Kennebecasis
Watershed
Restoration
Committee



Riparian Restoration Tool Box

For Watershed Organizations



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Introduction

The Kennebecasis Watershed Restoration Committee (KWRC) has been working at restoring aquatic, riparian and floodplain habitats since 1994. In that time, we have planted more than 300,000 trees that help increase biodiversity, reduce erosion, and shade streams to buffer temperatures. With landowner cooperation we have installed more than 50km of protective livestock fencing that allows riparian areas to naturally regenerate (which we facilitate with tree planting). The KWRC has also put in place more than 200 in-stream aquatic habitat structures such as digger logs and rock sills, which help moderate natural stream flow, improve oxygen levels in the waterway, and provide some improved cover habitat for fish. We have stabilized more than 3000m of severely eroding stream banks using various approaches, including rip-rap, tree revetments, wattle fencing, and bio-engineering and this work reduce sediment inputs into streams, reduce erosion, and provide a more stable land base which allows landowners to better use their lands.

Based on this extensive experience, we are pleased to produce this Riparian Restoration Tool Box, which we think will be valuable for leading interest groups and community organizations through riparian habitat restoration projects. In the past we have often been asked about how we complete our various projects, and it is the aim of this manual to help groups across New Brunswick and beyond with completing similar projects.

WHO IS THIS MANUAL FOR?

If you have noticed an issue within a waterway near you and would like to help mitigate that issue, then this document could be helpful in getting you started. If you're a watershed practitioner already working on improving a watershed, then this manual can provide some great insight from a group that has more than 20 years of boots on the ground experience. If you are part of a fish and game association, an environmental club, a naturalist club or other interest group and are seeking to improve a watershed in your area, then this manual is a good place to start.

WHAT IS THE GOAL?

The aim of this manual is to provide those interested in completing a watershed restoration project with some tools and knowledge to get them to the finish line. The manual will look at various aspects of completing a riparian restoration project including permitting, landowner engagement, volunteers, site planning, and some technical information on various approaches to riparian enhancement. When you look through the manual, we hope you realize that watershed restoration does not need to be difficult.

HOW DO I USE THIS MANUAL?

The KWRC divides our day-to-day work into three categories and our manual is organized in the same way. These include:

1. **Education and Outreach:** Here we focus on land owner engagement, volunteer recruiting, event hosting, and project promotion.
2. **Monitoring and Research:** This section focuses on how we set our priorities, how we measure impacts and gauge site success. We provide information on habitat assessment, water quality monitoring, and other important information that you should consider before commencing a riparian enhancement project
3. **Restoration Works:** This is where we discuss permitting, sediment control, the various riparian enhancement techniques, and some of the value-added components we implement within our riparian areas.

“How To” documents for many of the activities the KWRC carries out have been organized into these sections in the manual. Each “How To” document in the manual can also be used as a separate, stand-alone document. In the paper copy of the manual, we have colour coded the sections by using tabs in a binder. Where possible, we have provided links and pathways to additional resource materials that we often use. Keep in mind that these links may change and, while we hope to update the online version of this manual, the physical copy may get outdated.

The KWRC has also created various templates for such things as field sheets, report templates, landowner letters and other such documents. We have included our templates and encourage you to use them by simply printing them off or using the model to create your own. Having templates creates data consistency while also making uploading data to on-line folders and databases much easier. It also makes public consumption of the data more user friendly.

WHO SUPPORTED THIS MANUAL?

As you will find when you go through this document, partnerships are crucial when completing riparian enhancement work. The KWRC has secured funding partners to help with the generation and presentation of the manual, test partners to review the information contained in the manual, and has also had the support of committee members throughout the process as well.

SUPPORTING GROUPS

FUNDING SUPPORTERS

This project was undertaken with the financial support of:
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Kennebecasis Watershed Restoration Committee

1. Community Outreach

The following section contains watershed-related activities for engaging the broader community, as well as methods and ideas for fostering and tracking this engagement.

Community Outreach and Education is an important part of any restoration work that is undertaken. At the KWRC, when brainstorming around project ideas we often include a discussion around how we can engage volunteers and how we can leverage in-kind support. These volunteer hours and in-kind contributions can go a long way in strengthening funding proposals by allowing you to more readily meet matching requirements that many funding bodies have.

Each organization will approach education and outreach differently, depending on its capacity. For the purpose of this manual, we have developed the tools as if for an individual with no past communications skills. Our first renditions of some of these "How To" sheets were actually to help train first and second year university or college students, so we feel this information can be useful for a wide array of groups.

KWRC Project Manager, Ben Whalen (foreground) leads a group on a field tour of restoration sites while standing beside a sign that identifies the worksite.

HOW TO:

Host a Great Canadian Shoreline Clean Up

Kennebecasis Watershed Restoration Committee

WHAT IS THE GREAT CANADIAN SHORELINE CLEAN UP?

The Great Canadian Shoreline Cleanup (GCSC) is a national event that tens of thousands of Canadians participate in yearly. The event is presented by Loblaw Companies Limited and led by the Vancouver Aquarium and World Wildlife Fund. The KWRC hosts a GCSC event each year in our watershed.

PLANNING EVENT DETAILS

Many GCSC events take place on the third Saturday of September. The KWRC aims to host the event on any available Saturday of September. It is useful to check in with other local organizations to ensure that no similar events will conflict with the date chosen. For example, before finalizing the date, the KWRC checks in with the Sussex Fish and Game Association, who often have events in mid-September.

The KWRC hosts their GCSC event at Burton Park on Leonard Drive (8th Hussars Parking Lot), and it often runs from 9:30am to 12:00pm. By being consistent with the location and date, people have begun to look toward the event and we can more readily track and compare event success.

When hosting a GCSC event, it needs to be officially registered on the GCSC website (http://www.shorelinecleanup.ca/en). It is simple to sign up, and many great resources are available on the website and it is these resources that make registering the event worthwhile.

PARTNERSHIPS AND DONATIONS

It is useful to make contact with the local waste disposal station to enquire whether they can donate garbage bags and waive the tipping fee for any waste collected as part of the GCSC. They can also be invited to participate by hosting an information table.

In the past, KWRC has invited businesses and groups to put in a team for the Great Canadian Shoreline Cleanup and offered for them to do a section of the cleanup on a different day and time if that works better for them. This sort of outreach can be done by social media, website and invitation.

The Atlantic Superstore in Sussex has been a major sponsor for the GCSC events hosted by KWRC in the past (as they are a Loblaw company). In previous years, Superstore has provided all of the materials required for our free barbeque for our volunteers. A month prior to the event, the KWRC contacts the managers to inquire if they will continue their support.

ADVERTISING

Advertising a GCSC event within the community and on social media is crucial to the success of the event. It can be promoted using social media (e.g., Facebook), local media (e.g., newspapers and radio) and around the community (e.g., posters). When advertising, include such information as location, date, time, and the fact that all materials and food are provided by the hosting organization and sponsors. Participants should also be encouraged to wear appropriate clothing to the event.

Local media can also be invited to the event to interview participants and report on the event. A press release can be issued to facilitate this and help control your message.

Promotional materials are often provided through the GCSC website after you register your event. This includes posters, event registration forms, photo waivers, waste report forms, and other such documents.

REGISTRATION FOR PARTICIPANTS

Once a hosting organization registers their GCSC event on the GCSC website, participants can sign up for the event using the website. It is also useful to have a registration form available on the day of the event (see attached).

MATERIALS REQUIRED

It is ideal to have a registration station under a tent canopy, with a table, copies of the registration form, and a sign. At this station, participants should be provided with latex gloves, garbage bags, and access to hand sanitizer. There should be access to a dumpster or place for collecting bags of trash.

If lunch is being provided, supplies such as tables, a BBQ, coolers, napkins and food and drink will be necessary.

KWRC Project Manager, Ben Whalen (l) and past Restoration Coordinator, Jenna Strang (r) stand in front of a truck loaded with litter collected from nearby Trout Creek.

EVENT REGISTRATION FORM

Date:

Event:

The below signed have registered for the above noted event hosted by the Kennebecasis Watershed Restoration Committee (KWRC). By signing below, we acknowledge our support and effort as part of the volunteer event and support the watershed restoration, monitoring, and educational efforts of the KWRC.

NAME (Please Print)	Signature	Date

HOW TO:

Monitor Precipitation for CoCoRaHS

Kennebecasis Watershed Restoration Committee

INTRODUCTION

The Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) is a non-profit, community-based network of volunteers who monitor precipitation (rain, hail and snow). CoCoRaHS uses low-cost measurement tools and an interactive website to provide useful precipitation data for education and research purposes. Major funders of CoCoRaHS include the National Oceanic and Atmospheric Administration (NOAA) and the National Science Foundation (NSF). The information generated by volunteers is publicly available and can be used by researchers, climatologists, water management specialists, and many others.

WHO CAN PARTICIPATE AND HOW?

Anyone can participate in monitoring precipitation with CoCoRaHS. As their website states, “The only requirements are an enthusiasm for watching and reporting weather conditions and a desire to learn more about how weather can affect and impact our lives.”[i] By participating, “citizens scientists” can feel the satisfaction of contributing important and useful information.

Those interested in volunteering can sign up with CoCoRaHS at https://www.cocorahs.org/Application.aspx. The KWRC purchases CoCoRaHS rain gauges in bulk and helps to install them on a volunteer’s property within our watershed. Other watersheds groups may be interested in doing the same. KWRC staff install a post on the volunteer’s property and attach a CoCoRaHS rain gauge to the post. The

post should not be installed near any buildings or tree cover. It should be in a wide-open space so that the values recorded are representative of the true natural rainfall values. The gauge should be level and ensure that the top of the gauge sits higher than the post it is installed on. After the gauge is installed, volunteers make a daily habit of visiting the gauge at a certain time and measuring the amount of precipitation. Observations are recorded on the CoCoRaHS website (www.cocorahs.org) or using the CoCoRaHS app.

The KWRC has a list of sites we have set up and we can view reports on each of the sites. We can further generate our own multi-site reports while also tracking the effort of those volunteers and use it as support for the KWRC.

MATERIALS NEEDED TO INSTALL RAIN GAUGE

- Rain gauge kit (includes Screws)
- 6' cedar post
- Shovel
- Fencing maul
- Drill and drill bit

TOOLS NEEDED TO RECORD DATA

- CoCoRaHS rain gauge
- Meter stick
- Snow board
- WiFi access

MORE INFORMATION

For more information, visit the CoCoRaHS website (https://www.cocorahs.org) or check out their manual (https://www.cocorahs.org/media/docs/CoCoTrainingSlideshow_v9.2B.pdf).

[i] Community Collaborative Rain, Hail and Snow Network. https://www.cocorahs.org/Content.aspx?page=aboutus

HOW TO:

Publicize an Event

Kennebecasis Watershed Restoration Committee

INTRODUCTION

Publicizing events and work that a community organization is doing is critical to achieving success. KWRC relies on a variety of media outlets to publicize events. Social media pages and websites require continual upkeep and contributors to keep them relevant. If you have one or more capable contributors, these outlets are a great way to spread the word about your work, messages, and events. Traditional media (print, radio, and TV) may be better suited for event promotion but can also help with spreading your message, acknowledging funding partners, and simply creating a community buzz.

WRITING A PRESS RELEASE

Publicizing an event through news or social media is an effective way of advertising to the broader community. The timing of the release should allow readers to react and plan to attend the event – at least 2-3 days prior to the event. A press release can be used to invite local news media as well as the general public.

Following an event with a press release (including photos) is an effective way of celebrating the success of an event with the wider community and building credibility for the host organization.

A sample press release for an event hosted by KWRC is attached. We encourage you to create your own template and simply use the example as a model.

LOCAL NEWSPAPERS

A list of local newspapers in New Brunswick and relevant contact information can be found here:

- Daily publications: https://www2.gnb.ca/content/gnb/en/news/media_list/dailies.html
- Weekly publications: https://www2.gnb.ca/content/gnb/en/news/media_list/weeklies.html
- Biweekly publications: https://www2.gnb.ca/content/gnb/en/news/media_list/biweeklies.html
- Electronic publications: https://www2.gnb.ca/content/gnb/en/news/media_list/electronic_publications.html

SOCIAL MEDIA

Having a social media presence is a very effective way of communicating with the broader community. Posting about events and including pictures of people participating goes a long way to building credibility and engagement. Make sure everyone in a photo has given permission for the photo to be used publicly (see attached photo release form). At KWRC, if someone decides not to sign the photo release form at an event, they are given an armband to wear. After the event, any photos that contain a person wearing an armband are not used publicly.

Watershed organizations in New Brunswick are encouraged to use the hashtag #eaunbwater for their postings. Each organization can also develop their own signature hashtag. KWRC's is #worthwadinginto.

RADIO

Many local radio stations are happy to publicize community events on the air. For example, CBC New Brunswick has a number you can call and leave a voice message with all the information about an event and they will play the message during the local morning or afternoon shows. A list of radio stations and contact information is available here: https://www2.gnb.ca/content/gnb/en/news/media_list/radio_stations.html.

TRACKING

It is important to track the media coverage you receive. You should attain paper clippings of print media, copies of radio interviews, and recordings of the TV exposure you receive. Copies of the media spots should be submitted with your funding reports or to potential partners. This will help provide credibility to the project or to the proposal and make future funding more readily available. Keep a running spreadsheet that highlights where the coverage came from, what the readership or viewership is, and note what the topic was that was covered.

Photo Release and Registration Form

Date:

Event:

The below signed hereby provide permission to the Kennebecasis Watershed Restoration Committee (KWRC) to take and use their photo in association with the above titled event. All below signed understand that this picture may appear on promotional items, pamphlets, posters, and in on-line albums and KWRC websites. The KWRC will not profit from any picture taken in association to the above titled event and will not distribute any photos to any group or individual.

In addition, this form will serve as a registration form. A parent or guardian must sign the form or the child cannot participate.

Participant Name (Please Print)	Parent/Guardian Name	Signature	Date

Press Release Press Release Press Release

"Helping To Restore Our Waterways"

DATE: **Wednesday, September 20th, 2017 - 10:00 am**

LOCATION: **Burton Park, Leonard Drive, Sussex, NB**

TOPIC: **Celebrating National Forest Week 2017**

DETAILS: As the leaves begin to change colour this fall, it is hard to not notice just how much of our landscape is dominated by forests. Not only do forests provide us with many important natural resources that support our daily needs and local economy, they are critical to the health and well-being of all living things who rely on them to provide clean air and water, diverse habitats for plants and animals to live in and a favourite place for people to visit to enjoy recreation and peaceful solitude.

National Forest Week runs from September 17th - 23rd and in appreciation of all that our forests provide us, the Kennebecasis Watershed Restoration Committee (KWRC) is partnering with the Communities in Bloom Urban Forest Committee and The Town of Sussex to do a symbolic tree planting at Burton Park in Sussex on Wednesday, September 20th.

The trees will be planted to enhance Sussex's "urban forest" which is made up of the trees and other plants present throughout the town's streets, green spaces and private and commercial properties. The urban forest is an important part of our community that can easily be overlooked in the hustle and bustle of our days. The KWRC and Communities in Bloom Urban Forest Committee hope that everyone takes some time to celebrate National Forest Week by getting outside in nature everyday to enjoy and appreciate our abundant natural and urban forests in the Kennebecasis Watershed.

FURTHER INFORMATION:

Website: kennebecasisriver.org
Facebook: Kennebecasis Watershed Restoration Committee
Instagram: kennriverrestoration

CONTACT: Sarah Glinz - Education and Outreach Coordinator
Kennebecasis Watershed Restoration Committee
(506)433-4394 education@kennebecasisriver.ca

HOW TO:

Track Volunteer Engagement

Kennebecasis Watershed Restoration Committee

INTRODUCTION

Designing and hosting programs and events that engage the broader community is essential to the work of most environmental organizations. Environmental awareness and values are fostered when we get out into the community to present our work, or when we host events that invite others into their local environments to work and explore.

In order to plan successful community events and to obtain the funding that is essential to run them, it is important to maintain detailed records of previous events and the associated volunteer engagement.

EVENT AND VOLUNTEER TRACKING

The KWRC uses an Engagement Report template to track the details of each program or event that it hosts. This is useful for recording additional community partners that were involved in an event, as well as the hours that any participants volunteered. Tracking the number of volunteer hours allows the event host to calculate the amount of in-kind support that an event generated, which is very useful information for potential or actual funding bodies. Having a detailed account of the attendance of each event or program also allows those planning future events to gauge how many people to expect, and more easily facilitates planning events by different staff members over the years. It is important to have a good registration process so that you can effectively count the number of volunteers or event participants. The Engagement Report template used by the KWRC is attached.

ENGAGEMENT REPORT

DATE:

REPORTER:

Type of Engagement (check all that apply)			
Presentation		Education Outreach	
Event		Restoration	
Volunteer		Monitoring	

PRESENTATION / EVENT DETAILS

Title:		
Location:		
Engagement (list all groups/partners and their attendance)	**Groups/Partners Involved**	**Attendance**
	Total # Engaged	
Handouts provided		
Funding generously provided by (if applicable)		

VOLUNTEER DETAILS (if applicable)

Activity undertaken	**Result of effort (i.e. # trees planted, km stream cleaned, etc.)**

Volunteer / In kind Contribution Values			
Volunteer Contribution		**In-kind Contributions (Describe)**	**$ Value**
(A) # of Volunteers			
(B) Hours volunteered			
(C) Rate ($/hour)	$		
(D) Total (A x B x C)	**$**		**(E) $**
Total Cash Value of Engagement (D + E)			**$**

COMMENTS ON EVENT:

HOW TO:

Make Contact with Landowners

Kennebecasis Watershed Restoration Committee

INTRODUCTION

Meeting with landowners to discuss stewardship opportunities and potential restoration activities for their property is an integral part of the work of KWRC. There are a number of best practices with respect to landowner contact which can help to facilitate positive relationships and outcomes.

BEST PRACTICES IN LANDOWNER CONTACT[ii]

1. Reach out first by mail, phone or email to request a time to visit. People are more likely to engage in a productive and positive conversation if they are not taken by surprise.
2. Listen patiently – Start by finding out what the landowner knows about their property and what they might be concerned about. Don't make them feel like they need to defend their opinions. Take note of the emotion and knowledge behind their statements.

3. Respect – Respecting the landowner and the opinions they express is a key ingredient for a positive relationship. Establishing trust and mutual respect is essential for maintaining a longer term, and productive relationship.
4. Provide information and support – Help connect the landowner with stewardship information that relates to their interests for their property. Explain the relevant stewardship or restoration activities that are offered by your group. Closely monitor the discussion and be ready to change topics or styles to meet the needs of the landowner.

