Developing a Decision Support System for Riparian Management

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Forests Have Multiple values

- Human Actions (Private/Public)
  - Impacts/Preservation/Conservation
  - Social Function Valuation

- Cultural Values
  - Ecological Function Valuation

- Ecosystem Goods & Services
  - Ecological Services Valuation
  - Economic Valuation

- Riparian Structure & Function
  - Core basis for DSS

Adapted from: *Valuing Ecosystem Services*. NRC 2005
The CCFM criteria recognize the social, environmental, and economic importance of riparian areas

- Biological diversity
- Ecosystem condition & productivity
- Soil & water
- Role in biogeochemical cycles
- Economic & social benefits
- Heritage values and aboriginal TEK
The many values of shoreline forests may come into conflict when their relative importance is perceived differently by different user groups.

While it may not be possible to achieve a true “balance” between competing values, management will be made easier if there is:

1) Cooperative, integrative, science-based guidance

2) An effective system for decision-making
….. a Decision Support System!

"guilty... not guilty... guilty... not guilty..."
“DSS’s for forest resource management are most effective when integrated into an adaptive management approach, including identification of potential conflicts between competing objectives, providing an interface for the integration of value perceptions and preferences of decision makers and stakeholders”

Rauscher 1999 (For Ecol. Managem. 114: 173-197)
The Role of DSS in forest Management

- The goal of a DSS is, of course, to make decisions
- But…..
- It is often impossible to immediately test a decision on a complex problem in forest resource management (other than modeling) so emphasis must be placed on the process of decision making

It is important to “get it as right as possible” the first time!
Developing a Riparian DSS

- Arguably, the least information is known about riparian systems yet they often require the greatest planning workload related to non-timber features.

- In the absence of scientific information, this often leads to a conservative, precautionary approach to making decisions about harvesting and other actions in riparian forests.
Developing a Riparian DSS

macalester.edu

kansasforests.org
Core Characteristics of a Riparian DSS

1) Provide science-based decisions

2) Facilitate decisions related to:
   1) Social/cultural/heritage values and special features
   2) Ecological values and special features
   3) Economic and operational (safety) concerns

3) Provide information on the scientific process (rationale) behind the decisions it promotes
Core Characteristics of a Riparian DSS

4) Serve as a communication tool to help explain decisions to the public for unconventional actions on shorelines

5) Be flexible so that it can accommodate the diversity of regional landscapes and issues across Canada
Ontario has adopted an approach of emulating natural disturbance patterns as the core feature of its forest management strategy.

S&S Guide encourages disturbance:

“In contrast to the Timber Management Guidelines for the Protection of Fish Habitat (1988), direction in the new guide not only permits, but encourages management in shorelines areas, primarily to meet ecological objectives”

(Stand & Site Guide, page 36)
The historical default approach of leaving buffers and ribbons around water bodies is “easy” from a management standpoint.

However, this approach does not recognize the disturbance regimes that affect riparian areas and may lead to “unnatural” riparian condition (e.g., increased homogeneity, reduced diversity, etc.)
In terms of riparian management, it also helps if we are clear about “why we are doing it”…… Is it for ecological values or timber values?

Decision points within the DSS will necessarily be based on whether the goal of riparian management is ecological or economic.
Ontario Stand and Site Guide

- One of several guides used by forest managers in Ontario when planning and implementing forest management activities.

- Section 4.0 provides specific guidance on aquatic biota and their habitats (pertinent to riparian and hydrologically sensitive areas).

- To be effective, a DSS must be consistent with the provisions of the guide.
Developing a Riparian DSS

The approach we have used to develop a riparian-based DSS has been to:

1) Develop the conceptual basis of the DSS

2) Develop a DSS based on Ontario’s new Stand and Site Guide

3) Develop a generic DSS that can be adapted regionally
DSS Generic Framework

Tier 1
Values and Special Features Assessment

Tier 2
Criteria and Indicators (Lines of Evidence [LOE])

Tier 3
Risk Characterization (Weight of Evidence)

Tier 4
Management (Harvesting Options)

Summary of Actions

Consider all values, special features and landscape attributes that might preclude/restrict harvesting in a riparian area from the outset of the planning process.

Consider all relevant biophysical lines of evidence (LOI)/indicators: application of decision keys for management of site-specific habitats.

Evaluate decisions from decision keys to determine overall susceptibility of riparian area to determine when, where and how much harvesting should be conducted.

