

# NORTHWOODS STEWARDSHIP CENTER

*Connecting people and nature through research, education and action.*

## **Clyde River Wetlands Natural Community Mapping Project Final Report**



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## **Clyde River Wetlands Natural Community Mapping Project 2012 Final Report**

### **I. INTRODUCTION**

This project expanded upon natural community mapping conducted by the NorthWoods Stewardship Center in the wetlands of the Upper Clyde River Watershed in 2010-2011. A prior survey of wetlands throughout the Lake Memphremagog watershed in 1998 by the Vermont Nongame and Natural Heritage Program (NNHP) identified the upper Clyde River wetlands as one of the four most significant complexes in the Memphremagog watershed, and a priority area for additional study and conservation efforts (Engstrom et al. 1999). This assessment was based on the diversity and extent of wetland types found here, multiple high quality occurrences of natural community types that are uncommon statewide, and significant populations of multiple rare plant species.

Subsequent Stream Geomorphic Assessment (SGA) work undertaken by NorthWoods beginning in 2005 identified the Clyde River watershed as the healthiest among the four primary Vermont tributaries of Lake Memphremagog – though some impacts were also noted (Dyer et al. 2008). The extensive wetlands of the upper watershed were credited as contributing significantly to the overall stream health and water quality found in the Clyde River through their role in filtering sediment and nutrient inputs from the surrounding uplands and in absorbing flood waters, thereby reducing flood damage to downstream areas.

Given the exceptional functions and values associated with these wetlands, their importance to local and regional biodiversity and water quality, and limited understanding of the natural communities present and threats to them, detailed natural community mapping and threat assessment was identified as a high priority for these wetlands. This work was initiated in 2010-2011 when funds became available through EPA Section 604(b) Water Quality monies allocated to the State of Vermont and subsequently to the Northeastern Vermont Development Association (NVDA), which contracted NorthWoods to complete the project.

Initial work by NorthWoods in 2010-2011 began with delineation of natural communities using aerial photography and GIS reference layers for the section of wetlands extending from the Five Mile Square Road in Brighton, downstream to the VT Route 105 Bridge at Buck Flats in Charleston. In this first phase of the project, 902 acres falling within the Vermont Significant Wetland Inventory borders were mapped. Phase 2 involved field surveys for areas identified as high priorities within these wetlands, resulting in 210 acres (24%) of the overall area being field checked. The field surveys led to significant revisions of the Phase 1 mapping, identification of a rare (S2) natural community not previously known to occur in the wetlands (Black Spruce Woodland Bog), as well as new locations of rare plant species and several threats to the wetlands.

Public education was also conducted in 2011 through a workshop hosted at NorthWoods and included a field trip to the wetlands.

Funding was made available again in 2011-2012 for continuation of the project, based in part on water quality priorities identified by VT Department of Environmental Conservation (VTDEC) Watershed Coordinator Ben Copans and various regional conservation groups, and described in the VTDEC's 2012 Basin 17 Water Quality Management Plan. In this second year of the project, funds were allocated toward two focal areas; 1) Riparian Buffer Restoration site identification and planting plans (watershed-wide), and 2) continued Natural Community Mapping in the Upper Clyde River wetlands. Part 1 of the project was completed in 2011 and summarized in documents provided to NVDA in April, 2012. This report summarizes the results of part 2 of the project.

Goals for the second year of the wetland mapping were adjusted slightly to focus on field surveys and data reporting, due both to the evolution of the project (GIS draft maps had been completed in 2011) and to reduced funding for the mapping portion of the project.

### ***2012 Project Goals***

- Complete natural community mapping and wetland threat assessments, in coordination with the Vermont Agency of Natural Resources, for the Clyde River wetlands from the VT Route 105 bridge at Buck Flats (Charleston) to ~1 mile upstream, where mapping ended in 2011, and
- Summarize results of survey work and provide, with recommendations, to the Vermont Nongame and Natural Heritage Program, NVDA, and wetland landowners.

## **II. METHODS**

Methods in 2012 followed fairly closely those used in the Phase 2 (field) component of the 2011 mapping. One exception is that natural community boundaries drawn prior to the fieldwork in GIS were omitted from the field maps in 2012, as these were found to be often inaccurate and unhelpful.

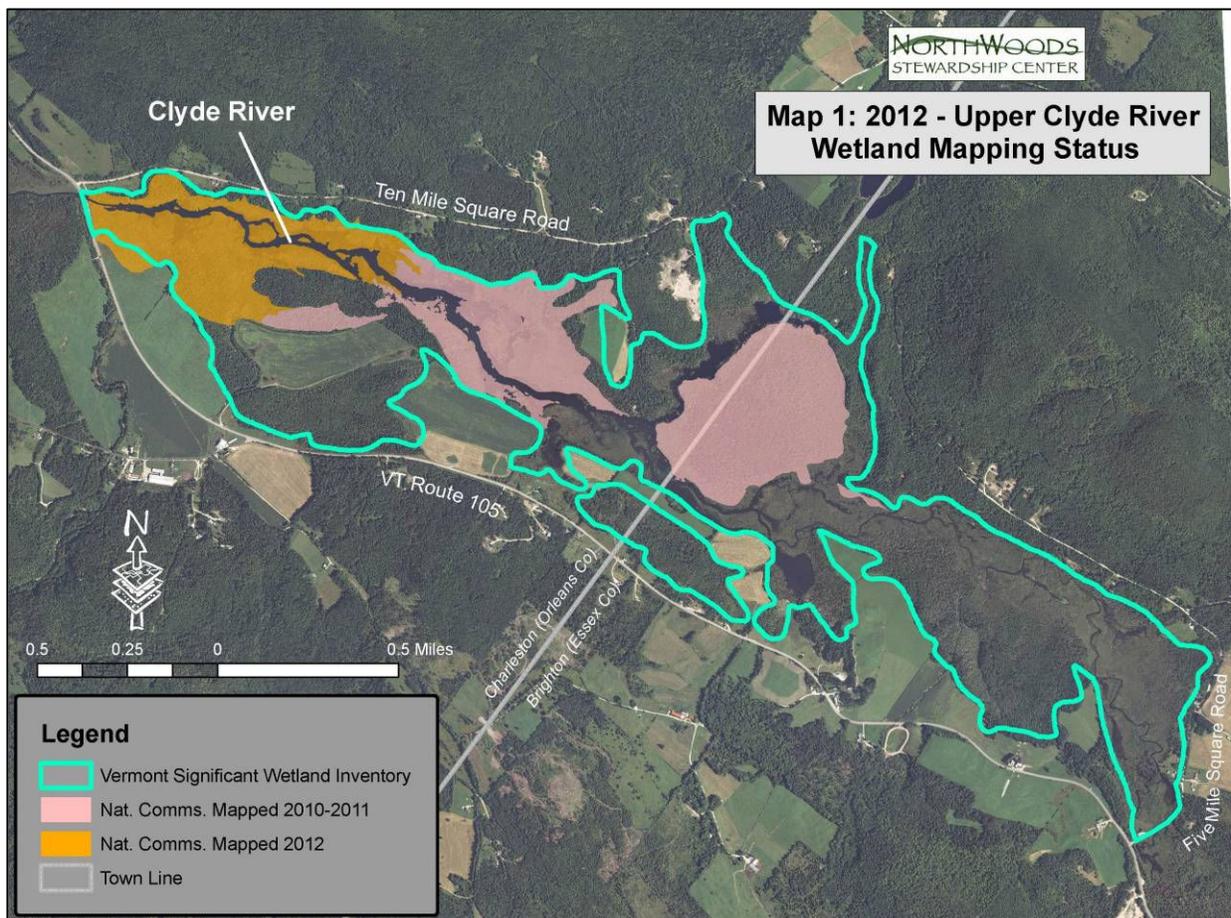
In February 2012 letters were sent to wetland landowners, explaining the goals and anticipated timeline for the project and requesting notification if the landowner did not wish that this work be completed on their property. Eight landowners were contacted, with two responding in the affirmative and no landowners refusing access.

