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CLEANING PRIORITY INDEX FOR AQUATIC BIRDS
VULNERABLE TO OIL SPILLS IN THE ST. LAWRENCE

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ABSTRACT

We developed a cleaning priority index (CPI) for 129 species of aquatic birds present in the St. Lawrence River system and vulnerable to the effects of an oil spill. Six criteria were considered in drawing up the index: world population size, productivity, vulnerability, local numbers, economic value and survival during rehabilitation. Each species was assessed with respect to each criterion on a semi-quantitative ordinal scale ranging from 0 to 5 (with the highest score indicating the greatest importance), and the scores were totalled to give the species' CPI. Species considered to be vulnerable, threatened or endangered in Quebec were given the maximum score of 30, and classified as very high priority. Conversely, species for which there is a population reduction program were given a score of 0 (no cleaning priority). Species classified as high priority--with a CPI between 19 and 24--belonged mostly to the Anserinae, Accipitridae and Falconidae families. The CPI can be used as a decision-making tool for directing oiled-bird capture in the field as well as cleaning operations in rehabilitation centres. However, the CPI cannot be used as the sole criterion in these decisions and users must also take into account birds' physiological condition when deciding which individuals to clean. The CPI was developed so that it could be easily adapted to other regions.

RÉSUMÉ

Un indice de priorisation de nettoyage (IPN) a été développé à partir de six critères (la taille de la population mondiale, la productivité, la vulnérabilité, les effectifs locaux, la valeur commerciale et la survie pendant le nettoyage) pour 129 espèces d'oiseaux aquatiques présentes le long du Saint-Laurent et susceptibles d'être contaminées par un déversement accidentel d'hydrocarbures. Pour chaque espèce, une cote ordinale semi-quantitative, variant de 0 à 5 (nulle à haute importance), a été attribuée à chaque critère, selon des barèmes précis, l'IPN correspondant à la somme de ces points. Les espèces vulnérables, menacées ou en danger d'extinction au Québec ont été classées de très haute priorité de nettoyage, ayant un IPN maximum de 30. Par ailleurs, les espèces faisant l'objet d'un programme de réduction de leurs effectifs ont reçu un IPN de zéro. Entre ces extrêmes, ce sont des espèces appartenant surtout aux familles des Anserinae, des Accipitridae et des Falconidae qui se sont classées dans les hautes priorités de nettoyage (IPN variant de 24 à 19). L'IPN pourra servir d'outil d'aide à la décision pour orienter les interventions de récupération d'oiseaux souillés sur le terrain et les opérations de réhabilitation dans les centres de nettoyage. Il ne peut toutefois se substituer au jugement des utilisateurs qui devront aussi considérer l'état physiologique des oiseaux dans le choix des oiseaux à nettoyer. L'IPN a été construit de façon à être facilement adaptable à d'autres régions.

TABLE OF CONTENTS

ABSTRACT	iii
RÉSUMÉ	iii
LIST OF TABLES	v
1. INTRODUCTION	1
2. DESCRIPTION OF REGION COVERED	2
3. LIST OF SPECIES	2
4. MODEL USED	2
5. CRITERIA AND RATING SCALES	3
5.1 World population	3
5.2 Productivity	3
5.3 Vulnerability	3
5.4 Size of local population	5
5.5 Economic value	5
5.6 Survival prospects during cleaning operations	5
6. ANALYSIS BY FAMILY	23
6.1 Very high priority	23
6.2 High priority	23
6.3 Medium and low priority	23
6.4 Zero priority	24
7. LIMITS OF MODEL AND FUTURE IMPROVEMENTS	24
8. ACKNOWLEDGEMENTS	25
9. LITERATURE CITED	25

