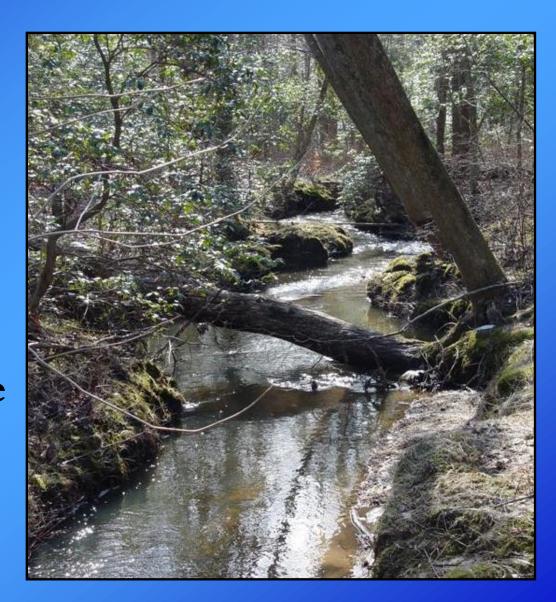


Stream Health Workgroup

Mark A. Secrist
U.S. Fish and Wildlife
Service





Presentation Outline

- Workgroup Status and Next Steps
- Overview Stream Functions Pyramid and Functional Lift Framework

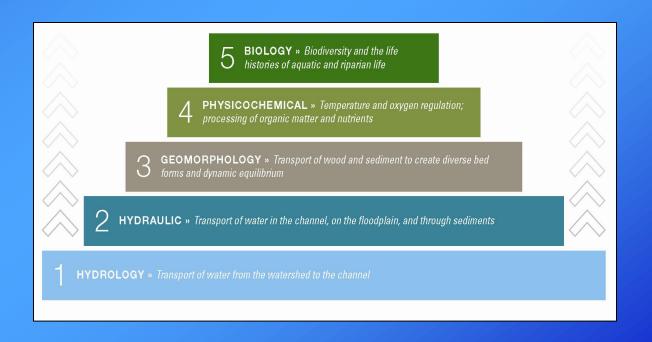


Workgroup Status and Next Steps

- Co-Chairs Mark A. Secrist USFWS and Ron Kluda MDNR
- Assemble current members and recruit additional members
- Complete Group Mission and Workplan



Functional Lift Framework: A Guide for Restoring Stream Functions





Why are we struggling with determining the success of stream restoration projects?

Current knowledge and application of that knowledge.



20th Century Shift



Traditional Channel Design

Transport water quickly; Bed and banks don't move



Natural Channel Design

Create a dimension, pattern, and profile that transports water and sediment.











21st Century Goal

Restoration of Dimension, Pattern, and Profile







Stream Functions Pyramid

5 BIOLOGY » Biodiversity and the life histories of aquatic and riparian life

4 PHYSICOCHEMICAL » Temperature and oxygen regulation; processing of organic matter and nutrients

GEOMORPHOLOGY » Transport of wood and sediment to create diverse bed forms and dynamic equilibrium

PHYDRAULIC » Transport of water in the channel, on the floodplain, and through sediments



Stream Functions Pyramid

A Guide for Assessing & Restoring Stream Functions » OVERVIEW

Biological

5 BIOLOGY » Biodiversity and the life histories of aquatic and riparian life

Chemical

4 PHYSICOCHEMICAL » Temperature and oxygen regulation; processing of organic matter and nutrients

Physical

GEOMORPHOLOGY » Transport of wood and sediment to create diverse bed forms and dynamic equilibrium

 $m{\gamma}$ HYDRAULIC » Transport of water in the channel, on the floodplain, and through sediments

HYDROLOGY » Transport of water from the watershed to the channel

Function - The physical, chemical, and biological processes that occur in ecosystems.