Fieldwork was conducted June 11-30, 2012 by Jayson Benoit of NWSC, with assistance from Land Management Americorps member Meghann Carter. Water levels were low during much of this period, allowing for good access to most of the wetlands. Several days of rain toward the end of the field surveys raised water levels 12-15 inches and made observations at the west end of the survey area more difficult. Relevant background information, including Ecological Occurrence data and Natural Community data criteria from the Vermont NNHP, and the Lake Memphremagog Inventory report (Engstrom et al 1999), were reviewed prior to the fieldwork. Laminated field maps were prepared using 2008 NAIP Color Infra Red 1-meter resolution aerial imagery and 2008 Border Region True Color 0.3-meter resolution aerial imagery.

Field surveys were conducted by foot or canoe, with natural community boundaries sketched directly (where possible) using indelible markers onto the laminated photos. Detailed notes were collected including; general site descriptions, plant species found within each community, digital photographs, and GPS points (Garmin 76csx handheld unit). Features of special interest were also noted, such as locations of rare species or potential threats (invasive species, etc). Tree cores were collected at 17 sites to better understand the extensive mortality noted in the outer forested wetland areas and plants were sometimes collected for later identification in the office. Notable wildlife evidence within the natural communities was also recorded. Data were later entered into ArcView v.9.2 and Microsoft Excel.

Natural communities were delineated in the office in ArcView, using the aerial photography described above, maps and data generated in the field, and GIS reference layers obtained from the Vermont Center for Geographic Information (wetland boundaries, hydrology, etc) and other sources (NRCS Orleans County soils data and aerial imagery – various years back to 1942).

Finally, a follow up letter was sent to wetland landowners at the conclusion of the project, describing outcomes and actions that landowners can take to preserve the unique values of these wetlands. This letter was sent to the eight landowners contacted prior to the fieldwork, and a copy is included with this report.



### III. MAPPING RESULTS

The section of wetlands mapped in 2012 extends from the VT Route 105 Bridge at the west end of the Ten Mile Square Road to a point roughly 0.9 miles upstream, where the 2011 mapping ended (Map 1). This area is located entirely in the town of Charleston. In broad overview this section of wetlands can be described as three distinct but connected areas. The *Main Channel Border Wetlands* extend along the Clyde River channel within a 700-900 foot wide floodplain, and are broadly organized channel-to-land by the decreasing influences of flooding and wave action. A second *Buck Brook Area* of the study site extends south along Buck Brook from its very diffuse confluence with the Clyde River to a more defined channel to the south. This mostly forested wetland continues south between farm fields to a larger forested wetland near Route 105, but only the northern part of this area was surveyed in 2012 due to time limitations. Finally, a third smaller area, the *Southwest Wetlands*, lies southeast of the Route 105 bridge and, unlike the previous areas, is in the early stages of re-growth following clearing and agricultural use. These areas are each described in more detail below.

#### **Main Channel Border Wetlands-**

The organization of community types along the Clyde River follows a somewhat predictable pattern created by the association between plant species, substrate, and hydrology, and especially the relative tolerance of each species to flooding (as described by Thompson and Sorenson, 2000). This pattern is (from channel to upland edge); Deep Broadleaf Marsh, Sedge Meadow *or* Intermediate Fen, Red Maple-Northern White Cedar Swamp, and Northern White Cedar Swamp. This arrangement and the species associated with each community type repeat across the wetlands, yet great complexity and diversity is also found within - each area having unique character as a result of its species mix, hydrology, structure, etc.. This mapping is therefore by necessity crude and describes in relatively broad strokes the communities found. More detail is given for each polygon mapped in the GIS shapefile - provided to NVDA and the VT NNHP.

#### ***Deep Broadleaf Marsh:***

This natural community type occurs extensively in bands along the edges of the main channel and amongst the many bay and backwater areas in water ranging from roughly 6-40 inches deep. In several locations it also forms mid-channel submerged “islands” of vegetation. It is best defined by pickerelweed (*Pontederia cordata*), but also commonly includes patches of yellow water-lily (*Nuphar variegatum*), fragrant water lily (*Nymphaea odorata*), pondweeds (mainly *Potamogeton amplifolius*, *P.natans*, and *P.epihydus*), bur-reeds (*Sparganium spp*), common bladderwort (*Utricularia vulgaris*), arrowheads (*Sagittaria spp*), water horsetail (*Equisetum fluviatile*), and quillworts (*Isoetes spp*). Other species found less frequently include sweet flag (*Acorus calamus*), the aquatic green algae muskgrass (*Chara sp*), and pipewort (*Eriocaulon sp*). At multiple locations along the main channel edge are found large submerged beds of state-endangered mare’s tail (*Hippuris vulgaris*). The related natural communities Deep Bulrush Marsh and, more commonly, Cattail Marsh also occur along this section of river.

#### ***Sedge Meadow:***

The Sedge Meadow type is found occasionally in large uniform patches, most notably on the large mid-channel island, but it occurs more often as patches grading into other natural communities. The type is associated with mucky inundated soils and along this section of the Clyde River characteristically includes Northwest Territory sedge (*Carex utriculata*), tussock sedge (*C.stricta*),

three-way sedge (*Dulichium arundinaceum*), blister sedge (*Carex vesicaria*), bur-reed (*Sparganium sp*), broadleaf arrowhead (*Sagittaria latifolia*), bluejoint (*Calamagrostis canadensis*), water horsetail, and marsh cinquefoil (*Potentilla palustris*). Small to large beds of rare marsh mermaid-weed (*Proserpinaca palustris*) were found in 2012 at three Sedge Meadow sites, and rare water sedge (*Carex aquatilis*) at another.

### ***Intermediate Fen:***

Though small in comparison to the expansive fen areas located upstream closer to the Charleston-Brighton line, numerous high quality examples of this natural community - hosting impressive numbers of rare plant species – occur within the 2012 survey area. These are found in widely varying conditions ranging from loose floating mats less than 30 square feet in area to firm grounded-mat areas covering up to two acres. Intermixing is common with adjacent Sweet Gale Shoreline Swamp, Sedge Meadow, or Deep Broadleaf Marsh areas. Depths through the poorly-decomposed peat mat to a sandy substrate range from 4-11 feet. Ubiquitous species in the fen areas are hairy-fruited sedge (*Carex lasiocarpa*) and marsh cinquefoil, while nearly as widespread are sweet gale (*Myrica gale*), buckbean (*Menyanthes trifoliata*), three-way sedge, royal fern (*Osmunda regalis*), marsh St. Johnswort (*Hypericum virginicum*), large cranberry (*Vaccinium macrocarpon*), swamp rose (*Rosa palustris*), and bog rosemary (*Andromeda polifolia*). The rare bog willow (*Salix pedicellaris*) is found in most of these fen areas and in some pockets this species becomes abundant. Rare water sedge (*Carex aquatilis*) and slender cotton-grass (*Eriophorum gracile*) also occur in this community type, as do several large beds of state-endangered mare's tail.



*Intermediate Fen on a floating peat mat, with sweet gale visible beneath waves of hairy-fruited sedge.*

Species diversity increases notably in a variation of the intermediate fen type (often located at or near the mat edge) where a slightly raised micro-environment supports a mixing of classic intermediate fen plants with species more indicative of a poor fen or bog. In many cases these areas are characterized by a dense carpet of buckbean, accompanied by swamp candles (*Lysimachia terrestris*), northern bugleweed (*Lycopus uniflorus*), water parsnip (*Sium suave*), beggarticks (*Bidens sp.*), stiff marsh bedstraw (*Galium tinctorium*), common marsh bedstraw (*Galium palustre*), orange spotted jewelweed (*Impatiens capensis*), marsh speedwell (*Veronica scutellata*), violet species (*Viola spp*), and various sedges (*Carex canescens*, *C.echinata*, *C.limosa*). Poor fen associates that occur and are sometimes abundant are pitcher plant (*Sarracenia purpurea*), small cranberry (*Vaccinium oxycoccos*), round-leaved sundew (*Drosera rotundifolia*), spatulate-leaved sundew (*Drosera intermedia*), and horned bladderwort (*Utricularia cornuta*). Several rare species observed in this fen subtype were state-endangered common arrowgrass (*Triglochin maritima*); rare bog-rush (*Cladium mariscoides*), bog sedge (*Carex exilis*), large marsh bedstraw (*Galium obtusum*), and Northeastern sedge (*Carex cryptolepus*); and uncommon rose pogonia (*Pogonia ophioglossoides*).

