Rhode Island Rapid Assessment Method User's Guide

RIRAM Version 2.10

Final Report

Prepared for
Rhode Island Department of Environmental Management
Office of Water Resources

April 2011

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NATURAL HISTORY SURVEY
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RIRAM Version 2.10

Thomas E. Kutcher
Rhode Island Natural History Survey
200 Ranger Hall
University of Rhode Island
Kingston, RI 02881
tkutcher@rinhs.org

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1. Introduction

1.1 Background

The State of Rhode Island Department of Environmental Management (DEM) and the Rhode Island Natural History Survey (RINHS) created the Rhode Island Rapid Assessment Method Version 2.10 (hereafter RIRAM) to systematize the rapid collection of observable information on freshwater wetland condition and characteristics. RIRAM was developed in accordance with the *Rhode Island Freshwater Wetland Monitoring and Assessment Plan* (hereafter the Plan; NEIWPCC and DEM 2006), which outlines actions and timelines pursuant to fulfilling short-term and long-term goals focused on enhancing the protection and management of wetlands within the State. The Plan and RIRAM were developed under guidance and funding from the U.S. Environmental Protection Agency (EPA) in accordance with the Clean Water Act. RIRAM represents the second level of an EPA-recommended three-level approach to wetland monitoring and assessment that includes landscape-level assessment (Level 1), rapid assessment (Level 2), and intensive assessment (Level 3). RIRAM is the result of a multi-year development and testing program that included five years of application in diverse drainage basins within the State, analyses of functionality and subjectivity, demonstrations of applicability, validations against Level 1 and Level 3 data, and input from numerous State, Federal, academic, and regional technical advisors and reviewers (Kutcher 2009a; Kutcher 2010a, b, and c).

1.2 Intent of RIRAM Application

RIRAM is a passive freshwater wetland assessment method designed to inventory ecological data and quantify the relative condition of a user-defined wetland assessment unit. RIRAM generates descriptive and semi-quantitative data that can be applied to address State-identified objectives and to establish reference conditions for reference-based monitoring (such as biomonitoring) efforts. It also provides a measure of wetland condition that can be applied to address requirements of the Clean Water Act, regarding the reporting of wetland condition.

RIRAM is organized in a worksheet of attributes and metrics designed to guide the user through a logical data-collection and scoring process based on estimation and interpretation of field observations and remote-sensed data (App. 1). Metric scoring culminates in a set of sub-indices and a final overall index of condition. RIRAM attributes directly characterizing wetland structure, classification, and functions/values are not scored to minimize their contributions to the condition indices, thus ensuring that the indices are not biased by wetland type, size, setting, or other innate characteristics (i.e. are “blind” to wetland type).

RIRAM condition indices do not represent the value of a given wetland unit; rather, they represent condition of the unit compared with its hypothetical pristine (unstressed by

anthropogenic influences) state. Deviation from pristine condition incrementally lowers the score of the unit according to the intensity and proportion of stress effects and observable wetland degradation. Because the original value (social, environmental, economic, etc.) is never quantified nor implied, net value of the unit (value minus loss due to degradation of condition) cannot be, and *should not* be, interpreted through any metrics, attributes, or indices produced by RIRAM.

Conducting a RIRAM assessment entails the identification and evaluation of the evidence and intensity of anthropogenic wetland stresses and the visible integrity of wetland characteristics; this requires that the user holds considerable knowledge of wetland ecology. Specific training in the application of RIRAM is highly recommended, as this User's Manual cannot possibly replace the value of applied field training. RIRAM is not intended to be a citizen-applied assessment. It is intended to be applied by qualified wetland ecologists, specifically to address State monitoring and assessment needs.

2. Overview of RIRAM V2.10 Format and Content

RIRAM draws from various existing RAMs (e.g. The Highway Methodology, USACOE 1993; ORAM, Mack et al. 2002; DERAP, Jacobs 2007) in concept and content, but is unique in format and approach. RIRAM produces a condition index by evaluating stressor intensity and wetland integrity (suggesting response), which closely follows EPA wetland monitoring and assessment guidelines (USEPA 2006). Three sub-indices evaluating landscape stresses, in-wetland stresses, and apparent integrity, can be summed to generate a single relative index of overall wetland condition (App. 1). The index (hereafter *RIRAM* index) is based on 100 possible points; where a score of 100 indicates pristine condition, and a score approaching zero would indicate very-degraded condition. Sub-indices (hereafter identified as specific indices) and metrics can also be used separately for various analyses to inform management or policy.

In the first section, Section A, RIRAM utilizes attributes to document wetland characteristic and classification information to establish baseline and enhance data analysis (App 1, A). The attributes document an assessment unit's size, hydrologic status, habitat structure, classification type, and simplified functions and values, according to predetermined classes. Because the information is not stress-response-based and does not necessarily indicate wetland condition, Section A is not scored.

In the first scored section, Section B, RIRAM utilizes two metrics evaluating surrounding landscape stress by estimating the proportion of land use categories within 100 and 500 feet (30 and 150 meters, respectively) (App. 1, B). These metrics are weighted ten points each and are summed to comprise the *Landscape Stress* index, which represents 20% of the *RIRAM* index.

In the next section, Section C, RIRAM utilizes seven metrics evaluating in-wetland stress by the intensity and proportionality of effect (App. 1, C). In-wetland stress (hereafter *Wetland Stress*) metrics are categorized by stress type and include the following (listed by metric number):

3) Impoundment
4) Draining or diversion of water from wetland
5) Anthropogenic fluvial inputs
6) Filling and dumping within wetland
7) Excavation, grading, and other substrate disturbances within wetland
8) Vegetation and detritus removal within wetland
9) Invasive species within wetland

Where applicable, each *Wetland Stress* metric includes a checklist to document evidence, stressors, and sources associated with the stress type. Each *Wetland Stress* metric is given equal weight; they are summed, and then subtracted from 70 to generate the *Wetland Stress* index score, which comprises 70% of the *RIRAM* index.

In the final scored section, Section D, RIRAM generates an index to summarize and document the apparent integrity (i.e. observed state) of the unit (App. 1, D). The index evaluates the integrity of each of five functional wetland characteristics along a continuum ranging from *characteristic* through *degraded* to *destroyed*; values are assigned to these designations. The characteristics are intended to represent key physical drivers of previously-identified wetland functions and values (e.g. per USACOE 1993); characteristics include the following:

- Hydrologic integrity
- Water and soil quality
- Vegetation/microhabitat structure
- Vegetation composition
- Habitat connectivity

The values are summed to generate an *Observed State* index score that comprises 10% of the *RIRAM* index. The *Observed State* index is based upon identification and interpretation of evidence gathered from all previous metrics and requires a strong understanding of wetland processes.

3. Conducting the RIRAM Assessment

3.1 General Methods

Site Selection

Sites should be selected according to the goals of a given project. Because it is virtually "blind" to wetland type, RIRAM is flexible in that it can be used to assess freshwater wetlands of various classes, conditions, sizes, and settings. RIRAM has been demonstrated to be effective in characterizing condition across wetland types within specific basins and in characterizing specific wetland types across basins (Kutcher 2009 and Kutcher 2010a and b; and Kutcher 2010a and c respectively). In these applications, sites were either randomly selected along a sorted gradient of surrounding land use intensity or were selected using a stratified-random approach using landscape intensity metrics. Other applications and study designs are certainly possible.

Defining Assessment Units

Assessment units can be defined using one of two general approaches. A commonly applied approach uses a modified hydrogeomorphic (HGM) classification to classify and delimit wetland units by broad basin classes that include depressional, slope, flat, fringe, and riverine designations (Brinson 1993). This approach was utilized during the first three seasons of piloting RIRAM, using methods developed by Ohio EPA (Mack 2002). Units delimited according to Mack's protocols characterize wetland complexes that may include numerous vegetation communities if they share the same HGM unit. This may be appropriate for characterizing wetland condition across a given area (e.g. a municipality or a drainage basin).

Rhode Island formerly applied a similar method to define wetland assessment units for wetland functional assessments. The method (hereafter DEM method) was developed by Golet et al. (1994) and refined by DEM for statewide application (App. 2). Similar to the modified HGM method, the DEM method discriminates units by wetland-complex continuity rather than dominant vegetation type; thus units may contain numerous vegetation communities. Wetland assessment units (or "wetunits") may be separated by upland, lacustrine open water, highways, or railroads, but are considered continuous across river channels (Golet et al. 1994). Pending department review, this method is under consideration for long-term statewide application of RIRAM in Rhode Island.

Another approach utilized in our pilot studies defines assessment units by a vegetation community classification such as the National Wetlands Inventory (NWI) classification (Cowardin et al. 1979). NWI classifies wetland units by dominant vegetation structural type (e.g. *forested* versus *emergent*), hydrology (e.g. *semi-permanently flooded* versus *seasonally flooded*), and other ecological characteristics. Units delimited according to NWI methods may produce assessment units representing specific vegetation

communities that may be contained within larger wetland complexes, thus surrounding wetlands may effectively buffer the units from stresses acting elsewhere in the wetland complex. This method can be used to characterize and inventory certain wetland community types and may be useful for assessing the condition of a particular resource State-wide (e.g. Atlantic white cedar swamps).

Some rapid assessment methods utilize assessment units generated by delineating circular plots with predetermined areas around randomly-selected points within wetlands, which has the advantage of being more standardized for probabilistic analysis. This method has not been tested for RIRAM application. Because RIRAM was designed to characterize units bounded by existing ecological or physical features, some metrics may not properly apply to a unit delineated around a random point. The point method is therefore not recommended for RIRAM application at this time.

A key consideration in defining assessment units is to use a consistent, single approach within a given project, or among projects that will be directly compared. Because they are often buffered by surrounding wetlands, vegetation community-derived units may score higher than the complex continuity-derived units they are contained within; although this may be an appropriate and valid concept (the centers are actually in better condition than the edges), it could introduce undesirable biases to certain interpretations or applications.