5. Cultivate a positive reputation in the community – Landowners are more likely to participate in stewardship activities if they have heard of the positive work of an organization, and if they hear about other neighbours and friends who have these activities.
6. Prepare for questions – Conversations with landowners can go in many different directions, and they could ask questions on a myriad of topics. Sometimes questions will be tangential to the topic at hand (e.g., Was it your organization that opposed fracking in this area?) or will be confrontational (e.g., Who are you to tell me what to do with my property?). Answer as best you can, and be prepared to tell them you will follow up with information about topics you cannot speak to.
7. Keep good records – While it is okay to make note of a few things during the visit (e.g., questions they want followed up on), keep extensive note-taking for right after the visit – when things are still very fresh in mind. This will help cultivate an informal and collegial atmosphere during the visit, and will feel less like an interview or surveillance.
8. Follow up – Sending a follow-up letter within a month of the visit can go a long way to fostering a positive relationship. Include any responses to questions that couldn't be answered during the discussion, and include any relevant resources that pertain to topics of interest that were discussed.

PROJECTS ON PRIVATE LAND

Once a relationship has been established with a landowner, there may be a need to pursue restoration work on their property. At this stage, KWRC often carries out a site assessment (see section 2.4 of this manual). After a site assessment, the KWRC can outline for the landowner what restoration activities are feasible (a restoration plan) with an associated budget. If the landowner is in favour of the work being carried out, a landowner agreement is established (see attached template). This document legally protects the restoration organization and also provides incentive for the landowner to maintain the site after the work has been carried out. It is important that the restoration organization does not over commit or oversell the work they are able to carry out – be realistic with expectations about the project.

After restoration activities have been carried out, it is important to maintain a relationship with a landowner to monitor the site and track any future changes. A continued relationship will also flag whether the property changes hands, and can allow proactively fostering a relationship with future owners.

In some cases, no restoration activities need to be carried out on a property. Rather, a relationship with landowners can be established so that monitoring sites can be accessed through their property. Each time the property is accessed, staff members should attempt to advise the landowner in person. If the landowner is not home, KWRC leaves a note stating that the monitoring site has been accessed through their property and invites follow up if the landowner has questions or is curious about the results of the monitoring.

[ii] Duynstee, Theresa.1997. *Landowner Contact Guide for British Columbia.* Ministry of Environment, Lands and Parks. http://www.dfo-mpo.gc.ca/Library/216861.pdf

LETTER OF UNDERSTANDING

This letter states the understanding between the landowner, _____, and the Kennebecasis Watershed Restoration Committee regarding stream and riparian enhancement activities conducted on the land of the above mentioned property owner along a tributary of the Kennebecasis River, and in the County of Kings.

The landowner, _____ agrees to allow the Kennebecasis Watershed Restoration Committee (KWRC) to perform stream and riparian enhancement work as approved by the Department of Fisheries and Oceans (D.F.O), and under N.B. Department of the Environment and Local Government's Water Course Alteration Permit.

The landowner, _____ agrees to permit personnel and equipment of the Kennebecasis Watershed Restoration Committee and its subcontractors to enter upon their land to conduct stream and riparian enhancement activities.

The landowner agrees to the following:

1. Staff and/or volunteers of the KWRC will be allowed future access to the site to monitor and evaluate the results of the project(s) as required and agreed upon based on **Prior Notification**.
2. Upon **Prior Notification,** the landowner agrees to allow the KWRC to conduct educational tours of the site(s).
3. That any trees planted as part of the project will not be willingly destroyed.
4. That fencing installed as part of the project will not be willingly destroyed, and will be maintained by the landowner to acceptable standards
5. That signage installed by the KWRC will not be willingly destroyed or damaged by the landowner.

By signing this letter of understanding the landowner agrees that he has read and understands all term and conditions mentioned above.

Date: _____

Landowner: _____ **For KWRC:** _____

Kennebecasis Watershed Restoration Committee

2. Monitoring

The following section contains information on a variety of monitoring activities undertaken by the KWRC. Other watershed groups may be interested in gathering similar information.

Monitoring and research help watershed groups set mandates and priorities, and aids in gauging restoration success. In order to understand what aspects of the watershed need work, one first needs to know what areas are damaged or impacted. As this information is gathered, goals and objectives can be set for addressing damaged areas. Monitoring and research can be done on a variety of geographic scales and, in many instances, volunteers can help with some of the work.

After restoration work has commenced, it is useful to gauge how the waterways are improving or how the restored riparian zones are adding value to the ecosystem. Having good baseline monitoring data will allow one to assess changing conditions and make confident statements about the improvements that have been made. Such information is very useful to funding partners, allowing them to feel confident in the utility of the work and compelling them to fund future projects or continue existing efforts.

The KWRC uses a combination of staff and volunteer effort to complete its monitoring programs. Some of our monitoring work is done through grants and other work is through corporate partnerships and data sharing agreements, which allow us to build capacity and data sets. If you can be flexible but consistent in your data collection and presentation then the opportunities are endless.

This section will provide direction on how to gather data for your own assessment and monitoring programs. The manual provides field sheet templates that can be printed or adapted as you see fit. and there are links to additional information sources.

HOW TO:

Create a Cross-sectional Stream Profile

Kennebecasis Watershed Restoration Committee

INTRODUCTION

Cross-sectional stream profiles are established to monitor stream channel stability and changing conditions. The profile assesses the stream width, depths, substrate, and flood plain characteristics. Changes in the profile over time are expected, but large changes could indicate severe or sudden alterations to the stream that may require investigation and action. In many cases the cross-sectional profile is collected along with flow rate data so that information on discharge can be confidently calculated.

CROSS-SECTION LOCATIONS

The KWRC has a number of water sampling sites, restoration sites, and other points of interest across the watershed. Often times the cross-sectional profiles (CSPs) will be completed in association to these points of interest, to monitor the performance of various tributaries or potential restoration sites.

Sites can be selected based on a number of variables:

Site access: For efficiency reasons the site should be fairly accessible by staff carrying large amounts of field gear.

Site definition: The site needs to be definable year after year and thus have solid natural or man-made features that can be readily recognizable.

Purpose: Before establishing a site, one needs to determine what purpose the site will have in the continuing monitoring program. Is it building on site data from the same stream or location? Is it acting as a comparison for a site above or below? Is it in preparation for a restoration project? The answer to these questions may determine if one or more CSPs are needed. There is no great need for

more than one CSP in the same reach, however if you want to know how an entire stream is performing, more than one CSP will be needed across the stream.

Wading or floatability: To complete a CSP you have to cross a section of the river while taking measurements. This means you should be able to safely wade or float across the section you are profiling. When considering this, thought should be put into all water conditions.

METHODOLOGY

Establishing CSP Width: Once the general site location is determined, based on the factors listed above, a site investigation will help establish the precise CSP location. With the CSP site located, you then need to establish the start and end point of your cross-section or the sectional width. When establishing the CSP width, it is important to consider the flood plain. The KWRC typically will utilize the 2-year flood plain level when establishing the CSP width. Moving beyond that range will result in an excessive number of data points for the site without truly adding value. When determining the two-year flood plain, you can often note bank elevation changes or vegetative cover changes that correlate to the flood plain. If you note more than two changes from the water's edge up the bank, then at the second one create your start or end pin location.

Placing Survey Pins: Once you have established where you wish to place the pins (your start and end points), you can drive the pins into the ground with flagging tape/paint to mark the location for future reference. Using your GPS, take a coordinate for each pin and note it on your field sheet. Use your field tape to measure the distance between each pin and the wet width of the stream. For lines less than 15m you can pull the field tape tight and tie it to each pin. For wider sites use the segmented string which will be removed at the end of each site visit. The tape or string provides the rod holder with the line route. A photo should be taken of the line and the photo number documented on your field sheet.

Setting up the Survey Level: Establish the survey level in a location that will allow you to work right to left along the survey line. Make sure the survey level is level and stable. In the stream is not an ideal location. A baseline elevation is not needed, unless you wish to tie in with other sites. In most cases the elevation can be determined using the GPS or a desktop application.

Surveying the Line: With the level in a stable location, you take your first elevation from the right bank pin and it would be recorded as "0-0-0" - 0cm wide, 0cm deep, and 0cm

elevation. The next measurement is at an established interval based on the stream width (see table below).

Suggested intervals based on stream width	
Width of stream	*Interval*
500 cm or less	25 cm
501 – 1500 cm	50 cm
>1501 cm	100cm

The rod holder moves the rod to the established interval and relays the line width to the note taker. Then the rod holder also reads the water depth off of the survey rod and communicates that to the note taker. The survey level reader then reads the elevation off the rod and communicates that to the note taker.

Tips:

- When reading water depth, the person holding the rod should minimize the displacement of water by the rod by placing the narrow part of the rod perpendicular to the flow.
- When the level reading is being taken, the rod should face the reader and it should be moved front to back slowly by the rod holder, with the reading being the average observed reading.
- A video showing how to set up the survey level and use the survey rod can be found at: http://youtu.be/czPibdRDDUU

Completing the CSP Data Sheet: The KWRC has adapted a spreadsheet (originally from Parrish Geomorphic) that facilitates the completion of this work. It can be used either as a hard copy in the field or as a digital file on a field computer. It is an MS Excel spreadsheet with linked formulas and an automatic graph function. The file has two spreadsheets, one for CSP data and one for site information. A third spreadsheet is simply a linked sheet for calculating flow/discharge data if that information is being collected. The data to be entered on the CSP Data Sheet tab is listed below along with a brief description.

1. Width: This is equivalent to the CSP width, as described in the initial step. Cross-sections measuring from 1-500cm use a 25cm interval so the entries in this column would read 0-25-50-75, etc. For larger cross-sections, adjust according to the table above.

2. Rod Elevation: This is recorded in cm and indicates the noted measurement of the rod from the survey level. It is then converted automatically into "Bankfull Depth" on the worksheet.
3. Bankfull Depth: These numbers provide the profile of the stream bank and substrate of the cross-section. The numbers are automatically generated from the rod elevation readings. The first and last readings are considered "0" elevation for the site and the bankfull depth is derived from that first reading.
4. Water Depth (measured): The water depth is measured off the survey rod in cm and entered into the column at the corresponding interval of the cross section. If the survey rod is at 125cm on the cross-section, then the depth read from that location is entered in the same row, in the water depth column.
5. Water Depth (graph): This number will be generated automatically as you fill in your "water depth (measured)" values in the digital file. This data provides the graph with water level input, and the number should be very consistent from one entry to the next. If a variation of greater than 5cm occurs, you should re-evaluate your measurement or your survey level positioning.

Completing the Site Information Sheet: As mentioned above, in addition to the CSP Data Sheet, there is also a Site Information sheet that should be completed. The information on this sheet provides data on the substrate and channel location that are valuable in determining channel changes over time. The data to be entered on this sheet is shown below:

1. Cross-section width: This refers to the total width of the cross-section being measured and this value determined the surveying interval.
2. Wet Width: This value is measured from water contact on the right bank to the water contact on the left bank along the profile.
3. Entrenchment: The position of a river between its valley walls is considered its entrenchment. It is recorded as a percentage so that if, in a 100m wide valley, the

channel was located 20m from the right side and 80m from the left, the data would be entered 80% right, 20% left.

4. Wood Debris: A quick observation of the amount of wood debris in the area will suffice for this item, and no measuring is required. The photo to the right shows major wood debris.

5. Exposed Bedrock: Bedrock is the consolidated, slow eroding substrate of the river system. For this purpose, simply check whether bedrock is present across the cross-sectional profile in either the channel, on the bank, or not at all.

6. Pebble Count: For this exercise, the assessment team randomly selects 40 stones from the river, from within 2m upstream or downstream of the profile line, and takes one measurement of the length and records it to the closest tenth of a centimeter using a ruler.

7. Embeddedness: By removing a couple of stones from the substrate, the depositional lines on them should be visible. The amount of rock that is "dirty" is considered its embeddedness. A diagram of this is shown to the right.

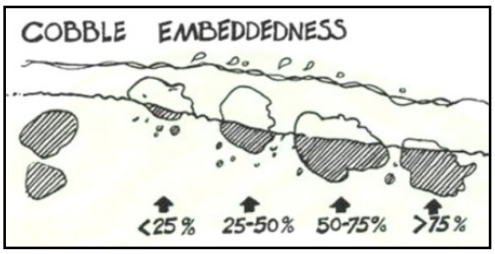


Image from www.dep.wv.gov

8. Particle Shape: For this parameter you need to measure the length, width, and height of three stones as they lie in the watercourse using the ruler. You can remove the stones from the water but must keep them oriented as if they were still in the stream when measuring them. Measure "X" as the length of the rock parallel to the flow, the "Y" you measure as the width of the rock perpendicular to the flow, and the "Z" as the height of the rock above the natural substrate. This provides an indication of hydraulic roughness or channel friction.

9. Bed Form Type: Simply state whether the cross-section measures the profile of a pool, rifle, or transition area on the stream. In most instances it is beneficial to have a CSP in each type of bed form for each system.

   Additional Notes: You should photograph your survey line, a photo of the site substrate, and a photo looking upstream and downstream from the survey line. It is also important to note the photo numbers so they can readily be organized when back in the office. Creating a site numbering process is also important in tracking

field data so that it is easy to compile once back in the office. Taking a picture of your field sheet will help track photos and sites as well.

MATERIALS REQUIRED

When working in or near water, safety is important. When performing the cross-sectional profile, workers should exercise caution and wear PFDs. Other required materials include:

- Survey level and rod
- Rope, cord, or string (30m+), segmented according to the table on page 2-5
- 30m field tape measure
- Ruler
- Field sheets for notes and measurements, extra pencils
- Camera
- GPS
- Site pins/survey stakes
- Flagging tape
- Waders
- Sunscreen & bug spray
- First aid kit

USING THE DATA

When finished a CSP assessment, enter all the data into the electronic version of the CSP Data Sheet to graph the stream profile.

Information collected from CSPs can be used over time to determine changes to the natural system, comparing data from year to year. The CSP data can also be used with associated stream flow data to monitor and estimate discharge events and model potential climate change characteristics.

HOW TO:

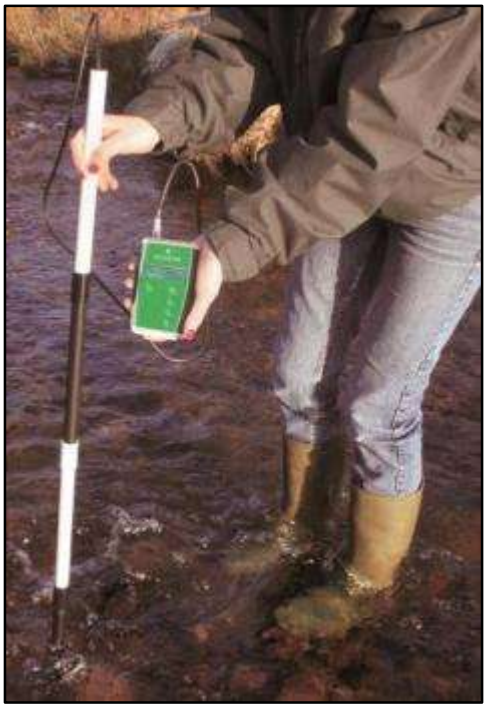
Conduct Stream Flow Sampling

Kennebecasis Watershed Restoration Committee

INTRODUCTION

The summer staff at KWRC helps to collect measurements of stream width, depth and velocity. This data can be used to determine the average discharge for the sample location at that particular time. Before collecting stream flow data, it is useful to have completed a Cross-sectional Stream Profile (see document 2.1).

METHODOLOGY



Physical Characteristics Recorded:

The KWRC uses a wade in rod (an MFP126-S Advanced Stream Flowmeter), shown to the right, to collect the flow rate for each site. Three flow readings are taken at each site: one at 1/3 the total width from the right bank, another in the center, and one a 1/3 from the left bank. The average of these three values is used in calculating flow for that day. Three depth measurements are also taken at each site. These measurements are recorded at the same three locations as the flow readings. The wet width is measured each sample day at each site. The width is measured using a 30 m open reel tape measure. Two staff work together to ensure the tape is pulled tight, just above the water, from right bank to left bank, measured from the location where the water meets the land.

The flow meter measures the stream velocity in meters / second (m/s), which is then multiplied by the measured wet width, and the average of the three depths, which are measured in metres. This calculation provides the average river discharge rate in m^3/s.

Chemical Readings Recorded:

Using a YSI Pro Unit (shown in the picture to the immediate right), the dissolved oxygen (ppm), conductivity (µm/cm), and water temperature (C˚) are measured. Using the TRACER Pocket Tester (also pictured, furthest right), the pH and total dissolved solids (ppm) are measured. The resulting data should be recorded on a field sheet. Both units are used by taking the cap off the end piece (YSI has a long cord – Pocket tester does not) and placing the end in the water. Only record units once the numbers have levelled out, which may take a couple minutes.

These units should be calibrated on a regular schedule for accurate results. See user manuals for instructions and maintain contact with the provider for assistance. The KWRC does not advocate for any one brand of field unit over another, so groups are encouraged to seek out a unit that meets their specific needs and budgets.

MATERIALS REQUIRED

The following materials are necessary to carry out stream flow sampling:

- MFP126-S Advanced Stream Flowmeter
- YSI Pro Unit
- TRACER Pocket Tester
- 30 m measuring tape
- Field notebook and pencils
- Waders
- Sunscreen & bug spray
- First aid kit

DATA ANALYSES

Using Microsoft Excel spreadsheets, the data collected is analyzed to provide average stream depths and velocities, as well as discharge rates per sample day. In KWRC's watershed, the control site or comparison discharge data for the analysis is attained from the real-time hydrometric station in Apohaqui (Station #01AP004). This Environment Canada (EC) station has a long history of gauging water levels and with

some calculations EC can provide discharge rates. We are able to attain the discharge data from this site thanks to a partnership we have with the Environment Canada Office in Fredericton, New Brunswick. The key comparison is the discharge rate at a sampling site compared to the discharge at the control site. To further illustrate this, we calculate the contribution of the flow from each tributary to that of the control site as a percentage. Graphs are created to depict the relationships between the collected data and the control. If all flow was perfect and no water loss occurred, either through evaporation or substrate absorption, then the sum of the discharge for the four sample sites would be equal to the discharge at the control site. In the natural environment, however, water loss does occur so the percentages are higher. With this in mind, the KWRC hopes to better understand the link between the sample sites and the control site.