### ***Sweet Gale Shoreline Swamp:***

Common along the Clyde River channel, this type occupies the hydrologic middle-ground between frequently flooded herbaceous wetland types and the seasonally-flooded red maple-northern white cedar swamps that often extend to the upland edge. Growth is often dense and dominated by sweet gale and other shrubs (3-9 feet tall) that include speckled alder (*Alnus incana*), swamp rose, leatherleaf (*Chamaedaphne calyculata*), alder-leaved buckthorn (*Rhamnus alnifolia*), shrubby cinquefoil (*Potentilla fruticosa*), winterberry (*Ilex verticillata*), red-osier dogwood (*Cornus stolonifera*), silky dogwood (*Cornus amomum*), bog rosemary, meadowsweet, and silky willow (*Salix sericea*). Forb diversity can be high as well, with bluejoint and royal fern mixing with the shrubs; swamp candles, marsh cinquefoil, sensitive fern (*Onoclea sensibilis*), bedstraws, and others occurring below the shrub layer; and blue flag (*Iris versicolor*), water parsnip, spotted Joe-pye weed (*Eupatorium maculatum*), dock species (*Rumex spp*), three-way sedge and others found in moist openings among the shrubs. Rare shining rose (*Rosa nitida*) and bog willow occur occasionally in this type and beds of rare marsh mermaid-weed and state-endangered mare's tail were found in several locations growing in the mucky channels and pools between shrub clumps.

Red maple (*Acer rubrum*) saplings also occur sporadically and Sweet Gale Shoreline Swamp appears to be expanding into former Red Maple-Northern White Cedar Swamp areas that have been declining. Such transitional areas where red maple and northern white cedar (*Thuja occidentalis*) regeneration is very limited (indicating unlikely re-establishment) were mapped as this type.

### ***Red Maple- Northern White Cedar Swamp:***

This forested wetland natural community makes up 27% of the area mapped in 2012, occupying the wetland – upland edge and bordered on the channel side by one or more of the non-forested wetland types described above. The width of the community is less along the north shore (as little as 25 feet), while in some areas south of the channel the width is as much as 400 feet. Frequently a sweet gale swamp community is found at the gradient between the open wetlands and this type.

Presumably as a result of changing hydrological patterns, this natural community is in an active state of flux throughout the Upper Clyde River Watershed. An increased frequency and/or duration

of flooding have caused the inner (channel-side) edge of this community to migrate landward, as evidenced by an abundance of red maple, northern white cedar, and black ash (*Fraxinus nigra*) snags and stumps 4-12 (20) inches in diameter extending out to the channel. Cedar blowdowns are also common with mostly >5 year old trunks stacked in some areas 6-9 feet high. While many red maple and black ash in this transition zone have died in recent decades, others persist in a stressed state with live branches only in the lower boles. Widely scattered super-canopy white pine (*Pinus strobus*) also are found, though a number have recently died. Other tree species present to a lesser degree are balsam fir (*Abies balsamea*), tamarack (*Larix laricina*) - also with high mortality, eastern hemlock (*Tsuga canadensis*), and yellow birch (*Betula alleghaniensis*).

The extensive dieback and windthrow along the inner edge of these swamps has resulted in very sporadic canopy cover and a resulting flush in shrubs and saplings (most often red maple or black ash). Winterberry is the most widespread and abundant shrub, with other common associates being speckled alder, sweet gale, leatherleaf, wild raisin (*Viburnum cassinoides*), nannyberry (*Viburnum lentago*), black chokeberry (*Aronia melanocarpa*), silky willow, alder-leaved buckthorn, meadowsweet, red-osier and silky dogwood, and dwarf raspberry (*Rubus pubescens*), while less widespread shrubs are mountain holly (*Nemopanthus mucronata*), sheep laurel (*Kalmia angustifolia*), Labrador tea (*Ledum groenlandicum*) and serviceberry (*Amelancier sp.*).

The understory is also diverse and abundantly vegetated; reflecting a variety of growing conditions created by the flooding of the outer zone and the developed pit/mound topography closer to land. Well represented species include marsh marigold (*Caltha palustris*), royal fern, marsh St. Johnswort, swamp candles, water horsetail, tall meadow rue (*Thalictrum pubescens*), turtlehead (*Chelone glabra*), cinnamon fern (*Osmunda cinnamomea*), marsh fern (*Thelypteris palustris*), crested fern (*Dryopteris cristata*), swamp milkweed (*Asclepias incarnata*), three-way sedge, marsh bedstraw, water parsnip, spotted Joe-pye weed (*Eupatorium maculatum*), water purslane (*Ludwigia palustris*), and tufted loosestrife (*Lysimachia thyrsiflora*). Most notable among the rare species found in this community type are rare swamp fly-honeysuckle (*Lonicera oblongifolia*), observed at nine locations, and rare long sedge (*Carex folliculata*), found at >10 locations, and a single uncommon mountain fly-honeysuckle (*Lonicera villosa*).



*Swamp fly-honeysuckle*

While the change in flooding regime is the most dramatic and visible impact in this community type, some areas have also been selectively logged over the past few decades, particularly along the north shore. Other scattered small pockets are in an early successional stage of alder swamp or sedge meadow following abandonment as former farmlands. Areas were mapped as this type where regeneration and/or other site indicators suggest that red maple and northern white cedar are likely to re-establish as >40% canopy cover. Areas where shrubs now dominate were mapped as Sweet Gale Shoreline Swamp.

### ***Northern White Cedar Swamp:***

This natural community type is distinguished from the previous by a canopy dominated by northern white cedar and the absence of regular seasonal flooding. Like the Red Maple-Northern White Cedar Swamps described above, Northern White Cedar Swamp may have historically occupied more of the upper Clyde River wetlands and been reduced through an increase in flooding extent and/or duration. Within the 2012 survey area this type is best represented today in the Buck Brook area described below. A narrow band (20-150 feet wide) of NWC Swamp is also found along the north shore of the river between an equally narrow Red Maple-Northern White Cedar Swamp and the uplands. Within this forest are several acres of well-developed forest, with cedars ranging from 5-18" dbh. A cored 10" dbh cedar at the outer swamp edge was 150 years old, while a 15" dbh cedar within the swamp was 110 years old. Other trees sharing the cedar canopy are black ash, balsam poplar (*Populus balsamifera*), yellow birch, balsam fir, red maple, and eastern hemlock. A pit/mound topography is well developed and the canopy is mostly closed, except for several openings resulting from cedar windthrow and tamarack mortality. Understory plants include *Sphagnum spp*, bristlystalked sedge (*Carex leptalea*), prickly sedge (*Carex spicata*), silvery sedge (*Carex canescens*), threeseeded sedge (*Carex trisperma*), needle spikerush (*Eleocharis acicularis*), marsh bedstraw, greater bladder sedge (*Carex intumescens*), and fowl mannagrass (*Glyceria striata*). Rare species observed here were long sedge, prickly bog sedge (*Carex atlantica ssp capillacea*), and swamp fly-honeysuckle. The invasive plant true forget-me-not (*Myosotis scorpioides*) was noted in abundance in several low wet areas within the swamp.

### **Buck Brook Area-**

Buck Brook is a small tributary originating on the north slopes of Bald Mountain that flows northward, crossing a town road, VT Route 105, and corn/hayfields of the Taft Farm in Charleston before entering the Clyde River wetlands. As it approaches the main Clyde River channel the flow disperses among a series of beaver ponds and inundated swamp before an obscure confluence with the river just west of a large mid-channel island.

