BYPASS MEASURES REQUIRED***
Monitoring Hydromodification Using UAVs

Drivers → Effects → Management Actions
Effects – Ecosystem Response

Implications of current work
• What might “flow criteria” look like in the future?
• How might flow criteria affect water management, use, and reuse?
  • Relationship between changing hydrology/physical habitat and biological endpoints

Future research needs
• How to identify desired ecological assessment endpoints
  • What are the biological community targets we want to maintain? → shifting baselines

• Flow ecology analysis
  • Response of multiple biological endpoints (e.g. algae, fish, birds)
  • Improved modeling and assessment tools

• Development of physical habitat-ecology relationships
How are Flow Criteria Developed?

Relationships that could be used to set biologically-based management targets

Drivers → Effects → Management Actions
Demonstrating Application of Flow-Ecology Targets

**Goal** = To demonstrate how flow-ecology relationships can be implemented at a watershed scale to guide management targets/decisions

- Explore how flow ecology tools can support local decision
- Build capacity for implementation
- Summarize lessons learned and transferability to other areas of the State
- Summarize data and information needs
- Identify needs for additional tools and resources to aid in implementation

Drivers ➔ Effects ➔ Management Actions

![Map showing hydrologic alteration]
San Diego River Case Study: Priority Management Questions

• How might lower discharge of treated effluent due to increased demand for reclaimed water affect ability to meet biological targets?

• How might minimum flow requirements affect decisions regarding stormwater capture potential
  • Amount or location of capture

• How will BMPs affect flow conditions
  • ability to meet biological endpoints
  • evaluate different types of BMPs, including stream restoration
  • evaluate different locations of BMPs
  • prioritize potential alternative compliance areas  downstream effects on biology
Management Actions

Implications of future research
What management strategies can be used to help meet instream flow targets that are intended to protect beneficial uses?

Onsite
• Optimization of BMPs for hydromodification and flow management
• Quantifying benefits of floodplain and stream restoration

Regional
• Opportunities for water supply augmentation
  • Protection of source water and sediment supply areas
  • Stormwater capture opportunities
• Support development of integrated monitoring strategies

Offsets
• Designing optimal watershed management strategies
• Support development of equivalencies for flow, hydromodification, and water quality
Alternative Compliance: Hydromodification

- How to determine equivalencies for “offsite” mitigation?
  - Size and location
  - Amount of offset needed to achieve compliance
New BMP Types: Quantifying Benefits of Stream Rehabilitation

- How much water quality or hydromodification credit?
  - Allowable locations
  - When do credits “mature”
Prioritizing Areas for Source Water Protection

What areas should be prioritized?

How should these areas be managed?

Drivers

Effects

Management Actions
**Conceptual Model – Status and Needs**

- **Low**: Focus on Streams
- **Moderate**: Little effort in wetlands or estuaries
- **High**: Development of research priorities

**Diagram Elements**:
- **Land Use**
- **Climate Change**
- **Water Use**
- **Past Efforts**
- **Research Needs**
- **Hydrology**
- **Physical Habitat**
- **Ecosystem**
- **Site Specific**
  - BMP
  - LID
- **Regional**
  - Source Control
  - Offsets

**Status and Needs**:
- Low/Moderate
- Moderate
- High
- Low
“IF YOU DON’T KNOW WHERE YOU ARE GOING, YOU MIGHT WIND UP SOMEPLACE ELSE.”

YOGI BERRA

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