Reference Guide, Feasibility Study, and Overview of Institutions Interested in Cumulative Effects Assessment Volume II

Feasibility Study in CEARC Cumulative Effects Assessment

Wetlands of the Boreal Agricultural Fringe of the Prairie Provinces

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VOLUME I A REFERENCE GUIDE TO CUMULATIVE EFFECTS ASSESSMENT IN CANADA .

By Patricia A. Lane, Ronald R. Wallace, Richard L. Johnson and David Bernard

VOLUME II FEASIBILITY STUDY IN CEARC CUMULATIVE EFFECTS ASSESSMENT (CEA) WETLANDS OF THE BOREAL AGRICULTURAL FRINGE OF THE PRAIRIE PROVINCES

By Ronald R. Wallace and Patricia Lane

VOLUME III OVERVIEW OF AGENCIES AND INSTITUTIONS INTERESTED IN CUMULATIVE EFFECTS ASSESSMENT AND MANAGEMENT

By Nicholas Sonntag, Patricia A. Lane, Ronald R. Wallace, Brian M. Marcotte and Stephen H. Janes

Please note that VOLUMES II and III are addenda to the main report (VOLUME I). VOLUMES II and III are available in xerox form upon special request to the Canadian Environmental Assessment and Research Council (CEARC) in Hull, Quebec.

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1.0 THE PROBLEM

The multiple pressures for the conversion of Canadian wetlands for agricultural, urban, industrial and recreational uses have resulted in a significant loss and fragmentation of this habitat. The definition of wetland adopted for this Addendum is given in Tarnocai (1979):

> "Wetland is defined as land having the water table at, near, or above the land surface or which is saturated for a long enough period to promote wetland or aquatic processes as indicated by hydric soils, hydrophilic vegetation and various kinds of biological activity which are adapted to the wet environment."

Table 1 shows the percent distribution of wetlands in Canada by province. As noted in Table 1, approximately 14% of Canada (1.27 million km^2) is covered by wetlands. The prairies (Manitoba, Saskatchewan and Alberta) together constitute 373 of the total Canadian wetlands.

Wetlands have been traditionally considered to be wastelands, that is, areas which could (or should) be converted to "productive" agricultural or urban uses. This view has led to the destruction of millions of hectares of such habitat across Canada. This problem has reached proportions which now seriously threaten waterfowl populations at a continental level. As noted by Lynch-Stewart (1983), one of the key factors which has frustrated attempts to slow this substantial loss of habitat is our inability to assign a value to the habitat, on a national basis. Although in the past decade we have begun to recognize wetlands for their natural value we still appear to have problems with preserving them.

In addition to the issue of relative valuation of these and other habitat types, the lack of coordination in jurisdictional responsibility has significantly reduced the ability of national and provincial agencies to attempt unified or long-term management planning through traditional means. Hence, initiatives to enhance or protect wetland habitat areas have tended to be reactive, sporadic and uncoordinated. The steady conversion of wetland habitat through incremental change across diverse jurisdictional (including privately-held lands) boundaries, represents a classic case of a cumulative impact occurring at a national, and indeed international., level. The major cumulative effect problem is one of habitat loss and fragmentation. In this Addendum, we describe this problem and a CEA approach to it.

Lynch-Stewart (1983) summarized the available data for national trends in wetland use. The prairie data base from this report is reproduced in Table 2. The table provides estimates of the extent of encroachment on wetland habitats for the period 1800 to 1980, with regional losses ranging from 7% to 73%.

The intensifying conflict between prairie wetland uses (wildlife habitat vs. agricultural use) is well-documented. In general, loss of wetland habitat to agricultural uses has been progressive and severe, and it is accelerating. In concert with the direct losses of wetlands through agricultural drainage/reclamation projects, agricultural usage also causes secondary effects such as destruction of marsh-edge vegetation and habitat. This

Table 1. Location and Relative Distributions of Wetlands in Canada (Source: Environment Canada, 1986)

Province/ Territory	% of Province/Territory Area Considered Wetland	% Total of Canadian Wetlands	
British Columbia	3	2	
Alberta	21	11	
Saskatchewan	17	8	37%
Manitoba	11	1.8	
Ontario	33	23	
Quebec	9	10	
New Brunswick	8	1	
Nova Scotia	3	1	
Prince Edward Island	1	1	
Newfoundland/Labrador	18	5	
Yukon	3	1	
Northwest Territories	9	22	
Canada	14	100%	

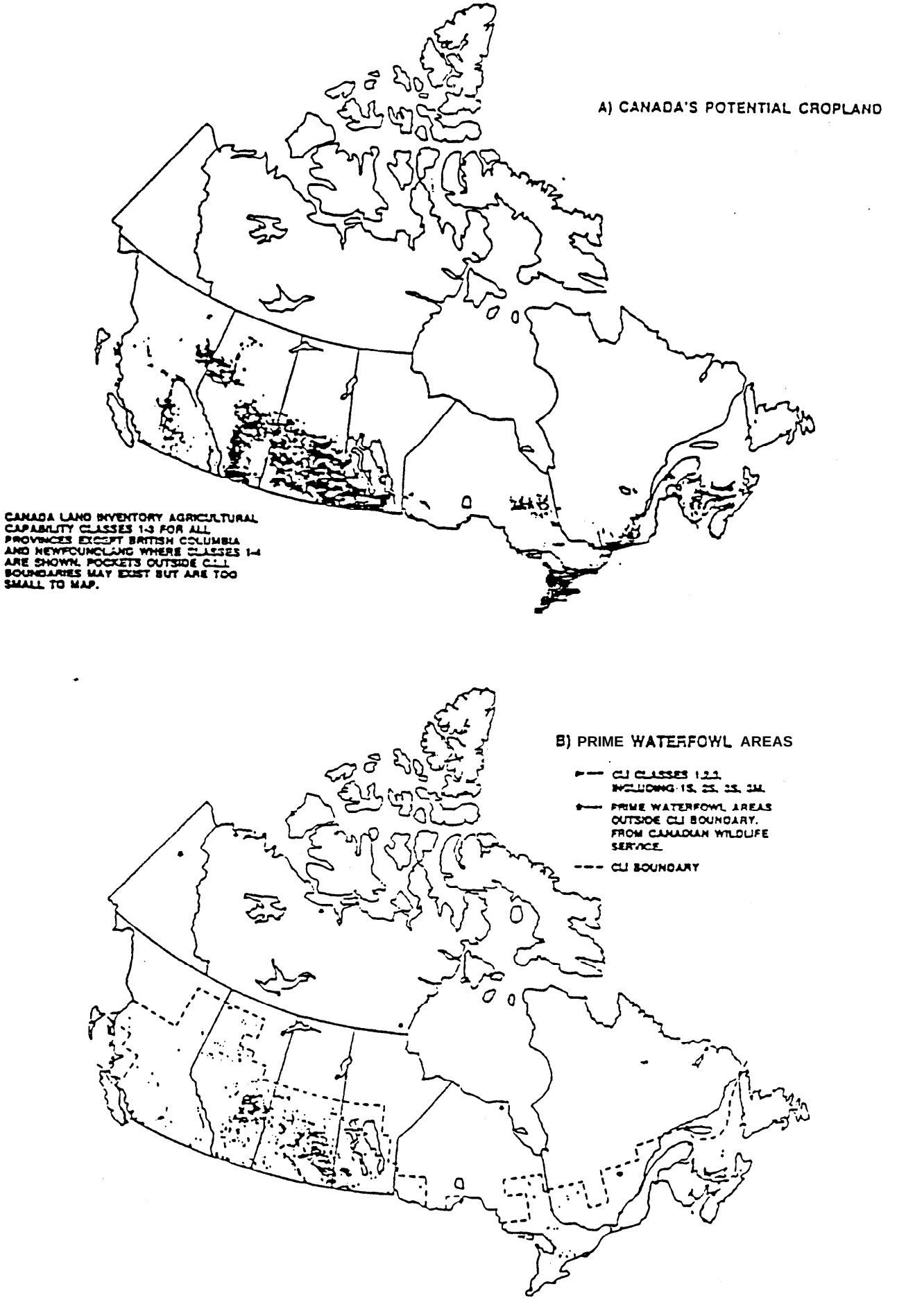
Table 2. The Impact of Land Use Change on Wetlands
(Prairie Region -- excerpt from Lynch-Stewart, 1983)