Moving southward, the wetlands along lower Buck Brook transition from the main wetland complex at the Clyde River into a series of two narrowing, mostly forested, wetland arms arcing to the east. These arcs may occupy ancient former river channels and are bordered by better drained soils, including a roughly 34-acre area cleared of its forest for cornfield approximately ten years ago. The wetland arc to the north was surveyed by NWSC in 2011 and is the location of the only Black Spruce Woodland Bog natural community known to the upper Clyde River wetland complex. The southern arc has yet to be surveyed but appears to include a northern white cedar swamp.

The Buck Brook wetlands are distinct in several ways from the main channel wetlands, beginning with the series of small beaver ponds and shallow emergent "beaver meadows" near the brook's outlet that feature elements of deep broadleaf marsh, cattail marsh, sweet gale shoreline swamp, and other community types. Flanking these diverse open wetlands is Alder Swamp that appears to have expanded in recent decades with the dieback of former cedar swamp in the wettest areas – part of the same process described above along the main channel. Moving east from Buck Brook, advanced regeneration of northern white cedar, red maple, and balsam fir up to nine feet tall mixes with the alder, among widespread red maple and cedar snags. Beyond this a narrow band of Northern White Cedar Swamp is found ringing the upland edge. Plants found among the alder and regenerating red maple- cedar swamp are diverse and include winterberry, mountain holly, marsh

marigold, orange spotted jewelweed, horsetails (*Equisetum spp*), tussock sedge, royal and marsh ferns, common cattail, spotted Joe-pye weed, sheep laurel, sweet gale, heart-leaf willow, various bedstraws (*Galium spp*), dwarf raspberry, and an abundance of wild calla.

Both long term and more recent impacts associated with the nearby agricultural land are evident in these wetlands. A narrow swath of cleared forest along Buck Brook and other evidence (including aerial photos) suggest that dredging and straightening of the brook took place circa 1998 as far as the northwest corner of the present corn field (prior to the expansion of the field to this point), and was more recently extended north roughly 300 feet. This work was presumably done to prevent flooding of the field area. A patch of cedar up to 13" dbh off the northwest corner of the field appears to have died not long before 2008, possibly also in relation to the field clearing and/or stream alterations. Another impact has been the introduction of exotic plants, including several invasive species, which likely colonized the wetlands both from adjacent open fields and by transport in flood waters from upstream field areas. This impact is particularly clear in the open canopy clearing along Buck Brook and the adjacent alder swamp, where common plants include a mix of aggressive or invasive exotic species (common burdock (*Arctium minus*), true forget-me-not, bittersweet nightshade) and natives common to disturbed moist openings (orange spotted jewelweed, sensitive fern, virgin's bower (*Clematis virginiana*), and spotted Joe-pye weed).



*Cedar swamp west of Buck Brook*

To the west of Buck Brook is the most extensive intact Northern White Cedar Swamp encountered in the 2012 survey area. A mix of age classes occurs here and parts of the swamp may have been logged in the late 1960s, though other sections appear undisturbed except for windthrow and some canopy dieback. A cored 14" dbh cedar in this area was 125 years old. The eastern part of this forest is wettest, with a well developed pit/mound topography and upland herbs such as goldthread (*Coptis groenlandica*), wild sarsaparilla (*Aralia nudicaulis*), and mountain

wood sorrel appearing on the raised hummocks, while golden saxifrage (*Chrysosplenium americanum*), wild calla, marsh marigold, Pennsylvania bittercress (*Cardamine pensylvanica*), and various moss species are found in the adjacent the wet hollows. The understory also includes stairstep moss (*Hylocomium splendens*), naked miterwort (*Mitella nuda*), sweet-scented bedstraw (*Galium triflorum*), threeseeded sedge, softleaf sedge (*Carex disperma*), graceful sedge, littleleaf buttercup (*Ranunculus arborvitus*), creeping buttercup (*Ranunculus repens*), fowl mannagrass, and one-sided pyrola (*Pyrola secunda*). Rare plants found here were uncommon smooth sedge (*Carex laevivaginata*), rare large marsh bedstraw, and swamp fly-honeysuckle.

Cedar (5-22" dbh) is the dominant canopy species in this swamp, with some yellow birch, red maple, black ash, and balsam poplar also present. In the southern part of the mapped area are several white spruce rising far above the cedar canopy to heights of roughly 70 feet. Moving westward a clear gradient is crossed to a better drained soil (fine sandy loam over sand) and cedar becomes less dominant, with yellow birch (to 22"), black ash (to 13"), red maple (to 16"), and balsam fir (to 13") sharing the canopy. A cored 10" dbh black ash here was 129 years old. Within

the understory are sensitive fern, tall meadow rue, Jack-in-the-pulpit (*Arisaema triphyllum*), Canada mayflower (*Maianthemum canadense*), dwarf raspberry, greater bladder sedge, dwarf enchanter's nightshade (*Circea alpine*), false hellebore (*Veratrum viride*), foamflower (*Tiarella cordifolia*), long-beech fern (*Phegopteris connectilis*), oak fern (*Gymnocarpium dryopteris*), helleborine (*Epipactis helleborine*), and Canada fly-honeysuckle (*Lonicera canadensis*). A ground cover of poison ivy (*Toxicodendron radicans*) becomes abundant closer to the field edge and patches of this species also are found in the Red Maple-Northern White Cedar Swamp to the north. The better drained western area was also mapped as Northern White Cedar Swamp, based in part on the apparent persistence of cedar as a canopy species, though this portion is not typical in terms of soils or hydrology.

At the northwest corner of the Buck Brook cedar swamp is a notable small (0.7 acre) patch of northern white cedar, isolated somewhat from the main swamp by a blowdown area to the east and an arm of upland forest to the south. *Sphagnum spp* are common here in a well-developed understory that also includes royal fern, cinnamon fern, sweet gale, alder-leaved buckthorn, wild raisin sheep laurel, marsh marigold, turtlehead, swamp candles, spotted Joe-pye weed, marsh St. Johnswort, wild calla, *Sparganium sp*, marsh speedwell, various sedges (*C. canescens*, *C. flava*, *C. trisperma*), and true forget-me-not. Within this small area are also found patches of rare long sedge, at least 20 of the rare swamp fly-honeysuckle, and a small population of the uncommon Loesel's twayblade (*Liparis loeselii*). A larger (16" tall) unidentified orchid species was also present, but not in flower at the time of the survey.



*Loesel's twayblade*

### **Southwest Wetlands:**

This area of roughly 14 acres lies at the south side of the Clyde River channel and the east side of Route 105. It is distinctive from most of the upper Clyde River wetlands in being at the early stages of succession following relatively recent agricultural use. Though the date of abandonment is unclear, aerial photos from as late as the early 1990s show the area to be primarily herbaceous. Today much of this wetland is vegetated in a mix of low shrubs, herbs, and patches of shrub willows, with scattered hardwood regeneration up to 15 feet tall (mainly red maple and Freeman's maple (*Acer x freemanii*)- a cross between red and silver maple). Other species include sandbar willow (*Salix interior*), Bebb's willow (*Salix bebbiana*), an abundance of fringed loosestrife (*Lysimachia ciliata*), silky dogwood, nannyberry, and at least one rare shining rose among an abundance of swamp rose.

Adjacent fields to the south continue to be hayed as close to the river as conditions allow – well within the VSWI wetland soils boundary and into a forb-graminoid mix that includes a large proportion of sedges. In the relatively dry early summer of 2012 the fields were mowed in late June up to the tall willow shrub line, approximately 430 feet south of the river edge. We mapped these outer bands as Northern White Cedar Swamp and Red Maple-Northern White Cedar Swamp natural communities, based largely on 1940's aerial photography of adjacent intact forests, soil maps, and hydrology. These types should be considered preliminary given the current early successional stage and the apparent ongoing adjustment of these community types in the upper Clyde River watershed.