LIST OF TABLES

Table 1. Data used to determine scores for the size of the worldwide population (WP), productivity (PR), and survival during cleaning (SU) for 117 species of aquatic birds found in the St. Lawrence system (not including threatened, endangered, vulnerable and controlled species)	7
Table 2. Vulnerability to oil spills (VU) and local populations (LP) of 117 species of aquatic birds found along the St. Lawrence (not including threatened, endangered, vulnerable and controlled species). Vulnerability is assessed by averaging 8 variables. Local populations correspond to the maximum number in any given season	12
Table 3. Cleaning priority index (CPI) for 129 species of aquatic birds found along the St. Lawrence. The CPI is obtained by adding the scores in 6 criteria: WP: world population; PR: productivity; VU: vulnerability; LP: local population; EV: economic value; SU: survival during cleaning	17
Table 4. Classification of 129 species of aquatic birds found along the St. Lawrence in five categories of cleaning priorities according to their CPI.	21

1. INTRODUCTION

Oil spills are recognized to have dramatic adverse effects on marine animals (Blood 1977, Hay 1977, Anonymous 1979). The sight of oiled birds arouses our sympathy and pity and stimulates public pressure for safer ships and stricter controls on maritime shipping. Despite some improvements in the technical arena, however, accidents continue to happen, making birds, like other aquatic and semiaquatic animals, still vulnerable to oiling.

Several agencies have developed emergency response plans for aquatic birds in the event of an oil spill. The plans generally specify three types of measures: a survey of the populations present in the contaminated area, scaring to disperse birds from the area and the rehabilitation of oiled birds (Riley *et al.* 1985, Lehoux and Cossette 1991). Surveys and scaring, the purpose of which is to reduce birds' exposure to the oil, are generally considered to be the most effective and least costly way of dealing with spills since fixed-wing aircraft, helicopters, boats and scaring buoys can be used to scare away thousands of birds from a oil spill in a few hours.

The rehabilitation of oiled birds, an expensive technique allowing a few hundred birds to be cleaned in a week at best (Riley *et al.* 1985), has traditionally been considered as a method of last resort and one which is justified mainly by humanitarianism. However, in recent years, cleaning products and techniques, and rehabilitation methods in general, have been greatly improved, allowing more birds to be saved (Welte and Frink 1991, Frink 1993, Frink and Miller 1994). However, when a major spill occurs, rehabilitation teams may receive many more birds than they are able to clean. For example, in the *Exxon Valdez* spill, 28 000 birds died at the spill site in Alaska, 1888 oiled birds were brought to rehabilitation centres and 797 birds were treated and released (Piatt *et al.* 1990).

In a crisis situation such as a major spill, response teams must make quick decisions on which species to clean. To deal with this problem, we have developed a cleaning priority index (CPI) for aquatic birds threatened by an oil spill. The purpose of the CPI is to set priorities for rehabilitating species based on six criteria. These criteria include the status of the population (to preserve world and local biodiversity), as well the species' productivity (the ability of the population to recover), vulnerability to spills, economic value and survival prospects during cleaning operations. Indeed, from the point of view of conservation, the usefulness of capturing and cleaning high-priority species is questionable if they do not survive rehabilitation.

The cleaning priority index proposed is based on King and Sanger's oil vulnerability index (1979) and the bird/habitat oil index proposed by Speich *et al.* (1991). Although the CPI was developed to deal with the species found in the St. Lawrence River system in Quebec, it could be easily adapted to other regions.

2. DESCRIPTION OF REGION COVERED

The St. Lawrence River system is one of the main shipping routes in North America. It stretches 1700 km from Lake Ontario in the west to the Atlantic Ocean in the east and includes some 4300 km of shoreline. It is usually divided into three parts: the freshwater course, the St. Lawrence estuary and the Gulf of St. Lawrence.

The freshwater section of the river is generally less than 6 km wide. Along its 500-km length, it widens into three riverine lakes, Lake St. François, Lake St. Louis and Lake St. Pierre. Since this section is relatively shallow, most of it is dredged, and it contains a number of islands. The last 100 km of the freshwater section is subject to tidal action.

