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Species at Risk Act Implementation Guidance

-DRAFT-

**Technical Guidelines for
Identifying Critical Habitat**

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Canada

This guidance was developed on behalf of the Critical Habitat Working Group. The guidelines are a work in progress and have not yet been approved by EC, PCA, or DFO.

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Executive Summary

Recovery strategies and action plans under SARA require the identification of critical habitat for extirpated, endangered, and threatened species to the extent possible. Where available information to identify critical habitat (either in whole or in part) is inadequate, recovery strategies also require a schedule of studies that will lead to identification at a later date. These guidelines provide a summary of technical guidance for the identification of critical habitat under SARA. They aim to promote: i) a common understanding of the policy requirements for identification; ii) a consistent methodological framework for identification; and iii) the preparation of biologically and legally defensible critical habitat proposals.

Strategies and plans, including identification of critical habitat, should be developed by experts in cooperation with appropriate authorities and in consultation with organizations and people who are directly affected. Critical habitat identification may take many different forms depending on the species and the jurisdiction. However, it is essential that the process be based on the best available information, be it quantitative evidence, qualitative description, expert opinion, or any combination thereof. Critical habitat should be identified in support of specific population and distribution objectives for the species

The generic steps to identifying critical habitat are:

1. Synthesize the best available knowledge about the species
2. Locate the species and its appropriate habitat
3. Establish the species recovery goal and population & distribution objectives
4. Determine the whereabouts of proposed critical habitat
5. Review and revise proposed critical habitat
6. Finalize advice on proposed critical habitat
7. Legally identify critical habitat
8. Protect, manage, and monitor critical habitat
9. Update advice on critical habitat

Advice on critical habitat must consist of several basic elements:

1. A narrative of the species critical habitat(s)
2. Range coordinates that geospatially locate the proposed critical habitat
3. An explanation and documentation of the rationale underlying the proposed critical habitat
4. Specification of portions of critical habitat that are currently unprotected
5. Examples of activities likely to destroy critical habitat
6. A schedule of studies (if necessary)

Table of Contents

Executive Summary	2
1.0 Statement of Intent and Purpose	3
2.0 The Expected Product	4
3.0 Guiding Principles	6
4.0 Generic Steps in the Identification of Critical Habitat	7
5.0 How Much Critical Habitat is Enough?	12
6.0 Approaches to the Identification of Critical Habitat	14
7.0 Identifying Critical Habitat to the Extent Possible	18
8.0 Schedule of Studies to Identify Critical Habitat	20
9.0 Social and Economic Considerations	20
10.0 Examples of Activities Likely to Result in the Destruction of Critical Habitat	21

List of Tables

Table 1 Model types and associated data requirements for predicting species habitat	10
Table 2 Outline of two complimentary and sequential approaches to critical habitat identification	15

List of Figures

Figure 1 Generic steps in the identification of proposed critical habitat	12
Figure 2 Hypothetical illustration of a fundamental approach to proposed critical habitat identification	16
Figure 3 Another hypothetical illustration of a fundamental approach to identifying proposed critical habitat	17
Figure 4 Generalized example of partial (left) and comprehensive (right) critical habitat for the same species in the same landscape	18
Figure 5 Generalized example of the difference between a precautionary (left) and a more refined (right) identification of critical habitat for the same species in the same landscape	19

1.0 Statement of Intent and Purpose

Critical habitat is defined in the Federal *Species at Risk Act* (SARA) as *habitat that is necessary for the survival or recovery of a listed species and is identified as the species' critical habitat in the recovery strategy or in an action plan for the species*. Recovery strategies and action plans under SARA require identification of critical habitat to the extent possible for extirpated, endangered, and threatened species.¹ A schedule of studies that will lead to identification (either whole or in part) at a later date is required in recovery strategies where available information to identify critical habitat is inadequate. Program managers and recovery practitioners can find general direction regarding policy and procedures pertaining to critical habitat identification and its protection in the *Federal Policy Discussion Paper: Critical Habitat*². A literature review, workshop proceedings, and heuristic case studies have also been prepared which explore the problem and provide in-depth examples of a variety of approaches that may be used to identify critical habitat³.

These guidelines provide a summary of technical guidance for the identification of critical habitat under SARA. They aim to promote: i) a common understanding of the policy requirements for identification; ii) a consistent methodological framework for identification; and iii) the preparation of biologically and legally defensible critical habitat proposals. Lessons learned through implementation experience may necessitate changes in Federal policy and operational guidance over time. Similarly, advances in conservation science will undoubtedly lead to revisions in best practices for the identification of critical habitat. Lastly, while the guidelines provide direction for critical habitat identification under SARA, they might also be usefully applied in support of similar provincial and territorial legislation, notwithstanding differences that may exist between such laws and attending policies.

Other pieces of guidance that may be of importance when identifying critical habitat include: *Guidelines for Establishing Recovery Goals and Population & Distribution Objectives*, as critical habitat should be identified in support of specific population and distribution objectives for the species; and the *Framework for Identifying and Mitigating Threats*, as the threats to a species and/or its habitat may influence critical habitat identification.

¹ Throughout this document, 'species' refers to the entity listed under SARA.

² Accessible at: http://www.sararegistry.gc.ca/policies/default_e.cfm

³ The literature review, workshop proceedings, and case studies (whooping crane, western yellow-breasted chat, Acadian flycatcher, hooded warbler, prothonotary warbler, Banff Springs snail) are accessible at: http://www.cws-scf.ec.gc.ca/extended_sharing/ password = critical habitat

2.0 The Expected Product

Advice on critical habitat must consist of several basic elements and recovery practitioners should be aware of them before starting the identification process. The *Federal Policy Discussion Paper: Critical Habitat* outlines the minimal standards for communicating proposed critical habitat as follows:

1. **NARRATIVE** of the species' critical habitat(s), which may include such things as: an account of appropriate natural communities; habitat types; habitat features; necessary and sufficient quantities (e.g., hectares)⁴; compositional arrangement; and any essential ecological processes (e.g., pollination, parasitism, dispersal, fire, flood). In essence, this section describes proposed critical habitat by answering the question - **WHAT IS IT?**
2. **RANGE COORDINATES** (e.g., UTM zone, UTM easting, UTM northing, datum of coordinates) in order to geospatially locate the proposed critical habitat within Canada. Within the area(s) delineated by the range coordinates, only habitat fitting the narrative is considered actual critical habitat. In essence, this section contributes to the identification of proposed critical habitat by answering the question - **WHERE IS IT?**
3. **EXPLANATION & DOCUMENTATION OF THE RATIONALE** underlying the proposed critical habitat. This section should include an outline of the approach and methods used to identify critical habitat and formal reference to whatever combination of evidence-based information (experimental analysis and quantitative measurement), experience-based information (qualitative description, expert opinion), or traditional ecological knowledge that may have informed the identification of proposed critical habitat. In essence, this section contributes to the identification of proposed critical habitat by answering the question - **WHY IS IT?**
4. **SPECIFICATION OF PORTIONS OF CRITICAL HABITAT CURRENTLY UNPROTECTED**⁵ (e.g., outside protected areas, no existing stewardship arrangements), especially those in imminent jeopardy. Technically this information is to be included in the action plan. However, distinguishing between 'protected' and 'unprotected' portions of proposed critical habitat during the identification process may facilitate more rapid and effective protection down the road. Obviously, being able to categorize habitat as either 'protected' or 'unprotected' requires that one defines what constitutes 'effectively

⁴ See section 5.0 **How much Critical Habitat is Enough?** for additional discussion.

⁵ SARA s49(1c). An action plan must include, with respect to the area to which the action plan relates, an identification of any portions of the species' critical habitat that have not been protected.

protected⁶. In essence, this section contributes to the advice on proposed critical habitat by answering the question - **WHERE IS IT NOT PROTECTED?**

5. **EXAMPLES OF ACTIVITIES LIKELY TO DESTROY CRITICAL HABITAT⁷** are required at the time it is identified. Example activities should be based on demonstrated or probable threats to habitat. Identification of what may lead to destruction of critical habitat is likely to be context specific, and will play an important role in determining whether the critical habitat is effectively protected. In essence, this section contributes to the advice on proposed critical habitat by answering the question - **HOW MIGHT IT BE DESTROYED?**

6. **SCHEDULE OF STUDIES⁸** necessary to obtain additional adequate information to identify the type, whereabouts, and quantity of critical habitat to support the recovery goal. As such, identification of either all or some outstanding portions of critical habitat is deferred.⁹ The schedule of studies should be prefaced by explaining why some or all the critical habitat cannot be identified at present. In essence, this section contributes to the identification of proposed critical habitat by answering the question - **WHAT OTHER INFORMATION IS REQUIRED TO DETERMINE THE 'WHAT' AND 'WHERE' OF CRITICAL HABITAT?**

Although *maps* are not specifically required to legally define critical habitat under SARA it is recognized that their preparation and use will be common practice among recovery experts undertaking the task of critical habitat identification. Further, mapping data generated during the identification process will be of immense value for recovery implementation when it comes to protecting, managing, and monitoring critical habitat. As such, illustrative maps, GIS shapefiles, associated geospatial data, etc. may be referenced as part of a proposed critical habitat package. In such cases, sound data management practices need to be developed and exercised.

⁶ Policy and guidance around the meaning of effective protection is in development. In essence, effective protection should prevent any part of the critical habitat from being destroyed.

⁷ See section **10.0 Examples of Activities Likely to Result in the Destruction of Critical Habitat** for detailed discussion.

⁸ See section **8.0 Schedule of Studies to Identify Critical Habitat** for further discussion and an example.

⁹ See section **7.0 Identifying Critical Habitat to the Extent Possible** for a detailed discussion of incremental identification of critical habitat.

3.0 Guiding Principles

Whenever possible, recovery practitioners should follow five guiding principles to influence the process and outcome of critical habitat identification.

Be Precautious - Always take measures in advance that prevent harm or secure good in order to safeguard against irreversible catastrophes including extinctions or local extirpations. In essence, don't delay advancing informed advice on critical habitat for lack of full information or certainty. Make practical efforts to ensure representation, redundancy, and resiliency¹⁰ of habitat types and processes within critical habitat proposals, as well as connectivity between critical habitat parcels where appropriate.

Base advice on the best available information – Where possible, critical habitat proposals should be based on quantitative evidence (experimental analysis, quantitative measurement) from a wide range of sources. However, in many cases qualitative description, expert opinion, and/or traditional ecological knowledge may be the main source of information on which advice must be based. Although some types of information may be associated with privacy issues, generally strive to ensure that all information is available in an accessible and meaningful form to all concerned.

Variance is informative – Variance in species occurrences and habitats contains important biological information, the patterns of which should help inform proposals for critical habitat.¹¹ Because of variability in many population and/or habitat parameters, conclusions about them (e.g., the amount of critical habitat required for population viability) are bound to be accompanied by uncertainty. Be upfront about the perceived level of uncertainty, and ensure an appropriate precautionary approach is taken¹².

Recommendations should be testable - Advice on what constitutes critical habitat should be formulated such that it can be evaluated through the analysis of monitoring data.

Document the process – Key decisions and justifications relating to the process of critical habitat identification should be documented in writing (e.g., meeting minutes, date-stamped maps). Properly managed electronic “administrative

¹⁰ For further information on these concepts, see Stein, B. A., et al., (eds). 2000. Precious Heritage: The Status of Biodiversity in the United States. Oxford University Press, New York, New York.

¹¹ For further information see Wiens, J. A. 2002. Predicting species occurrences; progress, problems, and prospects. Pages 739-749. in Scott, J.M., et al. (eds.). Predicting Species Occurrences: Issues of Accuracy and Scale. Island Press. Covelo, CA.

¹² See section 7.0 **Identifying Critical Habitat to the Extent Possible** for additional discussion.

records" can serve as valuable evidence, especially when trying to resolve disputes and preparing for court challenges.¹³

4.0 Generic Steps in the Identification of Critical Habitat

Strategies and plans should be developed by experts in cooperation with appropriate authorities and in consultation with organizations and people who are directly affected. Recovery planning may take many different forms depending on the species and the jurisdiction. However, it is essential that the process be based on the best available information, be it quantitative evidence, qualitative description, expert opinion, or any combination thereof.

Case study experience¹⁴ has led to the development of a generic framework for the identification of critical habitat. The steps in this framework simply describe a general process that is comprised of both analytical and administrative functions. The details underlying these steps, including 'how', 'when', and 'who' (i.e., respective roles) will depend on the particular recovery planning model adopted for the species.

A schematic illustration of the generic process follows a brief description of each step.