Study Area Location	Study Area Size	Time Period	Land Use Change
Pairie			
- Black Soil Zone of the Prairie Provinces (Goodman & Pryor, 1972)	21 km² pristine wetland within 389 km²	1800-1970	- 19% of wetland adversely affected'by human alterations - 13% net loss of wetland area
Alberta			
- Alberta Aspen Parkland (Schick, 1972)	699 km²	1900-1970	- 61% net loss of wetland area
- Battle River Basin (Ritter, 1979)	301 km² of wetland within 11,002 km²	1800-1978	- 9% net loss of wetland habitat area
- South Saskatchewan River Basin (Schmitt, 1980)	45 km² of wetland within 19,501 km²	1800-1979	- 21% gross loss of wetland habitat area - 7% net gain of wetland and habitat area
Saskatchewan			
- Southern Saskatchewan (Millar, 1981)	82 km²	1800-1980	- 2,346 (73%) wetlands sites affected by permanent impacts
Manitoba			
- Newdale Plain (Adams & Gentle, 1978)	248 km²	1964-1974	- 17% of wetlands altered by clearing or partial drainage - 7% of wetlands eradicated

Table 3. Incremental Rates of Habitat Loss in the Minnedosa Region (Source: Environment Canada, 1986)

Time Span	% Loss of Habitat
1928-1964	27%
1964-1974	40%
1974-1982	33%

Figure 1. Total Canadian Waterfowl Habitat and Potential Cropland Areas.



habitat component is a key factor in the maintenance of waterfowl populations. Lynch-Stewart (1983) reported that a total of "approximately 1.2 million ha of wetland habitat have been converted to agricultural use in the Prairie Provinces...". The destruction of crops by wildlife is perceived as a serious problem, especially in the hard economic times presently experienced by the agricultural sector. Lynch-Stewart (1983) noted that "a conservative loss through tramping and . . . consumption of grain is about $16-25 million annually . . ."

Recently, discussions on the influence of periodic drought on the prairies have received greater attention from policymakers. These seasonal, and largely unpredictable, fluctuations in precipitation have long been an integral feature of the prairie environment although some data indicate that these extremes may be intensifying from climatic change. In addition to debilitating natural effects, these droughts also encourage farmers to expand cultivation into wetlands when these areas are potentially arable. Once the drought ends, these areas are often drained to maintain agricultural productivity, or they are abandoned with the vegetation in marsh-edges seriously, and even irreparably, damaged.

While a principle source of wetland habitat destruction is unquestionably agricultural encroachment, urban expansion also constitutes a significant influence. Kessel-Taylor (1984) provided a detailed survey across Canada of the estimated change related to such urban pressures. The author noted, for instance, that Calgary has grown since its founding in 1876 into a major urban centre: from 1951 to 1971, the population increased 183% to 403,343; by 1984, it had grown a further 47% to 592,743. At the time, it was the fastest growing urban centre in Canada. More recently, rates of increase have diminished; however, it is clear that this and similar urban centres are capable of explosive growth. The study found that 22% of the original 4,141 ha of wet soil in the urban-centred region of the study area remained as natural cover by 1981, as compared with 24% in 1966.

More recent studies in this area (Whillans, 1987) have revealed substantial, and continuing, destruction of wetland habitat. The author cited data which indicated that much of this destruction is a result of agricultural encroachment during dry years. It is estimated that on the prairies 61% of wetlands has been lost in this manner.

Overall, in Canada, wetland habitat loss has occurred primarily in areas close to settled regions such as farms and cities. There has been a steady conflict between wildlife use and land development. The recent formation of agencies such as Wildlife Habitat Canada and the Nature Conservancy of Canada, and the ongoing work of Ducks Unlimited (DU), have focussed attention on the magnitude of the problem. In spite of the increasing support for these agencies and their objectives, and for maintaining wetland habitat, there appears to be a lack of support from government agencies who implement land use policies. Currently the habitat conservation drive and land use strategies are not working in concert, resulting in both efforts being frustrated. What is needed is an overall strategy to integrate these two efforts (Wildlife Habitat Canada, 1986).

Recognition of the importance of wetlands as wildlife habitat, as moderators of watershed hydrology and as recreational areas, has led to national programs, such as the Canada Land Use Monitoring Program which has examined wetland conversion in southern Canada (Environment Canada, 1986). The proximity of wetlands to both agricultural and urban areas, coupled with a decrease in the availability of high-quality land for such activities, has led to the increased demand for such previously neglected areas. In short, the value of "developed" wetlands for agricultural and urban applications is rising. These efforts at land "reclamation" have led to the accelerated and irreversible conversion of wetlands across Canada.

2.0 REGIONAL ECOLOGICAL PATTERNS

In Canada, the Prairie Pothole Region, which is located in the southern third of Alberta, Saskatchewan and Manitoba, constitutes the largest single expanse of arable land in Canada. Large urban centres (Edmonton, Calgary, Regina, Saskatoon and Winnipeg) are also located there.

The Prairie-parkland region of Western Canada constitutes one of the most significant duck-breeding habitats in North America. Habitat deterioration has led to decline in the reproductive potential of several duck species on the Canadian prairies.