General Assessment Procedures

RIRAM is best conducted utilizing a combination of on-site and remote investigation to complete each assessment. Although RIRAM can be completed by a single site visit alone, information gained through the interpretation of remote-sensed imagery and investigation of existing geospatial data will result in a more thorough and accurate assessment.

Site Investigations

Each assessment unit must be directly observed by the user. A single RIRAM datasheet is filled out during the site visit and finalized afterward using remote-sensed data, when possible. Units are accessed on foot or by canoe, when necessary. The perimeter and multiple transects of each unit should be assessed when possible, otherwise assessments should be made by accessing as many areas within and around the unit as possible. Particular focus should be given to surface water inlets and outlets, and borders adjacent to current and historic cultural activities, since these are areas where condition is most likely to be affected. Because RIRAM is partly based on the structure and composition of vegetation, units should be assessed during the peak of the growing season, when possible; in Rhode Island this may range from June through October depending on the wetland type.

Field maps of each unit should be utilized for field orientation, determining wetland community and buffer characteristics, and evaluating certain RIRAM metrics. Ideally,

maps should be produced using a backdrop of the latest and highest-resolution leaf-off aerial imagery available, at a scale sufficient to illustrate wetland habitats and surrounding land uses. It should include a delineation of the assessment unit, a scale bar, and identifying information. If GIS is available, paper field maps can be produced that additionally contain 100 ft and 500 ft buffer delineations to facilitate landscape analyses in RIRAM Section B. A cartographic GPS unit loaded with the same information may be useful for spatial confirmation and ground-truthing site delineations. Figure 1 depicts a sample field map.

A field guide to invasive freshwater wetland plants should be utilized, if available. Identification of invasive species is critical to implementation of RIRAM, since invasive species may represent both a stress and wetland response to stress. Refer to Table 1 for a list of all known invasive species found in and around freshwater wetlands of Rhode Island.

Remote Investigations

Data obtained during field investigations can be updated, complemented, or completed via GIS analysis. The following GIS operations are recommended. RIGIS (2011) data are available on-line. Refer to the RIRAM field form (App. 1) and to section 3.2 for clarification and details:

- Latitude and Longitude of the assessment unit centroid can be determined to partly complete the datasheet header.
- Wetland size can be determined to answer attribute A1.
- The RIGIS *FEMA Statewide Flood Zone Map* data-layer can be overlaid to determine whether the unit falls within a designated 100-year floodplain to partly answer attribute A5.
- The RIGIS *Aquifer recharge zones* data-layer can be overlaid to determine whether the unit falls within a designated aquifer recharge zone to partly answer attribute A5.
- RINHS (2008) rare species geospatial data can be laid over sites to determine any occurrences of state/federal threatened or endangered species, to partly answer attribute A5 by determining the potential presence of rare species.
- The RIGIS *Sewered Areas* data-layer can be overlaid to partly answer Metric B2 by determining the presence of sewers.
- The RIGIS *Community Wellhead Protection Areas* and *Non-community Wellhead protection Areas* data-layers can be overlaid to support Metric C4 by determining the proximity of groundwater pumps.

Figure 1: Sample field-map used to facilitate wetland unit assessment using RIRAM Version 2 (scaled down from 8.5 by 11 inches)

Table 1: List of invasive plant species known to occur within or encroach upon wetlands in Rhode Island

Scientific Name	Common Name	Scientific Name	Common Name
Acer platanoides	Norway Maple	*Myriophyllum heterophyllum*	Two-leaf Water-milfoil
Acer pseudoplatanus	Sycamore Maple	*Myriophyllum spicatum*	Eurasian Water-milfoil
Aegopodium podagraria	Bishop's Goutweed	*Najas minor*	Brittle Waternymph
Alliaria petiolata	Garlic Mustard	*Phalaris arundinacea*	Reed Canary Grass
Amorpha fruticosa	False Indigo	*Phellodendron amurense*	Amur Corktree
Ampelopsis brevipedunculata	Porcelainberry	*Phragmites australis*	Common Reed
Berberis thunbergii	Japanese Barberry	*Pistia stratoides*	Water Lettuce
Cabomba caroliniana	Fanwort	*Polygonum caespitosum*	Oriental Smartweed
Celastrus orbiculatus	Oriental Bittersweet	*Polygonum cuspidatum*	Japanese Knotweed
Eichornia crassipes	Water Hyacinth	*Polygonum perfoliatum*	Mile-a-Minute Vine
Egeria densa	Brazilian Water-weed	*Polygonum sachalinense*	Giant Knotweed
Elaeagnus umbellata	Autumn Olive	*Potamogeton crispus*	Curly Pondweed
Epilobium hirsutum	Hairy Willow-Herb	*Ranunculus ficaria*	Lesser Celandine
Glossostigma diandrum	Mud-mats	*Ranunculus repens*	Creeping Buttercup
Hesperis matronalis	Dame's rocket	*Rhamnus frangula*	Glossy Buckthorn
Iris pseudacorus	Yellow Flag or Iris	*Rorippa amphibia*	Great Yellowcress
Ligustrum sp.	Privet	*Rorippa nasturtium-aquaticum*	Watercress
Lonicera japonica	Japanese Honeysuckle	*Rosa multiflora*	Multiflora Rose
Lonicera morrowii	Morrow's Honeysuckle	*Salix cinerea*	Grey Willow
Lythrum salicaria	Purple Loosestrife	*Solanum dulcamara*	Climbing Nightshade
Microstegium vimineum	Japanese Stilt Grass	*Trapa natans*	Water Chestnut
Myosotis scorpioides	True Forget-Me-Not		

3.2 Filling out the RIRAM V.2.10 Field Datasheet

This section details methods for interpreting, selecting, and scoring attributes and metrics of RIRAM V2.10. It is organized according to the field datasheet; refer to the datasheet for clarification (App. 1).

Header

Fill out the user(s) name, a designated (and exclusive) assessment unit number, and the date of the field visit on each page of the datasheet. On the first page, document the longitude and latitude of a point as close to the center of the assessment unit as possible. Longitude and latitude can be determined in the field using a GPS unit or by automating the coordinates of the unit's centroid using GIS.

A. Wetland Characteristics

This section contains classification and background information on the assessment unit; it is not scored, but the classification is critical to scoring and analysis. Fill out all attributes in this section. Completely or accurately answering certain attributes may require remote analysis or research.

A.1 Assessment Unit Area

This Attribute documents the size of the assessment unit in acres. Determine the unit size using GIS or a planimeter, or, less desirably, estimate the size using field measurements, best judgment, or research. Check the box next to the corresponding range.

A.2 Hydrologic Characteristics

Source of water

Using best professional judgment, select the main source of water. Most wetlands receive water from more than one source and it is often difficult to definitively establish the main source. This attribute is intended to document a general hydrologic setting for the wetland and high degree of accuracy is not expected.

- Select *Precipitation*, only if a wetland is *obviously* perched above the water table and receives no surface water from clearly defined channels.
- Select *Groundwater* if the wetland appears to receive most of its water from intersection with the water table or from adjacent springs.
- Select *Surface water* if the wetland appears to receive the *majority* of its water from a clearly defined channel(s) (perennial or intermittent) or from overbank flow.

Maximum water depth, today

Estimate the maximum depth of standing water in the deepest significant part of the assessment unit on the day of the visit. Do not include the depth of relatively small

features (<10% cover) within the unit, such as streams or ditches running through the unit.

- Select *Dry* if water is not at or near the surface of the substrate and no standing water is evident.
- Select *Saturated* if water is at or near the surface of the substrate and no standing water is evident.
- Select one of the listed depth categories if there is surface water present in a significant part (>10%) of the unit.

Water regime

Estimate the dominant water regime in the assessment unit. If more than one significant water regime is represented within a unit (e.g. one section is *permanently saturated* and one section is *seasonally flooded*), two may be chosen, but select no more than two dominant regimes. If the unit contains an area that is both flooded and saturated during most years, the flooded water regime generally trumps; e.g. a unit comprising a single section that is both *seasonally flooded* and *permanently saturated* during the same season would be classified as *seasonally flooded*. Refer to Table 2 for water regime definitions.

Table 2: Water regimes as defined by Cowardin et al. 1979 (verbatim modified to suit)

Permanently Flooded: *Surface water persists throughout the growing season in all years.*
Semi-permanently Flooded: *Surface water persists throughout the growing season in most years. When surface water is absent, the water table is usually at or very near the land surface.*
Seasonally Flooded: *Surface water is present for extended periods especially early in the growing season, but is absent by the end of the season in most years. When surface water is absent, the water table is often near the land surface.*
Temporarily Flooded: *Surface water is present for brief periods during the growing season, but the water table usually lies well below the soil surface for most of the season.*
Permanently Saturated: *The substrate is saturated to the surface throughout the growing season in all years, but surface water is seldom present*
Seasonally Saturated: *The substrate is saturated to the surface for extended periods during the growing season, but the surface is unsaturated by the end of the season in most years; surface water is seldom present.*
Regularly Flooded: *Tidal water alternately floods and exposes the land surface at least once daily.*
Irregularly Flooded: *Tidal water floods the land surface less often than daily.*

A.3 Habitat Characteristics

Habitat stratum diversity

From within the assessment unit, estimate the cover class of each listed habitat stratum and enter the cover class rank next to the stratum list. Use Cowardin et al. (1979) *Class*

definitions (Table 3) to define strata, but assess each stratum independently, ignoring rules of *Class* dominance.

- Assess each vegetation-layer cover-class (each stratum) independently from all other layers and during the peak of the growing season.
- The *Surface water* cover class should represent the entire flooded area, including water coverage under emergent, woody, and floating vegetation, on the day of the survey.
- The *Bare substrate* cover class represents unvegetated areas not covered by low vegetation or surface water on the day of the survey.

Tip:

- Wetlands may exhibit >100% additive strata coverage.

Microhabitat diversity

Rate each microhabitat feature listed using the presence scale to the right of the attribute. Use your best professional judgment to select the ecological significance of each feature within the unit as follows.