1. **SYNTHESIZE THE BEST AVAILABLE KNOWLEDGE** about the species' life history, population ecology, and especially population habitat requirements. This task may not be conducted expressly for the purposes of critical habitat identification especially since a literature review is likely to be undertaken at the start of general recovery planning for the species. The point is simply that all those engaged in critical habitat identification should be fully aware of what is, and is not, understood about the species as it pertains to critical habitat. It is upon this foundation that critical habitat advice will be established.
 - Best available knowledge is meant to include quantitative evidence, qualitative description, expert opinion, and traditional knowledge – though not all may have equal merit.
 - Do not assume that all populations of the species necessarily have the same habitat requirements. Differences may exist among populations depending on abundance, density, composition (age, sex), landscape context (agricultural vs. wildland), etc.

¹³ See Chapter 10: 136-140 in Andelman, S. J., et al. 2001. Scientific Standards for Conducting Viability Assessments under the National Forest Management Act: Report and Recommendations of the NCEAS Working Group. Unpublished Report by the National Center for Ecological Analysis and Synthesis, University of California, Santa Barbara, California, USA. Available online at: <http://www.treesearch.fs.fed.us/pubs/viewpub.jsp?index=3467>
<http://www.treesearch.fs.fed.us/pubs/viewpub.jsp?index=3467>

¹⁴ Example critical habitat case studies are available at: http://www.cws-scf.ec.gc.ca/extended_sharing/ password = critical habitat

- Characterizing the relationship between essential life history stages, key activities, and habitat features will help develop an understanding of the habitat(s) required throughout the species lifecycle, as well as requirements for landscape connectivity.
 - Describe any known distinguishing species-habitat associations, using both current and historical data. Historical data may be an essential source of information for identifying important habitat attributes - non-viable endangered populations may use habitat very differently than their historic viable counterparts.
 - Synthesis of available knowledge of the species' habitat needs will enable the preparation of a narrative conceptual model of the 'habitat mosaic' required by the species for recovery.
 - It may also be useful to create a graphical conceptual model that highlights the hypothesized predictor and response variables and where main versus interactive effects are likely to be important in maintaining habitat for the species.
2. **LOCATE THE SPECIES AND APPROPRIATE HABITAT 'on the ground'.** To the extent possible, practitioners need to gain full knowledge of the current and past geographic distribution of populations of the species and suitable habitat as a concrete step toward identification of critical habitat. In many instances, a comprehensive understanding of these distributions may require data mining, primary field inventories, verification of remotely-sensed data, and quantitative modelling. In other instances, understanding the whereabouts of the species and its habitat may be quite simple. Locating populations and habitat (both where they co-occur and areas of suitable habitat believed to be unoccupied) will often serve as geographic starting points to 'root' critical habitat on the landscape within the species' Canadian range. At the very least, locating the species and suitable habitat allows one to scope a rough approximation of the potential distribution of proposed critical habitat and any important connectivity pathways among parcels of critical habitat.
- Care should be taken to evaluate potential sources of bias associated with population and habitat datasets. It should be recognized that species occurrence in a particular habitat type may not equal use or preference, as the specific location of occurrence may be biased in a number of ways. This is especially problematic with opportunistic data.¹⁵
 - Ensure the use of data at a spatial scale that is appropriate for the species under consideration. The spatial scale of any landcover data (e.g., pixel size of 30m² for Landsat TM data) should be compatible with the perceptual or habitat selection scale of the species. It may not be biologically meaningful to identify habitat patches using data that are either too coarse or too fine for the species under consideration.

¹⁵ See Garshelis, D. L. 2000. Delusions in habitat evaluation: measuring use, selection, and importance. Pages 111-164 in L. Boitani and T.K. Fuller, editors. *Research Techniques in Animal Ecology: Controversies and Consequences*. Columbia University Press, New York, New York, USA.

- Identify areas where restoration may be possible, including areas that were historically occupied by the species but are currently thought to be vacant.
 - Make allowances for spatial and temporal shifts in habitat due to natural disturbance regimes (e.g., fire, flood) and other naturally occurring processes (e.g., gyres, ice edges). That habitats are dynamic in space and time suggests that proposed critical habitat should be broad enough to encompass such shifts – at least until critical habitat can be updated. When such shifts are known to occur frequently, it may not be advantageous to narrowly delineate critical habitat parcels. The spatial and temporal scales at which some habitats operate are known and these could be used to calibrate the size and shape of critical habitat parcels and the frequency with which revisions should be considered.
 - Where possible, models used to predict habitat occurrence (see Table 1) should be validated with independent field data, either by splitting data or gathering new data. Habitat models are only fully acceptable if validation data have been collected and the model gives sufficiently low false positive and false negative occupancy results. Habitat modeling should be approached in an iterative fashion, accommodating new data as it becomes available, with validation at each step. See table below for summary guidance on choosing the appropriate model for predicting species habitat.
3. **ESTABLISH THE SPECIES RECOVERY GOAL** in terms of viability or acceptable level of risk.¹⁶ In many instances this step will have been accomplished early on in recovery planning, before practitioners actually set out to identify critical habitat. The recovery goal establishes the strategic course for recovery planning and relates directly to population and distribution objectives and critical habitat because both should be defined in support of the goal. Ideally, population and distribution objectives should also be set before critical habitat is identified.
4. **DETERMINE THE WHEREABOUTS OF PROPOSED CRITICAL HABITAT** required to meet the species recovery goal and/or prepare a **SCHEDULE OF STUDIES**. This is the heart of the critical habitat identification process, a series of operations which should include: (i) a formal systematic analysis of the species' habitat needs which are necessary and sufficient to achieve a predetermined viability goal; (ii) a determination of the sites or landscapes which result from this analysis; and/or (iii) a careful evaluation of outstanding knowledge gaps that must be filled in order to identify critical habitat exhaustively – to be detailed in a schedule of studies.

¹⁶ See *Policy on the Feasibility of Recovery* and *Guidelines for Establishing Recovery Goals and Population & Distribution Objectives* for detailed discussion of this topic. Both documents are available at: http://www.cws-scf.ec.gc.ca/extended_sharing/ password = critical habitat

- Many methods and specific tools can be employed to solve the problem of critical habitat identification.¹⁷ From an analytical perspective, the methods used should be determined in a case-by-case manner that is tailored to particular ecological contexts.
- It may be important to consider not only areas that will actually harbour a population, but areas that may provide key processes to sustain habitat (e.g., areas that feed a dune system or upstream springs that provide water to riparian habitats).

Table 1—Sample model types and associated data requirements for predicting species habitat. Selecting the appropriate habitat model should be based on the type of data available and the expertise of recovery practitioners.