Several interesting small non-forested wetland types are found closer to the river channel, where unstable saturated soil conditions have likely always limited agricultural use. Features of this area begin at the river channel with narrow strips of the River Mud Shore community type upstream of the Route 105 Bridge. The extent to which these are depositional features resulting from the bridge constriction is unclear, but judging from aerial imagery, they appear to be fairly stable. Vegetation includes bur-reeds, broadleaf arrowhead, and common spikerush. Behind and upstream of river mud shore are a series of levee-like features with a mix of shrub and herbaceous growth; winterberry, willows (heart-leaved, silky, balsam, and shining), abundant swamp rose, speckled alder, red-osier dogwood, bluejoint, reed canary grass, Allegheny monkey flower (*Mimulus ringens*), swamp milkweed, royal fern, water parsnip, marsh cinquefoil, and swamp candles.

Beyond these areas are Sedge Meadow dominated by water horsetail, Northwest Territory sedge, blister sedge, and tussock sedge, with the rare water sedge and uncommon Gray's sedge (*C. grayi*) also present. A nearby patch of Intermediate Fen occupies a grounded mat with mainly hairy-fruited sedge, bluejoint, the common sedge species noted above, water horsetail, marsh cinquefoil, and blue flag. A small arm of Deep Broadleaf Marsh extending into a portion of this fen contains a large (500 sq ft) loose mat of rare marsh mermaid-weed. Finally, a narrow wet band lying just east of the highway right-of-way contains small examples of Intermediate Fen (on a shallow grounded mat), Deep Broadleaf Marsh, Sedge Meadow, and Cattail Marsh.



*View looking east from the VT Route 105 Bridge into the 2012 survey area –Dolof Mountain beyond*

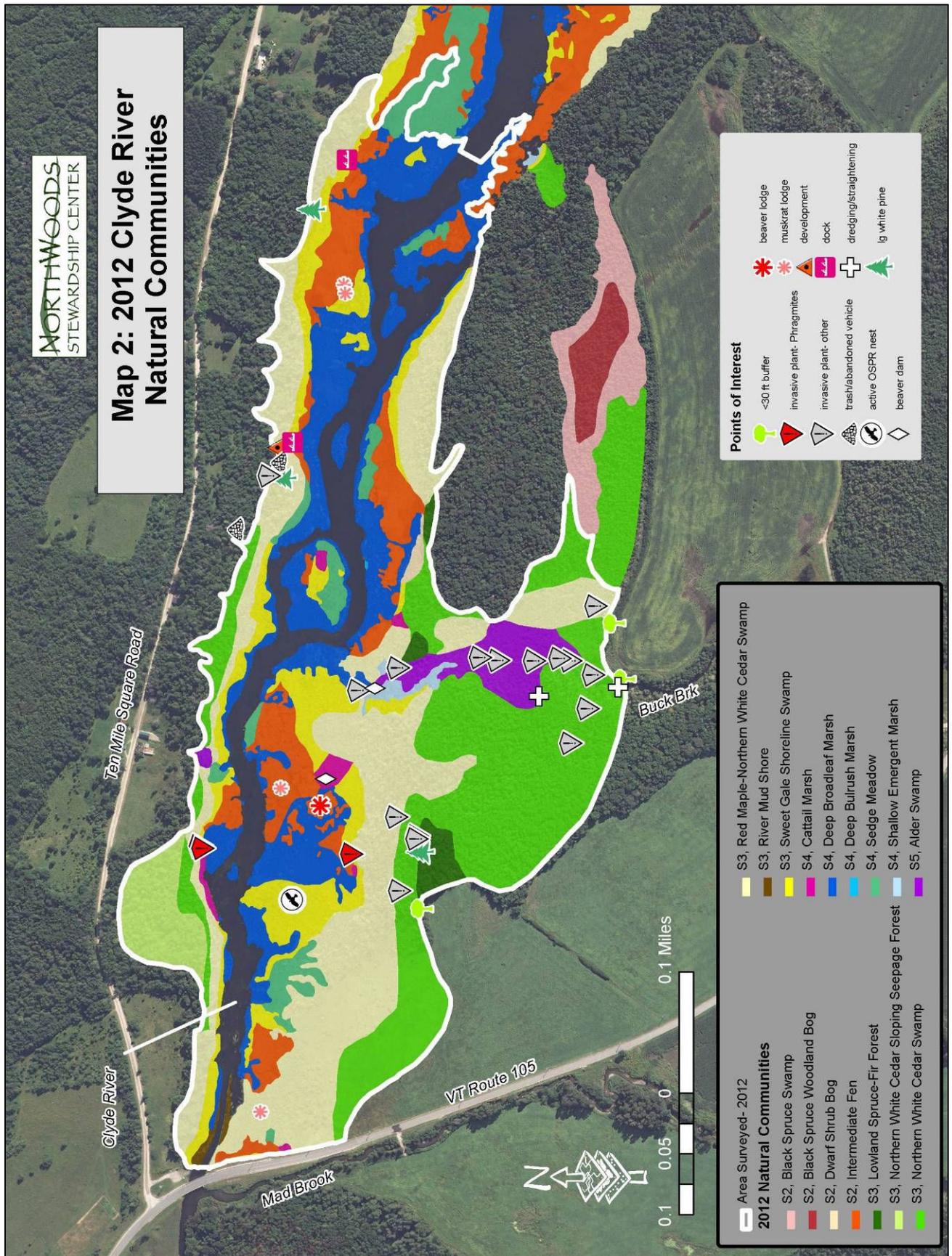
## **Summary of Findings:**

A total of 104 acres of wetlands were mapped in 2012, augmenting 210 acres mapped previously to the east and described in our 2011 report (Table 1). Within the 2012 project area, fourteen natural community types were encountered, with Red Maple-Northern White Cedar Swamp and Northern White Cedar Swamp making up the bulk of the area at 27% each, followed by Deep Broadleaf Marsh (17%), Sweet Gale Shoreline Swamp (10%), and Intermediate Fen (9%). Other community types were found in small acreages, including two new to this study area – Dwarf Shrub Bog (S2) and River Mud Shore (S3). Overall, 75% of the mapped area was occupied by rare (S2) or uncommon (S3) natural community types, mirroring previous mapping results in the upper Clyde River wetlands. Of 310 total acres mapped in upper Clyde River watershed from 2010-2012, 84% has been found to harbor natural community types that are ranked as rare or uncommon statewide.

The condition of natural communities mapped in 2012 was lower than in areas mapped previously to the east, with only 27% in A or B-ranked condition in the 2012 project area (compared to 61% in the previous area). This discrepancy is mainly due to the fact that previous mapping included larger areas of Intermediate Fen and Black Spruce Swamp, which have been less affected by invasive plants, changing hydrology, and land use history impacts.

<b>Table 1: Natural Community Results</b>		<b>2012 Project Area Condition Rankings</b>				<b>2012 Total Acres</b>	<b>2011 Total Acres</b>	<b>Grand Total</b>
		<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>			
S2	Black Spruce Swamp					31.7	31.8	
	Black Spruce Woodland Bog					2.1	2.1	
	Dwarf Shrub Bog	0.3				0.3	0.3	
	Intermediate Fen	<u>8.2</u>	<u>1.4</u>			<u>9.6</u>	<u>29.5</u>	
	<b>S2 Total:</b>	<b>8.5</b>	<b>1.4</b>			<b>9.9</b>	<b>63.3</b>	
S3	Lowland Spruce-Fir Forest (well drained variant)		1.6			1.6	5.9	
	Northern White Cedar Swamp	4.9	13.2	4.4	2.1	24.6	50.3	
	NWC Sloping Seepage Forest		3.4			3.4	3.4	
	Red Maple-NWC Swamp		15.8	12.6		28.4	104	
	River Mud Shore		0.3			0.3	0.3	
	Sweet Gale Shoreline Swamp	<u>8.6</u>	<u>1.6</u>	<u>0.1</u>		<u>10.3</u>	<u>28.0</u>	
<b>S3 Total:</b>	<b>13.5</b>	<b>35.9</b>	<b>17.0</b>	<b>2.1</b>	<b>68.6</b>	<b>191.8</b>		
S4	Cattail Marsh	0.5	0.3			0.8	0.9	
	Deep Broadleaf Marsh	14.8	2.6			17.4	32.7	
	Deep Bulrush Marsh		0.01			0.01	0.31	
	Sedge Meadow	1.5	2.1			3.6	6.0	
	Shallow Emergent Marsh	<u>0.5</u>				<u>0.5</u>	<u>1.2</u>	
<b>S4 Total:</b>	<b>17.3</b>	<b>5.1</b>			<b>22.4</b>	<b>41.1</b>		
S5	Alder Swamp		<u>3.5</u>			<u>3.5</u>	<u>8.4</u>	
	<b>S5 Total:</b>		<b>3.5</b>			<b>3.5</b>	<b>8.4</b>	
<b>Grand Total</b>		<b>39.3</b>	<b>46.0</b>	<b>17.0</b>	<b>2.1</b>	<b>104.4</b>	<b>314.6</b>	