- Select *0* if the feature is absent
- Select *1* if the feature is present, but of minor or no ecological significance
- Select *2* if the feature is ecologically significant, but does not dominate the unit
- Select *3* if the feature dominates the unit

Table 3: Wetland Classes as defined by Cowardin et al. 1979 (verbatim except within parentheses)

Forested *wetland is characterized by woody vegetation that is 6 m tall or taller* (with at least 30% cover). *All water regimes are included except subtidal.*
Scrub-Shrub *wetland includes areas dominated by woody vegetation less than 6 m (20 feet) tall* (with at least 30% cover). *The species include true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions. All water regimes except subtidal are included.*
Emergent *wetland Class is characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens* (with at least 30% cover). *This vegetation is present for most of the growing season in most years. These wetlands are usually dominated by perennial plants. All water regimes are included except subtidal and irregularly exposed.*
Aquatic Bed *includes wetlands and deepwater habitats dominated by plants that grow principally on or below the surface of the water* (with at least 30% cover) *for most of the growing season in most years. Water regimes include subtidal, irregularly exposed, regularly flooded, permanently flooded, intermittently exposed, semipermanently flooded, and seasonally flooded.*
Unconsolidated Bottom / Shore *includes all wetland and deepwater habitats with at least 25% cover of particles smaller than stones and a vegetative cover less than 30%.*
Rock Bottom / Shore *includes all wetlands and deepwater habitats with substrates having an areal cover of stones, boulders, or bedrock 75% or greater and vegetative cover of less than 30%.*

A.4 Wetland Classification

Hydrogeomorphic Class

Select the best single dominant HGM class of the unit as follows.

- Select *Isolated Depression* if the unit comprises a distinct depression, relative to the surrounding landscape, without perennial surface water inflow or outflow or connection to another wetland.
- Select *Connected Depression* if the unit comprises a distinct depression, relative to the surrounding landscape and has perennial surface water inflow or outflow, or is contiguous with or contained within another wetland.
- Select *Floodplain (riverine)* of the unit is within a river channel or its hydrology is dominated by riverine overbank flow.
- Select *Fringe* if the wetland is contained within the basin of a perennial lake or its hydrology is dominated by lacustrine overbank flow.
- Select *Slope* if the unit's hydrology is dominated by hillside seepage.
- Select *Flat* is the unit comprises or dominates a large, level wetland complex.

NWI Classes
Select all NWI *Classes* contained within the unit, according to Table 3 (Cowardin et al. 1979). Write in the *Dominance Type* (dominant or co-dominant [maximum two] species representing the *Class*) for each vegetated *Class*, using scientific names of taxa or appropriate USDA (2009) four-letter code (available on-line).

RINHP Natural Community Types
Select wetland habitat types representing all *current* classes within the unit. Refer to Enser and Lundgren (2007) available at on-line for habitat definitions. Enser and Lundgren define *natural* community types of RI; culturally dominated or sustained habitat types (e.g. wet meadow[1]) are not listed. For such areas, choose the natural community type that the assessment unit most closely resembles in structure and composition. For example, a wet meadow may be classified as a *shallow emergent marsh*, while a historic cow pond might be classified as *eutrophic pond* or *vernal pool*.

A5. Wetland Values

Select all known or observed values applying to the wetland unit as follows.

- Select *Within a 100-year floodplain* if unit falls within a designated FEMA 100-year flood zone.
- Select *Between stream or lake and human use* if the unit is situated between a cultural land use and a lake, pond, or stream (perennial or intermittent).
- Select *Part of a habitat complex or corridor* if the unit is contiguous with non-culturally-dominated lands that potentially supply habitat to wildlife.
- Select *Falls in an aquifer recharge zone* if the unit falls partly or wholly within a documented aquifer recharge zone.
- Select *Contains known T/E species* if any state or federal threatened or endangered species is observed, documented, or otherwise known to exist within the unit.

[1] A shallow persistent-emergent wetland that is structurally sustained by agricultural practices such as grazing or mowing

- Select *Significant avian habitat* if the unit is determined to be significant habitat for any avian species. This may be determined through observation, known documentation, or other knowledge of use by obligate wetland, wading, or waterfowl species, neo-tropical migratory songbirds, or other GCN[2] avian species.
- Select *Contains GCN habitat type* (refer to DEM 2007) if one of the listed GCN natural community types is checked in section A4.
- Select *Educational or historic significance* if the unit contains or is part of an area known to be used for educational purposes or that has some culturally historical significance.

B. Landscape Stresses

This section is comprised of two metrics that are calculated separately and summed to generate an index called *Landscape Stress*.

B.1 Degradation of Buffers

Degradation of buffers is a proxy that represents the effective in-tact buffer width surrounding the assessment unit by providing an estimate of the percentage of cultural land cover within 100 feet of the unit perimeter as follows.

- Using the field map and assessing visually in the field, estimate the percent of cultural land cover[3] within the 100 feet surrounding the assessment unit. Recovering vegetated lands are not generally considered cultural in this section.
- Enter the score associated with the class in the box at the left margin under metric B.1.

B.2 Intensity of Surrounding Land Use

Intensity of Surrounding Land Use, a metric representing the relative intensity of surrounding land use, is generated using a weighted-average model as follows.

- Using the scale bar or buffer delineation on your field map, establish and examine a 500' buffer zone surrounding the perimeter of the assessment unit.
- For each intensity class listed, interpret the aerial photography (and field verify) or directly estimate the proportion (to the nearest tenth, i.e. 0, 0.1, 0.2...1.0) of land within the 500' buffer zone that falls within the class.
    - Refer to the chart to the lower right of the metric to determine which cover class various land cover types fall into.
    - Interpret each intensity class proportion disregarding its position in the buffer. For example, a natural area (*Very Low*) should not be downgraded if it falls behind a cultural feature such as a major road, even if the feature impedes terrestrial access to the area.

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[2] Identified as being of *greatest conservation need* by RI DEM (2008)

[3] Cultural land cover is any cover that is directly modified by human activities (including grazing or trampling by livestock) more than once per growing season or is modified in a way that prohibits natural succession.

    - For roads and other linear features, interpret the proportion of the unit the feature covers, including all berms, fill, and bounded catchments associated with them.
- Enter the proportion on the line to the right of the intensity class listed.
    - If total cultural cover is <0.1 but >0.0, enter 0.1 for the most appropriate intensity class and 0.9 for *Very Low*.
- Check that the sum of the proportions is exactly equal to 1.0; otherwise, there is an error in your estimations.
- Multiply each proportion by the predetermined intensity-class score to generate four weighted values.
- Sum the weighted values to generate the score for B.2. The score should be between 1.0 and 10; otherwise there is an error in calculations or estimation. Enter that score on the sum line labeled *Sum weighted values for score* and again in the box in the left margin under metric B.2.

B.2 Associated Stressors

Check all stressors identified within the 500' zone surrounding the assessment unit.

B. Landscape Stress Score

Sum the scores for metrics B.1 and B.2 to generate the **Landscape Stress Score**. Write the score in the box at the bottom of Section B and again at the end of the datasheet.

C. Wetland Stresses

Metrics 3 to 9 represent types of effective stresses that can influence wetlands. Each metric requires the user to: assess whether a stress of the type is present, estimate the intensity of the stress, estimate the proportion of the unit affected, identify evidence of the stress, identify associated stressors, and identify the source of the stress. Each metric is scored separately (max 10 points for each); these **scores are summed and subtracted from 70**. The following rules apply for all *Wetland Stress* metrics in Section C:

- Scoring is based on evidence; therefore a score of zero (0) must be given to the metric if evidence (from the given list) cannot be identified and selected (checked). In metric C.9, evidence is assumed by the documentation of observed invasive species.
- Each metric is assessed as independent of all other metrics, and based on the current status and current type[4] of the wetland.
    - For example, if evidence suggests that the wetland status (e.g. size) has been changed by (e.g.) partial filling, points are assigned according to (e.g.) C.6 *Filling...* However, for all other metrics, the remaining wetland (unfilled part) is assessed as the entire unit.
    - Similarly, if a stress has changed the wetland type, e.g. impoundment has caused a swamp to become a shallow pond (evidence might be tree stumps within the pond), points are assigned for C.3 *Impoundment…*, but

[4] according to the wetland classification identified in A4

all other metrics consider the pond as the wetland type, not the former swamp.

- For those metrics that require estimating the proportion of the unit affected, any stress affecting less than one tenth of the unit (<0.1 but >0) should be documented and scored as affecting one tenth (0.1).
- Maximum score per metric is ten (10), even if a score higher than ten is generated. Many scores are generated by multiplying an intensity score (in parentheses next to each intensity category) by the proportion of the unit affected. Others are scored directly or by summing direct scores. Follow metric directions carefully to avoid errors in calculations.
- Select the *Primary Associated Stressor* that most strongly contributes the given stress type.
- Enter the designation C or H to document the *Source of Stress* associated with the *Primary Associated Stressor*. Source categories are self-explanatory (App. 1). If the source of stress cannot be determined, check *Undetermined*. When selecting the source for a stressor that is currently in use (e.g. a dam currently being used to run hydropower), write in the designation "C" for *current* (next to e.g. *Public utilities*). For a stressor that is no longer actively used but still affects the assessment unit (e.g. a historic mill dam, no longer powering a mill but still impounding water) write in an "H" for *historic* (next to e.g. *Commercial*).
- After scoring all *Stress* metrics (C.3 to C.9), add the scores together and enter the sum into the dashed box labeled *Sum of C3 to C9 Scores* at the end of Section C. Subtract that sum from 70 to generate the *C. Wetland Stress Score* and enter it in the appropriate box after Section C and again on the line at the end of the datasheet.

