

NYS Council Trout Unlimited

Brief Field Methods for Geomorphic Stream Assessment & The NYTU Resource Information System

- **Stream Visual Assessment Protocol (SVAP)**
- **Focused (Geomorphic) Reconnaissance (FR)**
 - **Detailed (Geomorphic) Evaluation (DE)**

Expanded from [A Field Manual for Brief Assessment Methods of Stream Health](#)

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Note: This manual is intended to enable TU Chapters to develop and post geomorphic stream data onto the Resource Information System. The SVAP level should be used in conjunction with the NRCS Stream Visual Assessment Protocol (available on line in PDF format). Focused (Geomorphic) Reconnaissance (FR) is a simplification of standard geomorphic survey methods (Rosgen Levels 1-3), combined with visual assessments proposed by recognized experts & adapted from the extensive stream assessment protocols of the Vermont ANR (available on line). The Detailed Evaluation level (DE) incorporates quantitative Rosgen Levels II & III. A short section on additional field methods has also been added to assist in developing data beyond these assessments. Users of these protocols are encouraged to review the listed sources along with the field methods previously presented by the Resource Management Team in both printed and seminar form, & to seek additional training before applying them. While these assessment tools will, when properly used, help you understand and prioritize stream problems, they should not be regarded as a sufficient level of analysis for restoration work. For guidelines in this area, please see the "deciding on a level of assessment" table in this manual and work with key agencies.

Acknowledgements

Clearly this set of tools reflects inputs from multiple sources that have been invaluable to us. We have freely borrowed from these sources and freely acknowledge that this manual would not have been possible if it were not for their expertise and leadership in this field. We have attempted to cull and organize this information to make it most understandable and practical for your own Chapter's use in assessing stream problems. These primary sources include:

- Applied River Morphology by Dave Rosgen (stream classification, survey methodology, BEHI & NBSI indices for bank assessment)
- Richard Hey coeditor of Applied Fluvial Geomorphology for River Engineering & Management
- USDA NRCS Stream Visual Assessment Protocol (available on line) –provided us with a an easy to use first layer strategy with enough “resolving power” & inclusiveness to build this manual with but a few modifications
- Vermont Agency of Natural Resources for their Stream Geomorphic Assessment Handbooks (Phases 1-3), available on line and by directly contacting the Vt ANR
- Gary Kappesser, Forest Hydrologist, Riffle Stability Index (8/94)

While we apologize for any inadvertent omissions of source material used. We would also like to refer our interested users to the following additional excellent sources:

- A View of the River, Luna Leopold
- The Stream Restoration Institute of North Carolina (information and downloads available on line)
- Determining Bankfull in Western & Eastern US Streams, US Forest Service Videos
- Stream Corridor Restoration, Federal Interagency Stream Restoration Working Group
- Better Trout Habitat by Christopher Hunter

All photographs were taken by Nat Gillespie. The “Focused (Geomorphic) Reconnaissance” is an outgrowth of key elements of a variety of assessments provided or suggested by the primary sources and reformatted by John Braico. The Detailed Evaluation (DE) follows Rosgen's Level II & III closely. We have also organized SVAP, FR & DE to link seamlessly with NYS Council's Resource Information System. Note that this manual does not provide assessment methods for fisheries, water quality & invertebrate clusters beyond the SVAP level. Users are referred to primary sources & agencies to develop information in this area at FR & DE levels.

It is our deepest hope that you will find these tools both easy to use and effective as you carry forward TU's central mission of “conserve, protect and enhance” our trout streams. Given the nature of river science, we can also anticipate a need to update and revise this manual. Please feel free to provide your input!

All the best in caring for our fragile stream resources,
 NYSCTU Resource Management Team
 John Braico, NYSCTU Resource Management VP

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Section I: The Stream Visual Assessment Protocol

Part 1: Introduction

Trout Unlimited's mission is to conserve, protect and restore North America's trout and salmon fisheries and their watersheds. TU accomplishes this mission on local, state and national levels with an extensive and dedicated volunteer network of 125,000 volunteers in 500 chapters nationwide. Since its founding in 1969, Trout Unlimited was guided by the principle that if we "take care of the fish, then the fishing will take care of itself." TU's focus on protecting habitat has evolved into the recognition that protecting watersheds and the area of land draining into a stream is critical. TU has always supported using the best available science to understand, protect and restore America's coldwater streams and rivers. In order to effectively protect trout and salmon habitat, we need to take a watershed, science-based approach to solving the problems.

The heart of Trout Unlimited is the grassroots chapters that work to protect and enhance their local streams. In order to understand how to devote your chapter's hard-earned money and valuable volunteer effort to an effective project, you must first understand how your home waters are doing. This understanding requires some form of assessment of the health of different components of the stream or river. While there are many stream assessment protocols available -- ranging from simplistic to sophisticated that often focus on a single facet of stream health, each can overburden eager volunteers and keep you from seeing the big picture. With this in mind, we selected a well-tested tool, the Stream Visual Assessment Protocol (SVAP) developed by the U.S. Department of Agriculture's National Resource Conservation Service (USDA NRCS) as the standard, first layer approach for TU Chapters in New York. We particularly like its integration of the major broad stream quality indicators (geomorphic/hydrologic, fisheries, water quality, and invertebrate) in a semi-quantitative, largely visual way* that is reliable and easy to use. Lastly it is a very logically developed first step that meshes well with higher level assessments.

The SVAP Manual is designed to give local TU chapters and volunteers the tools to begin the process of understanding, diagnosing, and restoring your local waters. The objective is to provide you and your chapter with a standardized quantifiable way to easily estimate the health of a stretch of your favorite stream or river. Proper use of this Manual will enable you to systematically assess what components of the stream are in good shape and not-so-good shape. The SVAP gives landowners the means to analyze what exactly is impacting the health of their stream over a period of time as opposed to simply saying, "the fishing used to be better years ago. When I was your age, this stream . . ." The SVAP, tested against rigorous, intensive assessments, has proven to be a very accurate method of rapidly assessing a stream's ecological health. It really works! Besides the Manual, all you need is a measuring tape, some time, a basic understanding of streams and rivers, and the cooperation of a few landowners to start.

*Our adjustments to this protocol were simply to add "deviation from optimal bankfull width" to the assessment section of the protocol, as well as a visual display to the 16 item assessment on the data summary sheet. The former was done to highlight the critical importance of deviations in channel width on stream function, while the latter clearly displays and helps prioritize the problems and assets of a given stream segment.