**Map 2: 2012 Clyde River  
Natural Communities**



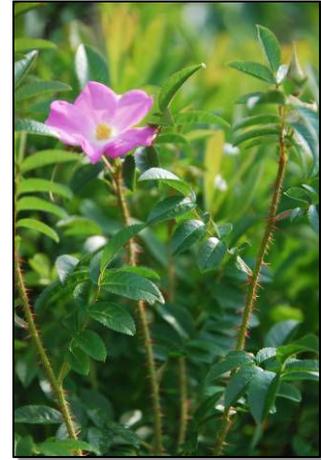
**Points of Interest**

- <30 ft buffer
- invasive plant- Phragmites
- invasive plant- other
- trash/abandoned vehicle
- active OSPR nest
- beaver dam
- beaver lodge
- muskrat lodge
- development
- dock
- dredging/straightening
- lg white pine

**2012 Natural Communities**

- Area Surveyed- 2012
- S2, Black Spruce Swamp
- S2, Black Spruce Woodland Bog
- S2, Dwarf Shrub Bog
- S2, Intermediate Fen
- S3, Lowland Spruce-Fir Forest
- S3, Northern White Cedar Sloping Seepage Forest
- S3, Northern White Cedar Swamp
- S3, Red Maple-Northern White Cedar Swamp
- S3, River Mud Shore
- S3, Sweet Gale Shoreline Swamp
- S4, Cattail Marsh
- S4, Deep Broadleaf Marsh
- S4, Deep Bulrush Marsh
- S4, Sedge Meadow
- S4, Shallow Emergent Marsh
- S5, Alder Swamp

Rare plants were encountered throughout the project area in most of the natural community types, with notable concentrations of rare species found at several Intermediate Fen sites (Table 2). One such site supported a large new sub-population of state-endangered common arrowgrass (estimated at >200 flowering individuals), in the company of uncommon rose pogonia (>100 flowering), and rare bog-rush, bog willow, bog sedge, and slender cottongrass (*Eriophorum gracile*). Uncommon long sedge and rare swamp fly-honeysuckle were noted in many of the Northern White Cedar Swamp and Red Maple-NWC Swamp areas, while uncommon mountain fly-honeysuckle was observed at one location. Mats of rare marsh mermaid weed were found at multiple sites, sometimes occurring below an emergent layer of hairy-fruited sedge, tussock sedge, bluejoint, sweet gale, and marsh cinquefoil, and at other times as a dense open mat shared with only a few other species, often including stunted marsh cinquefoil. One such open mat was one-tenth acre in size while another “understory” mat extended at least a quarter acre through several natural community types. In some areas emergent stems of state-endangered mare’s tail were found interspersed among the marsh mermaid weed mats, and dense beds of submerged mare’s tail were also found along the main channel. Specific locations and more detailed descriptions of rare species will be provided with this report to NVDA and the Vermont NNHP.



*Shining rose*

Evidence of wildlife was also seen throughout the wetlands. Most notable was an osprey nest, located in a large snag south of the Clyde channel in open wetlands and active for the first time in 2012. On several occasions during the fieldwork an osprey from this breeding pair was seen confronting and chasing mature bald eagles as they flew high above the channel. Other birds of interest were Canada warbler (regionally declining and fairly common in the dense understory cedar swamp areas), rusty blackbird (a large flock of this precipitously declining species was observed in the willow shrub area at the west end of the wetlands in mid-spring 2012), pied-billed grebe and sora (both species of species of Special Concern in Vermont heard in the open wetland areas), and willow flycatcher (heard for the first time in 18 years by the author in the upper Clyde River wetlands - where alder flycatchers are common). Nests or other confirmation of breeding were noted for Virginia rail, red-winged blackbird, common yellowthroat, brown creeper, hairy woodpecker, osprey, Canada goose, swamp sparrow, hooded merganser, and mallard.



A large active beaver lodge lies among floating mats of intermediate fen south of the channel and tended dams appear among the nearby cattails and along lower Buck Brook. Among the open wetlands are a number of muskrat lodges – 24” tall piles of sedges and bur-reeds, and also well-used mink/ otter haul out sites on the higher floating mats among the sweet gale and fen (evidenced by piles of scaly scat and crawfish remains).

**Table 2: Rare Plants - 2012 Clyde River Wetlands Project**

Common Name	Scientific Name	State Rank	Natural Community Type(s)	# sites
water sedge	<i>Carex aquatilis</i>	S2	Intermediate Fen, Sedge Meadow	10
Atlantic sedge	<i>Carex atlantica ssp atlantica</i>	S1	Intermediate Fen	1
Howe's sedge	<i>Carex atlantica ssp capillacea</i>	S1	Red Maple-NWC Swamp	1
Northeastern sedge	<i>Carex cryptolepis</i>	S2S3	Intermediate Fen	1
bog sedge	<i>Carex exilis</i>	S2	Intermediate Fen, Dwarf Shrub Bog	3
long sedge	<i>Carex folliculata</i>	S3	NWC Swamp, Red Maple-NWC Swamp	30
Gray's sedge	<i>Carex grayi</i>	S3	Sedge Meadow	1
smooth sedge	<i>Carex laevivaginata</i>	S3	NWC Swamp	1
bog-rush	<i>Cladium mariscoides</i>	S2	Intermediate Fen	10
slender cotton-grass	<i>Eriophorum gracile</i>	S1	Intermediate Fen	1
large marsh bedstraw	<i>Galium obtusum</i>	S2	Intermediate Fen, Sedge Meadow, NWC Swamp, Red Maple-NWC Swamp	6
small bedstraw	<i>Galium trifidum</i>	S3	Sweet Gale Shoreline Swamp, Sedge Meadow, NWC Swamp, Intermediate Fen	3
northern mannagrass	<i>Glyceria borealis</i>	S3	Deep Broadleaf Marsh	3
mare's tail	<i>Hippuris vulgaris</i>	S1(E)	Deep Broadleaf Marsh, Sweet Gale Shoreline Swamp	22
Loesel's twayblade	<i>Liparis loeselii</i>	S3	NWC Swamp	1
swamp fly-honeysuckle	<i>Lonicera oblongifolia</i>	S2	NWC Swamp, Red Maple-NWC Swamp, Dwarf Shrub Bog	16
mountain fly-honeysuckle	<i>Lonicera villosa</i>	S3	Red Maple-NWC Swamp	1
*common reed (native ssp)	<i>Phragmites australis ssp. americanus</i>	S1S2	Cattail Marsh	2
rose pogonia	<i>Pogonia ophioglossoides</i>	S3	Intermediate Fen, Dwarf Shrub Bog	4
marsh mermaid weed	<i>Proserpinaca palustris</i>	S2	Intermediate Fen, Sweet Gale Shoreline Swamp, Sedge Meadow	31
white water-crowfoot	<i>Ranunculus aquatilis var. diffusus</i>	S3	Sweet Gale Shoreline Swamp	1
Shining rose	<i>Rosa nitida</i>	S2	Sweet Gale Shoreline Swamp, Red Maple-NWC Swamp	5
bog willow	<i>Salix pedicellaris</i>	S2	Intermediate Fen, Sweet Gale Shoreline Swamp	38
common arrowgrass	<i>Triglochin maritima</i>	S1(E)	Intermediate Fen, Dwarf Shrub Bog	3

\* Preliminary identification – follow up needed to confirm not *P.australis ssp australis*

### **Threats:**

While excellent A-ranked examples of several natural communities (particularly Intermediate Fen and Sweet Gale Shoreline Swamp) occur in this section of the Clyde River wetlands, the condition of other communities has been diminished and is further threatened by several factors.