To determine if your watershed has a hydrometric station, check out Environment Canada's website for "Real-Time Hydrometric Data Map Search": https://wateroffice.ec.gc.ca/google_map/google_map_e.html?search_type=province&province=NB

This link can be shared with your stakeholders and it can provide good information when flood events are occurring - you can monitor the temporal trends and look at how the current event compares to past events.

STREAM FLOW SAMPLING FIELD SHEET

Location:_____ Crew:_____
Date:_____ Time:_____ Picture:_____

Physical Characteristics:

Velocity (m/s)			Depth (cm)			Width (m)
Right	Center	Left	Right	Center	Left	

Chemical Readings:

pH	DO (ppm)	Conductivity (µs/cm)	Temperature (˚C)	Total Dissolved Solids (ppm)

Precipitation in the last 24 hrs: Light Medium Heavy

Notes:

Location:_____ Crew:_____

Date:_____ Time:_____ Picture:_____

Physical Characteristics:

Velocity (m/s)			Depth (cm)			Width (m)
Right	Center	Left	Right	Center	Left	

Chemical Readings:

pH	DO (ppm)	Conductivity (µs/cm)	Temperature (˚C)	Total Dissolved Solids (ppm)

Precipitation in the last 24 hrs: Light Medium Heavy

Notes:

HOW TO:

Carry Out a Habitat Assessment

Kennebecasis Watershed Restoration Committee

INTRODUCTION

Assessing aquatic and riparian habitats has been a long-standing activity of the KWRC. We have developed a methodology that limits the amount of time needed for training while maximizing the information that can be gathered quickly in the field. While a lot of the data collected is subjective, it is still useful for the purpose of providing indications of areas that need further attention.

CREW REQUIREMENTS

To effectively complete a habitat assessment, a crew of 2-3 people is most effective. One person can record the information and take photos and video, where required. A second person is responsible for substrate and channel conditions and water quality data, while a final crew member can measure bank conditions, input geographic location, and note riparian status. As a team they can collect reach length, bank heights, and wet widths.

METHODS

<u>In the Office:</u>

1. Determine the location at which you intend to complete the habitat assessment.
2. Determine the best access route, keeping in mind where you start is not where you will finish (A good rule of thumb is to consider that you can survey approximately 1.0 - 1.5km of stream per day).
3. Leave your assessment plan with someone for safety.

In the Field:

1. Drive to your access point and GPS your vehicle location to avoid getting lost.
2. Access the river, starting at the upstream end of your desired reach and mark your first waypoint.

   Note: For waypoint numbering, the KWRC uses a set numbering system (see below as an example). An efficient numbering system is important for tracking sites. It is possible to use a quick and easy numbering method in the field and then adjust on a computer back at the office.

Example of Site Numbering

KV03-SB03-020

The final number indicates how many meters down the stream you have surveyed so for this example you have surveyed 20 lengths, therefore 20lengths X 100m/length = 2000m

This indicates Sally Brook on the third tributary, counting counter clockwise from the confluence

This indicates the Kennebecasis (KV) on Smith's Ck (03). Each of our sub-watersheds is given a number.

Sub-Watershed	#
Trout Creek	01
Upper Kennebecasis	02
Smith's Creek	03
Millstream River	04
Lower Kennebecasis	05
Kennebecasis Bay Composite	06

Table 1: Shows the corresponding number for each of the sub-watersheds

3. From the first way point, take a picture of your field sheet, then take one looking downstream and note the photo number. Do this each time you start a new field sheet.
4. At 0m take water quality readings (dissolved oxygen and pH) and temperature (air and water) and note on field sheet.
5. Measure out 100m of stream length using the measuring tape, keeping the tape along one side of the channel.
6. Channel Characteristics - At 0m, 25m, 50m, and 75m take wet width, depths, and bank height measurements. The depth is the average taken from each section and then the 4 sections are averaged again. The wet width is taken at each section to produce an average for the 100m reach. The bank height is taken on each side and is an average of all 4 sections (0m, 25m, 50m, and 75m).
   a. Wet Width – this measurement is taken using the water's edge on each side of the channel on the given day and is measured using the field measuring tape and noted in centimeters.

b. Depth – Once the wet width is established, estimate ¼ of the width and take 3 depth readings (1/4, ½, and ¾). Take the average of the 3 and note in centimeters in the appropriate section space. You will need to then calculate the reach average by averaging the sum of each section.

c. Bank Height – This height is measured from the water level to the top of the bank (the first elevation change or transition point) and it is noted in centimeters. Also note whether the bank is stable, slightly eroded, or highly eroded.

Note erosion and channel issues on field sheet and note location within the 100m section (e.g., a 12m long eroding bank starts at 22m, or a stream comes in on the right bank at 53m). Use the upstream distance as the indicator for such observations - no need to GPS the location.

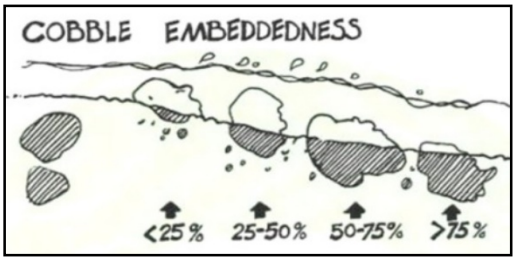


Image from www.dep.wv.gov

7. Substrate Characteristics - throughout the 100m length, note substrate composition and note a percentage of each (i.e., % of fines, gravel, boulder and bedrock). This measurement will be somewhat subjective, but try to be consistent between sites. Also note the % embeddedness of the substrate, as per the image shown.
8. Riparian Characteristics - Throughout the reach note the riparian cover, including the % cover by grasses, shrubs and trees and the % bare of vegetation. This should be an average for the entire 100m reach for one bank, and is a subjective estimate (however, try to be consistent between sites). The % shade for each bank should be noted, which involves estimating how much of the watercourse is shaded by vegetation from each bank (for each bank, the maximum would be 50%). Identify and note the dominant tree and shrub species (whatever can be seen from the stream).
9. At the 100m point, establish another waypoint and take a picture looking upstream.
10. Look over the field sheet and ensure all needed information has been collected. Do this while the disruption you created in the stream settles before starting the next segment.
11. Continue same process until the entire reach is complete, numbering the field sheets according to the upstream waypoint.

Back in The Office:

1. Upload all GPS points taken for the site.
2. Upload all pictures to an appropriate folder on your computer.
3. Enter all data into the digital copy of the field sheets and copy the upstream and downstream photos for each of the assessed segments.

Tips:

- Water quality data may vary based on the equipment. Be sure to properly calibrate the unit before going into the field with it.
- Be certain to write legible notes as data entry and future checking may be done by someone else. Good note taking in the field is important and cannot be stressed enough.

MATERIALS REQUIRED

Useful materials for carrying out a habitat assessment include:

- Multiprobe (for measuring dissolved oxygen (DO), temperature, pH, and conductivity)
- GPS
- Measuring tape (100m)
- Meter stick
- Digital camera
- Calculator
- Waders
- Flagging tape
- Field sheets/clip board/pencils
- Tree and shrub field guide
- Bug spray & sunscreen
- First aid kit

HABITAT ASSESSMENT FIELD SHEET

GENERAL INFORMATION

Date: _____ **Assessment Team:** _____
Time: _____ _____

River: _____ **Tributary:**_____

Stream order: _____ **Set Reach Length:** 30m 50m 100m

Downstream Coordinates: N_____ W_____
Upstream Coordinates: N_____ W_____

Weather:
Air temp: _____*C **Water Temp:**_____*C **DO** _____ppm **pH**_____
Notes on Location:

CHANNEL CHARACTERISTICS

Average Depth (cm):

Section	¼ Depth	½ Depth	¾ Depth	Avge. Depth
0m				
25m				
50m				
75m				
Total				

Wet Widths:

Section	Wet Width (cm)
0m	
25m	
50m	
75m	
Avge	

Bed Form Composition:

Form Type	Amount (%)
Pool	
Rifffle	
Run	

Bank Condition:

Left Bank

Section	Height (cm)
0m	
25m	
50m	
75m	
Avge	

Right Bank

Section	Height (cm)
0m	
25m	
50m	
75m	
Avge	

Notes on Channel:

SUBSTRATE CHARACTERISTICS

Substrate Type	Cover (%)		Notes on Substrate
Fines			
Sands			
Gravel			
Boulder			
Bedrock			
Embeddedness (%)			

RIPARIAN CHARACTERISTICS

Shade Cover Assessment

Bank Position	Shade Cover %
Left Bank	
Right Bank	

Vegetation Cover Assessment

Vegetation Type	% Cover	Trees and shrubs present
Bare		
Grasses		
Shrubs		
Trees		

Land use description:
Landowner Information:
Notes on Riparian Area:

OTHER GENERAL INFORMATION

Pictures:
Notable Issues (Check all that apply**):**

___ dump site
___ dead fish/animals
___ beaver dam
___ man made obstruction
___ ford/culvert/bridge
___ other

Other Notes:

HOW TO:

Carry Out a Site Assessment

Kennebecasis Watershed Restoration Committee

INTRODUCTION

Site visits are performed when the KWRC receives notice of a site of concern along a river in the watershed, either through observation while in the field or when an outside party notifies us. KWRC staff will visit the site and perform a number of measurements to evaluate its health. The site assessment is basically a small habitat assessment, and much of the same information is recorded as during our habitat assessments, per reach. The objective is to identify if any restoration work is required to improve the site and provide the land owner with an evaluation and recommendations for remediation on their riparian property.

CREW REQUIREMENTS

To effectively complete a habitat assessment the KWRC has found that a crew of 3 is most effective. One person can record the information and take photos and video where required. One person is responsible for substrate and channel conditions and water quality data while the final crew member can measure bank conditions, input geographic location, and note riparian status.

METHODS

In the Office:

1. Determine the location of the site assessment.
2. Determine the best access route.
3. Leave the assessment plan with someone for safety.

In the Field:

1. Drive to your access point and GPS your vehicle location if you need to walk to the site (to avoid getting lost).
2. Access the river starting at the upstream end of your desired reach and mark the first waypoint.

Note: For waypoint numbering, the KWRC uses a set numbering system (see below as an example). A strong numbering is important for tracking sites. It is possible to use a quick and easy numbering method in the field and then adjust on a computer back at the office.

Example of Site Numbering

KV03-SB03-020

The final number indicates how many meters down the stream you have surveyed so for this example you have surveyed 20 lengths, therefore 20lengths X 100m/length = 2000m

This indicates Sally Brook on the third tributary, counting counter clockwise from the confluence

This indicates the Kennebecasis (KV) on Smith's Ck (03). Each of our sub-watersheds is given a number.

Sub-Watershed	#
Trout Creek	01
Upper Kennebecasis	02
Smith's Creek	03
Millstream River	04
Lower Kennebecasis	05
Kennebecasis Bay Composite	06

Table 1: Shows the corresponding number for each of the sub-watersheds

3. Note Location on Field Sheet:
    a) Name/Date/Address and contact info of the landowner.
    b) Sub-watershed name as well as the current use of the property (e.g., agricultural, cottage, residential, etc).
4. Take a picture of your field sheet, then take a photo looking upstream and downstream of the identified site - record the photo numbers on the field sheet.
5. Take measurements:
    a) Water quality – measure the temperature, dissolved oxygen content and pH of the water.
    b) Bank height - this height is measured from the water level to the top of the bank (the first elevation change or transition point) and it is noted in centimeters.

c) Bank Length – the impacted area, or assessed area, is measured in meters along the water's edge.

d) Riparian zone status (i.e. percent cover by trees, shrubs and grasses).

e) Bank stabilization status (i.e. percent stable/degraded/ eroded).

6. Make Recommendations, which could include alternate watering, ford, fencing, planting, bank stabilization, buffer creation, or other such enhancement approaches.

Back in the Office*:*

1. Upload all GPS points taken for the site into an appropriate folder.
2. Upload all pictures to an appropriate folder.
3. Enter all data into the digital copy of the field sheets.

Notes:

- Depending on available equipment the water quality data may vary, be sure to properly calibrate the unit before going into the field with it.
- Be certain to write legible notes as data entry and future checking may be done by someone else. Good note taking in the field is important and cannot be stressed enough.

MATERIALS REQUIRED

The following materials are necessary to carry out a site visit:

- Multiprobe (for measuring dissolved oxygen, temp, pH, and conductivity)
- GPS
- Measuring tape (100m)
- Meter stick
- Digital camera
- Waders
- Flagging tape
- Field sheets/clip board/pencils
- Tree and shrub field guide
- Sunscreen & bug spray
- First aid kit

SITE ASSESSMENT FIELD SHEET

Property Owner Name:
Address:
Phone #:
Email:
Date Visited:

Sub Watershed:

Land Use:

Water Temp:_____*C DO _____ppm pH_____

Bank Length:
Right Bank _____m Left Bank_____m

Riparian Zone Status:
Trees_____% Shrubs_____%
Grasses _____% Bare_____%

Bank Stabilization Status:
Stable_____% Degraded_____% Eroding_____%

Ford Required:

Total Fencing Required
Right Bank _____m Left Bank_____m

Total Planting Required
Right Bank_____ m2 Left Bank_____m2

Notes:

HOW TO:

Carry Out a Culvert Assessment

Kennebecasis Watershed Restoration Committee

INTRODUCTION

The following field assessment template and methodology has been adapted by KWRC, based on a methodology from the Fundy Model Forest.

In order to assess the effectiveness of a culvert for ecological and functional capacity, a number of parameters have to be considered. Many of these parameters can be used as part of a ranking system (the KWRC has developed a system not included in this manual) to determine which culverts are most in need of remediation. Some of the parameters will simply provide background data for ongoing monitoring.

CREW REQUIREMENTS

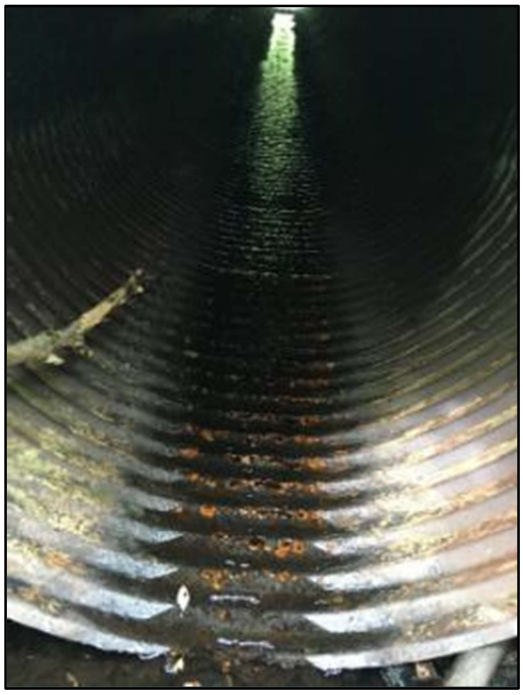
To complete a culvert assessment the KWRC has found that a crew of 2-3 is most effective. One person can record the information and take photos and video where required, while the other two people are responsible for taking all of the measurements. Crew members should exercise caution when working near roadways.

METHODS

<u>In the Office:</u>

1. Identify the culverts you aim to assess.
2. Determine the best access routes.
3. Leave your assessment plan with someone in the office for safety reasons.

In the Field:



1. Drive to your access point and GPS your vehicle location if you need to walk to the culvert (to avoid getting lost).
2. Make the following observations on the field sheet:
    1. General Information - Note the watershed name, crossing number, and the GPS point marking the culvert. All culverts are spatially located using a GPS and later mapped; the coordinates are noted in a consistent format to facilitate mapping with other assessment activities such as water sampling or electro-fishing. Waypoint designations should be determined using the name of the sub-watershed with a dash to the named tributary, followed by a sequential number.

       Photos can be taken of the culvert and the photo numbers should be listed on the field sheet.

    2. Road – the following information should be noted about the road going over the culvert:
        a. Road type – Road type is assigned to one of three categories: highway (primary highway), paved road (any paved or chip sealed road) or dirt road (any road way with a dirt top).
        b. Road condition – Make notes on the condition of the road. Pay particular attention to the shoulder of the road and look for erosion near the road bed.
        c. Road width (m) – This can be measured with the field measuring tape for quiet roads. For primary highways, an estimate will be sufficient. Crew members should use safety vests when working near roadways.
        d. Obstructions – Is the road eroded from water overtopping the culvert, making vehicle passage difficult? This would increase the priority of rehabilitating a culvert.
        e. Length from the edge of the road bed to culvert lip (m) – This measurement provides data on safety and potential stream sedimentation. On a dirt road the edge of the road bed would be the edge

of the normal tire track. For this, take an upstream and downstream measurement in meters.

3. Culvert – The following information should be noted about the culvert:
    a. Type – The culvert type is noted using visual observation (e.g., wooden, metal pipe, plastic pipe, cement, etc).
    b. Shape – The shape of the culvert (e.g., oval) should be noted.
    c. Culvert length (m) – Culvert length is measured from the inside of the culvert when it is large enough to walk through. If the culvert is too small, a length is taken from culvert lip to the shoulder of the road on each end, and then a road width is taken. The three measurements are then added to attain culvert length.
    d. Rustline / Waterline % - This refers to watermarks within the culvert, and is estimated as a percentage of the culvert height. It indicates how much of the culvert fills with water during high flow events.
    e. Fill % - This is an estimate of how much of the culvert is filled with substrate. A small amount of fill is ideal, but too much fill will impede water movement.
4. Water – the following observations should be made about the watercourse:
    a. Stream Order – If you have completed the water classification process you could use that here (it includes some social inputs when it was determined). However, most groups might not have water classification completed so we suggest entering the stream order as determined using the Horton-Strahler ordering systems. More on that can be found here: https://pro.arcgis.com/en/pro-app/tool-reference/spatial-analyst/how-stream-order-works.htm
    b. Inlet velocity – The flow is measured in m/s and should be determined using a wade in rod such as the Global Flow Pro FP101 flow meter. Measurements are taken at various points at the assessment site and an average is taken. At streams where flow is negligible, no reading is provided. (Note: The standardized 1/3, 1/3, and 1/3 measurement was not used because most streams are

less than 1m wide and do not have enough flow outside the main channel to register a reading)

c. Water depth – The depth of water in the culvert, at the culvert lip and at the scour (i.e., deepest part of the outflow pool where substrate is pushed aside) should be measured (cm) and recorded.

d. Dissolved oxygen and temperature – These are measured using a field probe such as the YSI DO200.