<u>Tips:</u>

- Proportions × intensity scores are estimates and are not intended to be highly accurate measurements; they are intended to increase precision over presence-absence and subjective (e.g. poor, moderate, good) categories and lend defensibility and information to the determinations. Select your best *estimate* of proportion and best judgment of intensity. Studying the field map is often helpful in making proportion determinations based on relative area. Do not spend excessive time calculating or deciding between proximate proportions (e.g. 0.3 and 0.4). If the proportion of effect is vague and can only be estimated within a broad range (e.g. 0.2 to 0.6), draw parentheses around the range and select (circle) the midpoint (e.g. 0.4); utilize the midpoint in score calculations. Strong-intensity stresses are usually clearly evident, while some lower-intensity stresses may be harder to rate or detect; be sure to base your selection on observed evidence (and document it). Because each metric is scored independently and modestly, scoring consequences of vague proportions and intensities are generally small. Multiple, additive stresses and their impacts primarily determine final RIRAM index values.

- For each *Stress* metric, if no evidence of stress is detected for any part of the metric, enter *None* or zero (0) and move to the next metric, since proportions, *evidence*, *associated stressors*, and *sources of stress* sections will not apply. However, all of these sections must be completed if any evidence of stress is detected for any metric or submetric.

- Don't forget to add all the Section C metric scores together at the end and subtract from 70.

C.3 Impoundment

This two-part metric inventories and scores the intensity and proportion of stresses associated with the *downstream* impoundment of the assessment unit. Document all evidence, the primary associated stressor and its source, and calculate the sub-scores from submetrics C.3a and C.3b as instructed below. Enter their sum in the box at the left margin of C.3.

C.3a Increase in depth or hydroperiod

This submetric requires the user to identify and evaluate hydrologic stress caused by increased water in the wetland due to anthropogenic impoundment as follows.

- Identify and document evidence of impoundment stress. Select categories from the *Evidence* box that most closely describe any observed evidence of increased water due to impoundment; select all that apply.
- Estimate the intensity of the impoundment. Use the *Water Regimes* chart at the bottom of the metric and Table 2 to determine the number of water regimes that the wetland has changed. Any change going across or down is considered one water regime; a change going across one and down one is considered two regimes and so on. Select the most appropriate category as follows. Select only one category.
    - Select *None* if there is no evidence of anthropogenic impoundment within the unit.
    - Select *Wetland was created by impoundment* if evidence suggests that >90% of the assessment unit did not exist before the impoundment (i.e. was upland). This most often occurs when a small river is impounded to create open water (e.g. for a mill pond), and can sometimes be determined by studying the field map; identified by a river running through upland, into an impoundment pond, and back into an upland-surrounded river.
    - Select *Change in velocity only* if evidence suggests that a downstream stressor has changed the direction or speed of the water moving through the unit, but has not deepened or extended the hydroperiod of the unit.
    - Select *Change of less than one water regime* if evidence suggests that the water regime has changed, but not a full water regime. This occurs most frequently within the *seasonally flooded* water regime, where evidence is

often dead red maples (*Acer rubrum*) surrounded by marsh, fen, or shrub swamp vegetation.

- Select *Change of one water regime* if evidence suggests that the water regime has increased one category according to the *Water Regimes* chart (down or across) upstream of the impoundment.
- Select *Change of two or more water regimes* if evidence suggests that the water regime has increased two or more categories according to the *Water Regimes* chart (down or across) upstream of the impoundment.
- Select Change to deepwater if evidence suggests that the water regime has increased to deepwater[5].

- Estimate and select (circle) the proportion of the unit affected by the impoundment.
- Calculate the submetric score for C.3a by multiplying the intensity rank by the proportion of the unit affected. The product should be between 0 and 10; otherwise there is an error in calculation. Enter the sub-score on the **line** at submetric C.3a.

Tips:

- Using a field map can help to remotely identify and quantify impounded areas within the assessment unit. Be sure to field check remote determinations. An impoundment can often be remotely identified by one of the following:
    - Open water at the downstream part of the unit, often shaped like a cone or semicircle with the flat side against the impoundment
    - Abrupt change to wetter hydrologic regime and associated vegetation upstream of impoundment
    - Abrupt change in wetland width, wider upstream of the impoundment
- To determine water regime changes, compare impounded vegetation to vegetation downstream (or well upstream) of the impoundment. For example, if the upstream side of a road (within the assessment unit) is a shallow pond dominated by aquatic bed vegetation (semi-/permanently flooded), and the downstream side of the road is a red maple floodplain swamp (temporarilly flooded), then the change is two water regimes (moving down the chart). This assumes that vegetation was originally continuous across the barrier and that the downstream side is not water-starved.
- If two or more areas are affected by impoundment differently (e.g. partly changed to deepwater and partly changed by one water regime), select the category that has the highest intensity or affects the greatest proportion of the wetland, whichever scores highest.
- Impoundment due to beaver damming should be counted as *None* (0), since it is a generally natural process. If damming is a combination of natural and anthropogenic sources (e.g. a beaver dams a culvert under a road), do your best

[5] Greater than 6.5 feet deep and unable to support rooted emergent vegetation (Cowardin et al. 1979)

to estimate the intensity and extent of stress caused by the anthropogenic stressor alone.

C.3b Artificial barrier to movement of resources through water

This submetric requires the user to identify and rate stresses to resource transport caused by physical impoundment. This submetric only pertains to cultural impounding features *adjacent to* and *downstream of* the assessment unit, since it addresses movement from the unit to other wetlands and waters outside of the unit, including other impounded areas. Rank this sub-metric by selecting *all that apply* as follows.

- Select *None* if evidence suggests that there is no artificial barrier to movement of resources during most years.
- Select *Barrier to upstream movement at low water* if evidence (physical barrier, dam or restricting culvert) suggests that upstream movement of aquatic fauna is impeded at least seasonally at the impoundment.
- Select *Barrier to downstream movement at low water* if evidence (physical barrier, dam or restricting culvert) suggests that downstream movement of any resources, including fauna, flora, nutrients, sediments, and detritus, is impeded at least seasonally at the impoundment.
- Select *Barrier to upstream or downstream movement above low water* if evidence (physical barrier, dam or restricting culvert) suggests that upstream or downstream movement of any resources, including fauna, flora, nutrients, sediments, and detritus, is impeded at the impoundment during higher water.
- Sum the ranks (max = 3) and enter the sub-score on the **line** at C.3b.

C.4 Draining or diversion of water from wetland

This metric inventories and scores the intensity and proportion of stresses associated with a decrease in the depth, size, or hydroperiod of the assessment unit due to draining or diversion of water from the wetland. Document all evidence, primary associated stressor, and source, and calculate the score as instructed below. Enter the score in the box at the left margin of C.4.

- Identify and document evidence of draining or diversion of water. Select categories from the *Evidence* box that most closely describe any observed evidence of decreased water; select all that apply.
- Estimate the intensity of the stress. Use the *Water Regimes* chart at the bottom of the metric and Table 2 to determine the number of water regimes that the wetland has changed. Any change going across or up is considered one water regime; a change going across one and up one is considered two regimes and so on. Select the most appropriate category as follows. Select only one category.
    - Select *None* if there is no evidence of anthropogenic draining or diversion of water within the unit.
    - Select *Change in velocity only* if evidence suggests that an upstream stressor has changed the direction or speed of the water moving through the unit, but has not decreased the depth or hydroperiod of the unit.

    - Select *Change of less than one water regime* if evidence suggests that the water regime has changed, but not a full water regime.
    - Select *Change of one water regime* if evidence suggests that the water regime has decreased one category according to the *Water Regimes* chart (up or to the left) somewhere within the unit.
    - Select *Change of two or more water regimes or to upland* if evidence suggests that the water regime has decreased two or more categories according to the *Water Regimes* chart or has changed to upland due to draining or diversion of water.
- Estimate and select (circle) the proportion of the unit affected by the draining or diversion of water.
- Calculate the score for C.4 by multiplying the intensity rank by the proportion of the unit affected. The product should be between 0 and 10; otherwise there is an error in calculation.

<u>Tips:</u>

- Using a field map can help to remotely identify and quantify affected areas within the assessment unit. Be sure to field check remote determinations. Drained areas can often be remotely located by identifying draining structures (i.e. ditches or tiles) or structures diverting flow away from the unit, such as dikes. Proportions of effect can often be quantified by photo-interpreting associated changes in vegetation on the map, as well.
- To determine water regime changes, compare vegetation adjacent to the stressors to vegetation elsewhere in the unit or in a nearby wetland in a similar setting. For example, if a cone of vegetation surrounding a ditch is characterized by a dry red maple swamp with a mix of hydrophilic and upland understory vegetation (temporarily flooded) and the rest of the wetland is a lush red maple swamp with a sphagnum and tall shrub understory (seasonally flooded), then the change is one water regime (moving up the chart). This assumes that vegetation was originally continuous across the wetland.
- If two or more areas are affected differently (e.g. partly drained and partly diverted), select the category that has the highest intensity or affects the greatest proportion of the wetland, whichever scores highest.

C.5 Anthropogenic fluvial Inputs

This metric requires the user to evaluate the evidence of impacts associated with each of four categories of anthropogenic fluvial inputs: (1) nutrients, (2) sediments and solids, (3) toxins and salts, and (4) increased flashiness (decrease in the time a given volume of surface water passes through the system). The proportion of the unit affected is assumed to be 1.0, since effects of water degradation are often wetland-wide. Document all evidence, the primary associated stressor and source, and assign a rank to *each category* as instructed below. Sum the assigned ranks to generate the metric score and enter the score in the box at the left margin of C.5.

- Assign a rank of zero (0), *No evidence*, if there is no evidence of sources or impacts of the input type.
- Assign a rank of one (1), *Stressors evident only*, if common sources of the input type are evident, but there is no evidence of ecological impact.
- Assign a rank of three, (3) *Slight impact evident*, if sources of the input type are evident and there is localized or uncertain evidence of ecological impact.
- Assign a rank of five (5) *Moderate to strong impact evident*, if sources of the input type are evident and there is strong evidence of significant ecological impact.
- Calculate the score for C.5. Sum the *evidence-of-impact* ranks from the four input categories to generate the score. If the sum is >10, enter 10 as a score; otherwise, the sum is the score for C.5.