#### *Land Use and Development-*

Some signs of past logging can be seen in the forested wetland areas, though agriculture is the primary land use impacting the wetlands. The formerly forested area lying upstream of the Route 105 Bridge and south of the Clyde River channel was probably cleared in the 19<sup>th</sup> century for agricultural use, which continued until as late as the 1980s. This area is now in the early stages of recovery, with a mix of herbaceous vegetation, shrubs, and red maple saplings. Adjacent hayfields to the south still encroach into the VSWI class 2 wetlands on dry years when this area is accessible (2012 is such a year). Active hayfields also abut the cedar swamp at the southwest edge of the wetlands, but of more immediate concern is the large (34-acre) cornfield lying east of Buck Brook amid a variety of sensitive forested wetland types. This area may have been used for agriculture historically, but by the 1940s it was well forested and impacted only periodically by logging.



*Altered Buck Brook near northwest corner of cornfield.*

Clearing and some wetland conversion for the current fields began in the early 1990s and was largely completed by 2002. As described previously, related alterations of the adjacent Buck Brook (presumably including straightening and dredging) appear to have impacted downstream wetlands by increasing sediment deposition and invasive plant introductions. Complete canopy mortality in a patch of cedar forest near the northwest corner of the cornfield may also be in some way related to these impacts, though this association is speculative at this point.

Areas lying north of the Clyde River floodplain continue along a path of forest recovery following a history of agricultural use, and are now generally well-buffered. Only minor development was found along this wetland edge, including two canoe docks and a small camp with outhouse. No visible impacts from these developments were apparent at the time of the fieldwork. The forested wetlands along the north bank also extend upslope through a series of hydric soil fingers that generally end at a toeslope spring or seep. Some of these approach open fields along the Ten Mile Square Road or the road itself, and future land use in these areas should therefore be mindful of the possibility of leaching or other effects on the wetlands below.

#### *Invasive Plants-*

Relative to heavily infested areas in other parts of the state and region, this problem is minor in the upper Clyde River watershed, though impacts are still apparent and a concern. This is particularly true considering the unique diversity of rare native plants and natural communities at stake in these wetlands, and the difficulty of mitigating invasive plant problems once populations have become established. Invasive plants are currently most apparent along Buck Brook and radiating outward into the adjacent non-forested wetlands and cedar swamps. True forget-me-not, in particular,

dominates the understory in the alder and cedar swamps adjacent to Buck Brook and is abundant, though not dominant, in other (particularly wetter) cedar swamp areas. This plant has a low growth habit and therefore many native species are able to co-exist above it. Nevertheless true forget-me-not commonly becomes the most abundant herb, forming a dense ground cover that could have detrimental affects on native species composition, access to nutrients, and possibly the germination of tree and shrub species. Reed canary grass (*Phalaris arundinacea*) is also present in many of the wetlands, with greatest abundance in the disturbed areas along Buck Brook and downstream of this stream's confluence. The adjacent wet hayfields to the south are likely source populations of this very aggressive species that can establish dense monocultures in wetlands- particularly disturbed areas. Given the current extent of these species, their aggressive colonizing abilities, and the continued input of root fragments and seed from adjacent or upstream pasture areas, they will be difficult to eradicate. Reducing future inputs through restored native plant buffer strips (upstream and at adjacent fields), and maintaining or improving the health of the existing natural communities will likely be the most prudent and effective control method. Another exotic, and potentially invasive, plant found more scattered throughout the forested wetland areas is bittersweet nightshade, though this is currently less of a concern than the previous two species. Each of these three species is officially recognized in other New England states as a damaging invasive or noxious weed, but not yet in Vermont.

Two small patches of common reed (*Phragmites australis*) also occur in the project area, one along the north shore of the Clyde River channel and the other south of the channel at the tall shrub/ red maple- cedar woodland swamp zone. Only the north patch was examined closely, and characteristics of both the invasive subspecies *P. australis ssp australis* and the native subspecies (S1/S2) *P. australis ssp. americanus* were observed in these plants (based on Swearington 2006). These patches should be revisited for closer examination during flowering time in late summer and removed if they are found to be the invasive subspecies.

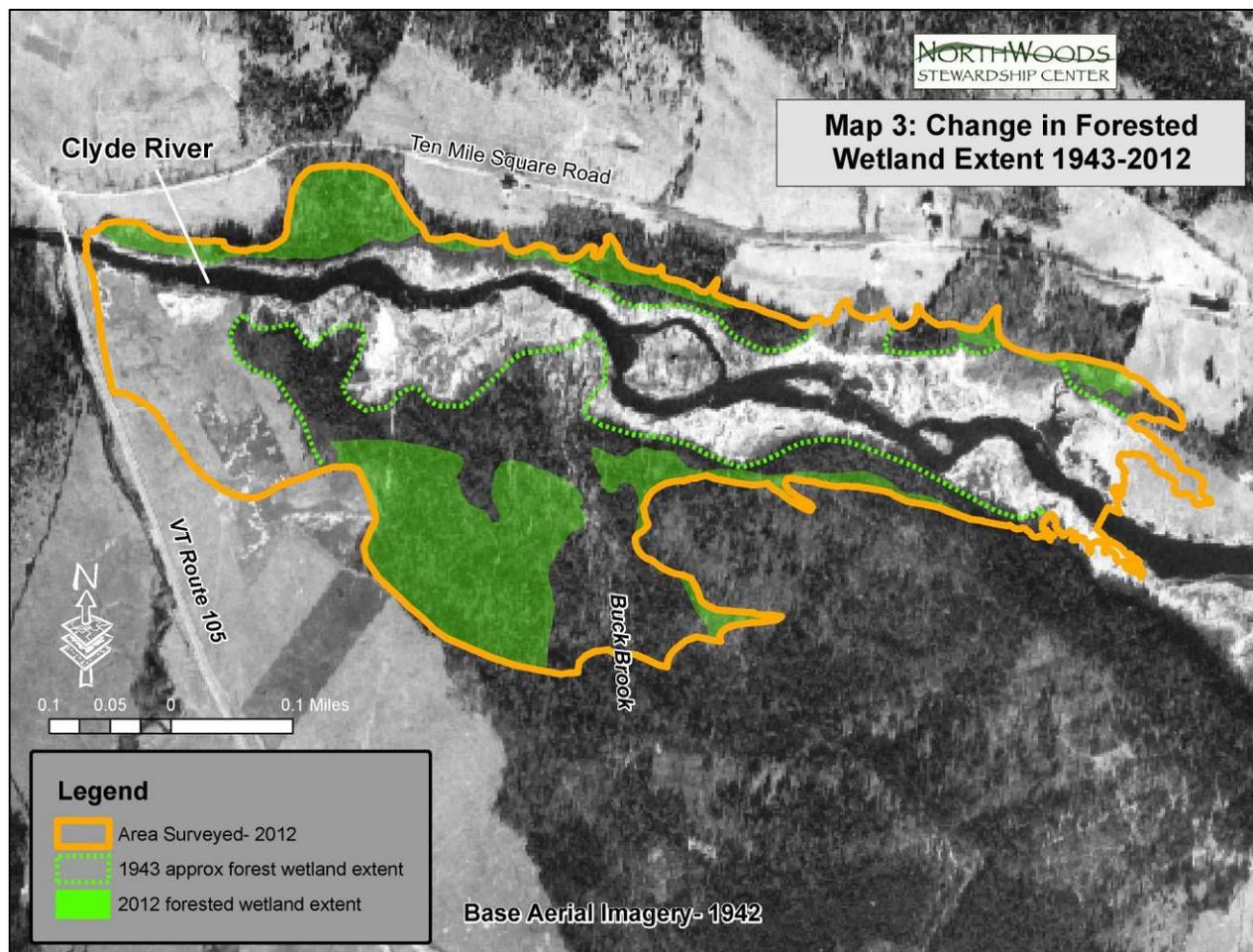
#### *Hydrology-*

Of the forested wetlands mapped in 2012, 34% were found to have either mostly dead or severely declining canopies. As found upstream in 2011, this situation was most pronounced in areas closest to the main channel, with the less flood tolerant northern white cedar being most affected. In many areas the cedar component has seen 90-100% mortality, while the relatively flood-tolerant red maple and black ash remain but are clearly stressed.