TYPE OF DATA AVAILABLE	APPROPRIATE HABITAT MODEL
Base maps & species experts	HSI (habitat suitability index)
Species locations only	Above plus MCP (minimum convex polygon), alpha hulls, kernels
Species locations & base maps	Above plus climatic envelopes (e.g., BIOCLIM), multivariate distance methods (e.g., DOMAIN), CCA (canonical correspondence analysis)
Species locations & random (i.e., available) locations & base maps	Above plus RSF (resource selection functions), logistic regression, GLM (general linear models), GAM (generalized additive models), ENFA (ecological niche factor analysis)
Presence – absence (occupied and unoccupied species locations) & base maps	Same as above (though results will be more robust with actual absence data)
Species abundance & base maps	Same as above (though abundance data gives more information and provides for more robust results than presence only data or presence – absence data)
Habitat dynamics	Landscape models (new in recovery context)
Supplementary methods only	Decision trees, neural networks, genetic algorithms

5. **REVIEW AND REVISE PROPOSED CRITICAL HABITAT**, consult and further revise (as necessary). As part of the recovery strategy or action plan review process, advice on proposed critical habitat should be subjected to external peer-review and systematic quality control to ensure scientific rigour and consistency. Necessary revision of the critical habitat proposal should follow.

¹⁷ See section 6.0 **Approaches to the Identification of Critical Habitat** for additional discussion.

In addition to requirements to cooperate and consult during the preparation of recovery strategies and action plans (including advice on proposed critical habitat), SARA also requires consultation via posting on the *Species at Risk Act Public Registry*. Comments and questions arising from consultation on the *Registry* may require that further revisions be made.

6. **FINALIZE ADVICE ON PROPOSED CRITICAL HABITAT**, as part of the recovery strategy or action plan, for Ministerial approval. Administrative endorsement by the competent Minister or a designate will be required prior to legal identification of critical habitat.
7. **LEGALLY IDENTIFY CRITICAL HABITAT**, this is a Ministerial role that will include posting the critical habitat within a finalized strategy or plan on the SARA Registry, thus formalizing its identification under SARA.
8. **PROTECT, MANAGE, AND MONITOR CRITICAL HABITAT (and populations)**, as necessary. Once critical habitat is legally identified SARA responsible authorities will be required to ensure that it is adequately protected.
 - In some instances, protection may require active management (e.g., prescribed fire, control of alien invasive species).
 - Knowledge of the effectiveness of protection and the utility of critical habitat for recovery will also require habitat and population monitoring.
 - Often it may be pragmatic to initiate protection efforts (e.g., stewardship), and establish monitoring baselines and sampling designs *before* critical habitat has been legally identified.
9. **UPDATE ADVICE ON CRITICAL HABITAT** as required. Habitats and populations are spatially and temporally dynamic and knowledge of species habitat requirements may improve through time. As such, advice on what constitutes critical habitat for a given species may need to be updated on occasion. Attention to the results of monitoring efforts and research findings should alert one to the need to formally review advice on critical habitat (probably in conjunction with a 5-y Recovery Strategy review). In such cases the process for identification of critical habitat should be repeated in full.

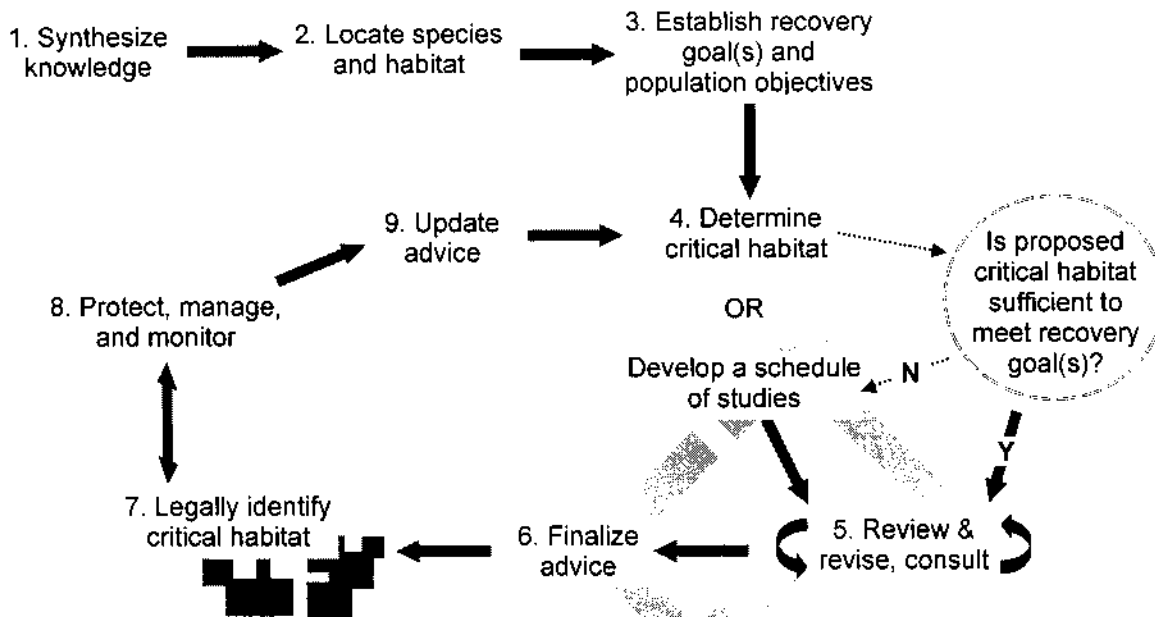


Figure 1 Generic steps in the identification of proposed critical habitat. See text for descriptions of each step.

5.0 How Much Critical Habitat is Enough?

Answering this question depends in part on what it is you want to achieve because critical habitat should be defined in support of a recovery goal and the associated population and distribution objectives. Indeed, there is a strong logical relationship between recovery goals and the establishment of population objectives and critical habitat. Preferably, both the population and distribution objectives one sets and the proposed critical habitat one identifies for species recovery should relate to population viability targets. That is, population objectives should be sufficient to enable acceptable improvement or maintenance of the species' viability. Similarly, the amount and configuration of proposed critical habitat identified should be adequate to support species viability.¹⁸

¹⁸ See *Policy on the Feasibility of Recovery and Guidelines for Establishing Recovery Goals and Population & Distribution Objectives* for additional discussion of these topics. Both documents are available at: http://www.cws-scf.ec.gc.ca/extended_sharing/ password = critical habitat

Ideally, recovery strategies will provide *quantitative* recovery goals and population and distribution objectives - e.g., attain >95% probability of exceeding 3000 females by the year 2015, <10% probability of dropping below a quasi-extinction level of 20 females through 2015. In the ideal scenario, there also will be knowledge of: i) species habitat use; ii) population-level habitat requirements; and iii) location of suitable habitat (either occupied or believed to be unoccupied). In such cases, one should be able to specify with a relatively high degree of certainty, the whereabouts of *necessary and sufficient* critical habitat required for support of the objectives and the recovery goal. Thus, all the relevant pieces of knowledge will be in place to provide a precise answer to the question: how much critical habitat is enough?