Effect



Cause

Stream Functions Pyramid

A Guide for Assessing & Restoring Stream Functions » OVERVIEW

5 BIOLOGY » Biodiversity and the life histories of aquatic and riparian life

4 PHYSICOCHEMICAL » Temperature and oxygen regulation; processing of organic matter and nutrients

GEOMORPHOLOGY » Transport of wood and sediment to create diverse bed forms and dynamic equilibrium

 $m{\gamma}$ HYDRAULIC » Transport of water in the channel, on the floodplain, and through sediments

HYDROLOGY » Transport of water from the watershed to the channel





Stream Functions Pyramid

A Guide for Assessing & Restoring Stream Functions » OVERVIEW

Site Selection

5 BIOLOGY » Biodiversity and the life histories of aquatic and riparian life

4 PHYSICOCHEMICAL » Temperature and oxygen regulation; processing of organic matter and nutrients

Reach Scale Improvements **GEOMORPHOLOGY** » Transport of wood and sediment to create diverse bed forms and dynamic equilibrium

HYDRAULIC » Transport of water in the channel, on the floodplain, and through sediments

Independent Variables HYDROLOGY » Transport of water from the watershed to the channel





Pyramid and Parameters

5

BIOLOGY »

FUNCTION: Biodiversity and the life histories of aquatic and riparian life PARAMETERS: Microbial Communities, Macrophyte Communities, Benthic Macroinvertebrate Communities, Fish Communities, Landscape Connectivity

4

PHYSICOCHEMICAL »

FUNCTION: Temperature and oxygen regulation; processing of organic matter and nutrients PARAMETERS: Water Quality, Nutrients, Organic Carbon

3

GEOMORPHOLOGY »

FUNCTION: Transport of wood and sediment to create diverse bed forms and dynamic equilibrium
PARAMETERS: Sediment Transport Competency, Sediment Transport Capacity, Large Woody Debris Transport and Storage,
Channel Evolution, Bank Migration/Lateral Stability, Riparian Vegetation, Bed Form Diversity, Bed Material Characterization

2

HYDRAULIC »

FUNCTION: Transport of water in the channel, on the floodplain, and through sediments
PARAMETERS: Floodplain Connectivity, Flow Dynamics, Groundwater/Surface Water Exchange



HYDROLOGY »

FUNCTION: Transport of water from the watershed to the channel

PARAMETERS: Channel-Forming Discharge, Precipitation/Runoff Relationship, Flood Frequency, Flow Duration



Parameters and Measurement Methods

HYDROLOGY		
Parameter	Measurement Method	
Channel-Forming Discharge	1. Regional Curves	
Precipitation/Runoff Relationship	1. Rational Method	
	2. HEC-HMS	
	3. USGS Regional Regression Equations	
Flood Frequency	1. Bulletin 17b	
Flow Duration	1. Flow Duration Curve	
	2. Crest Gage	
	3. Monitoring Devices	
	4. Rapid Indicators	
HYDRAULICS		
Parameter	Measurement Method	
loodplain Connectivity	1. Bank Height Ratio	
	2. Entrenchment Ratio	
	3. Stage Versus Discharge	
low Dynamics	Stream Velocity	
	2. Shear Stress	
	3. Stream Power	
Groundwater/Surface Water Exchange	1. Piezometers	
	2. Tracers	
	3. Seenage Meters	

Parameter	Measurement Method	
Microbial Communities	Taxonomic Methods	
	2. Non-Taxonomic Methods	
	3. Biological Indices	
Macrophyte Communities	1. Taxonomic Methods	
	2. Non-Taxonomic Methods	
	3. Biological Indices	
Benthic Macroinvertebrate Communities	1. Taxonomic Methods	
	2. Non-Taxonomic Methods	
	3. Biological Indices	
Fish Communities	Taxonomic Methods	
	2. Non-Taxonomic Methods	
	3. Biological Indices	
Landscape Connectivity	Spatial Analysis	
=	2. Species Tracking	
	3. Habitat Models	