*Remains of former Red Maple-NWC Swamp forest.*

A change in hydrology is the apparent cause of this extensive dieback and appears to be resulting in a migration of the forested swamp edge landward and a corresponding expansion of the non-forested wetlands. Much of this leading edge “stress zone” is occupied – beneath the snag remnants of the former forest - by a mix of tall shrubs, herbs, and some red maple, black ash, and (fewer) cedar saplings. Therefore it remains to be seen whether the former forested wetland types will gradually re-establish or give way to a long term shrub swamp community type.



Also unclear is the cause of the change in hydrology. Based on several initial tree cores collected during our 2010-2011 surveys, trees in the wetlands appeared to have had a dramatic slowing of growth rates in the early 1990s. In 2012 we collected 17 additional cores – 13 of these from trees within or at the edge of the visible “stress zone” and the others well within the remaining healthy forested wetland areas. Of the 13 trees associated with the stress zone, 92% (all but one) showed constrictions in growth between 1990 and 1996, with eight showing extreme slowing of growth in this period. Most (8) were clustered between 1990 and 1993. The age of these trees ranged from 70 to 250, with a median age of 137 years. Many trees showed periods of relatively rapid and/or steady growth alternating with episodes of 10-30 years of slow growth through their lifetime, though for almost all trees sampled the slowing of the past several decades was the most extreme that they had experienced.

Increased beaver activity, a change in inputs from Buck Brook or other upstream tributaries, a change in climate patterns, natural fluctuations in flooding duration and/or intervals, or changes to the Route 105 bridge at the downstream end of the study area might be possible causes (or contributing factors) to this change in hydrology. Considering the extent of the dieback along the main channel, the cause is not a localized one – as would be expected with beavers or a single tributary input. Public records state that the Route 105 Bridge was last rebuilt in 1995, which seems to exclude (by just a few years) this as a likely single influence. Additional information; such as the presence or absence and timing of floodplain forest dieback in other parts of the

watershed, more details about past work on the Route 105 Bridge, and detailed historical weather data, will be needed to determine the cause of the hydrology change and dieback.

#### *Other Potential Concerns-*

The confluence of the Clyde River and Mad Brook, a main tributary stream, lies immediately downstream of the Route 105 Bridge at Buck Flats. Mad Brook crosses a broad section of the Clyde River valley before reaching the river, where it passes amid corn and hayfields and along Route 105. This stream has historically been straightened and dredged due to conflicts with these adjacent land uses, including significant in-channel alterations following Tropical Storm Irene in 2011. One result is frequent flushes of sediment into the Clyde River. The Bridge itself also presents a major constriction in the floodplain, most evident during periodic flood events when ponding occurs beyond the upstream wetlands into the adjacent hayfields. Though the full extent of impacts from the Bridge and Mad Brook are unclear, increased deposition is evident in the main channel for at least 500 feet upstream of the Bridge in the form of side and mid-channel bars, shallow depths within the channel, and increased algae and other aquatic vegetation.

Activity appears to have increased along the Clyde River in recent years in the form of recreational canoeing and kayaking, coupled with the traditional uses of hunting and fishing. The river also continues to gain recognition and use as part of the Northern Forest Canoe Trail (NFCT), which attracts more overnight users than ever before. Nevertheless, very little trash was found in or near the wetlands during fieldwork for this project, a notable exception being an abandoned pickup truck 30 feet from a cedar swamp edge along the north shore. Most recreational users stick to the main channel, therefore threats from this activity appear to be minimal at this point. Given a clear trend toward more through-paddlers on the NFCT, campsites that are sited an appropriate distance from the wetlands should be established to avoid problems associated with this use.

#### **Recommendations:**

In general terms, this project underscored the findings and recommendations summarized in our 2011 report, beginning with two conclusions from that report:

- ❖ The Upper Clyde River Watershed wetlands contain exceptional ecological values; particularly in terms of overall extent, natural community and species diversity, and the prevalence of rare species and community types. *Each survey of this area to date has deepened our understanding of this significance through discoveries of new rare species and community types within the wetland complex, and such discoveries are likely to continue with future survey work.*
- ❖ Though these wetlands include many high quality natural communities, a number of threats are evident and current protections may be insufficient to ensure their long term integrity.

To safeguard these wetlands and the unique values and functions associated with them, future efforts should include; (1) completion of the mapping and threat assessment work initiated in 2010-2011, (2) where possible, efforts to remove or mitigate currently identified threats, and (3) increased long-term protection measures.

In 2010-2011 we identified 903 acres of wetlands, extending from the Five Mile Square Road in Brighton downstream to Route 105, as a high priority area for surveys and protection, and completed mapping and threat assessments in 24% of this area. Our work in 2012 extended the

mapping and surveys to the downstream (west) edge of this priority area, of which 35% has now been completed. As additional funding becomes available, the remaining 65% of this area should be mapped and assessed for existing threats. Efforts should also continue to try to identify the most likely cause or causes of the changing hydrology in the upper Clyde River watershed and its potential long term impacts.

At the same time, threats identified in the recent surveys should be addressed, beginning where responses are most possible, most likely to have a positive impact, and are fundable. Priority areas within the section mapped in 2012 include invasive plants, establishing native plant wetland buffers (where these are lacking – including upstream along tributaries such as Buck Brook), and restoring natural stream geomorphology, structure, and canopy cover to Buck Brook.

The lands surveyed in 2012 are entirely privately owned and current protections are limited to those provided by the Vermont Wetland Rules for Class 2 wetlands. These include a required 50-foot buffer between new development and the wetlands, but allow for agricultural and timber harvest use within certain requirements. Over the long term, additional negative impacts on the wetlands are likely through development, agriculture, or other land uses close to the wetland edge unless additional protective measures are put in place. These could include increasing the wetlands designation to Class 1 (which would double the required buffer to 100 feet), or transferring fee ownership or development rights to a land trust organization. Recommendations and possible resources for their completion are summarized in Table 3. These largely follow the recommendations provided in 2011, with some minor changes based on our 2012 surveys.

**Table 3: Recommendations for Next Steps – Upper Clyde River Wetlands**

Category	Recommendation	Potential Resources
<b>Assessment</b>	Complete wetland mapping and threat assessments in the upper Clyde River watershed	Water Quality grants (604b, Watershed Grants, etc), NorthWoods Stewardship Center (NWSC), VT NNHP, consulting ecologists
<b>Recognition/Protection</b>	Pursue Class 1 wetland designation	Same as above, citizen groups
	Enrollment under UVA ESTA categories	Landowners, NWSC, Consulting Foresters
	Conservation ownership or easements for highest value wetlands and buffer areas	Landowners, Vermont Land Trust, TNC, land protection private foundations (various)
	Establish campsites for NFCT through-paddlers at appropriate distance from wetland edge	NWSC, NFCT, landowners
<b>Education</b>	Public lecture series/ outings	NWSC, VT NNHP, special presenters
<b>Threat mitigation</b>	Invasive plant monitoring and manual removal – Phragmites/ purple loosestrife	Landowners, Volunteer groups, NRCS- EQIP/WHIP, NWSC, VT Aquatic Nuisance Grant, Ecosystem Restoration Grant, Other grant sources
	Native species buffer plantings (adjacent agricultural edges and along tributary streams)	Landowners, Volunteer groups, NRCS- CREP, Orleans NRCD-Trees for Streams, NWSC, Ecosystem Restoration Grant, other grant sources
	Address concerns along tributary streams that are resulting in sediment/nutrient inputs or impacting hydrology	NWSC/ VT DEC (Stream Geomorphic Assessments and identified priority areas), Better Backroads grants (culvert retrofits/ stormwater inputs), NRCS- CREP or Orleans NRCD-Trees for Streams (buffer plantings)

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