The 1986 CWS study of regional waterfowl populations noted that the prairie landscape has been changed considerably as a result of a continuous expansion and intensification of agricultural practices and hence land use. This change has led to decreases in waterfowl nesting successes because the nests are more accessible to predators. Several studies through the Canadian and U.S. prairie region have recorded large percentages of habitat loss as a result of increasing land cultivation. These increased changes to uplands have reduced the capacity of waterfowl populations to rebound in years of good water conditions.

This region is characterized by wetland sloughs or "potholes", which vary in size from puddles to ponds of several hundred hectares. The density of these waterfowl habitat areas makes the region a vital component of the North American migratory bird habitat. The North American Waterfowl Management Plan (1986) recognized this and strongly recommended that the pothole breeding habitat including the associated uplands of the Canadian and American prairie region be protected for mallards and pintails. This Plan has set out ambitious objectives for the preservation and maintenance of waterfowl habitat from 1986 to 2000, calling for the restoration of 0.35 and 1.1 million additional hectares of water and upland habitats, respectively, in the Prairie-parkland region of Canada. The hectares involved demonstrate the seriousness of the situation.

The most important remnants of nesting habitat for prairie mallards and pintails are chiefly found in pasture land and areas of otherwise intensive agriculture. Loss of grassland continues at the rate of 2% annually, and in the last decade, one-third of the remaining grassland was converted to cropland (North American Waterfowl Management Plan, 1986).

In areas intensively studied by the Canadian Wildlife Service, such as the Minnedosa pothole region of southwestern Manitoba, the decline of available waterfowl habitat is clear (Table 3). Over 50% of the wetlands in this region were rated as prime waterfowl habitat. In total, in 1928, wetlands covered 13.2% of the total Minnedosa region. but by 1982 they were reduced to *only* **3.8%** -- representing a net loss of approximately **71%** in **54** years. Environment Canada (1986) estimated that by 1981 up to **76%** of the original wetland area surrounding the five major prairie urban centres had been. converted to agricultural uses, **13% to** urban use and less than **3%** remained for recreational uses. The importance of the prairies in terms of total' Canadian waterfowl habitat is illustrated by Figure 1. The Figure also demonstrates the direct overlap and conflict between these prime waterfowl areas and potential cropland.

The complexity of identifying and measuring regional waterfowl populations is compounded by many factors, some of which are:

- size of the range to be evaluated
- numbers of animal species
- changing factors
    - climate
    - agricultural use patterns
    - predator populations
- hunter takes and effort expended

These factors make the evaluation of regional population patterns difficult (Tables 4 and **5**). **The** trends shown in these tables clearly confirm the earlier conclusions by the Canadian Wildlife Service **(1986)** and demonstrate a significant regional decline, particularly in southern regions of Alberta.

It has been observed that the decline of suitable habitat areas has forced nesting waterfowl to less desirable sites where they are more vulnerable to predation. This emphasizes the need to understand linked variables in habitat studies and underlines the need for good, quantitative field data on specific populations and species, without which modeling capabilities are seriously hampered.

3.0 DESCRIPTION OF THE LOCAL ECOSYSTEM

Wetlands are an integral part of the prairie ecosystem. The numerous, scattered pothole basins collect and hold valuable runoff water which is vital in this semi-arid region of Canada. The ponds replenish local aquifers and contribute to the maintenance of high-quality groundwater needed to sustain the human population, wildlife, crops and native vegetation.' The wetlands serve an important role in the purification of waters and in the stabilization of land against erosion, and they play a part in restricting encroachment of salts in topsoil. As a result of the alternating wet and dry periods common on the plains, nutrients contained in wetland plant material are released and thus form a key link in maintaining the prairie food chain.

Table 4. Long-term trend in adjusted total duck population by survey unit and year (estimates in thousands).
(Source: Canadian Wildlife Service - Edmonton)

Year	Northern Alberta	Southern Alberta	Total
1955	4160	6730	10,890
1956	3400	6060	9,460
1957	3540	5820	9,360
1958	6960	6210	13,170
1959	9850	5170	15,020
1960	3480	5050	8,530
1961	7570	4560	12,130
1962	3340	3120	6,460
1963	2980	4540	7,520
1964	5290	4150	9,440
1965	3590	3720	7,310
1966	3480	5660	9,140
1967	2360	6240	8,600
1968	3540	3700	7,240
1969	2300	5120	7,420
1970	2580	5470	8,050
1971	3100	6450	9,550
1972	4460	6460	10,920
1973	3710	6040	9.750
1974	3510	7690	11,200
1975	3440	6540	9,980
1976	1910	6020	7,930
1977	3240	4010	7,250
1978	3700	4440	8,140
1979	4390	5440	9,830
1980	3140	4970	8,110
1981	3200	4770	7,970
1982	3030	3570	6,600
1983	4140	3190	7,330
1984	4040	2880	6,920
1985	2300	3430	5,730
1986	2930	2710	5,640
1987	3710	3200	6,910

Table 5. Long-term trend in adjusted mallard population estimates by survey unit and year (estimates in thousands).
(Source: Canadian Wildlife Service - Edmonton)

Year	Northern Alberta	Southern Alberta	Total
1955	880	1940	2,820
1956	470	1790	2,260
1957	720	2020	2,740
1958	1340	2110	3,450
1959	2120	1690	3,810
1960	490	1450	1,940
1961	1820	1360	3,180
1962	890	980	1,870
1963	890	1190	2,080
1964	970	1120	2.090
1965	570	890	1,460
1966	530	1550	2,080
1967	450	1500	1,950
1968	780	910	1,690
1969	640	1120	1,760
1970	620	1590	2,210
1971	640	1870	2,510
1972	1040	1830	2,870
1973	890	1730	2,620
1974	770	1580	2,350
1975	650	1400	2,050
1976	390	1450	1,840
1977	590	850	1,440
1978	670	820	1,490
1979	880	980	1,860
1980	840	980	1,820
1981	620	950	1,570
1982	630	770	1,400
1983	890	850	1,740
1984	550	710	1,260
1985	530	800	1,330
1986	590	700	1,290
1987	700	750	1,450

The life cycles of prairie waterfowl species have evolved in close conjunction with this variable water regime.

The degree and nature of agricultural development throughout the North American prairie Savannah over the past century have significantly interrupted the natural dynamics of waterfowl populations and wetland habitat. Losses of upland nesting cover and innumerable prairie potholes have forced the concentration of waterfowl and their predators into diminishing patches of suitable habitat. As a result, in much of the Prairie Pothole Region, the recruitment of young birds is inadequate to increase, or even maintain, many waterfowl populations even during favourable water conditions. Table 6 lists important habitat requirements of wildlife in this ecosystem.