The 300-km-long estuary is divided into three parts: the upper estuary, which has brackish water and is less than 30 m deep on average; the middle estuary, which has saltwater and reaches depths of up to 300 m; and the lower, or maritime, estuary, which widens to 50 km before it flows into the Gulf of St. Lawrence.

The 900-km-long Gulf of St. Lawrence flows into the Atlantic Ocean and is relatively narrow, given the presence of three large islands, Newfoundland, Anticosti Island and Cape Breton Island.

There is some navigation risk along almost the entire system year round. Between 1971 and 1988, 641 spills of dangerous products occurred in the St. Lawrence (Anonymous 1990). However, no major ecological disaster has occurred yet, despite the 25 million tonnes of dangerous goods that are handled every year.

3. LIST OF SPECIES

More than one million aquatic birds use the St. Lawrence River system during migration (Lehoux *et al.* 1985, Maisonneuve *et al.* 1990). The number of birds found decreases somewhat in summer (Gauthier and Aubry 1995) and winter (Lehoux *et al.* 1985), although at least 200 000 individuals can be found in the system at these times. A total of 129 species, divided into 20 families and subfamilies, are present. Our list of aquatic birds that frequent the St. Lawrence River system and that are vulnerable to oiling is based on the list drawn up by the Association québécoise des groupes d'ornithologues. Classification and nomenclature, including both English and Latin names (Table 3), are those used by the American Ornithologists' Union (1983).

4. MODEL USED

The cleaning priority index was based on six criteria. The first four criteria, all related to the preservation of biodiversity, include the size of the world population, productivity (ability of population to recover), vulnerability (a complex notion combining distribution, behaviour, etc) and local population (regional diversity). The fifth criterion is the economic value of the species and the sixth criterion, how well the species survives

cleaning efforts. Each species was given a score of between 0 and 5 in each category, according to a specific rating scale developed for that criterion (Tables 1, 2 and 3). The CPI was obtained by adding up all the scores in all six categories, with the maximum score being 30 (Table 3).

The species have been divided into five groups according to their CPI (Table 4). Very high priority species were defined as those with a CPI between 25 and 30, high priority species with a CPI between 19 and 24, medium priority species with a CPI between 13 and 18, low priority species with a CPI between 1 to 12 and no priority species with a CPI of 0.

5. CRITERIA AND RATING SCALES

5.1 World population

The size of the world population (WP) of each species was evaluated as follows (Table 1):

- 1 = roughly 10^7 individuals
- 2 = roughly 10^6 individuals
- 3 = roughly 10^5 individuals
- 4 = roughly 10^4 individuals
- 5 = roughly 10^3 individuals

5.2 Productivity

The productivity rating (PR) for each species was based on the size and number of clutches (Eggs), the age at which the species first breeds (Age) and the species' longevity (Life). The scoring is as follows:

- 1 = high productivity (clutch > 6 eggs, reaches sexual maturity at one year of age)
- 3 = medium productivity (clutch of 4-6 eggs, reaches sexual maturity at two years)
- 5 = low productivity (clutch of 1-3 eggs, reaches sexual maturity at > 2 years)

Data on productivity and the corresponding references are given in Table 1.

5.3 Vulnerability

The vulnerability (VU) of each species is a complex criterion combining several characteristics. To evaluate vulnerability as accurately and objectively as possible, we divided it into eight variables. A score of 1 to 5 was awarded for each variable and the eight scores were averaged to obtain the final score (Table 2).

Distribution (Cramp 1977, 1980, 1983, 1985; Godfrey 1986; National Geographic Society (U.S.) 1987; Morrison and Ross 1989; Butler 1992; del Hoyo *et al.* 1992; Gibbs *et al.* 1992; Gratto-Trevor 1992; Parmelee 1992; Ryder 1993; Sodhi *et al.* 1993 [main references are in bold]).