Parameter	Measurement Method
	1. Shear Stress Curve
Sediment Transport Competency	
	2. Required Depth and Slope
- 1	Spreadsheets and Computer Models
Sediment Transport Capacity	1. Computer Models
	2. FLOWSED and POWERSED
	3. BAGS
Large Woody Debris Transport and Storage	1. Wohl, et al. (2009)
200	2. Large Woody Debris Index
Channel Evolution	Simon Channel Evolution Model
	Rosgen Stream Type Succession Scenarios
Bank Migration/Lateral Stability	1. Aerial Photography
and the state of t	2. BEHI/NBS
	3. Bank Pins
	4. Bank Profiles
	5. Cross-Sectional Surveys
	6. Bank Stability and Toe Erosion Model
Riparian Vegetation	1. Buffer Width
Tupatian regeation	2. Buffer Density
	3. Buffer Composition
	4. Buffer Growth
	5. Canopy Density
	6. Proper Functioning Condition (PFC)
Bed Form Diversity	Percent Riffle and Pool
Bed Form Diversity	2. Facet Slope
	3. Pool-to-Pool Spacing
	4. Depth Variability
Bed Material Characterization	1. Bevenger and King (1995)
Ded Material Characterization	2. Riffle Stability Index (RSI)
PHYSIOCHEMICAL	2. Killie Stability lildex (KSI)
Parameter	Measurement Method
Basic Water Chemistry	
	2. Dissolved Oxygen
	3. Conductivity
	4. pH
	5. Turbidity
Nutrients	 Field test kits using reagents reactions
	2. Laboratory analysis
Organic Carbon	Laboratory analysis



Parameters and Measurement Methods

GEOMORPHOLOGY

Sediment Transport Competency

HYDROLOGY		
Parameter	Measurement Method	
Channel-Forming Discharge	Regional Curves	CECT
Precipitation/Runoff Relationship	Rational Method	GEOM
	2. HEC-HMS	Paran
	3. USGS Regional Regression Equations	Sedim
Flood Frequency	1. Bulletin 17b	
Flow Duration	1. Flow Duration Cui Parameter	
	2. Crest Gage	
	3. Monitoring Device	
	4 Rapid Indicators	
HYDRAULICS	Floodplain Connect	17/1 tv
Parameter	Measurem Method 1100 april 1100 a	rvicy
Floodplain Connectivity	Ratio	
	2. Entry alment Rat	
	3. Stage Versus Discl	
Flow Dynamics	Stream Velocity	
0000000000000000000000000000000000000	2. Shear Stress	
	3. Stream Power	
Groundwater/Surface Water Exchange	1. Piezometers	
	2. Tracers	Ripari

Parameter	Measurement Method	
Microbial Communities	Taxonomic Methods Non-Taxonomic Methods Biological Indices	
Macrophyte Communities	Taxonomic Methods Non-Taxonomic Methods Biological Indices	
Benthic Macroinvertebrate Communities	Taxonomic Methods Non-Taxonomic Methods Biological Indices	
Fish Communities	Taxonomic Methods Non-Taxonomic Methods Biological Indices	
Landscape Connectivity	Spatial Analysis Species Tracking Habitat Models	

	3. Staş	ge/Q Relationships
Ш		6. Bank Stability and Toe Erosion Model
II	Riparian Vegetation	1. Buffer Width
Ш		2. Buffer Density
Ш		3. Buffer Composition
Ш		4. Buffer Growth
Ш		5. Canopy Density
Ш		6. Proper Functioning Condition (PFC)
Ш	Bed Form Diversity	Percent Riffle and Pool
Ш		2. Facet Slope
Ш		3. Pool-to-Pool Spacing
Ш		4. Depth Variability
Ш	Bed Material Characterization	 Bevenger and King (1995)
Ш		2. Riffle Stability Index (RSI)
Ш	PHYSIOCHEMICAL	
Ш	Parameter	Measurement Method
Ш	Basic Water Chemistry	1. Temperature
Ш		2. Dissolved Oxygen
Ш		3. Conductivity
Ш		4. pH
Ш		5. Turbidity
Ш	Nutrients	 Field test kits using reagents reactions
Ш		Laboratory analysis
	Organic Carbon	Laboratory analysis

Measurement Method

Measurement Method

Bank Height Ratio

Entrenchment Ratio

Shear Stress Curve



Performance Standards Floodplain Connectivity Example

Measurement Method	Functioning	Functioning-At- Risk	Not Functioning
Bank Height Ratio (BHR)	1.0 to 1.2	1.3 to 1.5	> 1.5
Entrenchment Ratio (ER) for C and E Stream Types	> 2.2	2.0 to 2.2	< 2.0
Entrenchment Ratio (ER) for B and Bc Stream Types	> 1.4	1.2 to 1.4	< 1.2
Dimensionless rating curve	Project site Q/Q _{bkf} plots on the curve	Project site Q/Q _{bkf} plots above the curve	Project site Q/Q _{bkf} of 2.0 plots above 1.6 for d/ _{dbkf}



How can we use the pyramid? -Application-

Function-Based Assessments

Goals and Objectives

Debit and Credit Determination



Function-Based Assessments Why do we need them?