Waterfowl tend to concentrate more during molting, migration and wintering than during the nesting season. Thus habitat loss or degradation, or outbreaks of disease in critical areas can have serious impacts on waterfowl populations. Habitat conditions along the major migratory routes directly affect 'the survival of migratory bird populations and will, therefore, influence the subsequent reproductive success in the waterfowl communities.

Habitat deterioration causing decline in the reproductive potential of several species in Western Canada is now acknowledged as a serious problem, Measures to mitigate such deterioration in habitat as supported by advocates of migratory birds have been countered by economic, chiefly agricultural, interests. This conflict has been intensified by the significant impact which existing waterfowl populations have had on cereal grain crops -- particularly at a time when farmers are financially hard-pressed.

Concurrent with habitat deterioration, North American harvesting of waterfowl populations has increased in the past decade. The Canadian Wildlife Service (1986) found that the current kill distribution in the U.S. and Canada is 80% and 203, respectively, and that kills are increasing for certain waterfowl species in the U.S. while remaining constant in Canada.

These anthropogenic stresses, coupled with the natural effects of predation and disease such as Type C Avian Botulism, have made the overall diagnosis of limiting factors and population decline both complex and difficult for waterfowl populations. Carl Walters at the University of British Columbia (pers. comm.) recently indicated that predation is perhaps the key factor in the decline of the black duck population. Although the premise of most conservation agencies appears to be that habitat loss and deterioration in breeding, migration and wintering areas is the major reason for declines in waterfowl populations, predation-is, in fact, closely tied to habitat loss. Thus, both habitat deterioration and harvesting can be said to be factors in population decline.

4.0 USER PATTERNS AND JURISDICTIONAL CONSIDERATIONS

In the past decade, wetland functions and their values to society have been recognized at local, provincial, national and international levels. These worthwhile initiatives underline the growing recognition that jurisdictional

Table 6. Important Habitat Requirements of Wildlife Guilds (Adapted from Green et al., 1986).

	Important Habitat Requirements
Waterbody Characteristic	
	Water permanency
	Water depth
	Water level stability
	Area1 extent of water
	pH
	Salinity
	Shoreline complexity
	Density of protruding structures
	Density of waterbodies
Land Base Characteristics	
	Soil type
	Soil moisture
	Topography
Aquatic Vegetation Characteristics	
	Density of submergent vegetation
	Species of submergent vegetation
	Density of emergent vegetation
	Height of emergent vegetation
	Species of emergent vegetation
	Area of emergent vegetation
	Water-to-emergent cover ratio
Upland Vegetation Characteristics	
	Density of herbaceous vegetation
	Height of herbaceous vegetation
	Species of herbaceous vegetation
	Distribution of herbaceous vegetation from water
	Density of trees/shrubs
	Height/vertical distance of shrubs/trees
	Size of trees
	Species of shrubs/trees
	Area of shrub/tree cover
	Distance shrub/tree cover to water
	Amount of litter/deadfall
Human Influence	
	Surrounding land use

boundaries will have to be overcome if migratory waterfowl populations are to be maintained and enhanced.

The evolution of new legislation and programs aimed at the preservation of critical wildlife habitat have been plagued with constraints arising from inter-jurisdictional conflict. Fragmented jurisdictions across North America allocate responsibilities for wetlands among federal, provincial (or state) and municipal agencies. These relationships are further complicated by the degree of private land ownership and the types of subsidies which are directed toward expansion of the agricultural land-base. Often these public subsidies directed to private landowners ultimately result in progressive erosion of waterfowl habitat. At a private level, such habitat is generally valueless and the land is not considered to be improved until waterfowl areas are agriculturally productive.

Another obstacle to habitat conservation is the inability of decision makers, at all levels, to define the value of natural wetlands within our present system of resource allocation. This failure to quantify the resource and to act to protect it has seen significant erosion of these lands to uses whose immediate economic benefit can be more readily calculated and realized. Moreover, wetland benefits accrue to the public-at-large and rarely to private landowners. Clearly, the conservation of wetland areas will require a major, well-directed effort by the public-at-large if the insignificant, but cumulatively devastating, individual interests are to be over-ridden in the best interests of waterfowl habitat preservation.

The Canadian Wildlife Service began acquiring important wildlife habitats in 1966 under the National Wildlife Area program. Forty-four National Wildlife Areas, many of which are wetlands, have been designated across Canada, and more are planned.

Canada is a signatory to the Ramsar Convention on Wetlands of International Importance. This 1981 convention designated 17 wetland sites across Canada for protection. Canada is also a participant in the World Conservation Strategy initiated by the World Wildlife Fund and the International Union for Conservation of Nature and Natural Resources. This strategy makes specific reference to the need for wetland preservation as an urgent, international issue.

As noted earlier, the North American Waterfowl Management Plan (NAWMP) was jointly signed by the U.S. and Canada in 1986 in order to establish broad objectives for the preservation and restoration of waterfowl habitat. Implementation will preserve and restore 1.45 million hectares of Canadian prairie wetlands and associated uplands.

Many national initiatives are underway in habitat protection (Tables 7 and 8). It is clear that, through the activities of organizations such as Ducks Unlimited and Wildlife Habitat Canada, many significant results have been achieved in habitat conservation and protection. The agencies may, indeed, be far more cost-effective in the long term than traditional government approaches to habitat improvement, simply because they are small, quick to act and largely unfettered by jurisdictional constraints.

Table 7. National Organizations for Habitat Development Rehabilitation and Education

Canadian Nature Federation
Canadian Wildlife Federation
Ducks Unlimited Canada
Environment Canada (CWS) and related agencies
Nature Conservancy of Canada
Trout Unlimited
Wildlife Habitat Canada
World Wildlife Fund

Table 8. Selected Organizations Involved in Habitat Development, Rehabilitation and Education
(Source: Wildlife Habitat Canada, 1986)

Province	Organization/Agency
Alberta	Alberta Environment/Alberta Fish & Wildlife Division
	Alberta Fish and Game Association
-	Alberta Wilderness Association
-	Alberta Wildlife Foundation
-	Buck for Wildlife
-	Recreation, Parks and Wildlife Foundation
-	Wildlife Trust Fund
Saskatchewan -	Acres for Wildlife
	Critical Wildlife Habitat Protection Act
-	Habitat Trust
-	Heritage Farmstead
-	Heritage Marsh Program
-	Saskatchewan Environment
-	Wildlife Development
Manitoba -	Heritage Marsh Program
-	Manitoba Environment/Natural Resources
-	Manitoba Habitat Heritage Act & Program
-	Manitoba Wildlife Federation Habitat Trust
-	Manitoba Wildlife Foundation
-	North American Wildlife Foundation (Delta)

Provincial programs such as wetland inventories and maintenance programs have increased both public awareness and interest in wetland conservation programs. In the Prairie Provinces many significant initiatives are underway (Tables 7 and 8). These programs, sponsored through agencies like Ducks Unlimited, are acknowledged as being vital to the substantive progress in, and public recognition of, waterfowl habitat protection.