Tip:

- Refer to the *Evidence* section of this metric for examples of evident stressors and impacts for the four fluvial-input categories.
- Dense, monotypic growth of certain flora may indicate nutrient enrichment. The following species have been identified as nutrient indicators: cattails (*Typha* sp.), common reed (*Phragmites australis*), reed canary grass (*Phalaris arundinacaea*), true forget-me-not (*Myosotis scorpioides*), and duckweeds (*Lemna* sp.).

C.6 Filling and dumping within wetland

This metric inventories and evaluates the intensity and proportion of stresses associated with filling and dumping within the assessment unit. Document all evidence, the primary associated stressor and source, and calculate the score as instructed below. Enter the score in the box at the left margin of C.6.

- Select *None* if there is no evidence of filling or dumping within or directly abutting the unit.
- Select *Affects aesthetics only* if there is filling or dumping (including litter) evident that affects the aesthetics of the unit, but there is no evidence of ecological impacts.
- Select *Affects water regime, vegetation, or soil quality* if there is filling or dumping evident that affects the water regime, vegetation, or soil quality of any area within the unit, but has not changed the area to upland.
- Select *Changes area to upland* if there is filling or dumping evident within or along the perimeter of the unit that has changed the affected area to from wetland to upland. In many cases, the proportion of the area filled cannot be determined, so the proportion of affected perimeter must be substituted in calculations.
- Select *Area is above upland grade* if there is filling or dumping evident within or along the perimeter of the unit that is higher than the surrounding upland. This commonly occurs when highways and railways are built across wetlands. In many cases, the proportion of the area filled cannot be determined, so the proportion of affected perimeter must be substituted in calculations.

- Calculate the score for C.6. Multiply the intensity rank by the proportion of the unit (or unit perimeter) affected to produce the score. The product should be between 0 and 12; otherwise there is an error in calculation. If the product is >10, enter 10 as a score; otherwise, the product is the score for C.6.

Tips:

- Many areas of fill also impound wetlands and should be scored on their contributions to both stress types. For example, a highway across a floodplain wetland may both impound and fill the wetland. Both metrics C.3 *Impoundment* and C.6 *Filling*… should document evidence and be scored for intensity of stress caused by the highway.
- The area (proportion) considered *filled* in a unit bordered by fill that effectively splits a wetland in two should include the entirety of the fill (i.e. to the outer edge).

C.7 Excavation and other substrate disturbance

This metric inventories and scores the intensity and proportion of stresses associated with excavation and other substrate disturbances within the assessment unit. Document all evidence, the primary associated stressor and source, and calculate the score as instructed below. Enter the score in the box at the left margin of C.7.

- Select *None* if there is no evidence of substrate disturbance within the unit.
- Select *Wetland was created by excavation* if the majority (>90%) of the wetland is manmade by excavation, rutting, or otherwise artificially lowering the substrate level.
- Select *Soil quality or vegetation disturbed* if there is evidence of substrate disturbance that affects the vegetation or soil quality of an area within the unit, but has not affected the water regime.
- Select *Changes water regime* if there is evidence of substrate disturbance that has affected the water regime of an area within the unit, but has not changed the area to deepwater.
- Select *Excavated to deepwater* if there is evidence of excavation or other substrate manipulation that has changed an area within or adjacent to the unit to deepwater. In some cases, the proportion of the area excavated cannot be determined; the proportion of affected perimeter can be substituted in calculations.
- Calculate the score for C.7. Multiply the intensity rank by the proportion of the unit (or unit perimeter) affected to produce the score for C.7. The product should be between 0 and 10; otherwise there is an error in calculation.

Tips:

- Substrate disturbances can include ditching, wherein the direct physical impacts of the ditches themselves are assessed (not their impacts on hydrology, which are quantified in metric C.4). In such a case, only the intensity of disturbance *within* the ditches and the proportion of the unit the ditches cover are entered to calculate the score for C.7. Remember that stresses affecting less than a tenth (0.1) of the unit area are entered into calculations as 0.1.

C.8 Vegetation and detritus removal within wetland

This metric inventories and scores the intensity and proportion of the removal or otherwise direct eradication (e.g. via application of herbicides) of each of five vegetation strata from within the assessment unit. Document all evidence, the primary associated stressor and source, and calculate the score as instructed below. Enter the score in the box at the left margin of C.8.

- For each stratum, enter a zero (0) under *Extent* if there is no evidence of its removal/eradication from within the unit.
- For each stratum, enter a two (2) under *Extent* if there is evidence of its partial or recovering[6] removal/eradication from within the unit.
- For each stratum, enter a three (3) under *Extent* if there is evidence of its complete or nearly complete removal/eradication from within the unit.
- For each stratum, enter the appropriate proportion of the unit affected, from 0.1 to 1.0, under *Proportion* if any removal/eradication of vegetation is entered under *Extent*.
- For each stratum, multiply the *Extent* rank by the proportion and enter the product to the right.
- Add the products and enter the sum on the line marked *Sum*. If the sum is >10, enter 10 as a score; otherwise, the sum is the score for C.8.

C.9 Invasive species within wetland

This metric evaluates the intensity and proportion of invasive vegetation within or overhanging the assessment unit by estimating the total percent cover of all invasive species observed. Refer to the list of invasive species known to occur within RI wetlands (Table 1). Document all abutting stressors and the primary source of stress, where abutting stressors are defined as: any wetland stressors observed adjacent to or within the invasive vegetation incursion. Generate a score by selecting the most appropriate cover class from the list. Evidence is assumed by the identification of species. Enter the score in the box at the left margin of C.9.

- Under 9a, select the cover class that best represents the total percent cover of invasive vegetation growing within or overhanging the assessment unit, in proportion to the entire unit.
- Under 9b, list all invasive species observed within or overhanging the assessment unit by scientific name or USDA code; estimate and enter a discrete cover class (from 9a, far right) for each individual species.

D. Observed State of Wetland Characteristics

This final section rates the integrity of each of five wetland functional characteristics, along a continuum from *characteristic* through *degraded* to *destroyed*, to generate an *Observed State* index. The characteristics are intended to represent observable elements that control previously-identified wetland functions and values and should be evaluated against a theoretical unstressed (i.e. natural) wetland of the type identified in

[6] re-growing but immature or incomplete

Section A *Wetland Characteristics*. Evaluations should be based on evidence documented in Sections B and C; refer to the matrix in Table 4 for further guidance. Rate each component according to the following guidelines.

- **Hydrologic integrity** refers here to the intactness of characteristic surface water and groundwater hydrology. This submetric evaluates only elements of water regime and movement, such as hydroperiod, flashiness, residence time, flow rate and direction, and interconnectedness with other wetlands and surface waters. This submetric does not consider loading or chemical and thermal water quality, which are evaluated in a subsequent submetric.
    - Select 2 (*characteristic*) if the hydrology appears to be unmodified and uncompromised; i.e. the identified wetland type(s) occurs naturally.
    - Select 1.5 if any element of hydrology appears to be slightly degraded or affected by stresses identified in Sections B and C.
    - Select 1 (*degraded*) if any element of hydrologic integrity appears to be significantly degraded or artificially controlled by the stresses identified in Sections B and C. For example, a manmade impoundment wetland might fall into this category.
    - Select 0.5 if the hydrologic integrity appears to be strongly degraded by the stresses identified in Sections B and C.
    - Select 0 (*destroyed*) if the hydrologic integrity appears to be effectively or completely destroyed by the stresses identified in Sections B and C.
- **Water and soil quality** refers here to the condition of surface water, soil water, soil structure, and soil content, pertaining to their capacity to support expected biota. This submetric considers the temperature and chemical, suspended solid, and nutrient concentrations in surface and soil waters, but does not consider hydrologic-process elements, such as those rated in the above *Hydrologic integrity* submetric.
    - Select 2 (*characteristic*) if the water and soil quality appears to be reasonably representative of a typical unstressed wetland of the identified type (hereafter *expected water and soil quality*).
    - Select 1.5 if the expected water or soil quality appears to be slightly degraded by stresses identified in Sections B and C.
    - Select 1 (*degraded*) if the expected water or soil quality appears to be significantly degraded by the stresses identified in Sections B and C.
    - Select 0.5 if the water or soil quality appears to be dominated by the stresses identified in Sections B and C.
    - Select 0 (*destroyed*) if the water or soil quality appears to be effectively or completely destroyed by the impacts of stresses identified in Sections B and C.
- **Vegetation/microhabitat structure** is defined here as the physical framework, formation, and configuration of vegetation, microtopography, and detritus, assessed from vertical and horizontal perspectives. This includes expected proportions or presence of vegetation structure classes (see Figure 2),

topographic feature classes (e.g. floating mat, hummock/tussock, mound and pool, etc.), standing and fallen deadwood, and other detritus.

  - Select 2 (*characteristic*) if the vegetation/microhabitat structure appears to be reasonably representative of a typical unstressed wetland of the identified type (i.e. comprises, hereafter, *expected vegetation/microhabitat structure*).
  - Select 1.5 if the expected vegetation/microhabitat structure appears to be slightly degraded by stresses identified in Sections B and C.
  - Select 1 (*degraded*) if the expected vegetation/microhabitat structure appears to be significantly degraded by the stresses identified in Sections B and C, but natural processes still dominantly control structure.
  - Select 0.5 if the vegetation/microhabitat structure appears to be dominantly controlled by the stresses identified in Sections B, rather than by expected natural processes.
  - Select 0 (*destroyed*) if the vegetation/microhabitat structure appears to be effectively or completely destroyed by the stresses identified in Sections B and C.