Using the SVAP Manual may *at times* lead your chapter or a cooperating agency to proceed with more detailed methods of analysis (see below) applied to a given area of concern before proposing an intervention: Just how much study is warranted is an important question – while doing too much is pointless, doing too little is a recipe for failure. We have tried to give you some rough guidelines on this in Section III.

A Sampling of More Extensive Studies Beyond this Manual to answer specific questions:

Aspects of concern:	Typical assessment tools
Geomorphic cluster	Rosgen levels 1-4, sediment transport
Fisheries cluster	additional studies by fisheries personnel – eg, limiting factor analysis, electrofishing, telemetry, etc.
Water quality cluster.....	chemical (Oxygen, alkalinity, toxics), coliform, temperature studies
Invertebrate cluster.....	EPT index Ephemoptera/plecoptera/ tricoptera), full analysis by lab

Once you have used the SVAP to diagnose the health of your stream, you will have also ranked the areas of the stream most impacted. With the problems of each area prioritized, you now have direction as to what components of the stream's health may need to be treated. You and your chapter then have to decide how to best collaborate with landowners, local agencies, and other nonprofit groups to address the source of your particular impact and begin the process of healing instead of putting a bandaid on isolated symptoms. Section III identifies possible solutions for specific problems identified by the SVAP. Finally, this section offers some advice on how your chapter may be able to work in partnership with other agencies, non-profit groups or coalitions. Given the variety of expertise available and the fact that funding often drives restoration work, the ability of your chapter to collaborate with others and raise money may prove to be one of the most important challenges to a successful project. As you plan your field studies, please keep in mind that this brief manual has been limited by design in an effort to provide you key broad level assessment tools and skills.

Part 2: Basic Stream Concepts

In order to effectively use the SVAP protocol and the other components of this Field Manual, there are a few "stream mechanics" concepts that need to be reviewed. (Additional clear and concise information is available on line as "River Course" downloads from "The Stream Restoration Institute" in North Carolina by using google.com as your search engine).

Bankfull Concept: *Bankfull* is a term applied to both the *flow rate* (or discharge in Cubic Feet per Second) and the *water stage* (level) that actively controls the shape and size of the stream channel over time by controlling sediment movement. Bankfull flow rates occur, "1 or 2 days each year and have a [log pearson flood frequency] recurrence interval [for annual peak flows] that averages 1.5 years" (Leopold, *A View of the River* p 129). Bankfull water stage is typically the elevation where water just starts to overflow onto the floodplain on stable streams. (For determining bankfull elevation & bankfull width, see Luna Leopold's video and Harrelson's description on pp 33-36 of USDA FS technical report RM-245.) A note of caution, of all stream assessment skills, this one is most challenging. Study these sources well, carefully check out several stable reaches, and if possible enlist the help of someone skilled in recognizing bankfull indicators. A landowner can be very helpful in confirming frequent high flow levels, i.e., 1-2 days each year – just ask!

Bankfull Width: is the narrowest width of a stream at the bankfull stage. Typically this is found in a STABLE faster segment – riffle or run – where the stream is not constrained by bedrock, a terrace or hillside.

Stable Reaches: are recognizable as those that score high on the SVAP geomorphic cluster -- particularly on the width, channel & bank conditions. (*Aside: more precisely, --stable reaches are neither incising or aggrading, show little bank erosion, are connected with the flood plain, and effectively transport sediment during high flows.*)

Natural Stream Dynamics – Extensive research has shown that *natural rivers attempt to maintain a dynamic and continuing balance between sediment loads (sand, gravel, cobble, boulders) and the energy available from stream flow to perform work. Natural stream channel stability is achieved by allowing the river to develop a stable dimension (x-section), pattern (planform meanders) and profile (longitudinal slope variations) required to transport existing sediments under bankfull conditions.*

Sediment – Bed load is the portion of the total particles that move on or near the streambed during flows approaching or exceeding bankfull. Suspended load is the portion of total particles suspended in the water column. Larger sediments are deposited in riffles and in bars during high flows. [*Aside: sediment loads are increased by timbering, mining, roads, agriculture & construction. Sediment transport is affected by straightening, widening, berming, gravel removal & damming. Alteration in transportable bedload will cause channel changes.*]

Flow Resistance: a straight Teflon coated rain gutter has little flow resistance, while a natural stream has important flow resistance coming from its side to side meander, its slope variations (riffle, pool) channel materials, woody debris, aquatic vegetation & riparian vegetation (all provide roughness). As a consequence, steeper upland reaches with naturally higher flow resistance, may not have higher flow velocities than downstream reaches. Flow resistance & channel roughness are key for both controlling stream energy AND FOR PROVIDING HABITAT.

Form Completion—Shared Elements of SVAP, FR, DE

- I. **Shared Data:** The intent is to collect relevant information once (who, when & where) with a few fine tuned adjustments thrown in. This common baseline is shared by each level of the Resource Information System and entry once allows you to proceed right to field data entry at what ever levels you choose. Although this portion of the data summary sheets is largely self evident, several items deserve explanation.
- **Watershed Code:** New York State is divided into the following major drainage areas:

Long Island (LI)	Lower Hudson (LH)	Mohawk/Hudson (M/H)
Upper Hudson (UH)	Champlain (CH)	St. Lawrence (SL)
Raquette (RA)	Oswegatchie/Black (O/B)	Delaware/Susquehanna (D/S)
Ontario (ON)	Oswego (OS)	Genesee (GE)
Erie/Niagara (E/N)	Alleghany (AL)	Chemung (CH)
 - **Locator Code:** (source is VT. ANR Geomorphic Assessment Handbook, Phase 1, pp 12-13)

Ground rules for labeling reaches:

 1. Consistently define reaches from downstream to upstream on the main stem first as “M1, M2, M3” – using major tributaries & changes in sinuosity/valley slope as significant break points.
 2. Similarly, number major tributaries as T1, T2, T3 From downstream to upstream along the main stem.
 3. Individual reaches on major tributaries are labeled T1.1, T1.2 & so forth.
 4. Minor tributaries of the Mainstem or of major tributaries are labeled -S1, -S2 tacked on to the mainstem reach number (eg. M1-S1) or the major tributary number (eg. T1.2-S1)
 5. Mark segments on your maps & label . (USGS &/or Delorme)
 - **Latitude & Longitude Coordinates:**
 6. This is very easily obtained from a GIS unit, from computer mapping tools, or using a latitude/longitude ruler to read directly from a USGS map.
 7. Record as in this example: 44 deg - 17' - 00" N for longitude, & 73 deg-17'-30"W for latitude, for downstream (& upstream limits). (Note that the upstream limit of one reach is the downstream limit of the next reach, so it is really most important to indicate the downstream limits of all reaches.)
 - **Verbal Description:** Accurately & concisely describe the reach so anyone can find it.
Example: 6.2 mi East of Battenville along Rt 22 (or an intersection, or a bridge), reach begins at tributary entering on the South bank.
 - **Drainage area in sq mi:**
 1. Draw watershed limits onto a USGS map
 2. Transfer this on to a transparency sheet
 3. Transfer this on to graph paper & tally up squares & convert according to the map scale to square miles. (Alternatively use a land area scale or use a MapTech 's Terrain Navigator Pro to find areas automatically.)
 - **Dominant Substrate:** for SVAP (& FR), visually estimate using the Rosgen system—
bedrock = 1, boulder = 2, cobble = 3, gravel = 4, sand = 5, clay/silt = 6
 - **Channel Form:** for SVAP (& FR) use an approximation of the Rosgen system, roughly:

cascades & torrents = Aa, A	rapids & runs = B
riffle/pools = C	braided = D
meandering meadow = E	trapezoidal channels that rarely flood = F
gullies = G	

(Please note that this is a rough visual approximation adequate for SVAP. Formal stream classification in the Rosgen system requires actual channel survey & pebble count methods as described in his texts. Use Rosgen's classification flow chart for the Detailed Evaluation Level.)
 - **Width:** always use the narrowest stable bankfull width taken from a riffle for riffle pool systems and from a run for step pool systems.
- II. **Reference Reach Candidate:** This is a very important item, as there are relatively few remaining examples of intact stream reaches in NY -- given 200 years of deforestation, agriculture, channel straightening, road & RR building. Reference Reaches provide the optimal form to compare degraded reaches to & the template for restoration work. **On the SVAP, candidate reference reaches will score high in the geomorphic cluster, have good pool status (if appropriate for that stream type), a good riparian zone, & a low level of embeddedness (if in the bedrock through gravel groupings).** When studied further (FR & DE) they will be shown to have stable channels & will fall within parameters established by Rosgen.

NYSCTU Stream Visual Assessment Protocol: Brief Reference Sheet

Channel Condition	Hydrologic Alteration	Width Deviation	Assigned Score
natural channel no structures, berms no downcutting no lateral cutting	over bank flooding = 1.5-2 years no dams no water withdrawals full access to flood plain no channel incision	none, channel at bankfull width +/- <10%	10
past alteration, recovered channel recovered banks no or well set back berms	over bank flooding = 3-5 years limited channel incision minor water withdrawal (not affecting biota)	channel 10-20% greater than expected bankfull width	7
altered channel <50% riprap or channelized excess aggradation braided channel constricting berms	over bank floods = 6-10 years channel deeply incised significant water withdrawal (affects biota during low flow)	channel >20%, but <50% of expected bankfull width	3
active downcutting active widening >50% rip rap or channelized berms block floodplain access (one or both banks)	no over bank flooding deeply incised structure blocks access to F.P. (or) severe loss habitat from water withdrawal (or) flooding yearly or more	channel >50% greater than expected bankfull width	1
<hr/>			
Bank Stability	Pools	Riparian Zone	Score
stable Bank Height = Bankfull height >33% of eroding surface on outer bends protected by roots extending to base flow	deep pools common 5 feet or more at base flow	natural vegetation extends 2 bankfull widths on each side	10
moderately stable bank height = bankfull height < 33% of eroding surface on outer bends protected by roots extending to base flow	present, not abundant depth >= 3 ft at base flow	natural vegetation = 1 bkfl width, score = 8	7
moderately unstable banks usually high (1.5 Bkfl Ht) active erosion (overhang, annual tree loss, slope failure)	present, shallow depth < 3ft at base flow	Nat. vegetation = ½ bkfl width, score = 5	3
unstable Bank Height 2x Bkfl Ht active erosion on straight or inside bends w/ numerous slope failures, tree loss annually, tree absence	absent or very shallow	N. vegetation < .33 bkfl width, or lack of regeneration or severely impacted filtering	1
<hr/>			
Instream Fish Cover	Canopy *	Fish Barriers	Score
>7 types* = 10	>75% shaded & upstream 2-3 mi shaded	none	10
*(LWD, deep pools, overhanging veg, boulders/ large cobble, deep riffles, undercut banks, root mats, backwater pools)			
6-7 cover types = 8	>50% in reach = 7	seasonal = 8	7-8
4-5 cover types = 5	20-50% shaded = 3	<1' drop structures = 5	5
2-3 cover types = 3			
0=1 cover type = 1	<20% shaded = 1	>1' drop structures = 3-1	1-3

Water appearance	Nutrient enrichment	Temperature range	Score
very clear or tea objects visible at 3-6' no oil sheen no film on submergents occasionally cloudy, clears rapidly objects visible 1.5-3' may be slightly green no oil sheen	clear along entire reach diverse aquatic plants low quantities of many macro- phytes, little algal growth	optimal year round for salmonid species present	10
mostly cloudy objects visible .5-1.5' pools may be pea green objects with green film odor of ammonia or rotten eggs	slightly greenish moderate algal growth on substrates	summer or winter temperatures rarely & briefly in stress range, no effect on population	8
very turbid usually objects visible <.5' obvious pollutants, scum algal mats, foam strong odor of pollutants	greenish water lush green macrophytes esp in warmer months	temperatures frequently reach stress range, thermal kills occur once every 5 - 10 years, periodic impacts on population	3
	pea green, gray, brown clogging macrophytes severe algal blooms thick algal mats	sustained major thermal stress occurs at least annually, population depressed due to thermal effects	1

Macroinvertebrates*	Riffle Embedded*	Invertebrate Habitat	Score
Group I with good diversity (mayflies, stoneflies, caddis, hellgramites) = 15	gravel/cobble <20% embedded = 10 20-30% embedded = 8	= > 5 types, at correct stage for colonization	(10) (see specifics)
Group II dominates (damselflies, dragonflies, sowbugs, blackflies, crayfish) = 6	gravel/cobble 30-40% embedded	3-4 types of habitat, some potential habitat	7
Group III dominates (midges, crane flies, horseflies, leeches, worms) = 2	gravel/cobble >40% embedded	1-2 habitat types, substrate covered or scoured at hi flows	3
very reduced = -3	totally embedded	0 to 1 habitat type	1

INVERTEBRATE HABITAT TYPES: fine woody debris, submerged logs, leaf packs, undercut banks, cobble, boulders, coarse gravel

Manure Presence*			
none no score!	livestock access to riparian channel 5	occasional or waste storage on flood plain 3	extensive on banks untreated sewage 1

*score only if applicable!