Undoubtedly, many private landowners contribute to overall wetlands habitat maintenance. As noted earlier, however, there are few data available on this subject. Wildlife Habitat Canada, Ducks Unlimited and the Nature Conservancy of Canada have taken worthwhile initiatives through joint ventures with private landowners in habitat maintenance. This is an area which requires much more attention and support from federal and provincial agencies if major advances in habitat preservation are to be achieved.

There are several instances where trans-jurisdictional initiatives of governments have led to substantive progress in waterfowl habitat management. The 1986 North American Waterfowl Management Plan is a continental example. Another example is the 1979 Prairie Waterfowl Harvest Program, where the Canadian Wildlife Service and the provincial wildlife agencies of the three Prairie Provinces initiated this multi-agency program to advance waterfowl management in Western Canada. Two key steps were involved:

1) Regulations were stabilized for a five-year period in order to address causal relationships between hunting regulation and waterfowl population dynamics.

2) Cooperation between agencies was assured for a five-year period (1979-1984) after which time the survey data were to be reviewed and applied to future management programs.

Initiatives such as these tend to reinforce the optimistic view that jurisdictional boundaries need not necessarily present insurmountable difficulties for addressing regional cumulative impact processes.

5.0 JURISDICTIONAL CONFLICT WITH LEGISLATIVE MANDATES

As noted earlier, the policies and programs of large institutions and government departments may significantly influence both perceptions of, and approaches to, cumulative effects assessment (CEA). It was suggested that new institutional frameworks may need to be developed in order to foster methodologies for long-term assessments, such as those noted by Peterson et al. (1984).

While the jurisdictional matrix for environmental and socio-economic assessment in Canada may present significant problems for coordination, it may also pose serious problems of conflict. For instance, agriculture departments may have numerous programs for the developmerit and expansion of agricultural lands which may seriously jeopardize wetlands. In contrast, wildlife interests may be attempting to conserve, protect or expand just such wetland areas through their own programs and legislation.

Hence, a jurisdictional dynamic may lead to conflicting interests and policies at municipal, provincial or federal levels. One problem with assessing the true magnitude of such conflicts is that they may emanate from diffuse, and subtle, origins. For instance, a federal grain subsidy program or low-interest loan subsidy for land purchases may significantly contribute to the expansion of the agricultural land-base in certain regions, which may directly accelerate the incorporation of marginal wetlands into agricultural land. Major government policies or programs (agricultural subsidies, expansion of the agricultural land-base, or stabilization policies) rarely consider the secondary or tertiary effects on habitat or regional wildlife populations. Indeed, the history of the western Canadian prairie and boreal fringe region has been characterized by a steady encroachment by traditional agricultural interests and concomitant decline of wildlife populations. Viewed in this context, the decline of Western Canadian waterfowl populations may represent just another phase of a progressive destruction of wildlife and habitat, a process which began a century ago with the elimination of the open Savannah and its herbivore (buffalo) populations.

The effect of such contradictory resource uses, resulting from'institutional development policies, may be manifested at a local, regional or national level. Table 9 illustrates the type and level of conflict at each level of government, each of which exerts a cumulative influence through successive levels. As Table 9 implies, any program designed to conserve or enhance waterfowl habitat must, by definition, be integrated with other federal or provincial wildlife conservation programs. These may conflict, however, with the aims and priorities of private landowners, regional associations or provincial agencies whose mandate is to maintain or expand the agricultural base. Clearly, this does not deny the goal of the interest(s) to sustain the long-term productivity of the agricultural sector. It does, however, point out the potential for policy conflict between the managed and wild habitat areas, particularly as the agricultural base expands into unimproved regions.

Strategies for conservation practices must either demonstrate immediate economic benefits to landowners or produce economic incentives/concessions which encourage the investment in waterfowl habitat. In essence, high priority waterfowl production areas must compete against existing subsidy/development programs and will be evaluated by individual landowners in their private cost/benefit decisions.

At a provincial level, regional policies may significantly influence the cumulative deterioration of wildlife habitat while cumulatively enhancing agricultural production. In Alberta, for instance, the Associate Minister of Public Lands and Wildlife announced a proposal to sell public lands which are capable of being improved for cultivation. While this possible policy for conversion of lands is consistent with the recommendations of the Environment Council of Alberta's report entitled, "Maintaining and Expanding the Agricultural Land Base in Alberta", such an expansion implies, indeed advocates, clearing, drainage and wetland destruction. This policy conflicts with the "Soils at Risk" report of the Canadian Senate in which recommendations are made for the conservation of soil and water on lands presently farmed before additional lands are cleared. This is one of many

possible examples of contradictory policies/practices leading to habitat destruction.

Tables 10 and 11 summarize the federal and provincial legislation and policies which may affect wildlife habitats in Alberta. This comprehensive overview of legislation which has potential impacts on waterfowl habitat demonstrates the need to resolve jurisdictional conflict within each agency and among agencies before such policies are implemented. It is probably doubtful that a super-agency could be created which would be able to integrate the numerous policies or practices of the several departments at all levels of government for all cumulative effects issues. The converse approach is to require each individual agency to employ a common sense approach to consideration of the conservation and protection of identified valued resources.

The use and value of private agencies, such as the World Wildlife Fund, the Nature Conservancy of Canada, and Wildlife Habitat Canada, are only just becoming apparent. These agencies could provide a significant focus for the conservation and protection of wildlife habitat. Indeed, it could be argued that such agencies provide far better returns per invested dollar than do broadly-based, traditional government departments in protecting and identifying specific habitat areas.

Wildlife Habitat Canada, for instance, has initiated independent assessments and studies of federal policies and legislation which affect habitat such as:

- the potential use of depreciation allowances for conservation purposes under Income Tax Law;
- the benefits of incorporating habitat incentives into crop depredation control/compensation programs;
- wildlife habitat conservation opportunities under federal/provincial agreements.

There is clearly a recognition on the part of jurisdictions of the need to resolve conflicts regarding wetlands and competing land uses. The numerous agencies and groups initiating plans which are aimed at mitigating conflicts are evidence of this recognition. It will take some time,. however, before the major problems of wetland land value and use are solved.

6.0 IMPLEMENTATION OF THE FEASIBILITY STUDY

In this section, we describe basic steps for implementing CEA of wetlands and the boreal agricultural fringe of the Prairie Provinces. The first step is to determine whether or not a CEA is needed.