- **Vegetation composition** is defined here as the makeup, richness, and evenness of plant species in all strata of the unit.
  - Select 2 (*characteristic*) if the vegetation composition appears to be reasonably representative of a typical unstressed wetland of the identified type (hereafter *expected vegetation composition*).
  - Select 1.5 if the expected vegetation composition appears to be slightly degraded by stresses identified in Sections B and C.
  - Select 1 (*degraded*) if the expected vegetation composition appears to be significantly degraded (e.g. less diverse or containing non-native species) by the stresses identified in Sections B and C.
  - Select 0.5 if the vegetation composition appears to be dominantly controlled by the stresses identified in Sections B and C. For example, non-native species or dying/dead vegetation cover >50% of the area.
  - Select 0 (*destroyed*) if the vegetation composition appears to be effectively or completely destroyed by the impacts of stresses identified in Sections B and C.
- **Habitat connectivity** refers here to the condition of the connectedness of the unit to adjacent natural habitats. This submetric evaluates landscape and aquatic connectivity as they relate to the transport, migration, and containment of biological resources among contiguous uplands, wetlands, and waters.
  - Select 2 (*characteristic*) if the habitat connectivity appears to be unimpeded.
  - Select 1.5 if the habitat connectivity appears to be slightly impeded by stresses identified in Sections B and C.
  - Select 1 (*degraded*) if any aspect of habitat connectivity appears to be significantly degraded by the stresses identified in Sections B and C.

- Select 0.5 if the habitat connectivity appears to be dominantly degraded by stresses identified in Sections B and C.
- Select 0 (*destroyed*) if the habitat connectivity appears to be effectively or completely destroyed by the impacts of stresses identified in Sections B and C.

3.3 Generating Indices

The final *RIRAM Index* and RIRAM sub-indices can be generated for various applications and analyses. The indices are generated by summing section scores on the last page of the field datasheet as follows. Sum the *Landscape Stress Score* (B) and the *Wetland Stress Score* (C) to generate the *Total Stress Score*. Sum the *Landscape Stress Score* (B), the *Wetland Stress Score* (C), and the *Observed State Score* (D) to generate the *RIRAM Index*.

Table 4: Matrix depicting potential interactions between anthropogenic wetland stresses (B and C) and the components of wetland integrity (D) evaluated in RIRAM, and between those components and wetland functions and values according to USACOE (1993). Direct interactions are denoted with an X.

	Stress Type, from RIRAM B & C					
B.1	Degradation of Buffers	X	X			X
B.2	Intensity of Surrounding Land Use	X	X			X
C.3a	Increase in Depth or Hydroperiod	X	X	X	X	X
C.3b	Artificial Barrier	X	X			X
C.4	Draining or Diversion of Water	X	X	X	X	X
C.5a	Nutrient Inputs		X	X	X	
C.5b	Sediments / Solids Inputs	X	X	X	X	X
C.5c	Toxins / Salts Inputs		X	X	X	
C.5d	Increased Flashiness	X	X	X	X	
C.6	Filling and Dumping	X	X	X	X	X
C.7	Excavation / Substrate Disturbance	X	X	X	X	X
C.8	Vegetation / Detritus Removal	X	X	X	X	X
C.9	Invasive Species	X	X	X	X	X
	Wetland Component from RIRAM D	Hydrologic integrity	Water and soil quality	Veg/microhab structure	Vegetation composition	Habitat connectivity
	Groundwater Recharge / Discharge	X	X	X		
	Floodflow Alteration	X		X		
	Fish and Shellfish Habitat	X	X	X	X	X
	Sediment and Toxicant Retention	X		X	X	
	Nutrient Removal / Reten. / Transf.	X		X	X	
	Production Export	X	X	X	X	X
	Sediment / Shoreline Stabilization	X		X	X	
	Wildlife Habitat	X	X	X	X	X
	Recreation	X	X	X	X	X
	Educational / Scientific Value	X	X	X	X	X
	Uniqueness / Heritage	X	X	X	X	X
	Visual Quality / Aesthetics	X	X	X	X	X
	Functions / Values from USACOE					

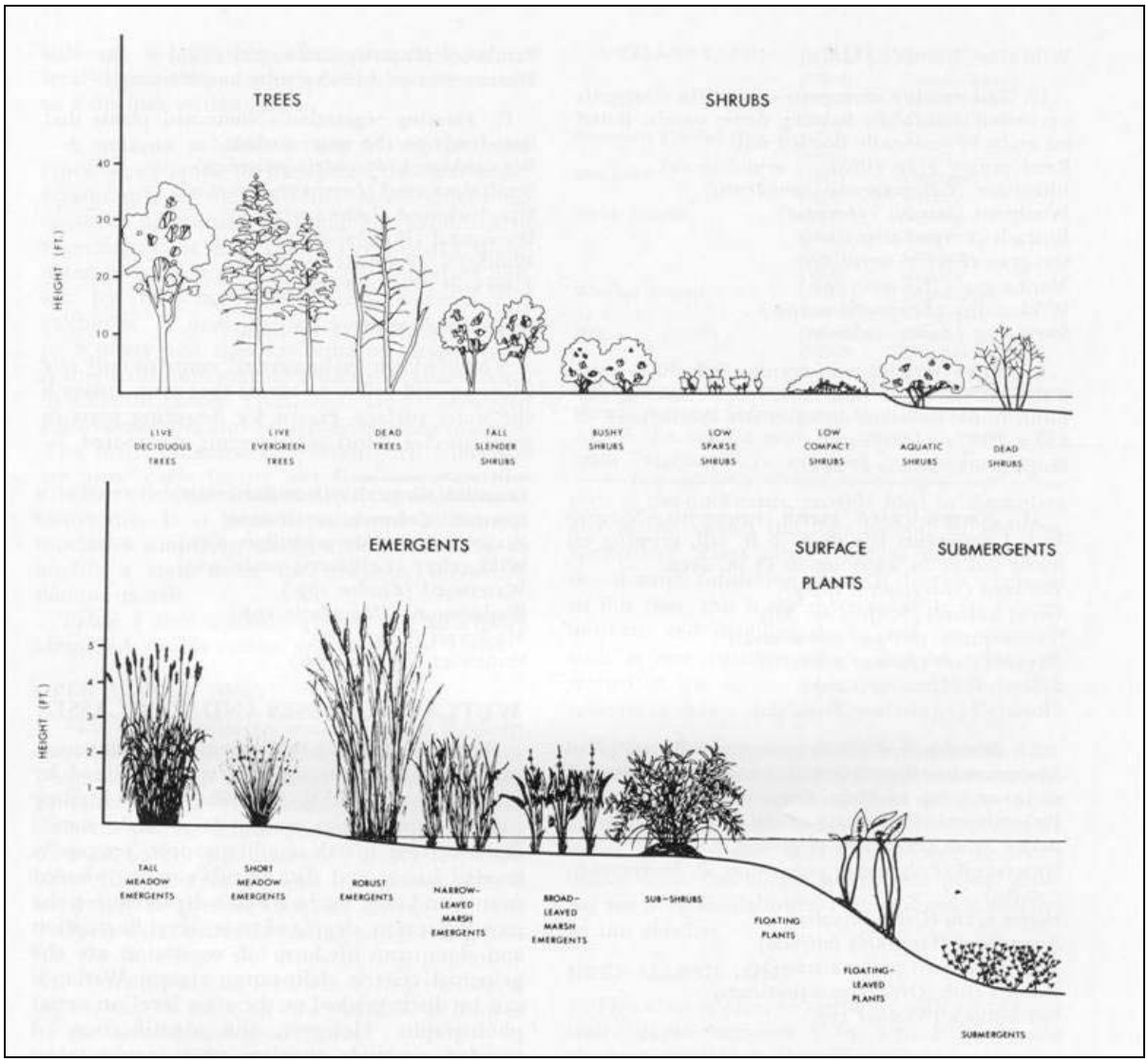

Figure 2: Vegetation *subforms* from Golet and Larson (1974)

4. Interpreting RIRAM Data

4.1 Interpreting the RIRAM Index

RIRAM was designed to generate a final condition index based on 100 points. A *RIRAM Index* score of 100 indicates no detection of stress or degradation (i.e. full integrity), while a score approaching zero would, in theory, indicate a total loss of wetland function. In practice, wetlands are seldom so impacted as to approach zero, since a score of zero for certain metrics would indicate that the wetland has been completely destroyed (i.e. no longer exists as a wetland).

No calibrations have been made to set RIRAM data on a consistent predictive scale, which could be useful in interpreting scores. However, empirical evidence suggests that RIRAM data follows an approximate academic grading curve when applied to characterize an area of concern. In a demonstration study, *RIRAM Index* scores followed the curve depicted in Figure 3 when applied along a gradient of surrounding land use intensity in a study area that ranged from rural to urban (Kutcher 2010b). This typical distribution may lend an intuitive utility to the data, since it closely follows a scale that nearly everyone is familiar with interpreting.

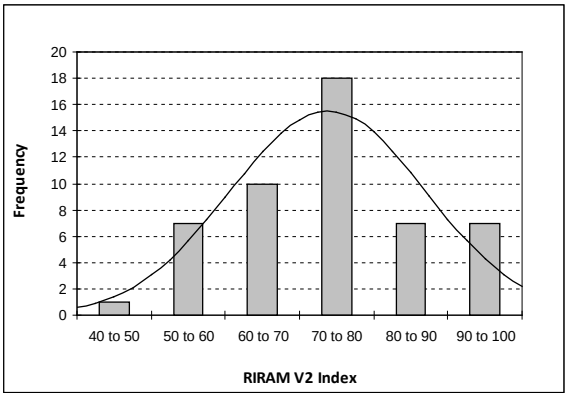

Figure 3: The distribution of RIRAM Index values among 50 freshwater wetlands located in a set of diverse Rhode Island drainage basins. Source: Kutcher 2010b

4.2 Limitations of RIRAM Data

RIRAM was designed to document monitoring data and produce relative condition data to characterize freshwater wetlands. The condition data are not absolute measures of condition or stress. RIRAM is designed to compare each wetland to its own theoretical pristine state. Deviations from pristine are assigned scores based on proportion and intensity. The scores are summed to characterize total deviation from pristine; i.e. the change from full integrity, which defines condition (U.S. EPA 2006). This approach allows RIRAM to be applied in characterizing relative condition across wetland types and in identifying reference conditions for reference-based assessment. However, due to inevitable environmental and temporal variability, RIRAM is not intended to provide a meaningful measure of wetland condition for any wetland in isolation; it should only be applied to assess condition relative to an appropriate sample of concern.