5. Other - The following observations should be made at the inlet and outlet of the culvert:

a. Bank height – The height of the bank should be measured in cm. Measure bank height on the right bank and left bank in an area not impacted by the road infrastructure.

b. Slope – Slope can be attained by using a proper survey rod and level to attain the rise and run, or you can use a laser level and measure the rise and run that way. With the rise and run you can calculate the slope as the rise (the difference in height between the culvert inlet and outlet) divided by the run (culvert length).

c. Armour – Note whether the culvert has rock armor around the inlet and outlet or other such armoring that will protect the culvert inlet and outlet areas from erosion. If this is degraded or failing it should be noted as well.

d. Channel water depth (cm) – This measurement is taken at the inlet riffle before it enters the upstream pool, and at the tail out of the plunge pool on the downstream channel, and at the downstream and upstream culvert lip.

e. Channel water width (cm) – The wet width is measured as a width of the wetted portion of the stream at the time of assessment. Take the average of three widths taken randomly at the site (ideally a width would be taken at a pool, a riffle, and run section of the drainage).

f. Culvert diameter - A measurement (in centimeters) should be taken from the top to the bottom of the inlet and outlet of each culvert. In the case where a culvert is not a circular shape, the narrowest point is measured.

g. Substrate composition - Using visual observation, the type of substrate should be indicated using percentage of bedrock, boulder, cobble, gravel, sands, and fines.

   Unnatural rock material in the stream is also noted as an indicator of bank armoring possibly failing.

h. Culvert alignment - Culvert alignment is assessed using a visual observation and is considered properly aligned if the stream enters the culvert with no interruption or unnatural change of direction to the flow and if the outflow maintained the natural channel flow as well.

6. Damage - This is assessed at the inlet and outlet, using the following traits:

   a. Obstruction – this is noted as a percentage of the channel which is blocked by any sort of obstruction. Note whether the obstruction is large woody debris, sediment, or other material. Also note whether the obstruction is blocking fish passage and whether it could be remediated.

   b. Undercutting - This refers to the amount of erosion at the upstream or downstream lip of the culvert and reflects fish passage issues. This is measured from water level to culvert lip (i.e., how far the water is below the culvert lip) at the time of assessment and indicated in centimeters.

   c. Overtopped – Has the culvert been overtopped? This refers to whether the water has gone over the top of the culvert. This can be seen from debris and erosion marks at the inlet. The presence of upstream debris can be noted here too.

   d. Perforation – Rust holes or wear holes in the culvert are observed and noted as a percentage of the amount of culvert they consume.

   e. Crushed – This is determined visually as a percentage of the culvert that is crushed or deformed at the outlet and inlet.

7. Vegetation (Riparian health) – This is noted at the inlet and outlet through visual observation of the amount and type of vegetative cover, including bare, grasses,

shrubs, and trees, represented as an observed percentage. The percentage of the watercourse that is shaded by vegetation is also noted.

It may be useful to note prominent species of plants in this section, or on the back of the field sheet.

8. Additional notes – It may be useful to include a sketch of the culvert, its alignment, damage, or other notable features on the back of the field sheet.

Back in the Office:

1. Upload all GPS points taken for the culvert assessments and place in the appropriate folder.
2. Upload all pictures to an appropriate folder and label them.
3. Enter all data into a digital copy of the field sheets.

Notes:

- Depending on the available equipment the water quality data may vary, so be sure to properly calibrate the unit before going into the field with it.
- Be certain to write legible notes as data entry and future checking may be done by someone else. Good note taking in the field is important and cannot be stressed enough.
- There are many ways to assess and rank culverts. The KWRC developed our methods prior to more regional efforts taking place. While our process works for us you may want to investigate others. Here are some other methods to consider:
    - https://www.fs.fed.us/biology/nsaec/fishxing/
    - http://www.adoptastream.ca/training/culvert-assessment-for-fish-passage

MATERIALS REQUIRED

The following materials are necessary for culvert assessments:

- Multiprobe (DO, temp, pH, and conductivity)
- Survey rod and level (or laser level)
- GPS
- Measuring tape (100m)
- Meter stick
- Bug spray & sunscreen
- First aid kit
- Digital camera
- Waders
- Safety Vests (1 per crew member)
- Flagging tape
- Field sheets/clip board/pencils

Culvert Assessment Field Sheet

General	Watershed name	
	Inspector name	
	Crossing number	
	GPS point	
	Photo numbers	
Road	Type	
	Condition	
	Width (m)	
	Obstructions	
	Length - road bed to culvert lip (m) – at inlet and outlet (U/D)	
Culvert	Type	
	Shape	
	Length (m)	
	Rustline / Waterline (%)	
	Fill (%)	
Water	Stream order (1, 2, 3, etc.)	
	Inlet velocity (average of a minimum 3 readings from near the inlet)	
	Depth in culvert (cm)	
	Depth at culvert lip (cm)	
	Depth at scour (cm)	
	Dissolved oxygen	
	Temperature	

		Inlet	**Outlet**
Bank Height (cm)			
Slope			
Armour (y/n)			
Channel water depth (cm)			
Channel water width (cm)			
Culvert diameter (cm)			
Substrate composition (% bedrock, boulder, cobble, gravel, sands, fines)			
Proper alignment (y/n)			
Damage	Obstruction (y/n) (%)		
	Undercut / Perched (y/n) (cm)		
	Overtopped (y/n)		
	Perforation (%)		
	Crushed (%)		
Vegetation	Shade (%)		
	Type (% bare, grasses, shrubs, trees)		

HOW TO:

Sample Water Quality

Kennebecasis Watershed Restoration Committee

INTRODUCTION

The KWRC collects water samples on a regular basis to examine water quality. The samples are taken using the New Brunswick Department of Environment and Local Government sampling standards, which are included in the additional information section of the manual. The key parameters being considered by the KWRC are *E.coli*, nitrates, total phosphorous and temperature. These parameters help us to track the strong anthropogenic influences on our watershed.

SAMPLING METHODS

Only standard sterile sample bottles are utilized for sampling, which are available from the Research Productivity Council (RPC) lab in Fredericton, NB (or other certified labs). Appropriate water quality sampling procedures are followed to ensure that no undue contamination occurs to the samples. Within the samples are periodic duplicate samples (e.g., one duplicate for every 10 samples), taken for quality control purposes, ensuring the soundness of sampling techniques and handling procedures. The samples are immediately packed in a cooler to impede degradation of the samples while being transported to the RPC lab for analysis. They must be delivered to the lab within 24 hours of the sampling period.

KWRC uses the Grab sample method to take our water samples. This requires a staff member to wade into the sample location with the sterile bottles in hand. Bringing a

small bag along to carry the bottles makes this task easier. Each site will require 2 large bottles and a smaller *E.coli* bottle.

Steps for taking a sample are as follows:

1. Label bottles (and sites) using a consistent numbering scheme. A site number and sample number should be given. The sample number is for the bottles and should be noted on the field sheet. It provides a tracking mechanism for that sample for that date, while the site number will allow you to track all samples for that site over many sample dates.
2. Remove cover. Be careful not to touch the inner part of the cap as this can impact bacteria sample results.
3. Turn bottle upside down (except for *E.coli* sampling bottle).
4. Dunk bottle under the water surface, at least a hands length (6”).
5. Fill bottle completely (*E.coli* – to line on bottle).
6. Put cover back on the bottle.
7. Place all of the sample bottles for each location in a designated Ziplock bag, labeled with an appropriate label.
8. Place samples in cooler immediately.
9. Repeat at each sample location.

Tips:

- Be sure **NOT** to touch the covers to the bottles or the inside stem of the bottles as this will cause contamination to the sample.
- The *E.coli* bottle should **NOT** be turned upside down as you will lose the preservative inside the bottle. It is dunked right-side up.
- The *E.coli* bottle only gets filled to the line on the bottle.

MATERIALS REQUIRED

The following equipment is necessary for water quality sampling:

- GPS
- Sterile bottles (make sure you have enough for each sample location plus a duplicate – it's always safe to bring a couple extra sets as well)
- Ziplock Bags
- Permanent Marker & Pencil/Pen
- Field Sheets (bring extras – you do need one for the duplicate)
- Lab submission form, which come from the lab when you get the bottles (usually need two – depends on number of samples)
- RPC labels
- Waders
- Bag to carry sample bottles to and from the site
- Cooler & ice packs
- DO Meter & pH pocket tester
- Watch/Phone (something to tell the time)
- Sunscreen & bug spray
- First aid kit

FIELD SHEET

A field sheet should be filled out for each sample location. It works best if one staff member takes the sample and the other fills out the field sheet. The field sheet is where you describe the characteristics relevant to that site on that day as well as the weather and water temperature, dissolved oxygen content (DO), conductivity and pH. Each site should be marked using a GPS. Be sure to properly label the sheets according to the site and sample numbering system you have selected. The field sheets should be scanned and saved.

DELIVERY

The samples need to be delivered to the certified lab within 24 hours of being taken. Samples can be put in a cooler with ice packs after sampling (refresh the ice packs if the samples will sit overnight). The lab submission forms need to be delivered with the samples and should include the sample field number.

WATER QUALITY SAMPLING FIELD SHEET

Location: _____

Date: _____Time (00:00-24:00): _____

Sample collected by: _____

Weather: _____

Rainfall in the last 24 hours: _____ None _____ Light _____ Heavy

Water level: _____ Low _____ Normal _____ High

Water clarity/colour? _____

Algae? _____

Oil/film/foam on water? _____

Garbage in water or on shore? _____

Fish (dead or alive), aquatic insects? _____

_____

Bank erosion / state of bank vegetation? _____

_____

ATV crossings / cattle crossings? _____

Construction (e.g. road, bridge) upstream of sample site? _____

_____

People fishing/swimming upstream? _____

Natural/man-made barriers, beaver dams upstream/downstream? _____

_____

Other general comments: _____

Water Temperature (°C): _____ Dissolved Oxygen: _____ (mg/L)

pH: _____ Conductivity:_____(µs/cm)

Kennebecasis
Watershed
Restoration
Committee

3. Restoration

The following section contains guides for a variety of restoration activities.

The KWRC has over 40 documented restoration sites and we have long been known for our ability to carry out such projects. Our successes have not come without challenges and some failures. We have learned many lessons along the way. We wanted to share some of these lessons with others, which is the reason behind this manual.

One key lesson we have learned is that a restoration site requires commitment. No project can be completed in one year, no matter how good the planning is. One must be prepared to revisit the landowner and the site to do follow up investigations for many years, making sure installed fencing is maintained, trees are succeeding, and bank armoring is holding. Often, additional maintenance work is required.

A second lesson we have learned is that every situation is different. No two sites are the same. There are many variables that need to be considered when developing a restoration plan and we try to cover as many as we can in this section of the manual: landowner requirements, geology, geomorphology, slope, soils…the list goes on. To prepare for the various conditions, it is important that you visit the sites prior to developing a plan; riparian restoration is not readily completed as a desktop application.

This section of the manual will walk you through, as best we can, various bank stabilization and riparian enhancement activities. It is important to remember that every site is different and you may have to be flexible and adaptable. Having an engineering company assist with design and installations can also alleviate risk and help with the permitting process. Keeping an open and honest line of communication with the land owner, the permitting department, and funding partners will also help in completing the restoration activities.

The photos above show a riparian enhancement project completed on land owned by the Hampton Bible Camp on a small tributary. The photo on the left is before (2013), and after (2015) is on the right.

HOW TO:

Obtain a Watercourse or Wetland Alteration Permit

Kennebecasis Watershed Restoration Committee

INTRODUCTION

In New Brunswick, any person intending to do construction, demolition, land clearing or landscaping within 30m of a watercourse or wetland must apply for a watercourse or wetland alteration permit (under the Watercourse and Wetland Alteration Regulation of the Clean Water Act).[iii]

APPLICATION PROCESS

There are two types of permits available. “Provisional permits” are for activities with a lower level of potential environmental risk, to which a standard set of approval conditions can apply. Provisional permits can take up to 10 days to approve and cost $10.00. “Standard permits” are for more significant projects that have a higher environmental risk and require a more in-depth review with project-specific approval conditions. These can take up to 8 weeks to approve and cost up to $25.00 (or 20.00 each for multiple permits related to a single project, up to $200.00 total).[iv]

An online application form is available, which is designed to guide the user to the proper permit application based on information about the site and activity in question. The application form is available here: https://www.elgegl.gnb.ca/WAWAG/en/Home/Site.

The following information is required to fill out the permit application form:[v]

- Project location - You will be able to use a map interface, but a Property Identification Number (PID) or coordinates will help in zooming in on your project location. You can find your PID on your property tax bill or by using the GeoNB mapping website (http://www.snb.ca/geonb1/)
- Full description of the project

  Tips:

  - Be concise and be certain to stress that the project is a restoration project.
  - When possible, try to stay out of the wetted portion when doing your work as this will improve permitting process (most times it can be reviewed through the provisional permit process).
  - Highlight a strong plan for sediment and silt control throughout the project. Having hay/straw bales on site and seeding the exposed soils is important. Proper installation of silt fencing and sediment traps is also important.
- Drawings/Sketches (fully dimensioned)

  Tips:

  - The GeoNB map layers provide measuring tools, drawing tools, and labelling capacity which can help with this.
  - Reference other government documents as the basis for design. Documents such as the "Ecological Restoration of Degraded Habitats: A Watershed Approach" from Fisheries and Oceans Canada (http://www.dfo-mpo.gc.ca/library/321286.pdf) also adds support to your project design and rationale.
  - **In higher risk projects it would be advantageous to attain the services of an engineering consultant to assist with design and drawings, this is a need if excavating a stream bank longer than 30m**
- Photos of the project area

  Tips:

  - Photos that show degraded riparian areas are important to show the need of the project.
  - Site photos taken in the early spring or late fall show degradation better than those taken during summer or winter months.
  - Photos should illustrate the site from many angles
- Letter of consent from the property owner (if you are not the legal owner)
- Method of payment (debit or credit card)
  - You can also pay by check but will not receive the permit until the check is cleared.

- If you have printed photos, maps, letters, or other documents to support your application and are not able to submit (upload) them electronically, you may mail or deliver them in person to your regional office, quoting your application reference number that you will receive at the end of the application process.

Additional Tips:

- Build a relationship with the permitting staff in your region. This can foster an open dialogue and you might be able to get information from them.
- Follow the conditions of your permit and demonstrate a willingness to fully protect the watershed as this will help in future permit applications.
- Keep spill kits, extra silt fencing, and a surplus of hay bales on site to accommodate damaged equipment or installations.
- Following completion of work, keep the silt control in place until the site is greening up and erosion is a minimal risk, but be sure to eventually remove the silt fencing.

For more information, consult the *Watercourse and Wetland Alteration Technical Guidelines*, 2012 (https://www2.gnb.ca/content/dam/gnb/Departments/env/pdf/Water-Eau/WatercourseWetlandAlterationTechnicalGuidelines.pdf).

[iii] Government of New Brunswick. *Watercourse and Wetland Alteration Permit*. https://www2.gnb.ca/content/gnb/en/services/services_renderer.2935.Watercourse_and_Wetland_Alteration_Permit_.html#serviceDescription

[iv] Government of New Brunswick. *Watercourse and Wetland Alteration Permit*. https://www2.gnb.ca/content/gnb/en/services/services_renderer.2935.Watercourse_and_Wetland_Alteration_Permit_.html#serviceDescription

[v] The list is taken directly from: Government of New Brunswick. *What you will need in order to submit an application*. https://www2.gnb.ca/content/gnb/en/departments/elg/environment/content/water/content/permits/what.html

HOW TO:

Install a Silt Fence

Kennebecasis Watershed Restoration Committee

INTRODUCTION

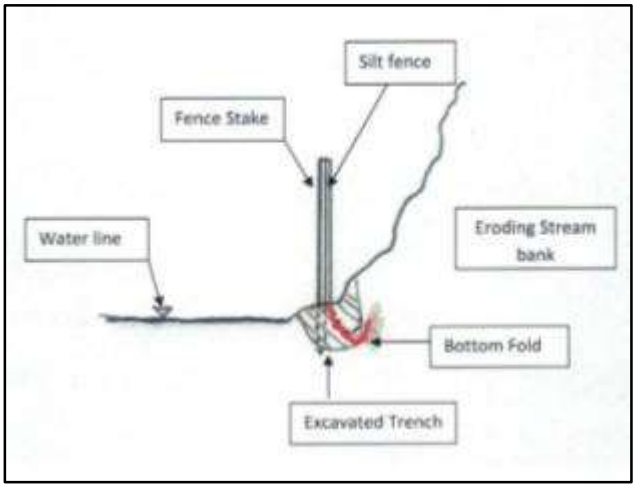
A silt fence is used as a method for preventing eroding soil from entering and negatively affecting a watercourse. It is often installed before engaging in bank restoration activities that could cause an initial increase in erosion during construction (e.g., installing erosion control blankets). The silt fence is made of a synthetic material that will allow the water to filter through, but will prevent the passage of soil and other larger materials.[vi] Rolls of silt fencing can be purchased with the stakes already attached. In some cases, a floating silt curtain can be utilized. Keep in mind that if you are working in the wetted portion of the watercourse you will need a full wetland and watercourse alteration permit.

METHODOLOGY

The following steps outline how to install a standing silt fence:

1. Roll out the silt fence on the ground and cut to the appropriate length, leaving enough to fully contain the site and have the fence anchored sufficiently to hold back run-off and rolling soil and rock material.
2. In order to anchor the silt fence into the ground (it should be partially buried to work properly), dig a trench along the ground where the fence will be located. The trench should be 30-40 cm wide and 20-25cm deep. Avoid cutting through tree roots – the

Figure 1: Shows the general orientation of a silt fence.



trench doesn't have to be exact.

3. Position the silt fence with the stakes to the water side and the bottom fold section to the landward side, as in figure 1 above.

Figure 2: Shows the bottom fold line on a typical silt fence package.

4. Drive your stakes, using a sledge hammer, in to a depth that will allow the bottom fold (see figure 2 to the right) to fill the bottom of your trench and work from the upstream position to the downstream position. (Note – The KWRC has attempted to use excavator and backhoe buckets to drive the fence stakes in but they tend to break instead.)
5. Anchor the bottom fold of the silt fence using rocks or soil from the excavated trench.
6. If you need more than one section of silt fence, overlap the next fence by placing it to the water side of the first section (see figure 3 below).
7. With all the stakes secure, go back and fill in the trench, keeping the bottom fold of the fence in the trench and closing gaps so that water and sediments collect in the fold. It only needs to be filled on the side where the water and eroding material will come from (not on the waterbody side). Compact the soil as much as possible.[vii]
8. With any type of silt curtain, it is important to remove the curtain once the site starts to green up. Leaving the curtain in place can do damage to your restoration efforts and lead to unwanted plastics in the watercourse.