6.1 Is a CEA Needed?

By referring to Figure 4.1 of Volume I: The Reference Guide (Lane et al., 1988), the reader should determine whether or not there is a cumulative effects

Table 10. Federal Legislation Which May Negatively Impact Alberta Wildlife Habitat

Legislation	Responsible Department	Programs	Habitat Impacts
Department of Agriculture Act	Agriculture Canada	Many programs to conserve and upgrade the land resource	The subsidies, grants, tax incentives, extension programs, and research activities are generally geared to convert the existing wildlife habitat base on private farms into agricultural land.
Farm Credit Act	Agriculture Canada	Farm Improvement Loans, Farm Syndicates Credit Act	Provide mortgages and loans to farmers at low interest rates to enable them to expand and improve their productive land base thus encouraging degradation and destruction of wildlife habitats on private and crown lands.
Prairie Farm Rehabilitation Act	Agriculture Canada	Land use management, water development and engineering	Programs and policies implemented under this act have both positive and negative impacts on wildlife habitats in Western Canada.
Agricultural Rural Development Act	Agriculture Canada	Soil and Water conservation	Both positive and negative impacts
Agricultural Stabilization Act	Agriculture Canada	Western Grain Stabilization Act, Crop Insurance Act, Agricultural Products Board Act, Agricultural Products Marketing Act	Farmers attempt to increase agricultural production on marginal lands
Income Tax Act	National Revenue	Programs to assist or support land clearing, leveling or drainage	Farmers may deduct land clearing, drainage and capital costs of equipment used in the above activities from their income. Thus, another incentive for landowners to destroy wildlife habitat.
Excise Tax Act	National Revenue	Agricultural Subsidy Programs	Exemptions are means of reducing farm operating costs and provide assistance for the purchase of specialized equipment which can be used to alter or destroy wildlife habitat.

Table 10. Federal Legislation Which May Negatively Impact Alberta Wildlife Habitat (continued)

Legislation	Responsible Department	Programs	Habitat Impacts
Canadian Wheat Board Act	Transport Canada	Prairie Grain Advance payments program, Initial Payment Guarantees, National Feed Grains Policy	To control grain movement and marketing, the board sets quotas based on the amount of improved land being farmed by the individual producers. The structure of this system encourages expansion of acreage classed as improved lands and thus encourages farmers to destroy existing wildlife habitat.

problem that can be assessed using the Guide. For the prairie example, the assessor would go through the decision tree in the following way:

1) Is the concern driven by an identifiable project and proponent? NO

2) Is the assessment motivated by a perceived gradual deterioration of the environment? YES

3) Are large spatial/temporal bounds needed to describe the problem-above the level of the local ecosystem? YES (large area of Western Canada' plus at least two decades of decreasing waterfowl populations)

4) Are the expected impacts of the same generic types described in Chapter 3.0? YES (habitat fragmentation)

5) YOU NEED CEA TYPE D (Top-Down CEA),

6.2 Initial Assumptions

Before proceeding with the CEA, there are some initial assumptions to be considered.

Interdisciplinary teams will have to "buy in" to the CEA framework:

Assembling the basic scientific information base necessary to support a CEA approach requires natural and social scientists from a wide range of disciplines. They must be adept at working in cooperative, long-term multi-disciplinary ventures. There are often few incentives to assemble such teams or for individuals to participate in them. Programs of communication and education coupled with support for the scientific/management team involved will have to be carefully devised and implemented for the teams to be efficient and successful.

Local decision makers must be able to access and influence the study:

While the local decision makers (e.g., landowners and hunters) unquestionably exert the greatest influence on wetland habitat, they have the least access to the scientific expertise needed to develop solutions for habitat degradation. Such individuals may be able to suggest approaches in conservation strategies which will have wide public appeal, and make the implementation portion of the program more successful. Their involvement in the study, however, is likely to promote acceptance of the proposals for implementation.

The CEA process must successfully match the scale of the problem:

This may constitute the most serious challenge to successful implementation of a CEA in this area. Even if valued ecosystem components (VECs) can be identified over such a vast area, achieving jurisdictional, institutional, and disciplinary agreement on possible approaches may be difficult. Given successful resolution of these questions, there still remain substantial conflicts between economic and wildlife interests which appear to have very

Table 11. Alberta Provincial Programs Influencing Waterfowl Habitat

Alberta Program	Agency	Habitat Effects	Possible Impact
River Basin Planning	Environment	Wetland maintenance or manipulation	Positive and negative
Irrigation Project Planning	Agriculture	Focus on agriculture development	Positive and negative
Irrigation Rehabilitation and Expansion	Agriculture	Irrigation expansion leads to lost wetlands	Positive and negative
AADC.Range and Soil Improvement and Loan Program	Alberta Agriculture Development Corporation	Land Use and Wetland Drainage	Positive and negative
Public Lands Disposition	Energy and Natural Resources	Retention and Development of Wetlands	Positive and negative
Bucks for Wildlife	Energy and Natural Resources	Retain and Enhance Wildlife Habitat	Positive
Tax Recovery Sales	Municipal Affairs	Wetlands Resort to New Owner/Managers	Positive and negative
Farm Surface Water Program	Environment	Drain and Consolidated Wetlands	Negative
Regrassing Program	Municipal Affairs	Enhance nesting waterfowl land cover	Positive
Farm Credit Program	Alberta Farm Credit Corp.	Low interest loans allow conversion of marginal lands.	Negative

disciplinary agreement on possible approaches may be difficult. Given successful resolution of these questions, there still remain substantial conflicts between economic and wildlife interests which appear to have very little in common. Massive institutional subsidies for agriculture, for instance, provide an enormous barrier to the achievement of habitat goals.

A pilot project which has the advantage of being manageable and which will provide usable scientific results may be attainable as a first-step. Participation in, and agreement about, such a project by the numerous agencies will provide essential components of the study. This is more prudent than going straight into a large study.

The pilot project could, once successfully initiated and agreed upon by the parties, be expanded in relation to its scientific output and demand for 'its results. If the CEA participants are not receiving value for their investment, they will move to stop the process and, consequently, a negotiated framework may be needed as the work proceeds.

The CEA Program will have to support, or enhance, existing monitoring work and basic research:

Without these components, CEA cannot be successfully achieved. A CEA will have a greater probability of receiving widespread support from the existing scientific community if it promises to augment and complement existing programs, rather than threaten them. Positive signals must be sent to those researchers to gain their support, which is vital to the success of any CEA program.

Agreement will have to be achieved early as to space/time boundaries of the study:

Forcing early agreement on these issues will require clear thinking about important issues and will provide decision makers and scientists alike with an understandable framework for the study. In addition, it will be easier to monitor the progress and cost-effectiveness of the study if space/time boundaries are agreed upon in advance.

6.3 The Top-Down CEA Process

It is critical to define the goals of a CEA as concisely as possible. The generic goals of CEA are to identify environmental cause-effect relationships in spatially and temporally extended ecosystems at the regional level in order:

- to detect the causes of environmental deterioration;
- to predict, avoid, minimize or mitigate undesirable consequences of human activities and developments, and
- to optimize desirable consequences, wise resource management, long-term planning and shared use of the environment.