- Is this stream sick?
- Is the stream moving towards stability or instability?
- Was there functional lift?
- Was this project successful?
- What reaches in the watershed need restoration?



Function Drivers

- Floodplain Connectivity
- Bedform Diversity
- Streambank Erosion (Lateral Stability)
- Riparian Buffer
- Site Selection

Requires

Appropriate Watershed Condition.

Adequate hydrology functions.

Reach scale versus watershed scale understanding.

Caveats

For perennial single thread, meandering, alluvial, riffle-pool dominated stream types.





- Establish the Current Functional Condition
- Channel Evolution
- Stressors
- Constraints





- What is the highest level of restoration that can be achieved, given the watershed conditions function-based assessment and constraints?





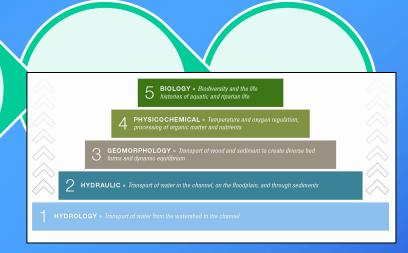
- Goals relate to solving a functional problem
- Objectives describe how the problem will be solved



Function-Based Assessment

Restoration Potential

Goals and Objectives



- Goals relate to solving a functional problem
- Objectives describe how the problem will be solved

BIOLOGY
FUNCTION (A citizens) and the 6th Nations of a quid and disprise Not Parallel STEEL S



Bad Goal

The goal of this project is to improve habitat



Better Habitat Goals

The goal of this project is to improve native brook trout habitat (Levels 1-3).

Even better – The goal of this project is to increase the biomass of native brook trout populations (Levels 1-5).







Quantitative Brook Trout Objectives



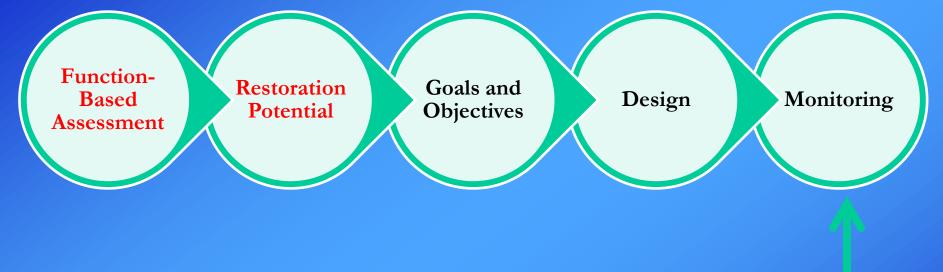
- Create pH of 6.5 to 8.0 (Level 4)
- Create water temperature of 11 to 16° C (Level 4)
- Create pool habitat of 40 to 60 percent (Level 3)
- Create 3 to 80 mm diameter substrate for spawning (Level 3)
- Create velocities of 2.8 to 4.3 ft/sec (Level 2)





- The Solution Based on all of the previous information.
- Not just to improve dimension, pattern, and profile.





- Were the goals and objectives achieved?
- How much functional lift was achieved?



Key Points

- The Stream Functions Pyramid can be as a tool that managers and practitioners can you to guide their restoration activities
- Restoration activities directly affect Level 2 and 3 Parameters.
 - May occasionally directly affect Level 1.
- Restoration activities along with proper site selection *may* affect Level 4 and 5 Parameters.
- This is a guide to help people think about how functions support each other and how to link restoration approaches with functional lift.
 - It is not a cookbook approach
- Successful watershed restoration results from a variety of restoration activities being implemented within a watershed and at a large enough scale to influence beneficial change.



Acknowledgement

- Funding and technical support was provided by the U.S. Environmental Protection Agency.
- Will Harman, Stream Mechanics.
- Rich Starr, U.S. Fish and Wildlife Service.





U.S. Fish & Wildlife Service Chesapeake Bay Field Office

177 Admiral Cochrane Drive Annapolis, Maryland 21401 www.chesapeakebay.fws.gov

Mark A. Secrist
Division of Habitat Restoration
(410) 573-4551
mark_secrist@fws.gov