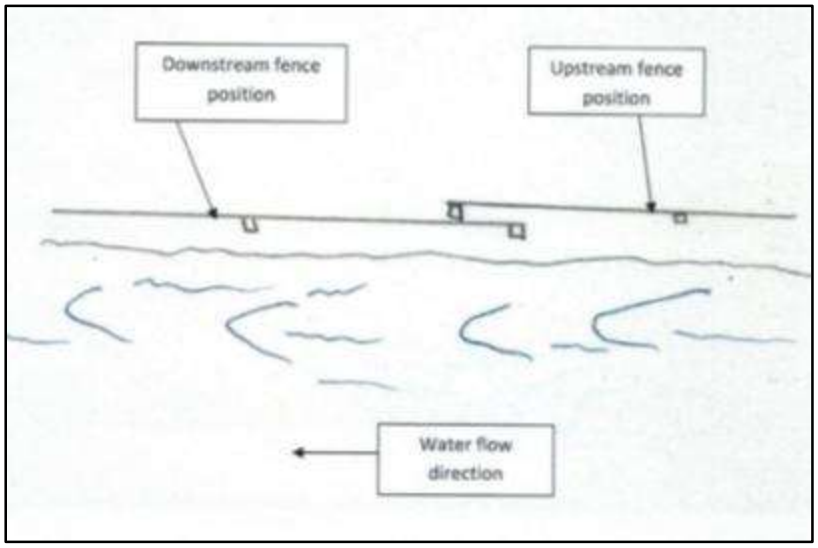


Figure 3: Shows how to overlap silt fence when more than one section is required.

A floating silt curtain keeps silt material on site but not necessarily out of the water. At times you will need to work in the wetted width of the watercourse, such as when you install a rock groyne or root wad to control flow and add cover habitat. At such times you can use a floating silt curtain to contain your work face to one side of the watercourse. The following steps describe how to install a floating silt fence, which is best used in water over 1m deep:

1. Lay out the mesh fencing on the ground and cut to the appropriate size. Remove the stakes from the fence if it has them.
2. Keeping the fence on the ground, lay out pool noodles along the top of the fencing and attach with zip ties.
3. Also while on the ground, lay out a chain along the bottom of the fencing and attach with zip ties.
4. Place the curtain in the water anchoring it to the upstream portion of the bank above the work site.
5. Float the remaining curtain downstream and let it straighten out.
6. The downstream end must also be anchored and secured strong enough to keep the work area closed off and contain the silt coming off the bank you are working on.

This method will reduce flow within the work face and give the silt time to settle before leaving the site.

MATERIALS REQUIRED

The following materials are required for installing a standing silt fence:

- Roll of mesh silt fencing
- Enough stakes to have one every 4m
- Sledgehammer
- Heavy duty staple gun and staples
- Shovels
- Pick ax

The following materials are required for installing a floating silt fence:

- Roll of mesh silt fencing
- Pool noodles
- Zip ties
- Chain

As always, remember sunscreen, bug spray and a first aid kit.

[vi] "How to Install a Silt Fence". https://www.doityourself.com/stry/how-to-install-a-silt-fence

[vii] "How to Install a Silt Fence". https://www.doityourself.com/stry/how-to-install-a-silt-fence

HOW TO:

Install a Rock Toe

Kennebecasis Watershed Restoration Committee

INTRODUCTION

Where urgent bank stabilization is not needed, toe armoring and/or back-sloping is a good remedy. Boulders are placed at the water's edge where erosion is occurring and the bank is then sloped back to prevent further soil and sod from sloughing into the stream. This technique is often used in smaller watercourses with slower flow, in areas where natural re-vegetation is more promising, and where landowners are agreeable to a wider setback. Sediment eventually deposits on and around the boulders as it becomes part of the watercourse. Once planted, back sloped banks become very stable and better suited for high water events as they more readily disperse the water's energy. In areas near homes or roadways it is advisable to work with an engineering consultant to properly plan projects involving rock toe and stream alterations.

INSTALLATION

The installation process is done by an excavator operator.

Steps:

1. Install a silt fence along the area which is to be excavated (see document 3.2).
2. Back-slope the bank with the excavator to a minimum 3:1 slope (greater would be better).
3. Excavate a trench along the toe of the bank, roughly half as deep as the boulders that will be installed. Rock size should be roughly twice the size as the largest mobile material in the stream and mimic natural boulders if possible or present.
4. Install the boulders in the trench, along the length of the bank. Press down on each boulder with the bucket of the excavator to secure it in place. The substrate will predict how much rock will be required to adequately fill the trench. The rock should sit above water level when finished.
5. Once all of the rock is installed, use the materials that were removed while back-sloping the bank to level the area behind the new rock toe. The slope should be a minimum 3:1 ratio.

6. If in a residential area, be sure to pick out any large rocks off the lawn and rake the ground to prepare for seeding and planting.

Placing the rock material

Installing Rock – Rock Groynes are also featured along US & DS portions of this installation.

NOTE: When working around an excavator you should always exercise caution and have on a hard hat and safety vest. If not in the water, you should also have on steel toe boots.

MATERIALS REQUIRED

The following materials are necessary for installing a rock toe:

- Wetland and Watercourse Alteration permit
- Excavator
- Rock material (size should mimic naturally occurring boulders)
- Silt fence
- Seed
- Rakes
- Buckets
- Hard hats
- High visibility vests
- Gloves
- Sunscreen & bug spray
- First aid kit

HOW TO:

Install Erosion Control Blankets

Kennebecasis Watershed Restoration Committee

INTRODUCTION

Erosion control blankets (ECBs) provide soil erosion protection and assist in the establishment of vegetation by providing protection while the vegetation matures. ECB's can be sourced at heavy equipment construction supply stores such as Arrow Construction or others. They can be made from a 100% biodegradable material and are used to stabilize soils and vegetation on a restoration site. Once it biodegrades, the site should be mature enough to hold up against future erosion.

The KWRC uses erosion control blankets on restoration sites that have significant erosion issues and lack of vegetation. There has to be space to adequately back-slope the bank of the river/stream in question, as this product is best used on moderate slopes. This type of work can be invasive and thus insight from a consulting engineer may be needed.

INSTALLATION

The number of steps for installation depends on the height of the particular bank being stabilized.

1. Prepare work site
    a. Have the wetland and watercourse alteration permit on site. This work may require a full permit so plan accordingly
    b. Have all spill kits (since you have heavy equipment on site, these are needed in case of a hydraulic or oil spill) available and daily site cover material (hay/extra erosion control blankets) on hand.

c. Properly install silt control structure and inspect this regularly throughout work.

d. Properly back slope the eroded stream bank to a suitable slope - typically no less than 3:1.

2. Install Rock Toe First (refer to section 3.3 for greater detail on this process)

   a. Rock material should be twice the size of the largest mobile material on the stream bed.

   b. The rock toe should extend the entire length of the eroding bank and be placed at the contact point between the bank and the low water level.

   c. The upstream end of rock toe should have a key installed that extends in-land no less than 1/2m past the anticipated top of bank line. A similar key will be placed at the downstream end; these protect the site from being eroded around.

   d. Following the installation of the upstream key, excavate a trench at the bottom of the bank to the landward side of the water line. Excavate the trench to a depth of half the width of the largest rock to be used – this will result in half the rock being exposed once it is placed.

   e. As you excavate the trench, place larger rock material at the base with smaller rock being placed up the bank. Complete the rock toe by creating a level shelf, with a 75cm-100cm wide bench, along the top of the rock before moving to the next phase.

3. Install the GeoRoll or Erosion Control Blanket

   a. Using the level shelf created in phase 2, commence the installation of the erosion control blanket. The blankets are typically 30m long by 2m wide. In many cases this can be paired with brush layering or willow staking. If pairing the georoll with a brush layer, the brush layer should be installed first.

   b. Roll out the length of the georoll along the length of the bank, rolling

downstream. If more than one roll is needed then the additional roll will be placed under the upstream roll and should overlap the previous roll by approximately 1m.

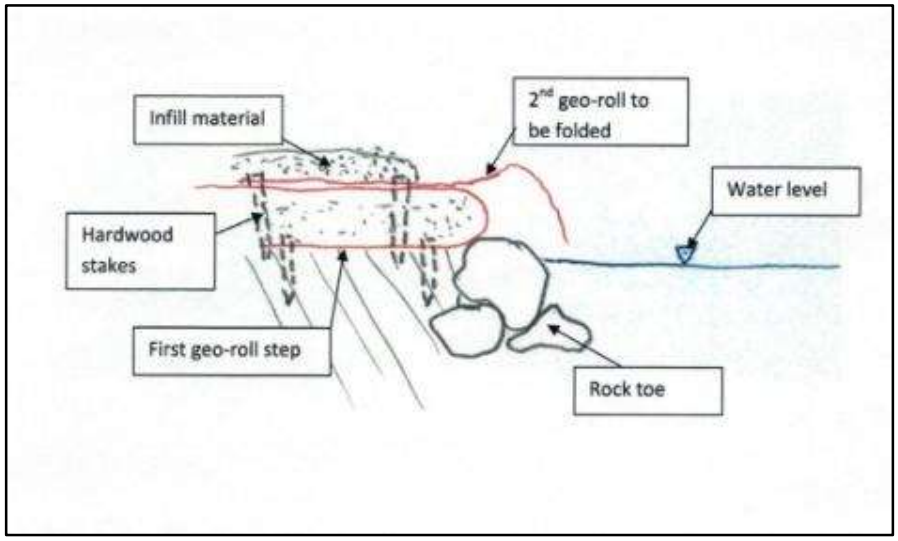
c. As the georoll is rolled out, it should be placed so that 120cm of the width is available beyond the top of the rock toe. Then it can be staked every meter along the length. Add an additional row of stakes on the first lift, staking the wrap onto the shelf every square meter. The stakes should be at least 45 cm in length and, if soil is suitable, living stakes can be used.

d. Place soil on top of half of the geo-roll to a depth of approximately 30 cm. Leave half of the wrap to fold over the fill - this will create the step.

e. Seed the soil with grass prior to folding wrap back onto top of lift.

f. Once seeded, fold the remaining portion of the geo-roll over and prepare the next geo-roll step. Here you can stake the top cover of the lower lift while staking the bottom cover of the upper lift. Figure 1 below shows the overall layout for a two lift installation.

Figure 5: The cut out side view of a geo-roll installation.



g. Repeat for as many lifts as needed. The number of steps for installation depends on the height of the particular bank being stabilized.

h. Seed with appropriate grass mix and water the seed into the geo-roll. You can also plant trees and shrubs directly through the roll.

For a video overview of the process, you can view our YouTube Channel:

https://www.youtube.com/watch?v=t4TfGgvSqRA&t=63s

MATERIALS REQUIRED

To install erosion control blankets, the following materials are required:

- Wetland and Watercourse Alteration Permit
- Excavator
- Rock material
- Erosion control blankets
- Lots of stakes (at least 45 cm long)
- Sufficient silt fence materials
- Maul
- Rake & Shovels
- Grass Seed
- Saw
- Buckets
- Willow whips
- Sunscreen & bug spray
- First aid kit

HOW TO:

Install Brush Layering

Kennebecasis Watershed Restoration Committee

INTRODUCTION

Brush layering or brush mats are mats of woody vegetation that help collect sediments from the water channel during high flow events and stabilize stream banks as they self propagate in the soils. The KWRC uses naturalized willow species to create brush layers on stream banks that have moderate slopes and moderate to low flows. Because brush layering requires a great deal of tree stock material, it is wise to attain brush material in advance of starting the work at the restoration site.

INSTALLATION

Steps for installing brush layering are as follows:

1. Collection of brush:
    a. The species of shrub or tree used for brush layering should be determined by careful consideration of site conditions, soil composition, and native species present within the drainage area. For most locations in the Kennebecasis watershed, willow is a suitable choice.
    b. Collection of the brush should be done before it greens, so a collection in early spring is preferable. However, provided a proper soaking is done, later dates of collection can be successful.
    c. New annual growth is preferred; for willow that is usually indicated by a more yellowish or brighter green bark layer.
    d. Stock for the brush layer should be cut at least 100cm in length.

2. Site Preparation:
    a. Brush layering works best on sites with gentle to moderate slopes and flows.
    b. KWRC has found that optimal success is accomplished when brush layering is used in conjunction with rock toes and geo-rolls.
    c. Have all permits on site.
    d. Make sure all silt control structures are in place.
    e. Excavate the bank back to a 3:1 slope with a 100cm flat shelf just above the water line.
3. Laying out the brush layer
    a. Place the brush stock, stem inland, to cover the length of the excavated flat bench.
    b. The buds and branches can be left on the brush stock.
    c. Bury the stock with parent soil material and water it before completing the remainder of the bank stabilization work.

Figure 6: Note the position of the willow stock and the manner in which the bank is prepared.

MATERIALS REQUIRED

The following materials are necessary for installing brush layering:

- Wetland and Watercourse Alteration Permit
- Excavator
- Silt fence
- High visibility vests
- Gloves
- Pruning shears
- Sunscreen & bug spray
- First aid kit

HOW TO:

Construct Wattle Fencing

Kennebecasis Watershed Restoration Committee

INTRODUCTION

The KWRC uses bioengineering to stabilize stream banks in our watershed. We use several different restoration techniques to accomplish the same results. Bioengineering is the process of using living things, like plants, to engineer something, like a stream bank. Wattle Fencing is one such bioengineering technique. In essence, it is the process of using willow or other such self propagating species to construct a fence along an eroding stream bank, thereby reducing erosion and promoting vegetation growth along the bank.

CONSTRUCTING WATTLE FENCING

As stated, wattle fencing is a bioengineering technique used to both protect an eroding stream bank and encourage vegetative growth along that same bank. It is a labor-intensive approach that requires a great deal of tree stock material to build.

1. The first step is to harvest many willow whips, roughly the diameter of a finger and 4-6’ long. They should not be cut into short lengths! The whips can be de-limbed, which will make building the wattle fence easier, but it is not required.
2. At the erosion site, wooden stakes (they can also be willow) are placed roughly a foot apart along the toe of the eroding stream bank (where the low water point meets the bank).
3. Once all of the stakes are in place, one can start weaving the willow whips through the stakes. This is continued for the entire length of the bank. The height of the weave will be roughly a foot high. The length of the fence will be determined by the length of the eroding stream bank.

4. The in-land backside of the fence should be backfilled with parent soil material and seeded with grasses or additional willow stakes. It is this area that will promote additional growth.

In the picture, two fences have been installed in a step fashion.

MATERIALS REQUIRED

The following materials are required for building a wattle fence:

- Wetland and Watercourse Alteration Permit
- Willow whips
- Grass seed
- Loppers
- Rubber mallet
- Willow stakes or wooden stakes
- Gloves
- Waders
- Sunscreen & bug spray
- First aid kit

HOW TO:

Install Tree Revetments

Kennebecasis Watershed Restoration Committee

INTRODUCTION

Tree revetments are made by placing and anchoring uprooted trees along an eroded or at-risk stream bank. This process is relatively inexpensive and is an effective way of stopping erosion.

"The trees greatly slow the current along the eroding bank; this decreases erosion and allows silt and sand to be deposited along the bank and within the tree branches. The deposited material forms a good seed bed in which the seeds of river trees…can sprout and grow. The resulting trees spread roots throughout the revetment and stream bank. By the time the revetment trees have decayed, the bank should be stabilized by the roots of the living trees. As an added benefit, tree revetments provide excellent fish and wildlife cover."[viii]

SELECTING TREES

There are a number of considerations regarding which trees are preferable for use in a tree revetment:[ix]

- The more limbs and fine branches a tree has, the better it will slow current and trap silt in a tree revetment. For this reason, eastern red cedar is usually the best choice. Cedar trees have the added advantage of good resistance to decay. Hardwood trees with brushy tops…will also work.
- Trees growing in uncrowded conditions are usually the best choice because their branches are denser. When growing in close competition with other trees, even cedars can have sparse tops.
- It is best to cut live trees for revetments; trees which have been dead for some time are usually brittle and may break apart as they are moved into place and anchored.

- Tree size is important. The diameter of the tree's crown should be about two-thirds the height of the eroding bank. A large tree covers more bank than a small one and isn't much more difficult to move into place. Both time and money can be saved by using the biggest trees available. Trees that are more than 20 feet tall are best for most stream banks.
- After felling trees, it is best to cut off any trunk at the bottom of the tree that is without limbs. The tree limbs are what protect the bank--any excess trunk is simply extra weight that makes it more difficult to move the tree into place.
- Transporting trees from off site is possible but difficult due to the load width. Smaller trees are easier to transport than larger ones.

INSTALLING A TREE REVETMENT

Equipment and techniques for building a tree revetment can vary. It is best to consider the particulars of each situation and implement a plan that is effective and efficient for the particular restoration site, the budget and the skills/equipment available. An engineering consultation should be considered when doing this type of work.

The following things are important when installing a tree revetment:

- The bottom ends of the trees should always be facing upstream.
- Cables and anchors should be used to secure the trees in place.
- Do not de-limb the trees that are being used – the limbs are the most important part.
- Install the revetment along the entire length of the eroded area being restored.

Depending on the location, the bank may need to be back sloped in order to install the tree. If so, use the substrate removed to fill in between the trees (if using multiple trees) - this will speed up the natural process of sediments being deposited by the water and allow vegetation to start growing immediately. Full length trees, especially larger ones, are difficult to manoeuvre and heavy equipment maybe required (hard hats and proper safety equipment should be available).

Figure 10: This shows a completed installation of tree revetments. At this location the Millstream River had blown out and caused issues for a crop farmer.