Design a riparian harvesting plan to ensure maximum benefit to forest industry and riparian area and minimum disturbance.
Shoreline Forest Management

“….understanding the human and societal dimensions of riparia may be the new important challenge we face at the present time”

“Landscape approaches are not really landscape approaches if they lack the human and societal dimension”

Naiman et al. (2005). In: Riparia, Ecology, Conservation, and Management of Streamside Communities
Values & Special Features
Social & Cultural Values

Value Category

Ecological

- Ecological Services
- Aquatic Values
- Terrestrial Values

Prioritized Value

- Recreation – shore lunches camp sites (M-H)
- Cultural and heritage sites (M-H)
- Aesthetics/viewscapes (M)
- Cottages/ trappers cabins (M)
- Community water supply (M)
- Public perception and politics (M)
- Protected Areas (M)
- Medical plants (L-M)

Social/Cultural

- Timber – cost to operate and revenue (H)
- Non-timber forest products (H)
- Trapping (M)
- Game/waterfowl/hunting/fishing (M)
- Recreation – camping/bird watching (M)
- Remote tourism (M)

Economic
Social & Cultural Values

- There is rarely a “science-based” right way to protect social or cultural (heritage) values.

- Most provinces have guidelines to ensure that social values are addressed in the planning process; in Ontario, this includes the:
  
  1) Resource-based tourism values guide
  
  2) Cultural heritage values guide
A DSS should provide the scientific basis for the ecological prescription(s); the final prescription would include both ecological and social considerations.

Thus, the proposed DSS does not directly deal with social and cultural issues; these are left to the broader planning process.
Values & Special Features
Decision Key

1) Social/Cultural
- Is the riparian area an important cultural or heritage site?
- Is the adjacent water-body a source of drinking water?
- Is this an important recreational area?

2) Ecological
- Is rare/critical habitat or are endangered/rare species present?
- Are critical ecosystem services (e.g., water supply) at risk?

3) Economic/Operational
- Is wood merchantable and cost-effective to harvest?
- Are there inaccessible areas (is it safe to harvest) in the riparian area?
- Can area be successfully regenerated (silviculture)?

Consult Regional Social Values Guides
1) Cultural Heritage Values Guide
2) Resource-Based Tourism Values Guide
3) Species at Risk Act

Feedback to Forest Planning Process:
Adaptive Management

No Harvest

Harvesting Possible: Consult regional Guidelines

To Tier 2 (Biophysical Lines of Evidence)
DSS Structure

Tier 1
Values and Special Features Assessment

Tier 2
Criteria and Indicators (Lines of Evidence [LOE])

Tier 3
Risk Characterization (Weight of Evidence)

Tier 4
Management (Harvesting Options)

Summary of Actions
Consider all values, special features and landscape attributes that might preclude/restrict harvesting in a riparian area from the outset of the planning process.

Consider relevant biophysical and site-specific lines of evidence (LOI): application of decision keys for management of site-specific habitats.

Evaluate decisions from decision keys to determine overall susceptibility of riparian area to determine when, where and how much harvesting should be conducted.

Design a riparian harvesting plan to ensure maximum benefit to forest industry and riparian area that minimizes disturbance.
Values & Special Features
Ecological Values

**Ecological Services**
- Drinking water (H)
- Biodiversity (H)

**Aquatic Values**
- Rare/endangered species (SARA: H)
- Critical habitat (H)
- Nesting Sites (H)
- Water quality & quantity (H)
- Fish & fish habitat (H)
- CWD (L-H)
- Hydrologic function (HSA's) (H)
- Ecotonal function (includes G-S and A-T) (M)
- Aquatic productivity (H)

**Terrestrial Values**
- Rare/endangered species (SARA: H)
- Critical habitat (H)
- Nesting Sites (H)
- Water quality & quantity (H)
- Fish & fish habitat (H)
- CWD (L-H)
- Hydrologic function (HSA's) (H)
- Ecotonal function (includes G-S and A-T) (M)
- Aquatic productivity (H)

**Social/Cultural**

**Economic**

**Prioritized Value**
- Rare/endangered species (SARA: H)
- Critical habitat (H)
- Nesting Sites (H)
- Water quality & quantity (H)
- Fish & fish habitat (H)
- CWD (L-H)
- Hydrologic function (HSA's) (H)
- Ecotonal function (includes G-S and A-T) (M)
- Aquatic productivity (H)
- Rare/endangered species (SARA: H)
- Critical habitat (H)
- Nesting Sites (H)
- Water quality & quantity (H)
- Fish & fish habitat (H)
- CWD (L-H)
- Hydrologic function (HSA's) (H)
- Ecotonal function (includes G-S and A-T) (M)
- Aquatic productivity (H)

**Ecotone**
- Soil productivity (H)
- Biogeochemical/nutrient cycling (M)
- Ecotonal function (M)
- CWD (M)
Water quality

- Change in water quality characteristics (e.g., ↑ or ↓ in nutrient status, sedimentation)
- Potential for ↑ or ↓ in nutrient cycling
- Changes in discharge (peak/low flow) - quantity

Fish Habitat

- % change in population abundance or community diversity
- Potential for HADD

Wildlife

- % area required by specific species
- % change in population abundance or community diversity