RIRAM data are not based on direct measurements. All metrics are based on estimation or interpretation. To produce RIRAM v.2 indices, metrics are summed according to an even weighing of metric scores. Metric sections (B, C, and D) are weighted based upon recent literature and attempts to maximize sensitivity and minimize subjectivity. Metric scores and their relative weights have not been otherwise calibrated in any way. Thus, metric and index scores should be treated as ordinal (rank) data and analyzed, when appropriate, using non-parametric statistics. Although analysis has indicated that producer errors are minimized (as opposed to magnified) by the summing of estimated/interpreted metrics, appropriate cautions should be used when applying and interpreting RIRAM data (Kutcher 2010b).

Efforts have been made to be as comprehensive as possible in characterizing stresses and responses within the constraints of rapid assessment protocol; however, none of the sections of RIRAM should be viewed as containing all the variables associated with wetland condition. For example, Section D includes only those characteristics that can be rated through the interpretation of observable evidence; impacts that don't present themselves visibly may not be captured. Further, RIRAM does not quantify wetland functions or values and is not intended to categorize wetlands by levels of protection.

While RIRAM data have been shown to correlate with independent biological and physical indicators of wetland condition (e.g. Kutcher 2010a), RIRAM data should be applied carefully until RIRAM v.2 is tested under varied circumstances. Analyses have suggested that RIRAM v.2 provides effective relative indices for elucidating relationships between individual stressors, cumulative stressors, wetland condition, invasive species, and landscape degradation, and may detect stresses associated with groundwater withdrawals among a sample of concern (Kutcher 2010b and c). The data provided by RIRAM may be further utilized in queries to shed light on other common and unforeseen questions regarding relative wetland condition and can be applied to identify reference conditions for reference-based assessment (Kutcher 2010c). But RIRAM data must be interpreted with respective cautions until its validity in representing relative wetland condition has been more thoroughly confirmed through further analysis and application. Confidence in RIRAM data will only grow relative to a growing body of supporting evidence of its functionality and utility.

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Appendix 1

Rhode Island Rapid Assessment Method version 2.10 Field Datasheet

RIRAM V.2.10 Investigators_____ Site Code_____ Date_____
Longitude (DD) _____ Latitude (DD) _____

A. Wetland Characteristics; apply to the *current* state of the wetland. Not Scored.

1) Assessment Unit Area; select one:

- ☐ <0.25 acres
- ☐ 0.25 to <1.0 acres
- ☐ 1.0 to <3.0 acres
- ☐ 3.0 to <10 acres
- ☐ 10 to <25 acres
- ☐ 25 to 50 acres
- ☐ >50 acres

2) Hydrologic Characteristics

Source of water; select main source:

- ☐ Precipitation
- ☐ Groundwater
- ☐ Surface water

Maximum water depth, today; select one:

- ☐ Dry
- ☐ Saturated
- ☐ <1 foot
- ☐ 1 to 3 feet
- ☐ >3 feet

Water Regime; select one or two dominant regimes:

- ☐ Permanently flooded
- ☐ Semi-permanently flooded
- ☐ Seasonally flooded
- ☐ Temporarily flooded
- ☐ Permanently saturated
- ☐ Seasonally saturated
- ☐ Regularly flooded (tidal)
- ☐ Irregularly flooded (tidal)

3) Habitat Characteristics

Habitat stratum diversity; estimate total cover of all habitat strata within unit using classes at right:

___ Trees
___ Shrubs
___ Emergent
___ Aquatic bed
___ Sphagnum
___ Surface water, today
___ Unvegetated substrate, today

Cover Classes:
0…..< 1%
1…..1-5%
2…..6-25%
3…..26-50%
4…..51-75%
5…..>75%

Microhabitat diversity; rate each present using the scale at right:

___ Vegetated hummocks or tussocks
___ Coarse woody debris
___ Standing dead trees
___ Amphibian breeding habitat

Ecological Significance Scale:
0…..None Noted
1…..Minor Feature
2…..Significant Feature
3…..Dominant Feature

4) Wetland Classification

Hydrogeomorphic Class; select main one:

- ☐ Isolated Depression
- ☐ Connected Depression
- ☐ Floodplain (riverine)
- ☐ Fringe
- ☐ Slope
- ☐ Flat

NWI Classes; select all comprising unit and indicate *Dominance Type*:

- ☐ Forested _____
- ☐ Scrub-shrub _____
- ☐ Emergent _____
- ☐ Aquatic Bed _____
- ☐ Unconsolidated Bottom or Shore
- ☐ Rock Bottom or Shore

RINHP natural community types; select all present within unit:

- ☐ Freshwater tidal marsh*
- ☐ Interdunal swale*
- ☐ Intermittent stream
- ☐ Eutrophic Pond
- ☐ Coastal plain pondshore*
- ☐ Coastal plain quagmire*
- ☐ Deep emergent marsh
- ☐ Shallow emergent marsh
- ☐ Emergent fen*
- ☐ Dwarf shrub bog / fen*
- ☐ Dwarf tree bog*
- ☐ Scrub-shrub wetland
- ☐ Floodplain Forest*
- ☐ Red Maple Swamp
- ☐ Vernal pool*
- ☐ Hemlock-hardwood swamp
- ☐ Atlantic white cedar swamp*
- ☐ Black Spruce Bog*
- ☐ Other Type: _____

5) Wetland values; select all known or observed:

- ☐ Within 100 year flood plain
- ☐ Between stream or lake and human use
- ☐ Part of a habitat complex or corridor
- ☐ Falls in aquifer recharge zone
- ☐ Contains known T/E species
- ☐ Significant avian habitat
- ☐ Contains *GCN** habitat type
- ☐ Educational or historic significance

_____
*Identified by DEM as habitat of *Greatest Conservation Need*

RIRAM V.2.10 Investigators_____ Site Code_____ Date_____

B. Landscape Stresses. Sum metrics 1 and 2

1) Degradation of Buffers

Estimate % cultural cover within 100-foot buffer. Select one.

- ☐ <5% (10)
- ☐ 6 to 25% (7)
- ☐ 26-50% (4)
- ☐ 51-75% (1)
- ☐ >75% (0)

Associated Stressors: Check all that apply

- ☐ Commercial or industrial development
- ☐ Unsewered Residential development
- ☐ Sewered Residential development
- ☐ New construction
- ☐ Landfill or waste disposal
- ☐ Channelized streams or ditches
- ☐ Raised road beds
- ☐ Foot paths / trails
- ☐ Row crops, turf, or nursery plants
- ☐ Poultry or livestock operations
- ☐ Orchards, hay fields, or pasture
- ☐ Piers, docks, or boat ramps
- ☐ Golf courses / recreational development
- ☐ Sand and gravel operations
- ☐ Other _____

2) Intensity of Surrounding Land Use

Land Use Intensity weighted average within 500-foot buffer.
Estimate proportion of each class to the nearest tenth and multiply.

	Proportion	Score	Weighted Value
Very Low	_____	× 10 =	_____
Low	_____	× 7 =	_____
Moderately High	_____	× 4 =	_____
High	_____	× 1 =	_____

Sum weighted values for score = _____

Very Low…….Natural areas, open water
Low……Recovering natural lands, passive recreation, low trails/dirt roads
Mod High……Residential, pasture/hay, mowed areas, raised roads to 2-lane
High……Urban, impervious land cover, new construction, row crops, turf crops, mining operations, paved roads > 2-lane

Sum of Metrics 1 and 2 = ☐ **B. Landscape Stress Score**

C. Wetland Stresses. Sum metrics 3 to 9 and subtract from 70.

3) Impoundment.

Sum a and b (Max = 10)

a. Increase in depth or hydroperiod. Select one and multiply by the proportion of the unit affected to the nearest tenth. = _____

- ☐ None (0)
- ☐ Wetland was *created* by impoundment (1)
- ☐ Change in velocity only (2)
- ☐ Change of less than one water regime (4)
- ☐ Change of one water regime (6)
- ☐ Change of two or more water regimes (8)
- ☐ Change to deepwater (10)

Proportion of unit affected (circle one)
0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0

Evidence: check all that apply

- ☐ Physical barrier across flow downstream of wetland
- ☐ Abrupt and unnatural edge downstream of wetland
- ☐ Dam or restricting culvert downstream of wetland
- ☐ Deepening of wetland upstream of barrier
- ☐ Widening of wetland upstream of barrier
- ☐ Change in vegetation across barrier
- ☐ Dead or dying vegetation

Primary Associated Stressor; check one:

- ☐ Road
- ☐ Railway
- ☐ Weir / Dam
- ☐ Raised Trail
- ☐ Development Fill
- ☐ Other

b. Artificial barrier to movement of resources through water. Select all that apply and sum. = _____

- ☐ None (0)
- ☐ Barrier to upstream movement at low water (1)
- ☐ Barrier to downstream movement at low water (1)
- ☐ Barrier to upstream or downstream movement above low water (1)

Primary Source of Stress; indicate as current (C) or historic (H):

- __ Private / Residential
- __ Commercial
- __ Agricultural
- __ Public transportation
- __ Public utilities
- __ Public recreation
- __ Undetermined

Water Regimes

(Upland)……Temporarily Flooded……..Irregularly Flooded
Seasonally Saturated ……Seasonally Flooded……Regularly Flooded
Permanently Saturated ……..Semi-permanently Flooded
Permanently Flooded

4) Draining or diversion of water from wetland.

Decrease in depth or hydroperiod. Select one and multiply by the proportion of the unit affected to the nearest tenth.