However, there will be situations in which the recovery goals and objectives are more *qualitative* in nature - e.g., improve viability, increase population size, maintain current geographic distribution. Under these conditions, it will be more difficult to determine and justify precise amounts of critical habitat required because the target goals and objectives are relatively vague. Nevertheless, assuming we have knowledge of the species' population habitat needs and the location of suitable habitat, practitioners are encouraged to proceed with critical habitat identification, recognizing that such proposals will provide more approximate answers to the question: how much critical habitat is enough?

The following scenarios illustrate how one might proceed in situations where the recovery goals are qualitative. Assume that the recovery goals are as simple as i) increase geographic distribution or ii) maintain geographic distribution. Under the *increase distribution* scenario, critical habitat might simply amount to habitat that is currently occupied, plus a portion of suitable habitat that is believed to be unoccupied at present. The difficulty here is in specifying how large a portion of suitable habitat is required to satisfy the recovery goal. Under the *maintain distribution* scenario, critical habitat might simply amount to habitat that is currently occupied. Again, defending any one parcel of habitat over another as critical habitat on the grounds of necessity may be problematic when recovery goals are unclear.

More often than not, it is implicitly assumed that the presence of the species equals 'suitable habitat', whereas absence of the species equals 'unsuitable habitat'. This may not necessarily be true. Because a species may be absent from an area for a variety of reasons unrelated to habitat preference (e.g., illegal harvest, disease, isolation), habitat that is believed to be unoccupied may be both suitable and necessary for recovery (although threat mitigation may be necessary). Likewise, occupied habitat may not always represent a species' preference for that habitat. The species may be present only because preferred habitat is no longer available. Occupied habitat may also be considered non-critical if it represents a habitat sink or if all occupied habitat is not necessary to

reach recovery goals. Be sure to carefully evaluate such assumptions when considering the identification of proposed critical habitat.

Thinking about what critical habitat represents and the type of support that may be required to successfully defend a proposal can help guide identification itself. To this end, critical habitat proposals should be regarded as *expert advice on the type and amount of habitat that in all likelihood is needed to reach the recovery goal*. The inverse is that anything less than the recommendation, or being below some acceptable threshold, increases the risk of not reaching the recovery goal.

6.0 Approaches to the Identification of Critical Habitat

Advice on the identification of critical habitat will typically be developed by, or processed through, experts in cooperation with appropriate governments, wildlife management boards and aboriginal organizations and in consultation with landowners and other persons who are directly affected by the recovery strategy.

Many approaches and analytical methods can be used to identify biologically and legally defensible critical habitat under SARA. A set of best practices cannot be expected to detail the wide variety of options available nor should it advance prescriptive conventions that might hinder identification of critical habitat for the diverse array of species listed under SARA. In general, these guidelines aim to reiterate policy direction in the context of operations and establish principles that will encourage the preparation of sound advice.

Nevertheless, it may be useful to provide a rough outline of two general *complementary* and *sequential* approaches to critical habitat identification. Table 2 outlines the comparative characteristics of two approaches: i) a *Fundamental Approach*; and ii) a *Synthetic – Quantitative Modelling – Approach*. This outline is not intended to be prescriptive or limiting. Rather, the purpose is simply to sketch two different tactics for identification. In the end, recovery practitioners will need to tailor the methods they use to the species and context with which they are working. Regardless of the approach or methods used to identify critical habitat, recovery practitioners are expected to provide sound advice based on (1) the best available information – including evidence-based information (experimental analysis and quantitative measurement), experience-based information (qualitative description, expert opinion) and traditional ecological knowledge; and (2) documented and transparent assumptions, methods, and results.

Ideal solutions for what comprises critical habitat might include quantitative estimates of necessary and sufficient amounts (e.g., hectares) and landscape qualities (e.g., configuration, composition) required to support viability at an acceptable level of risk.

Table 2 Outline of two complimentary and sequential approaches to critical habitat identification.

APPROACH	WHAT IS INVOLVED?	PROS	CONS
Fundamental	<ul style="list-style-type: none"> - early stakeholder engagement - locations identified that encompass known, inferred or projected sites of population occurrence, the extent of critical habitat surrounding occurrences should be contingent on species ecology (e.g., activity patterns, genetic structure) and landscape context - may incorporate evidence- or experience-based information, and traditional ecological knowledge - must ground-truth results - assumptions and results should be subjected to peer review - see Figures 2,3 below 	<ul style="list-style-type: none"> - relatively straightforward and easily understood - enables relatively rapid identification - defensible and repeatable if structured procedures are employed to guide the process including identifying experts, managing bias, and eliciting results - suited to preliminary identification - often serves as foundation for more involved and comprehensive identification 	<ul style="list-style-type: none"> - may not comprehensively account for habitat needs re. population persistence (e.g., unoccupied habitat, landscape requirements) - may include undetected habitat sinks or traps and non-habitat - may be weakly linked to demographic processes and species viability - full network of critical habitat may be sub-optimal if implemented in stages
Synthetic – Quantitative Modelling	<ul style="list-style-type: none"> - early stakeholder engagement - computer models integrate demographic and habitat parameter values and relationships to quantitatively estimate habitat requirements (e.g., type, amount) for population persistence - may incorporate evidence- or experience-based information, and traditional ecological knowledge - specific tools include population viability analysis, resource selection functions, compositional analysis, equilibrium analysis - must ground-truth results - assumptions and results should be subjected to peer review - see case studies examples¹⁹ 	<ul style="list-style-type: none"> - can be used to quantitatively assess viability, locate potential habitat, explore optimal combination of critical habitat parcels - provides framework for understanding, communicating, and managing system parameters, relationships, and assumptions - highly defensible and repeatable - suited to comprehensive identification of critical habitat - often sequential to fundamental approach 	<ul style="list-style-type: none"> - data intensive - takes time and resources to collect data if it does not already exist - may involve assumptions and estimation of parameters - takes time and resources to develop model, conduct analyses, and interpret results - careful use and interpretation of results is required - basic knowledge of computer modelling required - model validation and expert peer review of results required - process may be viewed sceptically by some - results are misleading when quality of data inputted is poor