7

The specific CEA feasibility study described here should incorporate the following elements:

1) It should complement existing programs of habitat/waterfowl assessment, monitoring and enhancement .

2) It should contribute new insights and a conceptual framework to existing management approaches and should enhance the, scientific data base for prairie waterfowl.

3) It should be confined to achievable objectives, all of which are endorsed by existing agencies and which add to our knowledge base.

4) It should allow the existing agencies to participate in a meaningful manner and should promise significant gains in knowledge given the necessary time and effort are expended by all parties.

As described in earlier sections of this chapter, there are already substantial initiatives underway in this area at the international, national, provincial and local levels. These initiatives, indicate the gravity of waterfowl population management problems in Western Canada. New initiatives in CEA in this area should work to complement, not duplicate, existing programs undertaken by federal, provincial and private waterfowl management agencies.

A very good procedure in the top-down approach would be to have an initial CEA workshop where all interested parties (farmers, hunters, Canadian Wildlife Service, Ducks Unlimited, Agriculture Canada, etc.) are brought together with the CEA analysts to find a common basis of understanding. At this workshop, the basic scoping and bounding would be done and the participants would be familiarized with CEA techniques

Having determined that there is a Type D CEA problem, the workshop should then focus on Table 4.2 of the Reference Guide (Lane et al., 1988) and follow the steps for completing the top-down assessment: Some highlights of this process are given here:

1) Scoping - Identify issues for a simplified example assume decline of a particular waterfowl species.
- Set CEA goals.
- Determine logistical support required.
(Note that after bounding, sub-issues may be specified)

2) Bounding - Determine spatial bounds (continental, national, regional, provincial, local ecosystems).
- Determine status of wetlands mapping for wetland type, extent, distribution and associated habitat type.
- Determine temporal bounds of interest for each issue.
- Determine jurisdictional institutional bound-
(often more than one level is needed)

Valuable information on bounding is available in techniques used for wildlife monitoring and habitat evaluation on the western plains, with particular emphasis on wetland habitat and waterfowl populations. These techniques have served to notify decision makers of the significant decline of vital wetland habitat on the prairies and the consequent decline of waterfowl populations which breed in them.

Traditional large-scale habitat assessment techniques for the formulation and use of habitat models for wildlife assessments have significant drawbacks. Technical limitations on air-photo interpretation and inventory classification' criteria present serious problems for wildlife managers. Often inventory data do not provide sufficient high-quality information to assess the capability of wetland habitat regions to provide essential habitat requirements for the wildlife groups being assessed.

In general, habitat models try to describe critical habitat requirements for key species (guilds) and to provide data on the inter-relationships between each variable and a carrying capacity for each species. In many cases, however, few wetland or upland vegetation characteristics are assessed by habitat classification systems (Green et al., 1986).

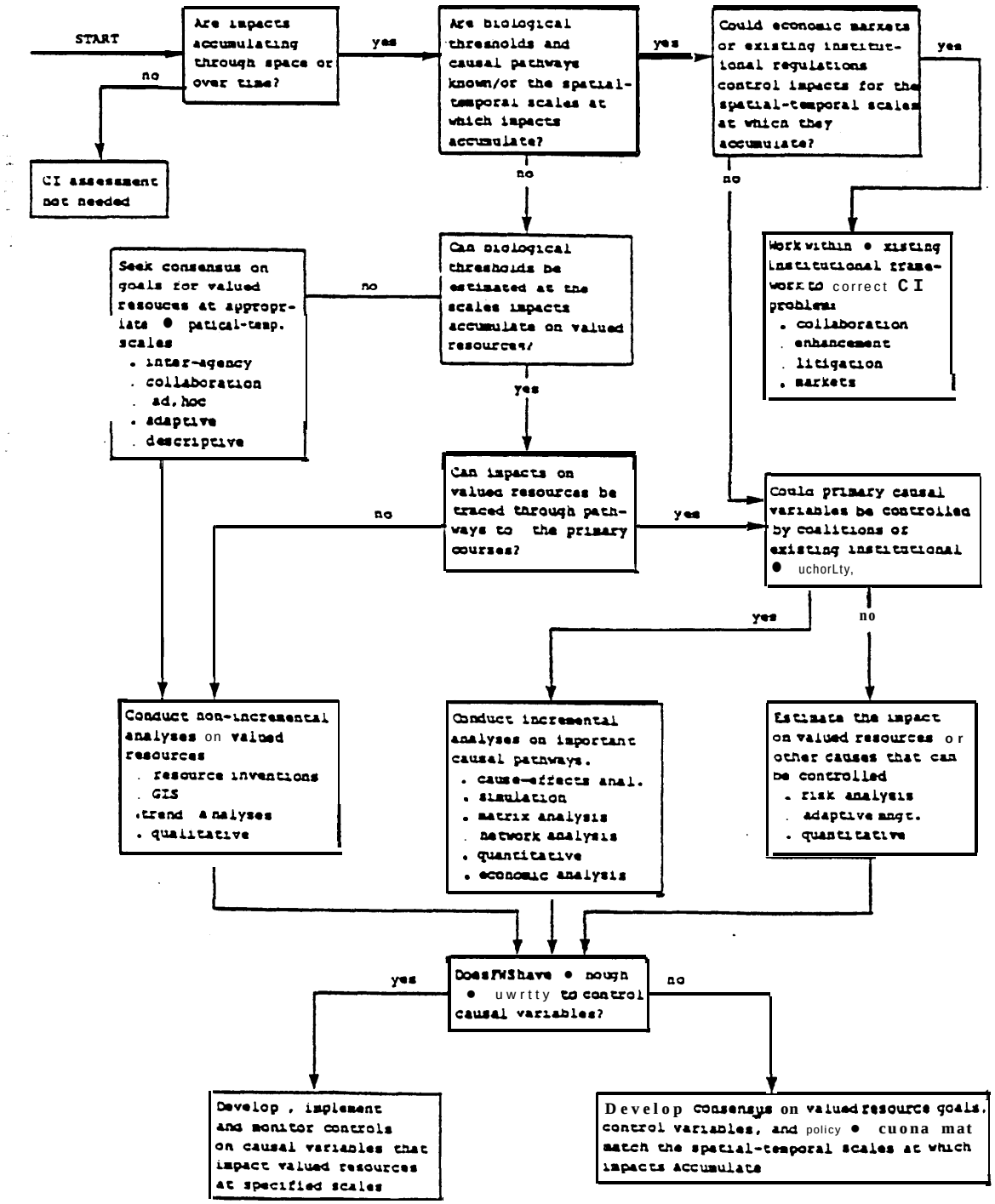
3) Common basis of understanding

After acquainting the participants with Figures 4.2 to 4.5 of the Reference Guide to Cumulative Effects Assessment (Lane et al., 1988), it would be useful to use a structure similar to that in Figure 2. This has been developed at the U.S. Fisheries and Wildlife Service by Richard Johnson, and it follows directly from the decision trees given in Chapter 4 of the Reference Guide (Lane et al., 1988). Much of the information necessary to pass through the decision tree in Figure 2 would need to come from workshop participants, and individual decision nodes are generally directly related to the steps in the top-down process. The decision tree in Figure 2 is essentially an aid to organizing the CEA workshop and to establishing the common basis of understanding.