B: extent of breeding range

- 1 = encompasses the majority of the Holarctic or has a widespread world distribution.
- 2 = encompasses less than half of the Holarctic or most of the New World.
- 3 = encompasses all of Holarctic coastal regions, at least half of the Nearctic or Palaearctic, less than half of the New World, or has a worldwide distribution.
- 4 = encompasses less than half of the Nearctic, less than half of Holarctic coastal regions, or has a worldwide, but localized, distribution.
- 5 = localized distribution; found on one or two continents.

W: extent of winter range

- 1 = widely distributed worldwide; on continents, coastal areas or offshore.
- 2 = encompasses all of Holarctic coastal regions or less than half of Holarctic region as a whole.
- 3 = encompasses at least half of the New World or has a worldwide but localized distribution.
- 4 = encompasses less than half of the New World, less than half of Holarctic coastal regions or less than half of Neotropical and Ethiopian coastal regions.
- 5 = localized; on one or two continents.

L: length of migrations

- 1 = <2000 km
- 3 = 2000-5000 km
- 5 = >5000 km

Behaviour (Cramp 1977, 1980, 1983, 1985; Terres 1980; Godfrey 1986; Butler 1992; del Hoyo *et al.* 1992; Ehrlich *et al.* 1988; Gibbs *et al.* 1992; Gratto-Trevor 1992; Parmelee 1992; Ryder 1993; Sodhi *et al.* 1993)

Re: resting

- 1 = in upland areas
- 3 = on shore
- 5 = on the water

Di: diet

- 1 = omnivorous
- 3 = more or less a generalist
- 5 = highly specialized

Fw: flocking on water

- 1 = alone or in small flocks (<20 individuals)
- 3 = medium-sized flocks (20-500 individuals)
- 5 = large flocks (>500 individuals)

Nd: nesting density

- 1 = solitary nester
- 3 = forms small colonies (a few dozen pairs)
- 5 = forms large colonies

Mortality (Mh): mortality from hunting (Lévesque *et al.* 1993)

0 = none

1 = low: ≤ 1000 individuals harvested annually in Quebec

3 = medium: 1000-10 000 individuals

5 = high: $\geq 10\ 000$ individuals

5.4 Size of local population (LP)

Since each species' population in the St. Lawrence varies a great deal over the year (David 1980, Lehoux *et al.* 1985; Gauthier and Aubry 1995), we evaluated the population by season first: P_{sp} (spring), P_s (summer), P_a (autumn) and P_w (winter):

1 = $> 10\ 000$ individuals

3 = 1000-10 000 individuals

5 = < 1000 individuals

The maximum value during any season was retained as the final value for the local population (LP). In the case of the Red-throated Loon, for example, $> 10\ 000$ individuals are found along the St. Lawrence during migration, but < 1000 breed and none winter, giving the species a score of 1 (Table 2).

Vulnerable, threatened and endangered species in Quebec (Robert 1989, Beaulieu 1992) received a score of 30, giving them a very high priority in cleaning operations regardless of their economic value and survival rates during cleaning operations.

Species that are considered to be overabundant and whose populations local authorities are trying to control through population reduction programs received a score of 0, giving them zero priority in cleaning operations. Indeed, it would be useless to try to rehabilitate a bird that could be killed the next day as part of a reduction program.

5.5 Economic value

The economic value of each species is evaluated according to its contribution to the economy through commercial activities like hunting (Lévesque *et al.* 1993), down harvesting, and as a public attraction. Species that congregate in large numbers at a specific place and time (e.g. snow geese at Cap Tourmente) are considered to be a public attraction.