¹⁹ Detailed case study examples of these approaches are available at: http://www.cws-scf.ec.gc.ca/extended_sharing/ password = critical habitat

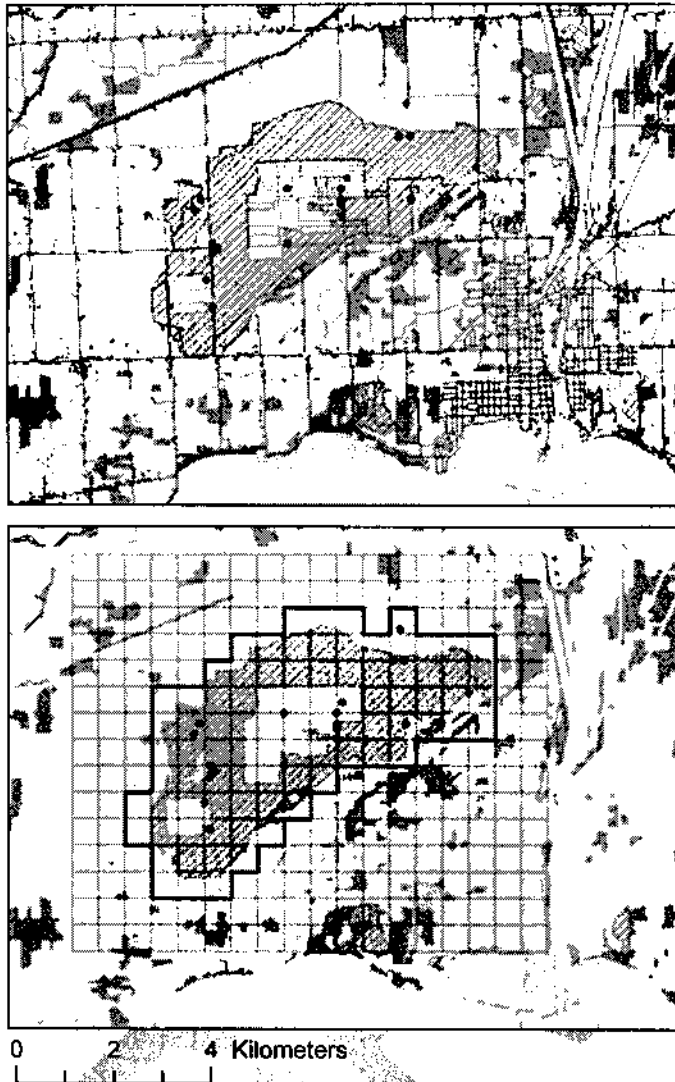


Figure 2 Hypothetical illustration of a fundamental approach to proposed critical habitat identification. Red points represent recent observations of individual eastern massasauga in Wainfleet Marsh population. Field studies of individual movements and habitat use demonstrate a close correspondence between the population range and the peatland community (upper panel).

An overlay of UTM grid cells (0.5 x 0.5 km) that encompass valid occurrences and habitat sites known to have been used provides a precautionary estimate of proposed critical habitat for this population (lower panel). UTM coordinates that describe the boundary of this polygon can be used to generate range coordinates for proposed critical habitat. Map projection: UTM Zone 17 NAD27.

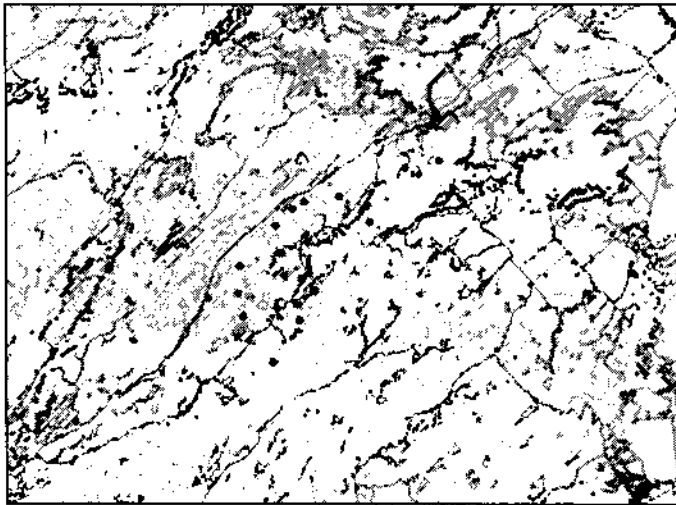
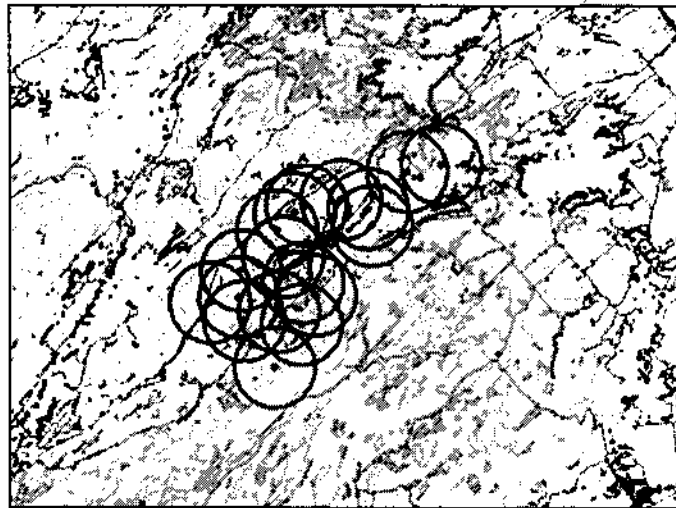
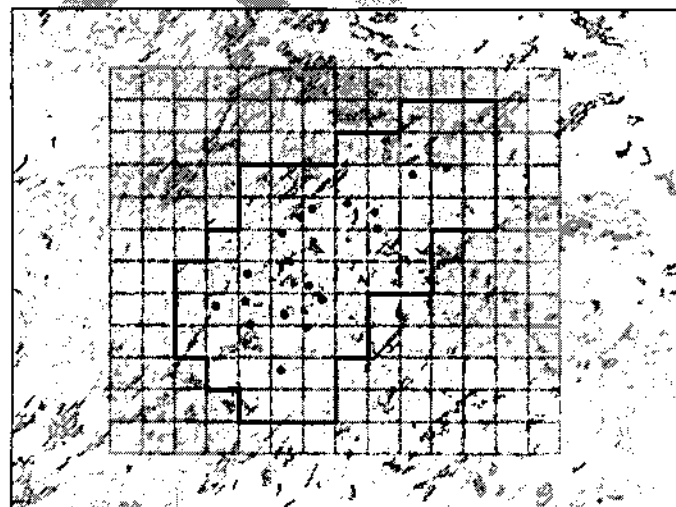


Figure 3 Hypothetical illustration of a fundamental approach to identifying proposed critical habitat. In this example the red points represent traditional communal hibernation sites for ratsnakes in a forested landscape in eastern Ontario (upper panel).