NYSCTU Stream Visual Assessment Data Summary Sheet

Date: _____ Party: _____

Chapter: _____ # _____ DEC Region: _____

County: _____ Township: _____ valley type (I-IX): _____

Watershed code: _____ Stream: _____ locator code: M _____ T _____ S _____

Reach: _____

Length: _____ ft Width: _____ ft Coord: _____ N _____ W

Drainage Area _____ mi sq Dominant substrate: _____ (1-6) Channel form _____ (Aa-G)

Land use in drainage area %: row crop _____ hayland _____ grazing _____ forest _____ residential _____

confined animal feeding _____ conservation reserve _____ industrial _____ other _____

Item (See protocol & field book summary sheet for criteria).

Ranking (weighted 15 to -3 scale)

	Ranking (weighted 15 to -3 scale)					
	optimal	severely impacted				
<u>geomorphic cluster</u>						
Deviation from Wbkfl	10	7	3	1		
Channel condition	10	7	3	1		
Hydrologic Alteration	10	7	3	1		
Bank Stability	10	7	3	1		
<u>fisheries cluster</u>						
Pool Status	10	7	3	1		
Instream Fish Cover	10	8	5	3	1	
Riparian Zone	10	8	5	3	1	
Canopy*	10	7	3	1		
Fish Barriers	10	8	7	5	3	1
<u>water quality cluster</u>						
Water Appearance	10	5	3	1		
Nutrient Enrichment	10	5	3	1		
Manure presence*	5	3	1			
Temperature range	10	8	3	1		
<u>invertebrate cluster</u>						
Macroinvertebrates*	15	6	2	-3		
Riffle Embeddedness*	10	8	7	3	1	
Invertebrate Habitat	10	7	3	1		

Average score for reach: _____ Status: poor fair good excellent

<6.0 6.1-7.4 7.5-8.9 >9.0

Reference reach candidate: ___Yes ___No ___Possible

**these items are optional on the Stream Visual Assessment Protocol*

Summary of observed problems: _____

Suspected causes: _____

Additional studies needed: _____

Options: _____

Section IIa: Focused (Geomorphic) Reconnaissance (FR) – one step beyond SVAP

As mentioned in the introduction, there are many times where additional, quickly obtained information is essential. Fortunately there are some fairly simple adaptations of Rosgen's geomorphic assessment methods that are largely visual or are quickly done -- lending them to an abbreviated approach. The list here is short and is designed to provide good to excellent answers to the following:

- how well is the stream connected with its floodplain?
 - check Entrenchment & Incision Ratios
- how high is the bank erosion potential?
 - check bank height erosion hazard index (BEHI)
- how much stress is the bank subject to during high flows?
 - check near bank stress index (NBSI)
- how stable is the channel bed really?
 - check visual indicators & riffle stability index (RSI)
- is the channel size (width and width/depth ratio) reasonable?
 - check W/D & compare to Rosgen's published values for the identified stream type
- is there evidence of recent or rapid channel shifting?
 - check visual indicators, aerial photographs, talk to the land owner about the history
- is the sediment supply appropriate, too high or too low for the stream type?
 - check visual criteria, pebble count

These questions are addressed by using the following techniques:

- an abbreviated cross section [measurements recorded only at bankfull (best to obtain 3 possible points – hi, lo & mid -- to assure that true bankfull is included), water's edge, thalweg & flood prone limit (based on best bankfull estimate)]. Yield: incision ratio, entrenchment ratio, w/d ratio, & Near Bank Stress Index, *approximate* cross sectional area and mean depth)
- a single riffle pebble count (looking for bimodal particle distribution & for comparison of the cumulative particle plot to the largest average particle size on a point bar)
- a Bank Erosion Hazard Index (BEHI)
- using visual criteria for: channel aggradation, degradation, sediment supply, planform adjustments

Steps in Obtaining an Abbreviated Cross Section:

1. Stretch a tape across the channel at bankfull elevation (best candidate)
2. Note the distance along the tape to each water's edge & to thalweg, simultaneously measuring the vertical distance from the tape to each point and to the top of the low bank.
3. Determine Incision Ratio by dividing: Low Bank Height from thalweg by bankfull maximum height. While the Incision Ratio is said to be more sensitive than Entrenchment Ratio for early degradation, it appears to be most useful on slightly to moderately entrenched (C, E & B) streams. We suggest recording graded results ranging from 0 (insignificant) to 4 (very significant) incision:

grade =	0	1	2	3	4
I.R. =	1.0-1.10	1.11-1.25	1.26-1.50	1.51-2.0	>2.0
4. Determine the flood prone limit by doubling the vertical "tape to thalweg" measurement and determining where that elevation projected horizontally intersects the ground on each side. (This can often be done by using a "steady stick" of known height positioned at thalweg, water surface or bankfull (whichever works best), a hand level & then pacing, taping or using a range finder to get a distance estimate out to the flood plane limits on each side.
5. In the field plot out the cross section to bankfull limits on grid paper & calculate the total XC area
6. Divide the bankfull width into thirds & determine the area of the 1/3 nearest the vulnerable bank. To determine Near Bank Stress Index, express this value as a ratio to total XC area & check below
low = < .33 moderate = .33-.41 hi = .42-.45 very hi = .46-.50 extreme = .51 or >
7. Determine Entrenchment Ratio by dividing Flood Prone Width by Bankfull width & check below:
slightly entrenched = above 2.2 moderately entrenched = 1.4 - 2.2 entrenched = < 1.4
 (Recall that the entrenchment ratio is the best measure of channel connection with its flood plain.)

Single Riffle Pebble Count & Riffle Stability Index (RSI):

(RSI is an index of the percentage of particles mobile at bankfull flows. It is based on the observation that in an incised stream, non movable particles dominate a riffle while fine particles dominate in an aggrading system. A stable system, being in dynamic equilibrium, is a mixture of fine & coarse.)