1 = no direct contribution

3 = direct contribution through one activity

5 = direct contribution through several activities

5.6 Survival prospects during cleaning operations

Survival during rehabilitation was evaluated according to the following scale:

1 = poor: $< 33\%$

3 = fair: 33-66%

5 = good: $> 66\%$

To determine these scores, we used the information available on the species as well as the genus and family (see Table 1 for this data, as well as information on the references). For example, data on the oldsquaw (Lehoux 1982) indicate that out of three oiled individuals recovered during one spill, three survived, suggesting that the species has a high rate of survival despite the small sample available. However, sea ducks usually have poor survival rates (Anonymous 1979, Welte and Frink 1991). Therefore, we gave the species a score of 3 (fair).

Table 1. Data used to determine scores for the size of the worldwide population (WP), productivity (PR), and survival during cleaning (SU) for 117 species of aquatic birds found in the St. Lawrence system (not including threatened, endangered, vulnerable and controlled species).

Family Subfamily	Worldwide population		Productivity				Survival during cleaning	
	Species	WP	Ref.	Eggs	Age	Life	Ref.	SU (ref.)
<i>Gaviidae</i>								
	Red-throated Loon	10 ⁴	18	2 (1-3)**	2-3	24	18, 26	poor (23); 10-15/1500 mainly loons (2)*
	Common Loon	10 ⁵	18, 53	2 (1-3)	2-3	8	18, 26	< 50% (22); 0/1 (8); 0/1 (25); 1/1 (56)
<i>Podicipedidae</i>								
	Pied-billed Grebe	10 ⁵	18	4-7 (2-10)***	1		26	<50% (22); 0/9 (8); 0/1 (56); 22/56 (57)
<i>Procellariidae</i>								
	Northern Fulmar	10 ⁷	11, 15, 18	1	9 (5-12)	34	18, 55	poor (23); 73% (22)
	Greater Shearwater	10 ⁷	15, 18	1			55	
	Sooty Shearwater	10 ⁶	11, 15, 18	1	5-9		18, 55	
	Manx Shearwater	10 ⁶	15, 18	1	5-6	30	18, 55	
<i>Hydrobatidae</i>								
	Wilson's Storm-Petrel	10 ⁷	15, 18	1			55	
	Leach's Storm-Petrel	10 ⁷	11, 15, 18, 20	1	5	24	26	
<i>Sulidae</i>								
	Northern Gannet	10 ⁵	11, 15, 18	1	5	25	18, 26	
<i>Phalacrocoracidae</i>								
	Great Cormorant	10 ⁵	11, 15, 18	3-5 (2-6)	4-5	18	18, 26	low (23); 1/2 (8); 5/11 (25); 10% (23)
<i>Ardelidae</i>								
	American Bittern	10 ⁴	14	3-5 (2-7)	1	8	26	
	Great Blue Heron	10 ⁴	12, 14, 16, 20	4-5 (3-7)	2	23	26	10/12 (25)
	Great Egret	10 ⁵	14, 20	3-5 (1-6)	2	23	26	0/3 (25)
	Snowy Egret	10 ⁵	14, 20	3-5 (1-6)			18, 55	3/14 (25)
	Cattle Egret	10 ⁵	14, 20	3-4 (2-6)			18, 55	
	Green Heron	10 ⁴	estimated	4-5 (3-6)	1	8	26	0/1 (25)
	Black-crowned Night Heron	10 ⁵	14, 16, 20	3-5 (1-8)	2-3	21	26	0/1 (25)

* Gaviidae have poor survival rates according to reference 23; 10-15 birds out of 1500 survived the oil spill described in reference 2.

** Average (extreme) values

*** May lay more than one clutch a year, generally two.

Table 1. cont'd.