Additional instructions on how to install a tree revetment are available here:

Fisheries and Oceans Canada. 2006. *Ecological Restoration of Degraded Aquatic Habitats: A Watershed Approach*. http://www.dfo-mpo.gc.ca/library/321286.pdf (p.117)

Missouri Department of Conservation. “Streams: Tree Revetments Stabilize Stream Banks.” https://mdc.mo.gov/property/pond-stream-care/streams-tree-revetments-stabilize-stream-banks

MATERIALS REQUIRED

The following materials are required to install a tree revetment:

- Wetland and Watercourse Alteration Permit
- Excavator/truck (depends on size of trees being used and whether or not you are back sloping the bank)
- Aircraft cable (1/4") & clamps
- Anchors
- Wrench (to tighten cables clamps)
- Fencing staples (helps to secure cable to trees)
- Hammer
- Saw
- Trees, preferably with limbs and enough to cover entire length of bank being restored
- Cable cutters
- Electrical tape (for ends of cable – prevents injury)
- Sunscreen & bug spray
- Hard hat, safety vest, and gloves
- First aid kit

[viii] Missouri Department of Conservation. "Streams: Tree Revetments Stabilize Stream Banks." https://mdc.mo.gov/property/pond-stream-care/streams-tree-revetments-stabilize-stream-banks

[ix] The list is taken directly from Missouri Department of Conservation. "Streams: Tree Revetments Stabilize Stream Banks." https://mdc.mo.gov/property/pond-stream-care/streams-tree-revetments-stabilize-stream-banks

HOW TO:

Complete a Willow Stand Inventory

Kennebecasis Watershed Restoration Committee

INTRODUCTION

The KWRC commonly uses willow cuttings in its bioengineering efforts to stabilize banks which have been subjected to erosion. As the number of restoration projects has increased, there is an increased need for willow staking, and a need to find harvestable willow stock within the area. Performing an inventory helps to identify areas within the watershed along the streams where stands of willow exist.

METHODS

Crews of 2 or more are ideal for gathering information in a Willow stand inventory. The data is recorded on the “Willow Stand Inventory” field sheet (see attached).

1. During the willow stand inventory, the team should aim to travel 1 km up each stream (wearing waders) to gain insight on the number of willow stand sites within a kilometre of an available access point (e.g., driveways, forest roads, ATV trails, etc), preferably those which have the ability to be accessed by truck to facilitate harvesting.
2. When a stand of willow is encountered, the stand area is measured using GPS. A GPS should be used to store the site locations (as a waypoint), and with “tracking”, or “calculate area” on to outline the perimeter of the willow patch to obtain the total area of the stand (see device instructions for details). The minimum stand area for recording should be $10m^2$. One way to know if a stand falls within this category is to use a piece of string 10m in length to measure with.
3. If the stand is more than $10m^2$, the following is noted on the sheet:
    - the name of the stream (location),

- the site ID (stands can be numbered, and GPS location can be noted here) and bank (which bank of the stream the willow stand is on),
- date, time and crew members' names,
- photo #s.

4. The species composition of the stand is described, including willow and non-willow species. Note: Selecting willow species that are native to New Brunswick is ideal. Red-tipped Willow (*Salix eriocephala*) and Sandbar Willow (*Salix exigua*) are recommended because they are native species, common, and are widespread.[x]

5. The accessibility of the site is ranked (Very Good, Good, Fair, Poor, or Very Poor). This is important for prioritizing more accessible sites for use with larger groups of volunteers.
6. The (DBH) of each Willow tree is measured and recorded. The diameters of trees should be taken approximately 1.3m from bottom (diameter at breast height), using callipers (for small trees) or DBH tape (for larger ones). Individual trees can be flagged using flagging tape to indicate that it has been measured. The height class for each tree is also estimated and recorded (< 0.5 m, 0.5 – 3 m, and > 3.0 m).
7. After individual trees are all measured, the number of trees per height class is calculated and recorded.
8. The usability is indicated by height class. Willow less than 0.5m in height should be left to continue to grow or be used for seedling propagation only. Willow 0.5-3.0m are ideal for sourcing stakes and whips, while trees greater than 3.0m are usually good for stakes, but the aging structure results in lower whip availability. Usability for stakes is entered as the percentage of trees over 3m while usability for whips is entered as the percentage of trees between 0.5m and 3m.
9. Lastly, in the comments section, notes can be made about the health of the trees, adjacent land-use, the presence of wildlife, and other descriptions about the site, including areas in need of restoration, accessibility, and potential impacts to waterways.

NOTE: This assessment is aimed at providing you with a tool to gauge the suitability of a willow stand for harvest and allow you to maximize the effort for successful harvest but does not guarantee successful harvest due to variable conditions and willow types.

MATERIALS REQUIRED

The following materials are required for carrying out a willow stand inventory:

- GPS
- Callipers/ DBH tape
- Meter stick
- 10m long twine
- Camera
- Flagging tape
- Waders
- Field gear (appropriate clothing for weather/ conditions)
- Willow inventory documents (field sheets, aerial maps, ID information, etc.)
- Pens
- First aid kit
- Sunscreen & bug spray

[x] Noseworthy, J. 2016. *Bottomlands Forever: A Guide to Restoring Floodplain Structure, Function and Biodiversityin the Lower St. John River Watershed.* https://www.nashwaakwatershed.ca/wp-content/uploads/NWAI_Bottomland_Restoration_2016.pdf

Willow Stand Inventory Field Sheet

Stream Name:_____

Site ID:_____ **Bank**:_____

Crew:_____

Date:_____ **Time**:_____**Photo #**:_____

Stand Area (m^2):_____

Species Composition: _____

_____

Accessibility: _____

Usability: Stakes:_____

Whips:_____

Willow Tally		
Tree #	**DBH**	**Height class**
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
Height Class		**% of stand (per class)**
< 0.5 m		
0.5 – 3 m		
> 3.0 m		

Notes:

(Comment on stand conditions, accessibility, other tree species present, wildlife, adjacent land-use, observations, etc.)

HOW TO:

Harvest and Install Willow Stakes

Kennebecasis Watershed Restoration Committee

INTRODUCTION

Willows are hardy, fast growing and propagate well from cuttings. They have extensive root systems and can easily grow shoots that are 2 feet high in a single growing season. Willow use for various bank stabilization treatments has been documented for more than 50 years, and documented in similar uses as far back as the 1700s.[xi]

HARVESTING

Harvesting willow stakes should take place during the tree's dormancy, usually in early spring is best. The following steps describe how to carry out the harvest:

1. Select healthy, live wood that is reasonably straight, with smooth bark. Selecting willow species that are native to New Brunswick is ideal. Red-tipped Willow (*Salix eriocephala*) and Sandbar Willow (*Salix exigua*) are recommended because they are native species, common, and are widespread.[xii]
2. Trim the terminal ends.
3. Make clean cuts without splitting ends.
4. Angle-cut the butt end and cut square the top.
5. Cuttings should be approximately 19 mm (¾ inch) in diameter, and be 0.5 m (18 inches) long minimum (long enough to reach into moist soils in mid-summer).
6. Store the cuttings in a cold environment so that they continue to stay dormant until you are ready to use them.

7. Before use soak cuttings in water for a minimum of 24 hours (5 – 7 days is ideal). Soaking significantly increases the survival rate.
    - **Stakes must not be allowed to dry out.**
    - They must be planted the same day they are removed from water.

INSTALLATION

To use willow stakes in bank stabilization follow these steps:

1. Attain a wetland and watercourse alteration permit for your work site.
2. Use an iron stake or bar to make a pilot hole in firm soil. Soil should be soft and easy to push the cutting into. If planting in clay soils, create a 2" diameter hole, install willow cutting, fill extra space with sand, then water. This is because clay soils can encourage rot.

3. Plant the stakes butt-ends into the ground, with the leaf bud scars or emerging buds always pointing up.
4. Plant randomly at a rate of 2-5 cuttings/m^2.
5. Set stakes approximately 80% of its length into the soil, protruding, at most, ¼ its length above the ground.
6. Stakes should extend above competing herbaceous vegetation.
7. At least 2 buds and/or bud scars should be above the ground.
8. Tamp the soil around the recently installed cutting.
9. If weather forecast calls for dry conditions, water the stakes shortly after planting.

<u>Important Considerations:</u>

- Shrub, rhizomatous and/or creeping-type willows are ideal for planting eroding stream banks.
- Tree-type willows are ideal for the upper bank and flood plain area.
- Be careful not to damage buds, strip bark or split stakes during installation.
- It is essential to have good contact between the stake and soil for the roots to sprout.

- To improve success, remove weeds by hand during the first season.
- Do not plant in frozen or cold ground. This will increase potential for rot.

For more information on willow harvesting and staking, see https://www.youtube.com/watch?v=_3OpOXLtjHg. (Keep in mind we are not professional videographers)

MATERIALS REQUIRED

The following materials are suggested for willow stake harvesting and installation:

- Pruning shears
- Cooler
- Twine
- Rubber ended hammer
- Pry bar
- Pails
- Bug spray and sunscreen
- First aid kit

[xi] Schiechtl, H. 1980. Bioengineering for land reclamation and conservation. Translated by N. Horstmann. Department of the Environment, Government of Alberta. University of Alberta Press, Edmonton.

[xii] Noseworthy, J. 2016. *Bottomlands Forever: A Guide to Restoring Floodplain Structure, Function and Biodiversityin the Lower St. John River Watershed.* https://www.nashwaakwatershed.ca/wp-content/uploads/NWAI_Bottomland_Restoration_2016.pdf

3.10

HOW TO:

Install a Rock Weir

Kennebecasis Watershed Restoration Committee

INTRODUCTION

Rock weirs, or kickers, are useful tools for slowing down water flow. This is useful in cases where water moves around a bend that has been rock armored and you want to prevent shifting flow issues downstream. Depending on the situation, you can have an “attracting weir” a “deflecting weir” or a “straight weir” - these are labelled based on how they alter the water flow. In many instances, rock weirs are constructed in coordination with rip-rap armor stone installations. However, they can also be installed as a standalone structure. Information on these structures can be found in the Fisheries and Oceans Canada document: *Ecological Restoration of Degraded Aquatic Habitats: A Watershed Approach* (see end of document for link). For a complicated in-stream structure such as these you should consult an engineering consultant.

CONSTRUCTING A ROCK WEIR

The Fisheries and Oceans document mentioned above has great examples of how to install kickers, and the diagrams can be used to more efficiently submit your wetland and watercourse alteration (WAWA) permit application. A full WAWA permit will be required to carry out this riparian enhancement work if installing a standalone rock weir. If you place a rock weir as part of a bioengineering project, the provisional WAWA application process can be followed. The process for obtaining the permit is explained in section 3.1 of the manual.

Plan appropriately and remember to abide by the conditions laid out in the WAWA permit. Sediment and silt control are important, so be sure to have those components in place before you start constructing the weirs (see section 3.2). You will likely need heavy equipment such as a backhoe or excavator to move the large rock material, so be sure to have a spill kit on site in case of an accidental spill.

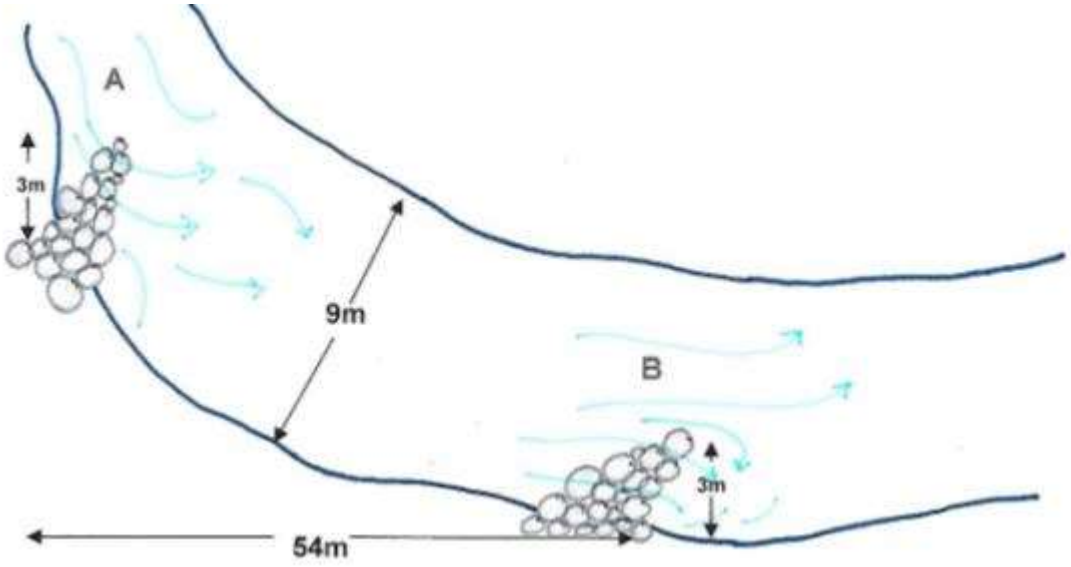
With proper site containment in place, you can begin placing the rock weir. On highly eroded stream banks, rock weirs can help slow erosion, create back eddies, establish deposition zones, and facilitate the natural back sloping of a stream bank while also

providing great resting habitat for various fish species. The general rule of thumb is that a rock weir should be placed every 6 times the stream width during normal flow conditions (e.g., on a 1m wide stream, a rock weir would be placed every 6m). The rock size used for the weirs should be a minimum 2 times the size of the largest mobile rock material within the stream. The rock weir should extend no more than 1/3 the stream width into the channel (e.g., for a 3m wide stream, the rock weir should be built out no more than 1m into the channel).

The rock weir should extend from the top of the eroding bank at a 3:1 slope until it tapers off, and in some instances this may mean the weir has to be extended into the bank so that it doesn't extend beyond 1/3 the stream channel. When multiple groynes are placed along the same eroding stream bank, deflecting and attracting groynes should be built in alternate fashion every 6 times the wet width of the stream.

- *Deflecting Groyne (Weir):* A deflecting weir is one that deflects the flow of water towards the far bank and thus reduces the erosion occurring on the working side of the watercourse. To build a deflecting weir, the taper of the rock weir would point upstream at approximately 30°. By pointing the weir upstream, the water flows over the weir and flows towards the far bank. This uses the changing water direction as a mechanism to slow water down in the middle of the channel and is ideal for situations where you don't want additional erosion to occur on the bank on which you are working.
- *Attracting Groyne (Weir):* When the stream bank you are working on is stable (or when you have armored the bank and it can handle additional flow), or you need to create back eddies for fish habitat, an attracting groyne or weir may be a better choice. The attracting groyne directs water to the bank and uses the stable bank to create a back eddy flow. The back eddy slows the water down and prevents the rock armoring from simply sending the problem downstream.
- *Straight Groyne (Weir):* The straight groyne uses the plunge of the water over the weir to slow down the flow, create oxygen, and provide fish habitat diversity. These groynes are constructed perpendicular to the flow. This type of groyne does not significantly slow down the flow but is optimal when banks on both sides of the river are unstable or prone to erosion.

Figure 1: Diagram of installed rock groynes in alternating fashion. “A” shows a deflecting groyne and “B” shows an attracting groyne.



MATERIALS REQUIRED

This work is technical and invasive, so proper planning and equipment is highly recommended. **It is advisable as well to consult an engineering firm for assistance with the planning of these structures** as it will likely be a required component of the wetland and watercourse alteration permit. The materials should include:

- Wetland and watercourse alteration permit
- Spill kit
- Silt fencing
- Shovels/rakes
- Grass seed
- Large rock material (2x the largest substrate)
- Clean/well maintained excavator and other heavy equipment as needed
- Hay/straw for site cover
- Bug spray & sunscreen
- First aid kit

ADDITIONAL INFORMATION

Fisheries and Oceans Canada: *Ecological Restoration of Degraded Aquatic Habitats: A Watershed Approach* - http://www.dfo-mpo.gc.ca/library/321286.pdf

NB Dept. of Environment and Local Government: Watercourse and Wetland Alteration Technical Guidelines - https://www2.gnb.ca/content/dam/gnb/Departments/env/pdf/Water-Eau/WatercourseWetlandAlterationTechnicalGuidelines.pdf

HOW TO:

Select Tree Species for Planting

Kennebecasis Watershed Restoration Committee

INTRODUCTION

When selecting tree species for planting in restoration projects, it is critical to consider the site conditions and the shade and moisture preferences of native tree species. The following tree reference charts can be used to assist in understanding which tree species will be most likely to thrive in the specific conditions at a site, providing the best possible survival rate per planting attempt. The chart outlines the shade tolerance, moisture and soil preferences of each tree species the KWRC works with.[xiii] If a species is not present, the information can be easily found and added to this sheet. This sheet can be printed and brought into the field as a reference. It should be noted that in many cases any tree is better than no tree and for the KWRC a free tree is the best tree, however, we always try to place a tree that has the best chance of survival.

Table 1. Visual representation of Shade Tolerance versus Moisture Preference

	Moisture Preference				
	Low	Mod/Low	Moderate	Mod/ High	High
Shade Tolerance					
Very High			Sugar Maple Beech		Red Spruce Eastern Hemlock
High		Ironwood			Basswood
Moderate/ High			Balsam Fir		White Cedar Black Spruce
Moderate			Serviceberry Hawthorne White Pine	Red Maple White Spruce	Yellow Birch Silver Maple
Moderate/ Low	Bur Oak	Bur Oak	Bur Oak Red Oak White Ash	Bur Oak Winterberry	Bur Oak Black Ash Red Ash
Low	Red Pine	Jack Pine Grey Birch Largetooth Aspen	White Birch Butternut Trembling Aspen Black Cherry		Tamarack Balsam Poplar Black Willow

Table 2. Tree Reference Chart

Type	Shade Tolerance	Moisture Preference	Soil	Mature Height
Red Pine	low	low	sandy	26 m
Jack Pine	low	moderate to low	sandy/poor soils	19 m
Grey Birch	low	moderate to low	wide range	11 m
Largetooth Aspen	low	moderate to low	sandy/ wide range	22 m
White Birch	low	moderate	sandy loam	24 m
Butternut	low	moderate	rich loam	21 m
Trembling aspen	low	moderate	wide range	18 m
Black Cherry	low	moderate	sandy loam	21 m
Tamarack	low	high	wide range	23 m
Balsam Poplar	low	high	sandy to loam	24 m
Black Willow	low	high	sandy loam	12 m
Bur Oak	moderate to low	high to low	sandy loam	18 m
White Ash	moderate to low	moderate	loam	23 m
Red Oak	moderate to low	moderate	sandy loam	24 m
Winterberry	moderate to low	moderate to high	well-drained or wet	5 m
Black Ash	moderate to low	high	poorly drained	18 m
Red Ash	moderate to low	high	wide range	18 m
Hawthorne	moderate	moderate	wide range	12 m
Serviceberry	moderate	moderate	wide range	12 m
White Pine	moderate	moderate	sandy loam	35 m
Red Maple	moderate	moderate to high	wide range	22 m
White Spruce	moderate	moderate to high	wide range	24 m
Yellow Birch	moderate	high	loamy sand	25 m
Silver Maple	moderate	high	sandy loam	27 m
Balsam Fir	high to moderate	moderate	wide range	21 m
White Cedar	high to moderate	high	wide range	15 m
Black Spruce	high to moderate	high	wide range	17 m
Ironwood	high	low to moderate	loamy sand	12 m
Basswood	high	high	loam	22 m
Sugar Maple	very high	moderate	loamy sand	28 m
Beech	very high	moderate	loam	24 m
Red Spruce	very high	high	sandy loam	26 m
Eastern Hemlock	very high	high	sandy loam	21 m

LANDOWNER AND LAND USE CONSIDERATIONS

Before finalizing the tree planting plan, discuss the species selection and plan with the landowner. In some cases, they may have a personal preference regarding tree species. They may have property specific information that affects tree placement or selection, such as septic infrastructure that they want access to which shouldn't be planted over, or drain tile where willow shouldn't be planted. Whatever the case, be sure to consult with the landowner.