Aquatic Indicators

Tier 2 (Biophysical Lines of Evidence)
Tier 2 (Biophysical Lines of Evidence)

Terrestrial Indicators

Soil quality

• Erosion potential (soil composition and slope) and loss
• Potential for ↑ or ↓ in nutrient cycling
• Potential for saturation, changes in shallow surface flow regimes

Wildlife

• % area critical to specific species (e.g., LLP for riparian area)
• % area retained for dispersal corridors

HSAs

• Changes in ground/surface water flow (e.g., discharge, peak/low flow)
• Number of linkages between land-water

Criteria

Indicator

• Number of linkages between land-water

% area retained for dispersal corridors
Establishing AOCs: Generic

Is the riparian area adjacent to:

- A lake, stream or pond with potentially high sensitivity to harvesting disturbance?
- A lake, stream or pond with potentially moderate sensitivity to harvesting disturbance?
- A lake, stream or pond with potentially low sensitivity to harvesting disturbance?
- Is there a potentially sensitive wetland?

Establish OAC Requirements

Examples:
1) Finite AOCs (minimum/maximum buffers)
2) Slope-based AOCs
3) Management zones

Harvesting may be permissible: Move to Special Habitat Features decision keys
Establishing AOCs: Ontario

Is the riparian area adjacent to:

- A large lake, small lake or HPS pond?
- An HPS stream or river?
- A MPS stream or pond?
- An LPS stream or pond?
- A provincially significant Wetland?

AOC Requirement:

- 0-15%: 30 m
- >15-30%: 50 m
- >30-45%: 70 m
- >45%: 90 m
- 75% residual timber

AOC Requirement:

- 30 m
- 30 m
- 15 m
- 120 m

Harvesting may be permissible: Move to Special Habitat Features decision keys.
Special Habitat Features: Generic

Are there defined species requirement areas (e.g., riparian equivalent LLP)?

- No
  - To Next Key (E.g., Water Quality Key)
- Yes
  - What species is being emphasized?
    - To species-specific habitat keys from regional S&S Guide

Adapted from Figure 3.2A Ontario S&S Guide 2009
Special Habitat Features: Wildlife Key
(Adapted From Ontario Stand & Site Guide, Fig 3.2A)

Are there defined species requirement areas (e.g., riparian equivalent LLP)?

No

S&SG
Section 3.2.2.2

Yes

What species is being emphasized?

Fish
S&SG
4.1/4.3.4

Moose
S&SG
3.3.4/4.2.4

Beaver
S&SG
4.2.3

Turtles
S&SG
4.3.5.3

Birds
S&SG
4.2.2.3

Raptors
S&SG
4.2.2.1/2
4.2.2.4-6

Harvesting may be permissible: Move to next decision key
Consider all values, special features and landscape attributes that might preclude/restrict harvesting in a riparian area from the outset of the planning process.

Consider all relevant biophysical lines of evidence (LOI)/indicators: application of decision keys.

Evaluate decisions from decision keys to determine overall susceptibility of riparian area to determine when, where and how much harvesting should be conducted.

Design a riparian harvesting plan to ensure maximum benefit to forest industry and riparian area and minimum disturbance.

Summary of Actions
Tier 3: Risk Characterization

Hazard Identification

Integrate LOE from decision keys to:

1) Determine *if/where* harvesting can/should be conducted within the riparian AOC
2) Determine *how much* timber can be accessed and harvested safely and with minimum disturbance
3) Develop a harvesting plan

Tier 4

Implementation: Management Option Decision Tree

Adaptive Management

Hazard Mitigation Strategies

Evaluation

Van Damme et al. 2003
Consider all values, special features and landscape attributes that might preclude/restrict harvesting in a riparian area from the outset of the planning process.

Consider all relevant biophysical lines of evidence (LOI)/indicators: application of decision keys.

Evaluate decisions from decision keys to determine overall susceptibility of riparian area to determine when, where and how much harvesting should be conducted.

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Harvest Management Options

Tier 4

Based on characterized riparian condition, implement a thoughtfully and carefully constructed harvesting plan that meets the stipulations of regional planning guides.

- Scenario A
  - Option A: No harvest

- Scenario B
  - Option B: Harvest with absolute buffer

- Scenario C
  - Option C: Harvest with selected tree removal

- Scenario D
  - Option D: Harvest using partial cuts (rows)

- Scenario E
  - Option E: Harvest using partial cuts (patches)

- Scenario F
  - Option F: Harvest with variable buffer widths

Adaptive Management Cycle
Riparian Management
(Considerations)

- Is it best to avoid approaches that are too prescriptive?
  
  “prescribing *how to* from a desk does not meet the litmus test of practicality”

- Perhaps it is better to indicate the desired results (ecological condition) but not limit the number of permissible operations

- Industry could then be creative based on the sound science supporting the decisions of the DSS