Family Subfamily Species	Worldwide population		Productivity				Survival during cleaning
	WP	Ref.	Eggs	Age	Life	Ref.	SU (ref.)
<i>Threskiomithidae</i>							
Glossy Ibis	10 ⁵	14, 20	3-4		21	18, 55	
<i>Anatidae</i>							
<i>Anserinae</i>							
Tundra Swan	10 ⁵	3, 7, 14	4 (3-5)	2-4	20	18, 26	>90% (58)
Greater White-fronted Goose	10 ⁵	7, 10, 14	5-6 (4-7)	3		18, 55	
Snow Goose	10 ⁶	3, 5, 7, 10, 16, 18	3-5 (2-9)	3	27	26	
Ross' Goose	10 ⁴	3, 5, 7, 10, 18	4-5 (2-6)	2-3		55	
Brant	10 ⁵	3, 5, 7, 10, 16, 18	3-4 (2-6)	2-3	22	26	
Canada Goose	10 ⁶	3, 5, 7, 10, 16, 18	5-6 (4-10)	2-3	24	26	90% (22, 23); 10/10 (57)
<i>Anatinae</i>							
Wood Duck	10 ⁶	3, 5, 7, 10, 18	12 (10-15)***	1	23	26	dabbling ducks: >90% (58); > diving ducks: <90% (58); sea ducks: 93/247, 6/11 (2) 0/1 (8)
Green-winged Teal	10 ⁶	3, 5, 7, 10, 18	9 (5-18)	1	20	26	
American Black Duck	10 ⁶	3, 5, 10, 16, 18	6-12	1	27	26	90% (22); 0/1 (36)
Mallard	10 ⁷	3, 5, 7, 10, 18	7-10 (6-15)	1	29	26	90% (22)
Northern Pintail	10 ⁷	3, 5, 7, 10, 18	8 (3-14)	1	27	26	
Blue-winged Teal	10 ⁶	3, 5, 7, 10, 18	9-10 (6-15)	1	22	26	
Northern Shoveler	10 ⁶	3, 5, 7, 10, 18	9 (5-14)	1	17	26	
Gadwall	10 ⁶	3, 5, 7, 10, 18	8-11 (5-13)	1	20	26	
Eurasian Widgeon	10 ⁶	14	8-9 (6-12)	1-2	9	26	
American Widgeon	10 ⁶	3, 5, 7, 10, 18	7-10 (6-12)	1	21	18, 26	
Canvasback	10 ⁵	3, 5, 7, 10, 18	9-10 (7-12)	1		18, 55	
Redhead	10 ⁵	3, 5, 7, 10, 18	9-11 (7-19)	1	22	26	
Ring-necked Duck	10 ⁵	3, 5, 7, 10, 18	9 (5-14)	1	21	26	
Greater Scaup	10 ⁶	3, 5, 7, 10, 18	8-9(6-11)	1-2	13	18, 26	0/1 (36)
Lesser Scaup	10 ⁶	3, 5, 7, 10, 18	9 (8-11)***	1-2	18	18, 26	
Common Eider	10 ⁶	3, 5, 7, 10, 16, 18, 20	4	2-3	23	18, 26	1/1 (33); 6/9 (35); 0/9 (37)
King Eider	10 ⁶	3, 5, 7, 10, 18	5(2-6)	2(3)	18	26	

Table 1. cont'd.