1. Estimate or measure riffle length, do a standard 100 count pebble count making transects that include top, bottom, and intermediate parts of the riffle. Plot this in standard fashion, noting d50 & how particles are distributed on the size class plot.
2. Go to the adjacent bar. At a point 2/3 down its length & halfway in elevation between bankfull & thalweg, measure & record the intermediate axis of ~10 of the largest particles. (These are the largest particles moving at bankfull flows). Average these measurements.
3. Compare this average intermediate axis of the largest bar particle size with the pebble count particle size distribution of the riffle. The RSI is the % finer than class that includes the average of the largest particle sizes on the point bar. E.G., if the average = 43mm on bar & if 65% of the riffle particle size were smaller than 43mm, then the RSI = 65.
4. Interpretation of RSI values:
Downcutting:RSI = <50 Stable:RSI = 50—70 Transitional:RSI = 70--90 Aggrading:RSI = 90—100

Assessing Bank Stability & Erosion Risk: Rosgen's "Bank Erosion Hazzard Index". This includes:

- Ratio of Total Bank Height/ Bankfull Height (both measured from thalweg)
- Ratio of Rooting Depth/ Total Bank Height
- Root Density (visually approximated)
- Percentage of bank protected by vegetation, stumps and logs (estimate)
- Bank Angle (use an angle measuring device from a hardware store)
- Soil Composition (see table)
- Presence of clay lenses or layers

Interpret findings using Rosgen's table 6-8 (see appendix)

Additional Visual Channel Stability Indicators:

1. **Aggradation evidence:** embedded riffle, pool siltation, mid channel bars & braiding, bar width greater than ½ water surface width at low flow, buried structures, exposed "relict" armor layer on eroding bank below top of channel bar (bankfull). Point bar particles much coarser than riffle particles (see Riffle Stability Index). Excess sediment loads will cause aggradation.
2. **Degradation evidence:** exposed infrastructure, undermined bank revetment, cut faces on point bar, head cuts, over steep riffle, exposed "armor layer" on eroding bank above current bankfull, large unvegetated point bars with particles much finer than riffle particles (see RSI)
3. **Widening evidence:** undercut leaning trees, exposed tree roots, toe scour on inside of meander, toe scour on both sides of riffle, non cohesive soil in steep bank, lack of vegetation at eroding banks
4. **Planform adjustment evidence:** channel braids, flood chutes & cut offs (may be at any elevation below bankfull), runs replace stable riffle/pool features, thalweg meander is out of phase

Optional Slope Determination: while not required at this level, it is a fairly simple matter to obtain a water surface riffle slope, and an energy slope. These values are essential if you are interested in estimating bankfull discharge & velocity. You can also see if local slopes are appropriate for the stream type.

1. Riffle slope: using a hand level with a steady stick (or surveyors level), note the elevational difference between the top and bottom of riffle. Divide this by the thalweg length.
2. Energy slope: using a level, take water surface shots at top of the first riffle and top of the next riffle downstream. Measure thalweg length along the deepest current thread between the two points. Calculate energy slope.

NYSCTU Focused (Geomorphic) Reconnaissance Data Summary Sheet

Date: _____ Party: _____

Chapter: _____ # _____ yrly rainfall: _____ DEC region: _____

County: _____ Township: _____ valley type (I-IX): _____

Watershed code: _____ Stream: _____ locator code: M _____ T _____ S _____

Reach: _____

Length: _____ ft Bkfl Width: _____ ft Coord: _____ N _____ W _____

Drainage Area _____ mi sq Dominant substrate: _____ (1-6) Channel form _____ (Aa-G) Reference reach: Y / N

I. Channel Stability Indicators: circle responses & criteria (from Vt. ANR)

Aggradation evidence: Y / N

- | | | | |
|---|-----------------------------|---|---|
| 1 | rifle embedded | 2 | pool siltation |
| 3 | mid channel bars & braiding | 4 | growing bars, no vegetation |
| 5 | bar W.>½ WSW at low flow | 6 | point bar particle much coarser than riffle particles |

Degradation evidence: Y / N

- | | | | |
|---|-------------------------|---|--|
| 1 | exposed infrastructure | 2 | undermined bank revetment |
| 3 | cut faces on point bars | 4 | head cuts, over steep riffle |
| 5 | suspended armor layer | 6 | large unvegetated point bars with much finer than riffle particles (see RSI) |

Widening evidence: Y / N

- | | | | |
|---|---------------------------------|---|-------------------------------------|
| 1 | undercut leaning trees | 2 | exposed tree roots |
| 3 | toe scour on inside of meanders | 4 | toe scour on both sides of riffle |
| 5 | non cohesive soil in steep bank | 6 | lack of vegetation at eroding banks |

Planform adjustments: Y / N

- | | | | |
|---|---------------------------------------|---|-----------------------------------|
| 1 | channel braids, flood chutes, cutoffs | 2 | runs replace riffle/pool features |
| 3 | thalweg out of phase | 4 | aerial photo (meander form, ROC) |

II. Abbreviated Cross Section (set tape at bankfull elevation, note optional bkfl candidates)

LFPL LBKFL opt LWS Thlwg RWS RBKFL opt Top Low Bk RFP

sta: _____

rod: _____

Bankfull Width: _____ Flood Prone Width: _____ Entrenchment Ratio (FPW/Wbkfl): _____

Cross Sectional Area: _____ Incision Ratio (Low Bank Ht/Bankfull Height): _____ Incision Ratio grade: 0 1 2 3 4

III. Bank Erodability Hazard Index: a quick semi quantitative measure of bank erosion risk (see Rosgen fig. 6.25)

visually estimate or, using a marked staff, approximate:

- | | | | | |
|----------------------|-------|-------|------------------------------|----------------------|
| | value | index | | |
| • Bank Ht/ Bkfl Ht | _____ | _____ | Final BEHI index (see sheet) | _____ |
| • Root depth/Bank Ht | _____ | _____ | | |
| • Root Density (%) | _____ | _____ | BEHI Interpretation: vl | low mod |
| • Bank Angle | _____ | _____ | (circle) | hi vhi extreme |
| • % Surface protect. | _____ | _____ | | |

IV. Near Bank Stress Index (visual approximation or quantitatively from cross section; see Rosgen fig. D-8)

- Area Near Bank/ total XC area **OR** Near Bank mean depth/ total XC mean depth ~ = NB shear stress/ total XC shear stress
- | | | | | | | |
|--------------|----------------------|----------|---------|---------|--------|-----|
| value: _____ | NBSI Interpretation: | .32 or < | .33-.41 | .42-.45 | .46-.5 | >.5 |
| | (circle) | low | mod | hi | vhi | ext |

V. Riffle Stability Index: Riffle D50: _____ mm D70 _____ mm D90 _____ mm

mean largest particle size on point bar: _____ + _____ + _____ + _____ + _____ + _____ + _____ + _____ /n = _____

RSI interpretation:	<50	50-70	70-90	90-100
(circle)	downcutting	stable	transitional	aggrading

Section II-b : Detailed Evaluation Level

Although data entry into the Resource Information System (RIS) is very simple at this level, the actual field assessments needed to derive these “yes, no” conclusions require careful measurement & adherence to rigorous methods. As the attached “Summary Data Sheet” indicates, for the geomorphic cluster you are verifying agreement with or documenting deviations from optimum reference values previously estimated by rapid methods.