- ☐ None (0)
- ☐ Change in velocity only (3)
- ☐ Change of less than one water regime (5)
- ☐ Change of one water regime (7)
- ☐ Change of two or more water regimes or to upland (10)

Water Regimes

(Upland)……Temporarily Flooded…… Irregularly Flooded
Seasonally Saturated ……Seasonally Flooded……..Regularly Flooded
Permanently Saturated ……Semi-Permanently Flooded
Permanently Flooded

Proportion of unit affected (circle one)
0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0

Evidence: check all that apply
- ☐ Drainage ditches or tiles evident
- ☐ Evident impoundment upstream of wetland
- ☐ Severe root exposure
- ☐ Moderate root exposure
- ☐ Soil fissures
- ☐ Uncharacteristically dry groundcover
- ☐ Dead or dying vegetation
- ☐ Change in vegetation across barrier

Primary Associated Stressor; Check one:
- ☐ Road
- ☐ Railway
- ☐ Dike
- ☐ Fill
- ☐ Drainage ditch / tile
- ☐ Major well withdrawals
- ☐ Surface water pumps
- ☐ Other

Primary Source of Stress; indicate as current (C) or historic (H):
- __ Private / Residential
- __ Commercial
- __ Agricultural
- __ Public transportation
- __ Public utilities
- __ Public recreation
- __ Undetermined

5) Anthropogenic fluvial inputs.

Rank the evidence of impact for each and sum (Max = 10).

____ a. Nutrients

____ b. Sediments / Solids

____ c. Toxins / Salts

____ d. Increased flashiness

Evidence-of-Impact Ranks
0…..No evidence
1…..Sources evident, only
3…..Slight impact evident
5…..Moderate to strong impact evident

Evidence: check all that apply
- ☐ Runoff sources evident
- ☐ Point sources evident
- ☐ Excessive algae or floating vegetation
- ☐ Excessive rooted submerged or emergent vegetation
- ☐ Uncharacteristic sediments
- ☐ Obvious plumes or suspended solids
- ☐ Chemical smell
- ☐ Strangely tinted water
- ☐ Dead, dying, or patchy vegetation
- ☐ Dead fauna or stark lack of life
- ☐ Root exposure or bank erosion due to scouring

Primary Associated Stressor; Check one:
- ☐ Point runoff
- ☐ Sheet runoff
- ☐ Effluent discharge
- ☐ Organic / yard waste
- ☐ Other point _____
- ☐ Riverine (up-stream)
- ☐ Multiple / non-point
- ☐ Channelization

Primary Source of Stress; indicate as current (C) or historic (H):
- __ Private / Residential
- __ Commercial
- __ Agricultural
- __ Public transportation
- __ Public utilities
- __ Public recreation
- __ Multiple / non-point
- __ Undetermined

6) Filling and dumping within wetland. Select one and multiply by the proportion of the unit affected to the nearest tenth (Max = 10).

Intensity of filling
- ☐ None (0)
- ☐ Affects aesthetics only (2)
- ☐ Affects water regime, vegetation, or soil quality (6)
- ☐ Changes area to upland (10)
- ☐ Fill is above surrounding upland grade (12)

Proportion of unit (or perimeter) affected (circle one)
0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0

Evidence: check all that apply
- ☐ Unnaturally abrupt change in ground level
- ☐ Abrupt change in soil texture or content
- ☐ Unnaturally straight or abrupt wetland edge
- ☐ Unnatural items on or within the sediments

Primary Associated Stressor; Check one:
- ☐ Road
- ☐ Raised Trail
- ☐ Railway
- ☐ Trash
- ☐ Fill
- ☐ Organic / yard waste
- ☐ Dam
- ☐ Dike
- ☐ Other

Primary Source of Stress; indicate as current (C) or historic (H):
- __ Private / Residential
- __ Commercial
- __ Agricultural
- __ Public transportation
- __ Public utilities
- __ Public recreation
- __ Undetermined

7) Excavation and other substrate disturbances within wetland. Select one and multiply by the proportion of the unit affected to the nearest tenth.

Proportion of unit (or perimeter) affected (circle one)
0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0

Intensity of disturbance
- ☐ None (0)
- ☐ Wetland unit was *created* by excavation (1)
- ☐ Soil quality or vegetation disturbed (4)
- ☐ Changes water regime (7)
- ☐ Excavated to deep water (10)

Evidence: check all that apply
- ☐ Unnaturally abrupt lowering in ground level
- ☐ Loss of vegetation
- ☐ Unnaturally straight and abrupt wetland edge
- ☐ Direct evidence of disturbance

Primary Associated Stressor; Check one:
- ☐ Vehicle disturbance
- ☐ Plowing / cultivation
- ☐ Excavation / Grading
- ☐ Channelization / Dredging
- ☐ Ditching
- ☐ Footpaths
- ☐ Trampling
- ☐ Other

Primary Source of Stress; indicate as current (C) or historic (H):
- __ Private / Residential
- __ Commercial
- __ Agricultural
- __ Public transportation
- __ Public utilities
- __ Public recreation
- __ Undetermined

8) Vegetation and detritus removal within wetland. Rank extent and multiply by the estimated proportion affected for each layer; then sum (Max = 10).

Proportion of unit affected
0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0

Layers affected	Extent		Proportion		
☐ Aquatic Bed	_____	×	_____	=	_____
☐ Detritus	_____	×	_____	=	_____
☐ Emergent	_____	×	_____	=	_____
☐ Shrub	_____	×	_____	=	_____
☐ Canopy	_____	×	_____	=	_____

Sum =_____

Evidence: check all that apply
- ☐ Cut stems or stumps
- ☐ Immature vegetation strata
- ☐ Missing vegetation strata
- ☐ Mowed areas
- ☐ Browsing or grazing

Extent of removal
0.....None
2.....Partial or recovering
3.....Complete

Primary Associated Stressor; Check one:
- ☐ Power lines
- ☐ Grazing
- ☐ Cultivation
- ☐ Timber Harvest
- ☐ Development clearing
- ☐ Trails / non-raised roads
- ☐ Excavation / ditching
- ☐ Other

Primary Source of Stress; indicate as current (C) or historic (H):
- __ Private / Residential
- __ Commercial
- __ Agricultural
- __ Public transportation
- __ Public utilities
- __ Public recreation
- __ Undetermined

9) Invasive species within wetland.

9a. Select one class for total coverage.
- ☐ None noted (0)
- ☐ Nearly absent <5% cover (2).....Cover Class 1
- ☐ Low 6-25% cover (4).....Cover Class 2
- ☐ Moderate 26-50% cover (6).....Cover Class 3
- ☐ High 51-75% cover (8).....Cover Class 4
- ☐ Extensive >75% cover (10).....Cover Class 5

9b. List and select a cover class for each invasive plant species noted.

Cover Class	Species
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Primary Abutting Stressor; Check one:
- ☐ Road
- ☐ Railway
- ☐ Raised Trail
- ☐ Footpath
- ☐ Dam / Dike
- ☐ Organic / yard waste
- ☐ Other Fill
- ☐ Drainage ditch / tile
- ☐ Stormwater input
- ☐ Clearing
- ☐ Multiple
- ☐ Other

Primary Source of Stress; indicate as current (C) or historic (H):
- __ Private / Residential
- __ Commercial
- __ Agricultural
- __ Undetermined
- __ Public transportation
- __ Public utilities
- __ Public recreation

Sum of C3 to C9 Scores = ☐ **70 Minus Sum =** ☐ **C. Wetland Stress Score**

D. Observed State of Wetland Characteristics. Circle one score for each characteristic and sum. Refer to Sections A through C to inform scores. Consider current wetland types.

Characteristics	Characteristic*		Degraded		Destroyed
Hydrologic Integrity……	2	1.5	1	0.5	0
Water and Soil Quality……	2	1.5	1	0.5	0
Vegetation/microhabitat Structure……	2	1.5	1	0.5	0
Vegetation Composition……	2	1.5	1	0.5	0
Habitat Connectivity……	2	1.5	1	0.5	0

SUM = ☐ **D. Observed State Score**

B. Landscape Stress Score (max 20) _____ **+**

C. Wetland Stress Score (max 70) _____ **=**

B+C. Total Stress Score (max 90) ☐

D. Observed State Score (max 10) _____ **=**

RIRAM V. 2.10 Condition Index ☐

* Characteristic of wetland type in an unstressed setting

Appendix 2

Rules for Establishing RIRAM Assessment Units

Rules for Establishing Wetland Assessment Units

In most instances, a wetland assessment unit is a discrete area of wetland that is bounded by upland, Riverine open water, or Lacustrine open water, or by some combination of these. Other specific rules apply as follow:

1. Where a wetland narrows to less than 50 ft or to less than 10% of its maximum width (i.e. along its narrower axis), a boundary should be drawn, dividing the segments into two assessment units, unless the entire wetland is less than 50 ft wide.
2. Bodies of water greater than 20 acres in area or 7 ft in average depth are considered lakes (i.e. deepwaters) and are not assessed, although vegetated wetlands fringing or contained within a lacustrine basin (i.e. lacustrine wetlands) may constitute or comprise assessment units.
3. Bodies of water less than 20 acres in area and less than 7 ft in average depth are considered wetlands and are assessed with contiguous vegetated wetlands (according to these rules) as a single assessment unit.
4. If there is wetland on opposite sides of a river, both sides are considered a single assessment unit, but the channel is not considered part of the unit unless it is vegetated or ephemeral. The unit continues as long as there is wetland on at least one side of, or within, the channel. The unit terminates wherever upland borders the channel on both sides, or where another rule applies.
5. A wetland complex is divided into two or more evaluation units where there is a change from a broad to a linear or braided configuration, where:
    a. The broad wetland is at least three times the width of the linear wetland(s), and
    b. Linear is defined as at least five times as long as wide.
6. Wetland that is bisected by a railroad or 2-lane (i.e. undivided) highway is considered to be a single assessment unit if:
    a. Culverts permit the free flow of surface water, and
    b. The slope and drainage of the wetland are unidirectional across the structure
7. A railroad or 2-lane highway splits wetland into separate evaluation units if either:
    a. There is no culvert, or culvert flow is blocked or inadequate, or
    b. The slope and drainage of the wetland run in more than one direction away from the road.
8. Wetland cut by a 4-lane (divided) highway is considered two separate assessment units.