Family Subfamily	Worldwide population		Productivity				Survival during cleaning
	WP	Ref.	Eggs	Age	Life	Ref.	SU (ref.)
Oldsquaw	10 ⁷	3, 5, 7, 10, 16, 18	7 (2-11)	2	15	26	3/3 (33)
Black Scoter	10 ⁶	3, 5, 7, 10, 18	7-8 (6-10)	2-3	16	18, 26	2/2 (8)
Surf Scoter	10 ⁵	3, 5, 7, 10, 18	5-8			18	144/228 (8)
White-winged Scoter	10 ⁶	3, 5, 7, 10, 18	9 (5-12)	2	18	18, 26	
Common Goldeneye	10 ⁶	3, 5, 7, 10, 16, 18	8-10 (5-15)	2	17	18, 26	
Barrow's Goldeneye	10 ⁵	3, 5, 7, 10, 16, 18	8-11 (6-14)	2	15	26	
Bufflehead	10 ⁵	3, 5, 7, 10, 18	6-11 (4-12)	2	14	18, 26	
Hooded Merganser	10 ⁴	3, 5, 7, 10, 18	11 (7-13)	2	11	26	
Common Merganser	10 ⁵	3, 5, 7, 10, 18	8-12 (6-17)	2	14	26	
Red-breasted Merganser	10 ⁵	3, 5, 7, 10, 18	8 (5-11)	2	9	26	
Ruddy Duck	10 ⁵	3, 5, 7, 10, 18	8(5-15)	2 (1-2)	14	26	73% (22); 0/1 (8)
<i>Accipitridae</i>							
Osprey	10 ³	14, 32	2-3 (1-4)	3	32	14	Bald Eagle: 98/113 (21)
Northern Harrier	10 ³	14	4-6 (2-12)	2-3	17	26	
<i>Falconidae</i>							
Merlin	10 ⁴	14	4-5 (2-7)	2(1)	11	26	
Gyr Falcon	10 ³	14	3-4 (2-6)	2		14	
<i>Rallidae</i>							
Virginia Rail	10 ⁴	estimated	7-12 (4-13)			26	
Sora	10 ⁴	estimated	10-12 (6-16)			26	
Common Moorhen	10 ⁵	14	5-9 (2-13)***	1	11	14, 26	
American Coot	10 ⁵	5	8-12 (2-12)***	1	22	26	1/1 (8)
<i>Charadriidae</i>							
Black-bellied Plover	10 ⁴	40, 41, 42, 43, 44	4 (3)	2-3	14	14, 55	
American Golden Plover	10 ⁴	40, 41, 42	4 (3)	1	12	14, 55	
Semipalmated Plover	10 ⁴	40, 41, 42	4 (3)		8	26	
Killdeer	10 ⁵	40, 43	4 (3-5)***	1	11	26	
<i>Scolopacidae</i>							
<i>Scolopacinae</i>							
Greater Yellowlegs	10 ⁴	40, 41, 42, 43	4			26	

Table 1. cont'd.

Family Subfamily	Worldwide population		Productivity				Survival during cleaning
	WP	Ref.	Eggs	Age	Life	Ref.	SU (ref.)
Lesser Yellowlegs	10 ⁵	40, 41, 42, 43	4 (3-5)		6	26	
Solitary Sandpiper	10 ⁴	40, 41, 42	4 (4-5)			26	
Willet	10 ⁴	41, 42, 43, 44	4	2		26	
Spotted Sandpiper	10 ⁴	40, 41, 42, 43, 44	4 (1-5)***	1-2	12	26	
Whimbrel	10 ⁴	40, 41, 42, 43, 44	4 (3-5)	2		14, 55	
Hudsonian Godwit	10 ⁴	40, 41, 42	4			55	
Marbled Godwit	10 ⁴	41, 43, 44	4 (3-5)		9	26	0/1 (8)
Ruddy Turnstone	10 ⁵	40, 41, 42, 43, 44	4	2		14, 55	
Red Knot	10 ⁵	40, 41, 42, 44	4	2 (3)		14, 55	
Sanderling	10 ⁵	40, 41, 42, 43, 44	4 (3)***	2		14, 55	0/1 (8)
Semipalmated Sandpiper	10 ⁶	29, 40, 41	4	2-3 (1)	12	26, 29	
Western Sandpiper	10 ⁵	41, 44	4			55	
Least Sandpiper	10 ⁵	40,41	4		16	26	
White-rumped Sandpiper	10 ⁴	40, 41, 42, 47	4			55	
Baird's Sandpiper	10 ⁴	40, 41	4			55	
Pectoral Sandpiper	10 ⁴	40, 41, 42	4			55	
Purple Sandpiper	10 ⁴	41	4	(1)		14, 55	
Dunlin	10 ⁵	40,41	4	1-2 (3)		14, 55	0/1 (8)
Stilt Sandpiper	10 ⁴	41	4			55	
Buff-breasted Sandpiper	10 ⁵	41	4			55	
Ruff	10 ⁵	41	4	1-2		14, 55	
Short-billed Dowitcher	10 ⁵	10, 41, 42, 43, 44	4 (3-5)	2 or +	13	26	
Common Snipe	10 ⁶	41	4 (3-5)	1-2	9	26	
<i>Phalaropodinae</i>							
Wilson's Phalarope	10 ⁵	40, 41	4 (3-4)***			26	
Red-necked Phalarope	10 ⁵	40, 41	4 (3)***	1	5	26	
Red Phalarope	10 ⁵	41	4(3)***	1		26	
<i>Laridae</i>							
<i>Stercorariinae</i>							
Pomarine Jaeger	10 ⁴	estimated	2 (1-3)			26	