This section is confined to a summary of key aspects of geomorphic survey methods needed for the “geomorphic cluster”. TU Chapters are reminded that since much of the water quality, invertebrate & fisheries data is available from Agencies, it is always appropriate to seek information from these sources first. If needed data is not available, this data may be developed either by either partnering with agencies or doing independent field work (geomorphic surveying, invertebrate & water sampling – the latter to be collected by approved methods & processed by an agency or lab).

In all cases, it is critical to determine what information is really needed to meet defined objectives before engaging in detailed studies. Keep in mind that the results of SVAP & Focused Reconnaissance studies should always indicate a clear need for specific Detailed Level studies.

- Recommended stream surveying techniques can be found in the monograph: Stream Channel Reference Sites: An Illustrated Guide to Field Technique, Harrelson et al, USDA Forest Service, Rocky Mountain Forest & Range Experiment Station, 1994 technical report RM-245. Rosgen’s Applied River Morphology, The Reference Reach Field Book, & Field Guide for Stream Classification are appropriate sources for surveying methods, stream classification and Rosgen level 1-4 analysis.
- Biologic sampling & water quality sampling should be done using the State or Federally approved methods.

Site Selection:

- Reference Reach:
 - *This needs to be done with great care!* Proceed only after doing a Rosgen level I (map, aerial, on the ground), SVAP & possibly FR evaluations for the geomorphic cluster. Be certain that:
 - the reach is representative of the Rosgen stream class of interest
 - the reach is of sufficient length (20 x Wbkfl) & has sufficient representative features
 - the channel is demonstrating bedload transport competency (has optimum width, w/d ratio & coarser riffle substrate)
 - the reach meets bank & channel stability criteria at SVAP & FR levels
- Problem Reach: Selection is usually dictated by the presenting problem or a specific focus of concern. In this case, you are documenting instability and deviation from optimal form, so your SVAP values will be low in the geomorphic cluster & FR will indicate channel/bank instability. Study the worst deviations or the highest risk.

Conducting Rosgen Level II (& III) Studies (This has been intentionally reserved for our “detailed level”).

1. Measuring a representative cross section:

- Selection criteria
 - Reference reach: straight (riffle or run), good bankfull indicator, presence of a terrace, typical of channel reach, visible geomorphic features, coarser substrate relative to other reaches (unless entire stream is of reference quality)
 - Problem reach: representative straight riffle/run
- Secure stretched tape or measuring cable with bank pins set well above bankfull elevation. (On smaller streams it is desirable to stretch a tape across the entire flood prone zone.)
- Measure elevations at every slope break on the cross sections, being very meticulous in the region of bankfull elevation. Record both horizontal distance from the Left Pin (LP, facing down stream) & elevation in nearest 10th in your field notes & if possible plot channel cross section in the field. Use standard abbreviations for key cross sectional features: LP = left pin, LFP = left flood plain, LBKFL = left bankfull, LWS = left water surface T = thalweg & so on for RWS, RBKFL, RFP.

Yield: accurate measure of channel dimension, entrenchment, flood prone area

2. **Obtaining water surface slope:**

Measure along the channel's meandering thalweg from the top of a riffle for a distance of 20 bankfull widths ending at another top of a riffle. For each break in channel slope (top & bottom of riffles or runs), measure & record the distance (station), project a right angle from thalweg to water surface and take an elevation. Now calculate reach water surface slope (WWS) as:

Reach Water Surface Slope = reach elevational difference/reach thalweg length.

Yield: reach water surface slope (an approximation of bankfull slope) & if valley elevations/distances are obtained you can calculate valley slope. Sinuosity = Thalweg length/Valley Length (or ~WSS/VS)

3. **Measuring bed material (proportionate reach sampling):**

Use blind/first touch rules, measuring the intermediate axis or using a gravelometer to speed up sorting into size classes. Record size classes on pebble count data sheets. (Note Rosgen specifies pebble counts should extend from bankfull to bankfull elevation to reflect bankfull channel flows. Unless otherwise specified, we suggest following that procedure.) For the reach: do proportionate sampling across all channel features as described by Rosgen.

Yield: A cumulative pebble count plot needed to determine the d50 for Rosgen level II classification & by looking at size distribution, sediment load can be inferred.

PEBBLE COUNT



Reach:
Date:

Party:

Particle	Type	Size (mm)	Particle Count		Total	item %	% cum
			Riffle	Pool			
	silt/clay	<.062					
v.fine	sand	0.062					
fine	sand	0.125					
medium	sand	0.25					
coarse	sand	0.5					
v.coarse	sand	1					
v. fine	gravel	2					
fine	gravel	4					
fine	gravel	6					
medium	gravel	8					
medium	gravel	11					
coarse	gravel	16					
coarse	gravel	22					
very coarse	gravel	32					
very coarse	gravel	45					
small	cobble	64					
medium	cobble	90					
large	cobble	128					
v. large	cobble	180					
small	boulder	256					
medium	boulder	512					
large	boulder	1024					
very large	boulder	2048					
	bedrock	4096					

TOTALS →

Notes:

* Note that for the size classes above, each size represents particles lying between the current size and the next larger size.