Field studies have documented individual home ranges of 18.5 ha on average. Two km diameter black circles surrounding communal hibernacula encompass activity areas for most individuals from a given hibernacula, including areas of overlap with individuals from immediately neighbouring hibernacula (middle panel).



An overlay of UTM grid cells (1.0 x 1.0 km) that encompass all extant hibernacula and associated activity areas provides a precautionary estimate of proposed critical habitat for this local population (lower panel). UTM coordinates that describe the boundary of this polygon can be used to generate range coordinates for proposed critical habitat. Map projection: UTM Zone 18 NAD83.

0 2 4 Kilometers


7.0 Identifying Critical Habitat to the Extent Possible

Our knowledge of a species' requirements for recovery is never perfect. Uncertainty arises because of perceptual limitations (e.g., measurement error) and because biological systems are dynamic (i.e., variable in time and space, rather unpredictable). Based on this reality, SARA recognizes the need for a precautionary approach to recovery planning in the absence of full certainty²⁰, and requires that critical habitat identification be based on the best available information²¹. This recognition has three implications for how we should approach the identification of critical habitat.

The first implication is that we do not need to identify the total critical habitat all at once. It is acceptable to identify what you can now, based on the best available information, and defer identification of any additional portions, which may be necessary for full support of recovery goals, until further knowledge is obtained (see Figure 4). Importantly, this approach requires that a *schedule of studies* be prepared that outlines the actions to be taken to gain outstanding information and determine the whereabouts of supplementary critical habitat areas (see section 8.0 Schedule of Studies to Identify Critical Habitat).²² Whenever proposed critical habitat is only partially identified such advice should be accompanied by a clear statement about its limitations. For example: 'At this time proposed critical habitat is NOT believed to be sufficient for the survival or recovery of the listed wildlife species. Further work is required to identify critical habitat comprehensively.'



Figure 4 Generalized example of partial (left) and comprehensive (right) critical habitat for the same species in the same landscape. Question marks represent areas of presumed critical habitat that require further investigation before final comprehensive identification.

²⁰ see SARA s38.

²¹ See SARA s41.

²² Note: There are potential risks associated with incremental identification of critical habitat. Specifically, there is evidence that when conservation reserve networks are implemented in stages over years, such solutions actually may be sub-optimal in the context of biodiversity loss and uncertainty. See Meir, E. et al. (2004) Does conservation planning matter in a dynamic and uncertain world? *Ecology Letters* 7:615-622.

The second implication relates to the degree of precision with which we might be able to identify critical habitat. When understanding of a species' habitat requirements is general, a more precautionary approach to estimation of critical habitat needs (i.e., type and quantity) may be appropriate when such an approach is cost-effective. By contrast, as our knowledge of the species' habitat requirements for recovery become more comprehensive and exact, the more precise and refined we can afford to be in identifying critical habitat (see Figure 5).

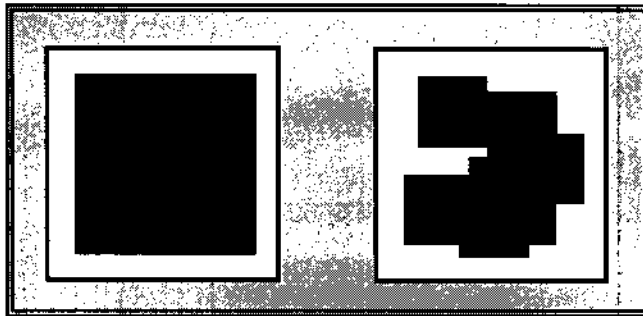


Figure 5 Generalized example of the difference between a precautionary (left) and a more refined (right) identification of critical habitat for the same species in the same landscape.

The third implication for critical habitat identification that arises from uncertainty relates specifically to the dynamic and unpredictable nature of biological systems. To illustrate - many species depend on disturbance-prone habitats that undergo ecological succession in relatively short timeframes (e.g., 3-5 y). For example, prime habitat for Furbish's lousewort (*Pedicularis furbishiae*) tends to shift along sections of the St. John River (in New Brunswick and Maine) due to shoreline ice scouring that occurs during spring flood events.²³ It is believed that this disturbance process is a fundamental aspect of quality habitat for the perennial herb. However, this makes it difficult to pinpoint the likely whereabouts of Furbish's lousewort critical habitat 5-10 years in the future. In other words, more temporally- and spatially-dynamic landscapes will have less point-in-time certainty associated with them, and in these situations it may be appropriate to identify critical habitat in a manner that accounts for such spatial and temporal dynamics. In the case of the lousewort, this might require identifying critical habitat throughout sections of the river shore within which populations could shift depending on the temporal and spatial pattern of flooding and ice scour.

Several fundamental ecological and environmental attributes of marine ecosystems indicate that when identifying critical habitat in oceans one should pay special attention to connectivity issues.²⁴ With respect to spatial structure,

²³ Menges, E.S. and S.C. Gawler (1986) Four-year changes in population size of the endemic plant Furbish's Lousewort: implications for endangerment and management. *Natural Areas Journal* 6:6-16.

²⁴ See Carr, M.H. et al. (2003) Comparing marine and terrestrial ecosystems : implications for the design of coastal marine reserves. *Ecological Applications* 13(1) Supplement S90-107.

marine ecosystems are typically "open", with waves and currents transporting nutrients, eggs, and young over vast areas (10 to 100 km). "Open" marine populations are not necessarily self-sustaining and are likely to depend on being replenished by young dispersing from another population. In order to account for the patterns and variability of currents that disperse young, it might be especially important to identify critical habitat in marine ecosystems as networks linked by dispersal currents to allow replenishment of populations. Concerning temporal structure, marine systems typically respond relatively fast to environmental change. Plant and animal distributions tend to shift on the order of decades rather than centuries. This fluidity results from two characteristics: i) young can disperse long distances; ii) primary producers are plankton which are tiny and short-lived. To accommodate for potentially rapid shifts in distribution, critical habitat in the oceans should include a range of depths and latitudes.