CLIMATE CHANGE CONSIDERATIONS

When selecting tree species for planting, it is also important to consider which trees will thrive in anticipated future climate conditions based on climate change models. The following tree reference chart is from the Fundy Biosphere Reserve, as part of a Forests of the Future project. It depicts which Acadian Forest species are most likely to thrive in future climate conditions, and illustrates their soil moisture and shade preferences. Because northern tree species are more likely to face conditions that could contribute to higher mortality (e.g., increased presence of insects, disease, extreme weather and competition), the chart contains mostly southern species, which are more likely to thrive.[xiv]

Table 3. Climate-resilient Tree Species of the Acadian Forest and their Sun and Moisture Preference

OTHER RESOURCES

An in-depth description of methods in restoring floodplain forests in New Brunswick, including site preparation, tree selection and planting can be found in the following document:

Noseworthy, J. 2016. *Bottomlands Forever: A Guide to Restoring Floodplain Structure, Function and Biodiversityin the Lower St. John River Watershed.* https://www.nashwaakwatershed.ca/wp-content/uploads/NWAI_Bottomland_Restoration_2016.pdf

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[xiii] Information in tables 1 and 2 comes from Ritchie, Geoffrey. 1996 (Reprint 2004). *Trees of Knowledge: A Handbook of Maritime Trees*. Canadian Forest Service – Atlantic Forestry Centre. p.38-39 (Tree Reference Chart).

[xiv] Fundy Biosphere Reserve. 2018. *Forests of the Future in the Fundy Biosphere Reserve: Planting Guide for a Climate Change Resilient Forest*. http://www.fundy-biosphere.ca/images/projects-initiatives/ForestsFuture_Guide.compressed.pdf

HOW TO:

Install Agricultural Fencing

Kennebecasis Watershed Restoration Committee

INTRODUCTION

After completing restoration work in an agricultural setting, it can be important to protect the work from livestock by installing fencing. Livestock access to a planting site can quickly degrade the site again and result in a lost investment of time and money if the trees aren't properly protected by fencing.

METHODOLOGY

Fencing a riparian area is much different than establishing a perimeter fence on a pasture. While it is important to deter livestock from the riparian area, the bigger consideration is that of high-water events. The KWRC strongly encourages farmers to use two strand electric fencing along the riparian area. An electric fence requires fewer posts and is easier to put out and pull up in the spring and fall respectively. The use of solar panels will help maintain power to the fence when they are far from other power sources, as most riparian fences are. Consider fording sites and cattle watering needs when setting up the fencing plan and think about how you can make the task of maintaining the fence as easy as possible for the farmer.

Step-in-stakes along with cedar posts make for a solid electric fence installation. We put a cedar post in as an anchor and then put in five step-in-stakes with each post placed approximately 10 paces apart (this may have to be adjusted based on topography). The fence should establish an adequate riparian area and be a minimum of 5m from the watercourse, as this is considered a regulatory agricultural setback. However, if the landowner is willing to provide a bigger setback, this is even better - larger setbacks mean less maintenance down the road.

An important consideration is the input from the farmer/landowner. Be certain to walk the proposed and finished fence line with them and ensure they are agreeable to the fence construction and line. Communicate with the farmer the value of maintaining the fence and when your organization has the resources try to help with maintaining the fence.

This photo shows a fenced off riparian enhancement site completed by the KWRC. At the time of this photo the site had been established for just over 10 years.

HOW TO:

Construct and Install a Bird Box

Kennebecasis Watershed Restoration Committee

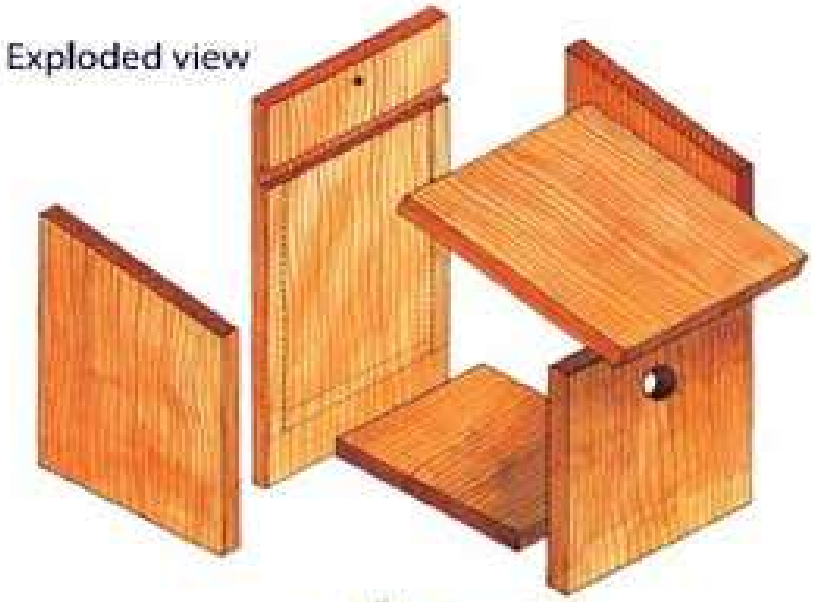
INTRODUCTION

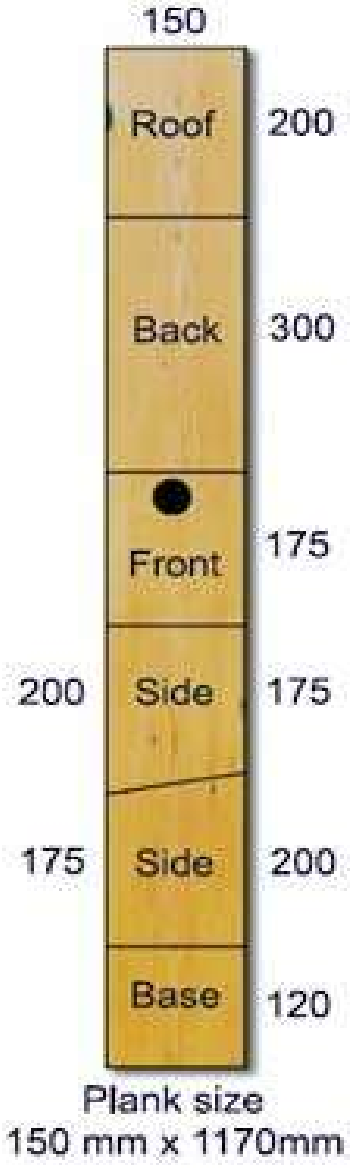
Installing a bird box encourages birds to nest in an area. The KWRC works to install at least one bird box at every restoration site worked on. Each box is geotagged, which makes maintenance easy. It is important to clean out the boxes yearly to ensure they get used again.

CONSTRUCTION

There are many bird box templates to choose from. The one used by KWRC can be seen below. We use a 4' x 6" board to cut the template from. The hole size on the front of the house will determine what types of birds will use the box. The holes should vary in size from 1" – 2 ½" to attract different species of birds. The holes should be cut using a hole-saw or a jig saw. It's very important to pre-drill the screw holes with a small drill bit. This makes construction much smoother, especially for volunteers.

Bird Species	Diameter of Hole (inches)	Height above Ground (Feet)
Bluebird	1 ½	5 – 10
Chickadee	1 1/8	6 – 15
Titmouse	1 ¼	6 – 15
Nuthatch	1 – 1 ¼	6 – 10
Bewick's Wren	1 ¼	6 – 10
Carolina Wren	1 ½	6 – 10
Swallow	1 ½	10 – 15
Downy Woodpecker	1 ¼	6 – 20
Hairy Woodpecker	1 ½	12 – 20
Crested Flycatcher	2	8 – 20
Flicker	2 ½	6 – 20
Red-Headed Woodpecker	2	12 – 20
Barn Swallow	Open Sides	8 – 12
Phoebe	Open Sides	8 – 12
Robin	Open Sides	6 – 15


Exploded view


150
Roof
200
Back
300
Front
175
200
Side
175
175
Side
200
Base
120
Plank size
150 mm x 1170mm

MATERIALS REQUIRED

The following materials are required to build and install a bird box:

- Wood (4’ x 6” board)
- Drill and drill bits
- Screws (1” – 1 ¼”)
- Jig-saw
- Circular saw
- Hole-saw (multiple sizes)
- Measuring Tape
- Pencil
- Ruler

INSTALLATION / MAINTENANCE

Bird boxes can be installed to fence posts or trees. For height references, please consult chart above. The boxes should be cleaned out between September and February to prepare for new nests.

HOW TO:

Build a Raptor Platform

Kennebecasis Watershed Restoration Committee

INTRODUCTION

Raptors that use open nests can also be persuaded to use artificial nests for the purpose of augmenting their populations. A number of raptor species have suffered declining populations, partly due to loss of nesting places and bioaccumulation of toxins. The use of nesting platforms has benefitted populations of birds of prey by increasing the breeding population, decreasing hatchling mortality, and increasing fledgling rates.

The designs and building instructions in this document are taken from the Landowner Resource Centre in Ontario (http://www.lrconline.com/Extension_Notes_English/pdf/ospry.pdf) They were designed with Osprey in mind, but could be useful for other raptor species as well. Several sections of the following document, most notably the construction steps, are taken verbatim from this website.

BUILDING A QUADRUPED PLATFORM

A quadruped platform has a four-legged base, and is designed with birds like Osprey in mind. It remains in the water year-round, making it important to choose an appropriate location where it will not be hazardous to boats and where ice will not disrupt it. An appropriate location for a quadruped platform could be in a quiet bay or in an isolated marsh. It can be easier to install a quadruped platform during winter time, such that ice-covered waters make it easier to get to the location. Be cautious when venturing on ice to install a platform. Such a platform should also be placed in a location where ice and debris are not likely to jam against the poles or knock the poles over. A team of 3-

4 people is best for carrying equipment, positioning the poles and constructing the quadruped platform.

The following materials are required for constructing a quadruped platform:

- 4 x 6m cedar poles, with one end sharpened
- 1.2 x 1.2m skid or pallet
- 8-inch ice auger
- 2 x 8-inch spikes
- 30 x 2-inch roofing nails
- 12 x 4-inch spiral spikes/nails
- 12 six-inch spiral spikes/nails
- 6m of black fencing wire
- Pliers, claw hammer, sledge hammer, saw and ice pick
- Four pieces of $1m^2$ sheet metal (or children's plastic roll-up toboggans) to be used as predator guards on the poles
- 1.2m of chain
- Hardwood block (about 10 x 10 x 25 cm)
- 5m ladder

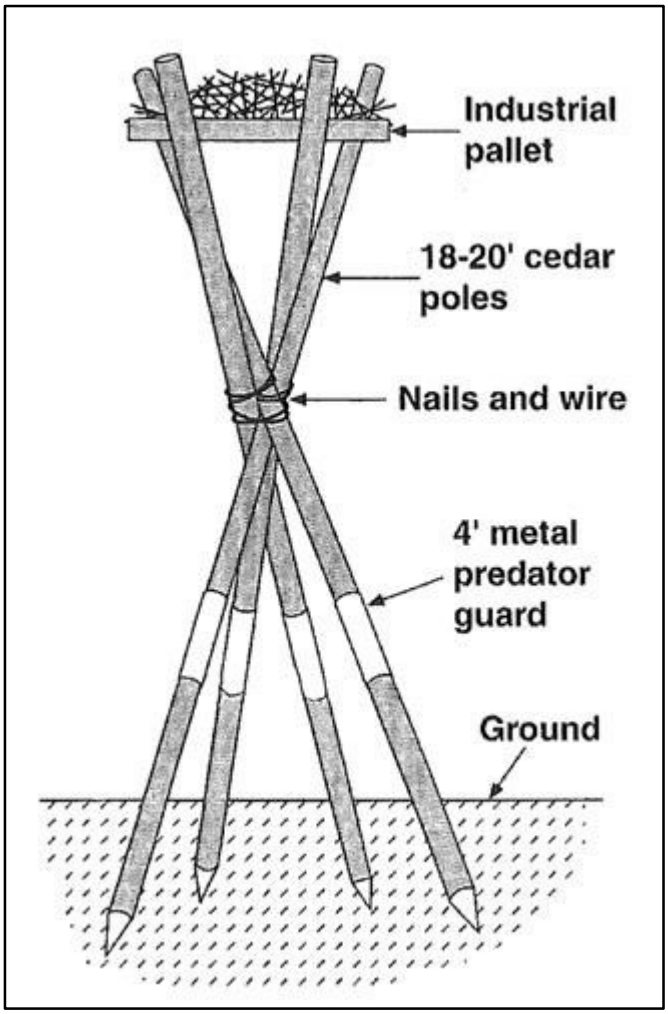


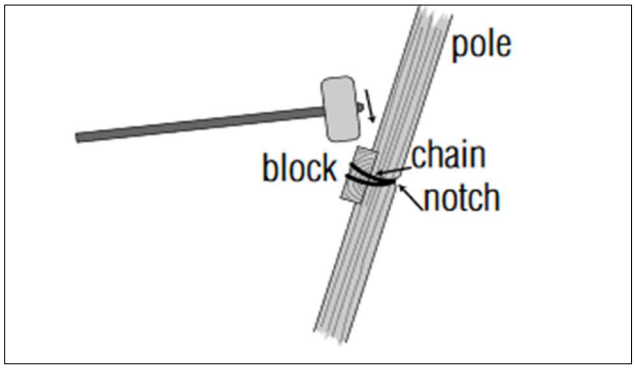
Figure 11: A quadruped raptor platform.

Use the following steps to install the quadruped platform:

1. Drill four holes into the ice at a 45-degree angle. The holes should be approximately two metres apart, forming a square.
2. Ram the sharpened poles down into the ice holes and then use the sledge hammer to knock them at least one metre into the ground below the ice. To make the job of hammering easier, attach the block of hardwood to the side of each pole using a length of chain. To hold the chain in position, notch a small V into the pole using the saw (see Figure 2).

3. Place the wood pallet or skid in a level position between the tops of the poles. The platform should be at least 2.4 metres above the ice. Using the six-inch spikes, nail and wire the platform to the poles.
4. Wire and nail the poles together using the eight-inch spikes where they cross near the centre of the structure.
5. Wrap the predator guards (sheet metal or plastic toboggans) around each leg of the structure. Nail them in place with roofing nails, ensuring that they are pounded in flush and can't provide toe-holds for predators.
6. Wire a few "starter" sticks onto the bottom of the platform to attract an osprey. An extra perch can be installed off to the side or above the platform. This provides a place for the male to roost during the nesting season

Figure 15: Illustration of how to attach a hammering block to the leg of a quadruped platform.

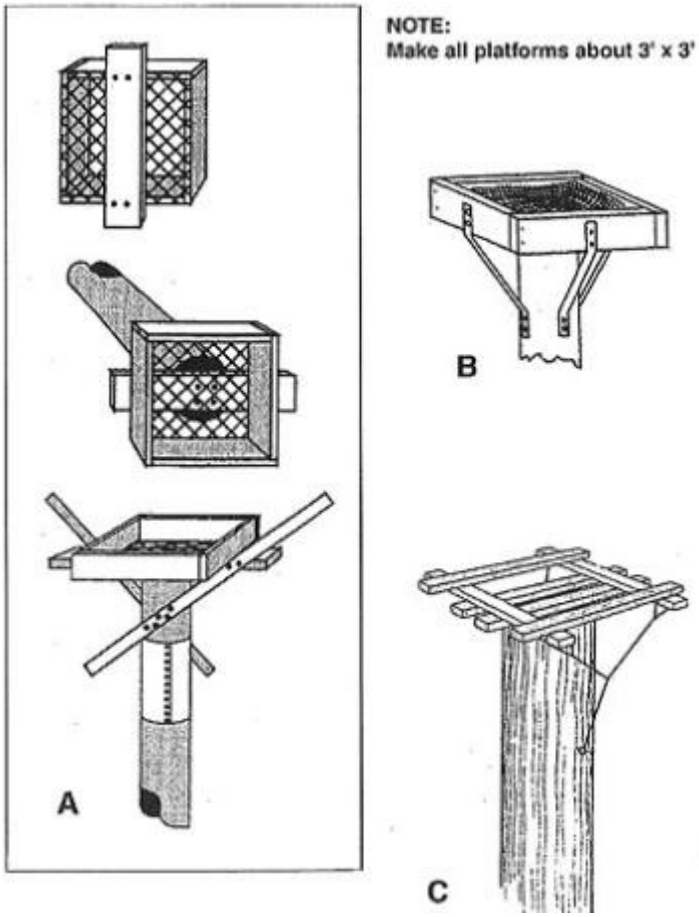


BUILDING A SINGLE-POLED PLATFORM

A single-poled platform is more suitable for use on land. It can be adaptable to areas with deep soil, as well as areas with no soil. It can be challenging to find a suitably long and sturdy pole for constructing this platform. Old hydro poles are ideal, and so it can be useful to contact a local utility company or the Bell Canada office to inquire about obtaining poles for this purpose.