DETAILED EVALUATION:

DATA SUMMARY SHEET

Date: _____ Party: _____

Chapter: _____ # _____ yrly rainfall: _____ DEC region: _____

County: _____ Township: _____ valley type (I-IX): _____

Watershed code: _____ Stream: _____ locator code: M _____ T _____ S _____

Reach: _____

Length: _____ ft Bkfl Width: _____ ft Coord: _____ N _____ W

Drainage Area _____ mi sq Dominant substrate: _____ (1-6) Channel form _____ (Aa-G) Reference reach: Y / N

REPRESENTATIVE CROSS SECTION

rifle _____ run _____	? IN RANGE CLASS _____	INTERPRETATION	SHIFTS?
bankfull width _____		_____	
max depth _____		_____	
Area bkfl _____		_____	
mean depth (Dm) _____		_____	
Wbkfl/Dmbkfl _____	_____	_____	<u>y n</u>
FPW _____	_____	_____	
ER (FPW/Wbkfl) _____	_____	_____	
Incision Ratio _____ (lowest bank ht/Dmax)		_____	

CHANNEL MATERIALS

D15 _____		
D50 _____		
D84 _____		
Sediment Supply L M H Vhi _____		

PROFILE

Slope (WS) _____		
------------------	--	--

PLANFORM

Sinuosity ("K") _____			<u>y n</u>
ROC (2.5-3.2 Wbkfl) _____			<u>y n</u>
Meander Width ratio _____ (Belt Width/Wbkfl)			<u>y n</u>

STREAM CLASS _____

y n

Bank Stability

B.E.H.I. _____		<u>y n</u>
N.B.S.I. _____		<u>y n</u>

Channel Stability

Largest Bar Particle _____		<u>y n</u>
D50 riffle _____		
RSI _____		
Pfankuch _____		

Alterations in Qbkfl

Volume _____		<u>y n</u>
Frequency _____		<u>y n</u>

REFERENCE REACH?

Y N ?

Section II-c : Optional Advanced Field Skills for Specific Needs

- **Note:** This section, while *exceeding* our analytical objectives of providing solid, basic assessment methods for TU Chapters, is included for those needing the additional data it provides.
- **Objectives:** estimating Bankfull Discharge, quantitatively checking channel stability, computing channel shear stress, estimating channel flows

Additional bed sampling protocols:

1. For a single riffle pebble count, do multiple transects to incorporate top, middle and bottom of riffle. (Use this for a Riffle Stability Index & for calculating discharge by hydraulic geometry & Manning's equation.)
2. For surface sampling of a bar, locate a point 2/3 along its length. Opposite this, determine thalweg & bankfull elevations. At an elevation of ½ bankfull along this transect, collect and measure 6-10 of the largest stones in arms reach. This represents the largest mobile particle size at bankfull elevation (See figure 14 in FR section).
3. For subpavement sampling at a bar* (needed for restoration work only): Excavate & discard 2 rock diameters below the largest mobile particle size (same spot) to remove the "pavement". Now excavate and save a sample that is an additional 2 rock diameters in depth. (A bottomless plastic 5 gallon bucket, small coffee can, and an empty feed sack work well for this purpose.) This sample is then sieve sorted, plotting each size class by weight to obtain the d50 value required for a calculation of shear stress needed to mobilize the largest particle size found on the bar.

*This same procedure may be used to sample mid riffle subpavement.

Measuring stream flow:

- Measurements are taken for a given stream stage at a given cross section using current meters as outlined in Harrelson or as detailed by USGS (monograph available on line). This is particularly helpful if you have established a crest gage as you will be able to develop a rating table linking discharge (Q) to gage height.
Hint: select a reach that is flat in cross section & has smooth flow – typically a glide.
- At higher flows when wading with a flow meter is unsafe, use bits of orange peel tossed at varying points across the stream (5-10 trials), timing flow over a measured (& flagged) distance with a stop watch. Average the times, compute the surface velocity & convert to mean channel velocity by multiplying by the velocity adjustment coefficient of .85 (.8 for very rough channels to .9 for very smooth channels). Since discharge = mean velocity X cross sectional area, compute the discharges at measured flows. If this is done at bankfull flows, a reasonable estimate of bankfull velocity (and discharge) will be obtained.

Estimating stream flow from Hydraulic Geometry:

- at a best representative riffle (trapezoidal in XC, uniform substrate, best w/d ratio)
- Obtain a cross section, pebble count, riffle slope and energy slope (from riffle crest to riffle crest above & below the cross section being studied).
- Use Rosgen's method of estimating Manning's n:
 - compute D_m/D_{84} (the ratio of cross sectional mean depth to D_{84} in feet)
 - plug this value into the log log graph of relative roughness vs resistance factor (u/u^*) to determine u/u^*
 - plug this u/u^* value into the log/linear graph of u/u^* vs Mannings roughness coefficient ("n") to determine Mannings "n"
- Use this derived "n" value in Mannings equation to compute mean channel velocity.
- Compute bankfull discharge from $Q = \text{velocity} \times \text{cross sectional area at bankfull}$.

Section III: General Supporting Materials

Deciding upon a level of assessment for possible channel, bank & habitat work

PROBLEM	SOLUTION	ASSESSMENT LEVEL
<ul style="list-style-type: none"> cattle in stream lack of canopy (one side) 	<ul style="list-style-type: none"> fencing & limit crossings revegetation of non stressed bank 	<ul style="list-style-type: none"> SVAP SVAP
<ul style="list-style-type: none"> barnyard seepage alder choked brook early erosion on a low bank without visual indicators of stress 	<ul style="list-style-type: none"> cattle yard debrushing & revegetation bioengineering 	<ul style="list-style-type: none"> SVAP SVAP SVAP
<ul style="list-style-type: none"> lawn extends to waters edge without significant erosion insufficient woody debris 	<ul style="list-style-type: none"> reestablishing a rooted buffer strip log vane, tree revettment 	<p>SVAP</p> <ul style="list-style-type: none"> SVAP/FGR/CGA (depending upon extent)
<ul style="list-style-type: none"> localized bank erosion less than 2 bankfull widths inadequate sediment trapping 	<ul style="list-style-type: none"> rock vane, root wads, log vane, log revettment brush mats for point bar generation 	<ul style="list-style-type: none"> SVAP + FGR SVAP + FGR
<ul style="list-style-type: none"> lack of canopy (both sides) lack of adequate bank cover on a low gradient stream 	<ul style="list-style-type: none"> revegetation bank cover devices, large woody debris near cool seep 	<ul style="list-style-type: none"> SVAP + FGR SVAP + FGR
<ul style="list-style-type: none"> berms channel instability extensive bank erosion 	<ul style="list-style-type: none"> berm removal geomorphic restoration possible geomorphic restoration 	<p>SVAP + FGR</p> <ul style="list-style-type: none"> SVAP + FGR + CGA SVAP + FGR + CGA
<ul style="list-style-type: none"> channelization channel straightening 	<ul style="list-style-type: none"> geomorphic restoration geomorphic restoration 	<ul style="list-style-type: none"> SVAP + FGR + CGA SVAP + FGR + CGA