8.0 Schedule of Studies to Identify Critical Habitat

If the best available information is insufficient to identify critical habitat (either all or part) in the recovery strategy, then recovery practitioners are required to draft a schedule of studies that outlines any knowledge gaps and actions to be taken to fill them in order that critical habitat may be identified in the future (e.g., surveys, distribution and resource mapping, studies of species habitat ecology, viability analyses). Knowledge gaps might include species-habitat associations, habitat carrying capacity, distribution of suitable habitat, ecological processes that maintain dynamic habitats, etc. Studies required to gain such knowledge might include habitat distribution surveys, population and habitat ecology field studies, habitat management experiments, spatially explicit viability analyses, etc. Schedules may apply to the entire entity listed under SARA, or may only apply to a particular portion or population of the listed entity. The schedule of studies should provide the overall strategy for gaining the information necessary to identify critical habitat, but should also be detailed enough to provide a clear understanding of what data and analyses are needed, as well as generally how the investigations will be carried out, what results are expected, and how these results will be used. The scope and timelines for the schedule of studies should be realistic and achievable, with the expectation that results will lead to an accurate proposal for critical habitat identification.

9.0 Social and Economic Considerations

First and foremost, critical habitat should be defined in support of a recovery goal and the related population and distribution objectives. Furthermore, advice on critical habitat should be based on the best available information and is expected to be legally, as well as biologically, defensible. While it is understood that a socio-economic assessment of recovery actions (including identification and protection of critical habitat) is not technically

required under SARA until the time of action plan development²⁵, case study experience indicates that sometimes knowledge of social and economic factors can help generate the *best* advice.²⁶ The use of social and economic information can be advantageous during the identification of critical habitat when not ALL habitat is needed and therefore choices must be made when selecting habitat parcels. In this context, the *best* advice on critical habitat is characterized as being optimal both from a species recovery perspective (i.e., satisfies biological requirements) AND from a social and economic cost perspective (i.e., minimally disruptive to society and economy). While biological considerations must be put first, *where there is flexibility* to accommodate social and economic concerns, an effort to address these concerns should be made.

For example, if the habitat currently occupied by a species is insufficient to satisfy population and distribution objectives, decisions must be made about where to include parcels of unoccupied habitat or where to restore habitat. Conversely, if all occupied habitat is not necessary to meet objectives, decisions must be made about which parcels to identify as being critical. When these types of decisions need to be made, choosing habitat parcels that will be the least disruptive to society and the economy, while still satisfying the recovery objective, would be wise. Social and economic data could in some instances help inform advice on critical habitat. For example, selection of more developed parcels may result in lower survival rates, and thus lower population viability.

Identifying less habitat than required or identifying unoccupied or low quality habitat in favour of occupied or high quality habitat should not be done for purely socio-economic reasons.

10.0 Examples of Activities Likely to Result in the Destruction of Critical Habitat

When identifying critical habitat, recovery practitioners are encouraged to evaluate habitat-related threats as they may discourage occupancy by the species or cause specific areas to operate as demographic *traps* or *sinks* and thus jeopardize population persistence. This evaluation will also aid preparation of a list of examples of activities that are likely to result in the destruction of critical habitat, a requirement of recovery strategies under SARA.²⁷ From an operational perspective, *destruction of critical habitat* can be defined as follows: any alteration of the biotic, abiotic, or ecological conditions of the critical habitat

²⁵ SARA s49(1) An action plan must include, with respect to the area to which the action plan relates, (e) an evaluation of the socio-economic costs of the action plan and the benefits to be derived from its implementation...

²⁶ See western yellow-breasted chat and whooping crane case studies as examples of how social and economic factors can contribute to the identification of critical habitat. Case studies are available at: http://www.cws-scf.ec.gc.ca/extended_sharing/ password = critical habitat

²⁷ SARA s41(1)...the recovery strategy must include... c) an identification of the species' critical habitat, ... and examples of activities that are likely to result in its destruction,...

that would negatively impact its function to the point of reducing the probability of survival or recovery of the listed wildlife species as outlined in the species recovery strategy or action plan.²⁸ As such, interpreting what constitutes “destruction” of critical habitat for an individual species is likely to be context specific.

Examples of activities likely to destroy critical habitat should be based on demonstrated or probable threats to habitat, and should have a measurable negative effect on the function of the habitat to a degree that is harmful to the species (e.g., quantifiable reduction in species survival, density, or productivity). Activities likely to destroy critical habitat may do so in varying degrees. Some activities may comprehensively alter or remove habitat. Other activities may be tolerable up to a particular threshold.²⁹ Specify, for example, if activities result in the destruction of critical habitat only during certain periods of time (e.g., during breeding season or migration), but otherwise cause no damage. In addition, it may be important to consider both the cumulative effects of one type of activity over time and the combination of many different activities at the same time.

The following example illustrates the link between an activity, habitat function, and species population health.

Direct cattle access to streambanks and plowing of agricultural lands to the edges of streams within the Sydenham River watershed result in increased loadings of suspended sediments and associated increases in turbidity and siltation. In turn, siltation can interfere with feeding, or bury or smother species such as the northern riffleshell (*Epioblasma torulosa rangiana*), causing increased mortality. Siltation can also reduce reproductive success by interfering with visibility of display mechanisms required for successful reproduction. Species residing in habitat associated with agricultural activities [i.e., cattle pasture] at streambank edges may experience increased mortality and reduced productivity.³⁰

²⁸ An equivalent but more elaborate definition within the *Federal Policy Discussion Paper: Critical Habitat* states that destruction of critical habitat is “any alteration to the topography, geology, soil conditions, vegetation, chemical composition of air/water, surface or groundwater hydrology, micro-climate, or sound environment of such a magnitude, intensity, or duration which significantly reduces the capacity of the critical habitat to contribute to the survival or recovery of the species at risk, based upon the biology of that species and as expressed in the approved recovery strategy/action plan”.

²⁹ See for example, Homan, R.N. et al. (2004) Critical thresholds associated with habitat loss for two vernal pool-breeding amphibians. *Ecological Applications* 14(5) 1547-1553.

³⁰ Dextrase, A. et al. (2003) *National Recovery Strategy for Species at Risk in the Sydenham River: An Ecosystem Approach*. National Recovery Plan No. 25. Recovery of Nationally Endangered Wildlife (RENEW). Ottawa, Ontario. 73 pp.