The following materials are required for constructing a single-poled platform:

- 1 pole, 6-9m in length
- 1.2 by 1.2m skid or pallet with 10-inch high
- Retaining fence
- 4 wood or metal braces
- Power auger (for deep soil sites)
- Rock drill and mounting set (for rocky sites)
- 6-inch spikes
- 2-inch roofing nails
- Steel guy wire
- 4 eye bolts (minimum 2-inch thread)
- Cement
- Pliers, claw hammer and sledge hammer
- 1x 1m^2 sheet metal or children's plastic roll-up toboggan



Use the following steps to install the single-pole platform in deep soil:

1. Attach the nesting platform (skid or pallet) to the pole. Wire a few "starter" sticks to the platform.
2. Use the power auger to drill a hole one to two metres deep.
3. Place the pole in the hole and secure it with cement, sand or rock.
4. If necessary, attach guy wires to add extra support.
5. Wrap the predator guards (sheet metal or roll-up toboggans) around the pole. Nail them in place with roofing nails, ensuring that they are pounded in flush and can't provide toe-holds for predators.

While a little more involved, it is still easy to erect nesting poles in rocky areas. The most difficult piece of equipment to come across may be the rock drill and mounting sets used by utility companies.

Follow these steps to install a single-poled platform on rock:

1. Attach the nesting platform (skid or pallet) to the pole. Wire a few starter sticks to the platform.
2. Use the rock drill to make the holes to accommodate the mounting set.
3. Set the bracket inside the holes. Pour in cement for additional support.
4. Raise and anchor the pole in place using the mounting set.
5. If necessary, attach guy wires prior to raising the pole to add extra support.
6. Wrap the predator guards (sheet metal) around the pole. Nail them in place with roofing nails, ensuring that they are pounded in flush and can't provide toe-holds for predators.

IMPORTANT CONSIDERATIONS

1. Place the nesting platforms within 50 m of water, preferably 1-2 m deep.
2. Use small rock islets, if possible, for predator protection.
3. Put structures on poles that are more than 10 m from the nearest trees, because Ospreys need room to maneuver in flight.
4. Place structures at least 100 m from houses or heavily traveled roads.
5. Space platforms at least 300 m apart.
6. Contact the local wildlife agency before erecting platforms to make sure that Ospreys or other raptors will not interfere with other sensitive wildlife.
7. Cedar is the best wood to use. Avoid pressure treated wood because it can leach preservatives into water courses.

8. Use galvanized nails, bolts, and wire. Pre-drill holes to avoid splitting wood.
9. If no tree perches are located near the platform, nail a length of wood to the platform sticking out 1 m for a perch.

HOW TO:

Build a Brush Pile to Attract Birds

Kennebecasis Watershed Restoration Committee

INTRODUCTION

A brush pile can add instant shelter to a property's bird habitat without needing to plant, prune and care for trees or bushes. Adding brush piles to a property is also an opportunity to practice conservation by reusing materials rather than sending them to a landfill.

Building a brush pile that will last for years takes more than just tossing branches into a corner of the yard. By planning carefully and constructing the pile with the birds in mind, birders can easily add shelter to their backyard habitats or to your riparian restoration site.

LOCATION

While useful and simple, brush piles are not the most attractive bird shelter. They should be placed carefully not only to be welcoming to the birds, but so they do not present an eyesore to the homeowners or neighbors. Choose an unobtrusive location that offers some shelter from prevailing winds (e.g., behind a shed, along a tree line). Ideally, if located along a tree line, it should not be more than 3m from the tree line. When choosing the pile location, also consider nearby features such as the proximity of food sources such as berries, nuts, seeds, and, water.

Four to eight brush piles per acre, spaced 30 to 50 meters apart, is a sufficient amount and will supply the needed cover requirements for most wildlife species.

MATERIALS

Any size sticks, twigs and branches can be used for a brush pile. Ideally, larger branches will be more useful to keep the pile stable, while smaller branches provide ample perching spots for birds. Piles can be made with branches from different types of trees, and leaving needles or leaves on the branches will help provide more security for hesitant birds, as well as better shelter in poor weather.

The ideal size for a brush pile is approximately 2m high and 4m in diameter. It can take a great deal of brush to create a pile that large, and using a fallen log, stumps, old wooden furniture or a few well-placed boards can help augment the pile.

Easily compostable materials such as leaves and grass clippings should not be used to build a brush pile. These materials will clog entrances to the pile and make it less attractive to birds. Adding some of this material to the base of the pile, however, can offer ground birds nesting material, and leaf litter can attract birds with food and water.

BUILDING THE BRUSH PILE

To build the brush pile, start by creating a horizontal frame of thicker logs or branches for stability. Leave holes along the edges of the frame to provide access for ground birds such as quail or pheasants. For larger piles, consider digging small trenches so the framework is more solid.

Next, create a cone shape with large and medium branches, bracing the bottoms of the branches against the solid frame. Small holes can help brace the largest branches.

Finally, weave smaller branches into the pile, creating layers of shelter and perching spots. If the pile is not naturally sheltered, use additional branches to create a thicker side to provide protection from prevailing winds.

BENEFITS AND CAUTIONS

When properly constructed and located, brush piles can benefit many species of wildlife, including bobwhite quail, cottontail rabbits, ruffed grouse, wild turkeys, skunks, raccoons, opossums, woodchucks, chipmunks, mockingbirds, white-throated sparrows and juncos. Predators such as foxes, bobcats, hawks, owls and coyotes benefit from the small mammal and bird populations found in or around brush piles.

Grasses, forbs and vines, which are highly valuable to wildlife, will grow up through brush piles and add density and permanence to the piles.

Caution should be taken when creating brush piles in densely populated areas, for they may lead to nuisance wildlife problems. Skunks, opossums and raccoons will, on occasion, live in or under these brush piles and may cause a nuisance situation for nearby homeowners.

MAINTAINENCE

Even the most stable brush pile will eventually settle and collapse as its branches slowly decompose. To keep a pile useful as long as possible, periodically trim climbing vines or weeds that are exerting stress on the pile's support and add additional light branches on top of the pile to maintain its height. Adding stronger supports as time passes will also help strengthen a brush pile.

A brush pile can be an easy addition to a bird-friendly riparian enhancement site, and by building it carefully, a brush pile can attract birds for years.

HOW TO:

Build a Drumming Log

Kennebecasis Watershed Restoration Committee

INTRODUCTION

Ruffed grouse are considered an indicator species that reflect the overall health of the environment. In the spring, male Ruffed Grouse perform a courtship dance to attract a female. The dance involves a rapid, wing-beating display that creates a low frequency sound (drumming), which starts slow and increases in speed. Even in thick woods this can be heard from more than 1/2 km away. This dance normally takes place on a naturally fallen tree, normally 2-3 feet from the root mass. A ruffed grouse will use the same log year to year if it proves to be successful. Male Ruffed Grouse are aggressively territorial throughout their adult lives, fighting for their exclusive use of a piece of woodland that is 6-10 acres in extent. Usually this is shared with one or two hens.

Building drumming logs can help to improve grouse habitat, which could assist grouse populations within a watershed. Improving habitat for ruffed grouse also enhances food and cover for the hundreds of other wildlife species that share the watershed.

BUILDING A DRUMMING LOG

When cutting down a log to be used as a drumming log, it is difficult to do so with the root-wad attached. The logs the KWRC has installed do not have a root-wad but we use additional logs or woody debris to mimic the root-wad. It is important to pick a tree that is at least 10-12” in diameter, since that is the rough height that a ruffed grouse prefers for a drumming log site. The log should be 4-6’ in length. If you intend to dig a shallow hole to submerge the log in to keep it in place it is important to take that depth into consideration when choosing your log. Likewise, if a log is found that is >12” in diameter, it can be put in a shallow hole to bring it to the required height. Since ruffed grouse do tend to choose drumming logs with the root-

wad attached, it would be beneficial to place woody debris near one end of the drumming log to mock a root-wad (however, this is not essential).

When situating the log, consider the following: the drumming stage selected by a male is most likely to be about 10-12” above the ground, in moderately dense brush, (usually 70 to 160 stems within a 10 ft. radius), where he can maintain unrestricted surveillance over the terrain for a radius of about 60 ft.

MATERIALS REQUIRED

The following materials are required when building a drumming log:

- Chainsaw
- Measuring Tape
- Shovel
- Truck (to transport log)
- Woody debris (optional)
- Sunscreen and bug spray
- First aid kit

ADDITIONAL INFORMATION

A KWRC YouTube video on drumming logs: https://youtu.be/lijpZ_B0xCA

Ruffed Grouse Society of Canada: http://www.rgs.ca/

HOW TO:

Build and Install a Duck Box

Kennebecasis Watershed Restoration Committee

INTRODUCTION

Duck Boxes promote nesting for cavity nesting waterfowl species. Wood ducks, Barrow's Goldeneyes, Common Goldeneyes, Hooded Mergansers, Common Mergansers and Buffleheads are all cavity nesting ducks. Installing a duck box encourages waterfowl to nest in the area and the KWRC works to install these units whenever and wherever they locate good waterfowl habitat. Each box is geotagged, to make maintenance easy. It is important to clean out the boxes yearly to ensure they get used again – this should be done between January and March.

CONSTRUCTION

There are many duck box templates to choose from. KWRC uses the following template: http://www.ducks.ca/assets/2016/01/duckbox.pdf. In addition to the directions in the link, we offer the following instructions:

- Use an 11' x 10" x 1" cedar board to cut the template from.
- The hole size on the front of the box should be oval and 4 ½" x 3 ½". The holes should be cut using a hole-saw or a jig saw.
- It is very important to pre-drill the screw holes with a small drill bit. This makes construction much smoother, especially for volunteers.
- Drilling a few holes in the base of the box allows any water that may enter the box during storm events to drain out.

INSTALLATION

KWRC often installs duck boxes to a tree or on top of a post. It is important that the box be at least 6’ off the ground. If on a post, we recommend installing some metal sheathing or a plastic crazy carpet around the post, 2’ off the ground. This is done to keep predators from climbing up the post, which makes the box on a post safer for those that may inhabit it.

Choosing a good place to install a duck box is just as important as its construction. The best locations include wetland areas, and on the banks of ponds or along streams/rivers that have an abundance of long grasses, reeds or low bushes. A hen (female duck) always chooses a nesting location within 90m of a water source and the tall grasses serve as tools for nest building as well as camouflage.

MATERIALS REQUIRED

The following materials are required to build and install a duck box:

- Wood (11’ x 10” x 1” cedar board)
- Drill & bits
- Screws (1”-1 ¼”)
- Jig-saw
- Circular Saw
- Hole-saw (multiple sizes)
- Measuring Tape
- Pencil
- Ruler

HOW TO:

Construct and Install a Bee Box

Kennebecasis Watershed Restoration Committee

INTRODUCTION

Bee Boxes create a habitat for solitary pollinator species to lay their eggs and hibernate over the cold winter months. Solitary bee species are exceptional pollinators. They have a success rate of 95% pollination compared to that of a Honeybee, which is only 5%. Solitary bees are extremely important for the pollination process and creating Bee Boxes for them around high pollination areas will benefit the environment as a whole, including those who will benefit from the by-products of the pollination process, like fruits and vegetables. The addition of a bee box to a riparian enhancement project is a truly value added approach and can help provide access to funding that might not otherwise be available.

BEE BOX CONSTRUCTION

There are many different Bee Box designs. Since the KWRC often uses volunteers to build the boxes, we strive to keep the work simple and this shows in the design we use. The design is simple and cost effective, making it ideal for watershed groups to utilize. Remember that if you have volunteers build the boxes, you should track and report their time as an in-kind contribution to your riparian restoration project.

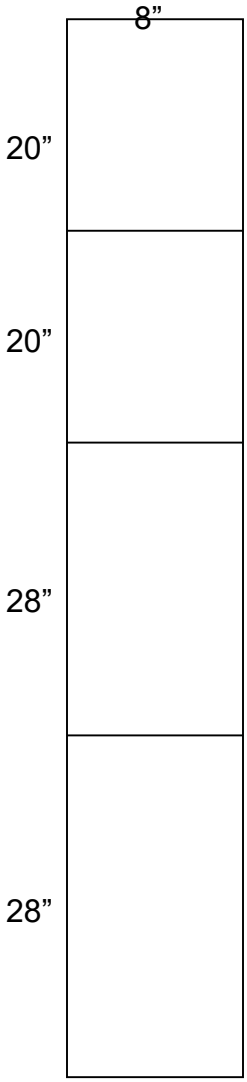
The important thing to remember when building a bee box is that the holes range in diameter within the box from 2mm-10mm. This will increase the success rate for solitary bee species, of which there are many different species, to use your box because they will have a better opportunity to find the right sized tunnel. The depth of the holes should also be at least 15cm. A depth of 15cm will allow the bees enough room to lay several eggs in one tunnel; optimally they would lay 6 eggs per tunnel.

The following are steps for constructing a bee box:

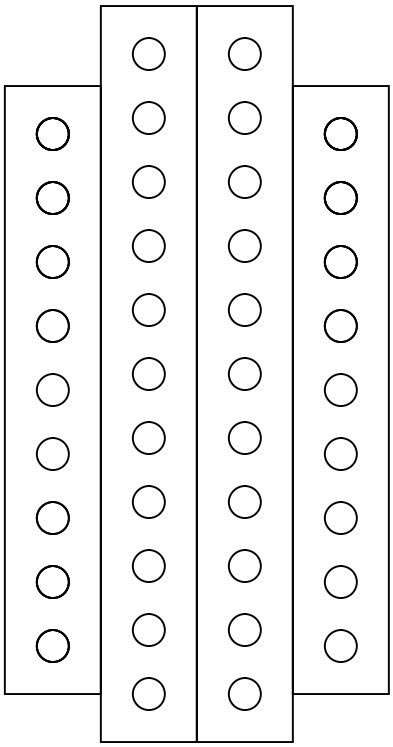
1. Cut the pieces from a single board, as per the cutting diagram below (left).
2. Stack cut pieces together (longer pieces go in the center).

3. Use carpenters glue or 2 ½” Screws to join pieces together (if using glue, use clamps to keep together tightly as glue sets).
4. Drill an assortment of holes, varying in diameter (2mm - 10mm) into the thin side of the boards.

Cutting Guide



Finished Product



MATERIALS REQUIRED

The following materials are required for constructing a bee box:

- One 8 “by 96” board
- Saw
- Measuring tape
- Drill

INSTALLATION

The Bee Boxes can be attached to a tree or post. They shouldn't be placed near high human traffic areas since people can be allergic to bees. It would be best to place it near a field or garden area where pollination is required. The range for solitary bee species is around 100m. Thus, it is very important that the bee box is placed in an area that requires pollination or it will not likely be used. The box should be at least 1m off the ground and placed in a sunny area. If the box is going to be exposed to the weather it should have a roof to protect the species using the box.

It could be beneficial to plant native species within a 100m radius of a bee box to ensure the bees have an adequate diet and to ensure the box gets used. Any local nurseries will be able to help with deciding on which native species should be planted. Some example of useful species to plant near a Bee Box include Daffodil, Rosemary, Bluebell, Cowslip, and Winter Honeysuckle.

For more information about Bees, visit https://www.buzzaboutbees.net/.

HOW TO:

Design and Install a Sign

Kennebecasis Watershed Restoration Committee

INTRODUCTION

At KWRC, our site signs are a very important part of our restoration efforts within the Kennebecasis Watershed. They serve to educate landowners and other public entities about species that inhabit the watershed and about the restoration techniques used. The site signs often use imagery to depict species and show before and after photos of the restoration sites to give passersby a good indication of the work that we performed.

The KWRC has also created signs for the upper and lower end of the No Kill section on the Upper Kennebecasis River. These are installed along crossings and beside known river access points where Anglers will see them.

SIGN DESIGN

The KWRC uses a template for all of our site signs to achieve consistency - once someone sees one sign, they will be able to identify any of our other signs throughout the watershed by just a glance. This allows them to rapidly identify a restoration site and more effectively understand and appreciate the amount of work the KWRC or other watershed groups have been completing.

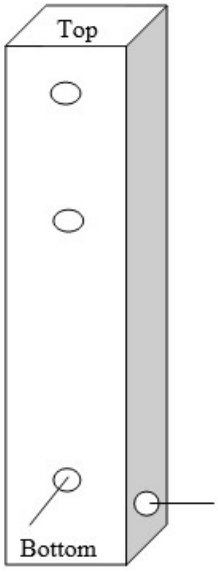
It is important to consider the requirements of funding bodies when designing signs – many have specific requirements about logo placement or wording.

It is also important that signs are UV resistant and are also tough enough to resist vandalism. If possible, try to have signs produced by a local business.

SITE SIGN INSTALLATION

The following steps show how KWRC installs site signs. Smaller signs are installed using one 4” x 4” x 8’ post, and larger signs require 2 of the same posts. The directions below relate to installing a larger (more common) sign using 2 posts, but are easily adaptable for smaller signs.

1. Drill two holes in the bottom of each post, large enough for a piece of rebar (> ¾”) to fit through. This portion of the post will be buried. The holes should be roughly 6” above the base of the post and 4” apart.
2. Drill two holes in the top of each of the posts. It is easiest to lay the sign on the post where you want it situated and drill through the sign until it hits the post. This will show you exactly where to drill the two holes in your post. (Make sure the sign is centered on the posts)
3. Once all the holes are drilled, insert the rebar into the holes on the bottom of each post. The rebar helps stabilize the posts and prevents them from readily being pulled out by potential vandals. Then attach the sign using ½ or ¾ x 6” carriage bolts. Place washers behind the sign on each side of the post and secure with nuts. The protruding portion of the bolt can be cut off with a hack saw to prevent vandalism.
4. Dig a minimum 2’deep hole for each post. This depth will be below the frost line which will keep the sign secure throughout all seasons. Place the sign posts in the holes and fill the holes.
5. Geo-tag your sign so you know where it is and you can add it to a maintenance program or schedule. Signs should be visited in the spring and you should make sure it is still level, aesthetically pleasing, and still legible.



MATERIALS REQUIRED

The following materials are required for installing a site sign:

- Drill
- ½ & ¾ inch drill bits
- 2 - 4” x 4” x 8’ posts
- 4 – 1’ pieces of rebar
- 4 - ½ or ¾ x 6” carriage bolts, 4 nuts & 8 washers
- Shovel
- Hacksaw
- Hammer
- Vice Grips
- Wrench
- Sunscreen & bug spray
- First Aid kit

NO KILL SIGN INSTALLATION

These signs are made of perforated plastic, which makes them very easy to install. Simply take a screw, fitted with a washer and drill the sign into place on a bridge, post or tree (preferably into non-living wood). It is important to place these signs in very visible locations so that anglers can readily notice them.

MATERIALS REQUIRED

- Drill
- 2 Screws & 2 Washers

OTHER CONSIDERATIONS

The type of sign you choose may be quite different from what is outlined here and therefore your installation may be much different. If this is the case, document the process so that future staff will understand how to effectively install similar signs.