It then becomes necessary to define the valued ecosystem components (V), the environmental changes (E) that affect them and the human activities (H). (Note that in the top-down approach the assessor, or workshop participants must work backward in Figure 4.6 of the Reference Guide [Lane et al.,1988]. The key to making a workable conceptual model is to simplify as much as possible the numbers of H,E and V components and linkages among them without sacrificing either variables or links that are essential for understanding system behaviour.

In any perturbed ecosystem, among the many variables which may generally influence overall system dynamics, some variables obviously produce greater effects than others. If management systems are to be applied efficiently, the variables which have the greatest potential for influencing desired responses will have to be identified, understood and properly maniptulated. Hence, any CEA framework will first have to be constructed around a core of such key variables. This may require significant new research, or initial judgments by qualified experts. Three types of variables and links are especially relevant

Figure 2. Decision Tree for Organizing a CEA Workshop (adapted from an unpublished figure of R. Johnson, U.S. Fish and Wildlife Service, Fort Collins, CO).



here: climate-habitat interactions, predator-prey interactions including hunting, and long-term agricultural practices.

Once progress is made in identifying the key variables which determine wetland habitat/waterfowl population dynamics, ecological thresholds will have to be assessed and quantified. This identification is crucial to the eventual achievement of local or regional habitat management schemes. Once properly quantified they will permit the design of management schemes which can be available and understood by the public.

The assessor should then turn to Figure 4.4 in the Reference Guide (Lane et al., 1988) and study the deductive causality involved in the cumulative effects problem. In addition, the assessor should begin to define the types and location of key feedback relationships involved in the problem as per Figure 4.6 of the Reference Guide (Lane et al., 1988). For example, for many habitat fragmentation problems, there is little feedback at the ecological level (F_E and F,), but there may be substantial feedback operating at the socio-economic levels (H,, F_{Hv} or H,,). This will result in the construction of a qualitative model for subsequent analysis and refinement.

As feedbacks are identified they would need to be checked against the initial bounding assumptions. For example, although it is well established that particular waterfowl population levels are declining, the causes of the declines are in dispute. Clearly, habitat fragmentation and loss of wetlands in the prairies have contributed to the decline: but are they the only cases or even major causes? Another hypothesis states that hunting predation is the leading cause of the decline and, in particular, the U.S. hunting laws are such that far too many animals are harvested. Some managers believe this overharvest has had severe ramifications on the levels of Canadian waterfowl.

Thus, if the CEA problem is initially bounded as a "within Canada" problem only and yet, in fact, American hunting is a crucial part of the dynamics, then much of the resultant analysis will be faulty. It might lead to management decisions regarding Canadian agricultural practices which would not bring about worthwhile improvement in duck population levels. In December of 1987, the prairie habitat portion of the North American Waterfowl Management Plan declared that a continent-wide breeding population goal should be set for waterfowl. This clearly recognized the need for an international level of management.

4) Identify known changes in qualitative state of H, E and V's.

This can be done most simply with checklists of H, E and V variables by identifying how they are changing with regard to the temporal bounding identified earlier.

5) List unacceptable trends.

Once a workable model is developed for understanding the-basic causality and feedback relationships, it is then possible to make checklists and identify the trends in the basic variables, to specify available data bases, and prepare them for use as needed.

6) Prepare a backward CEA diagram.

7) Identify all human activities that should be included in the diagram and establish hypothetical links.

8) Determine the location and amount of feedback (F_H, F_E, F_V, F_{HV}, F_{EV}).

When major decision points are reached and it is impossible to resolve the controversial issues or even to decide on the dominant cause-effect pathways, it is useful to construct some alternative qualitative (loop analysis) models. and ask a series of "what if" questions. This can help focus the workshop and the participants' thinking so that all relevant information is integrated into the shared understanding of the problem. It will often be necessary to build these models on more than one level (perhaps continental, national and the individual pothole ecosystem) to achieve sufficient understanding of how the dynamics work.

9) Decide on the CEA problem as one of space crowding (synergistic), time crowding (periodic), or combined.

The previous four steps essentially involve a reworking of Figure 4.6 of the Reference Guide (Lane et al., 1988) to achieve an agreed upon version of the cause and effect relationships operating in the cumulative effects problem.

10) Select the analytical tool and perform the analysis to determine the causes of the observed environmental deterioration.

Go to Figure 4.6 of the Reference Guide (Lane et al., 1988). Characterize also the level of uncertainty associated with the causes and the natural variability of the variables under consideration.

11) Explore management options, design strategy, and make recommendations.

Include additional data collection, more sophisticated analysis, environmental effects monitoring, post-project audits, socio-economic adjustments, and jurisdictional-institutional adjustments.

12) If it is a Type D CEA problem, assume corrective adjustments and prepare a forward CEA diagram to project whether future states of the environment are predicted to be acceptable or not.

13) Repeat steps 7-12 if additional scenarios of potential human activities are hypothesized to occur in the future and decisions need to be made concerning equitable division of the regional ecosystem.

The detail invoked for the last four steps largely depends on the results of steps 1-9 and the logistical base of personnel, data, analytical tools, motivation and support available for the CEA. For example, there exists a very sophisticated satellite system for geographical information collection and an equally sophisticated waterfowl population model (computer simulation).

The results from these can be placed in a network framework to explore management options. This would be cost-effective and lead to definite recommendations for CEA as well as a guide to future monitoring and data collection efforts.

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Table 9. Jurisdictional Conflicts at Successive Levels of Government that Affect Waterfowl

Scope		Level of Decision	Action/Policy/Decision
I.	Local	Individual Farmer	Burning/ploughing of land Herbivore use (cattle) Pesticide/herbicide use (type/frequency) Drainage/clearing of land Wildlife hunting/conservation
II.	Regional	Farmer Co-ops District Agriculturalist Improvement Districts Municipal Districts Provincial Agencies	Agricultural Subsidies Direct: Interest-free loans Improvement district grants Municipal drainage schemes Land purchase grants/loans Herbicide/pesticide grants Indirect: Transportation subsidies Grant price stabiliation schemes Production/grain quotas "Farming for the Future" grants
III.	National	Cabinet Major Federal Agencies	Agricultural Subsidy Policies Agricultural Development Policies Transportation Policies