Symptoms, Causes and Interventions

Symptoms	Causes	Interventions
<ul style="list-style-type: none"> headward erosion & downstream deposition aggradation in channelized reach 	<ul style="list-style-type: none"> straightening, meander cutoffs channelization, mining of bars 	<ul style="list-style-type: none"> full channel restoration & grade control full channel restoration
<ul style="list-style-type: none"> headward erosion & downstream erosion headward erosion & downstream erosion downstream erosion 	<ul style="list-style-type: none"> urbanization increasing flows & sediment interbasin transfers increasing flows dams, wiers, drop structures, or bed load traps 	<ul style="list-style-type: none"> channel restoration with grade control restore appropriate flows, restore channel as needed restore bedload input if severe, consider grade control
<ul style="list-style-type: none"> downstream deposition & upstream deposition 	<ul style="list-style-type: none"> greatly increased sediment supply 	<ul style="list-style-type: none"> reduce sediment supply & channel restoration to handle new sediment load

Good Coalition Building to Ensure Success in Stream Work

Premise: Working in stream corridors is extremely challenging as it entails working with diverse groups, each often having high levels of “investment”. Going it on your own or with cursory involvement of principal parties is a sure way to induce resistance and limit TU’s effectiveness. Effective coalition building will require:

- A sharing of leadership – no one group should control the agenda or provide “the solution”. All groups need to participate in defining the problems as they relate to the watershed, developing a clear statement of agreed upon objectives, and in planning targeted objectives.
- Proper initial presentation of TU’s interest -- i.e., an interest in understanding and solving stream problems as biologic/geologic ecosystem problems in cooperation with and in a manner that is beneficial to all parties. This implies a sincere commitment to look way beyond an interest in improving fishing. (Face it, we have to overcome the perceptions of TU as a self-interested fishing club with implied elitism. Remember, “the line between partners and enemies is thin.” Besides, to borrow from a well worn phrase: if we restore a stable stream, the fish will come!)
- Acknowledgement of the validity of the concerns of others from the outset – e.g., loss of agricultural land, damage to infrastructure, severe flooding, a need to water livestock are all real stakeholder values. In order to bring seemingly disparate sides to agreement, you must grasp the underlying problems, discuss different options and explain the implications of each option. As this is done, the best long-term solution usually makes itself apparent. *[Aside : although this is largely true in restoration, it certainly does NOT hold for issues involving large scale development & extraction where resource protection is the focus and a more aggressive stance may be needed!!]*
- A willingness to have as many players as possible provide input from earliest phases – the landowner is in a unique position to comment on stream behavior over time & help you ascertain bankfull elevation. Honestly meeting his/her objectives and concerns up front is crucial to engaging him in meaningful restoration work that he can endorse. Likewise local officials and agencies are also key – helping you develop critical local credibility & relationships, with permitting needs, with networking, and as insurance that no one is working at cross purposes.
- A willingness to find a way to meet TU objectives while meeting other objectives – or how can you turn it into a win-win situation for all concerned? Once everyone understands basic stream processes, it is nearly always evident that restoring natural stability does provide the best solution for all – restoring ecosystem functionality while protecting property & infrastructure and reducing maintenance costs. A stable, healthy stream is better in the long run for all parties, including your chapter, landowners, local road crews and resource agencies.
- Establish buy in – offering on the ground help & where feasible, assist with funding in some way. This too helps with genuine partnering as you are recognized as having a tangible stake in solution building.
- Maintain flexibility in all phases of project development – one way is only for traffic control, not for problem solving! (This doesn’t imply sacrificing river science in any way, only encouraging groups to look for other ways to meet mutual needs.)
- Ongoing inclusion of all players -- in project planning, data collection/sharing, analysis & implementation is crucial; paying keen attention to all inputs so they remain a genuinely valued part of the process is good policy. It will also help guard against an 11th hour withdrawal of support!
- Don’t neglect follow up – or your first project might be your last if some facet needs adjustment to meet everyone’s needs. To this end it is also wise to establish permanent cross sections & photography to monitor channel responses every 1-2 years.

The Players:

Landowners (those upstream, downstream, directly & indirectly affected)

Local Officials (village, town, county)

Agencies (county SWCD, USDA NRCS, USFW, NYS DEC, NYS DOT, ACOE)

Other interest groups (environmental and other) – they could be very important allies

Summary: Being knowledgeable, informed, attentive, inclusive, flexible, tolerant (as you will be “taxed”), committed, generous in sharing & unassuming will help you exceed your restoration objectives, gain long term allies and guard against project burn out.

Funding Opportunities

Given TU's limited funding capacity – your own Chapter, Embrace-A-Stream grants & Conservation Fund grants from Council – alternative funding is often imperative for larger projects. Fish America Foundation is another grant source up to \$10K. In all cases, successful grant requests must be written concisely, while clearly delineating: the problem, the cause(s), proposed intervention, projected outcome, itemization of probable costs, listing of all funding sources, listing of all involved parties/roles, and time frame for implementation.

Additional grants may be available via your coalition partners:

- **CRP** – Conservation Reserve Program – A voluntary program that offers financial assistance to farmers and ranchers in order to conserve and protect land adjacent to wetlands, streams and rivers. Contracts with the Farm Service Agency with technical assistance provided by the Natural Resources Conservation Service (NRCS) are usually 10-15 years and have a Signing Incentive Payment of \$100-\$150 per acre depending upon the length of the contract. Contact your County SWCS & NRCS service center.
- **WHIP** – Wildlife Habitat Improvement Program – A voluntary program designed to develop or improve wildlife habitat on private land through financial and technical assistance. The NRCS will reimburse landowners 75% of their project cost, which cannot exceed \$10,000 per contract. Most projects must be on lots no smaller than five acres and contracts must be signed for at least ten years.
- **Wetlands Reserve Program (WRP)** – A voluntary program designed to restore marginal farmland to its original wetland habitat. The WRP offers landowners three options: permanent easements, 30 year easements, or cost-share agreements designed to restore the wetlands with a minimum of a 10 year commitment. Each easement provides different financial incentives for the landowner, depending primarily upon duration of contract.
- **NYS Environmental Bond Acts** – these are a periodic source of funding, accessed again via your coalition partners.

The U.S. Fish & Wildlife Service is an invaluable source of expertise in natural channel restoration and can often provide direct project assistance.