Table 1. cont'd.

Family Subfamily	Worldwide population		Productivity				Survival during cleaning
	WP	Ref.	Eggs	Age	Life	Ref.	SU (ref.)
Parasitic Jaeger	10 ⁴	14, 15	2 (1)	3-5	30	26	0/1 (25)
Long-tailed Jaeger	10 ⁴	14, 15	2 (1-3)		8	26	
<i>Larinae</i>							15/18 (2); 6/9 (8); 27/99 (23); 0/1 (36)
Laughing Gull	10 ⁵	15, 20	3-4			55	4/17 (25)
Franklin's Gull	10 ⁵	55	3(2)			55	
Little Gull	10 ³	14	2-3 (1-5)	2-3		26	
Common Black-headed Gull	10 ⁵	14, 15	2-3 (1-4)	2-3 (1-4)	32	26	
Bonaparte's Gull	10 ⁴	15	3 (2-4)			26	3/7 (8)
Herring Gull	10 ⁵	11, 14, 15, 16, 20	3 (2-4)	4-5 (3-7)	32	26	2/4 (8); 1/1 (56)
Iceland Gull	10 ⁴	15	2-3	(4)		26	
Lesser Black-backed Gull	10 ⁵	14, 15	3 (2)	4	26	14, 55	
Glaucous Gull	10 ⁵	15	3 (2-4)		22	26	
Great Black-backed Gull	10 ⁵	11, 14, 15, 16, 20	3 (2-4)	4-5	23	26	
Black-legged Kittiwake	10 ⁵	11, 14, 15, 16	2 (1-3)	4-5 (3-8)	21	26	0/4 (8)
Sabine's Gull	10 ⁴	15	3 (2-3)			55	
Ivory Gull	10 ³	14, 15	2 (1)			14, 55	
<i>Sternae</i>							
Common Tern	10 ⁵	11, 14, 15, 20	2-3 (2-4)	3-4 (2)	24	26	0/1 (25)
Arctic Tern	10 ⁵	11, 14, 15, 20	2 (1-3)	3 (1-3)	34	26	
Black Tern	10 ⁴	14	3 (1-4)	(2)	17	14, 26	
<i>Alcidae</i>							low (23); 89/186 (2)
Dovekie	10 ⁷	11, 14, 15	1			55	5/25 (33)
Common Murre	10 ⁷	11, 14, 15	1	5-6 (3-9)	27	26	0/1 (33); 11/12 (56)
Thick-billed Murre	10 ⁵	11, 14, 15	1			14	
Razorbill	10 ⁵	11, 14, 15, 16, 20	1	4-5		14	6/8 (56); 21/425 razorbills and guillemots (13); 1/1 (33)
Black Guillemot	10 ⁵	11, 14, 15, 16, 20	2(1)	4 (2-4)	13	26	2/394 (13); 21/425 razorbill and guillemot (13); 150/5800, 109/630 mainly guillemot (2); 0/2 (33); 0/4 (37)
Atlantic Puffin	10 ⁷	11, 14, 15, 20	1	5 (3-6)	21	26	

Table 2. Vulnerability to oil spills (VU) and local populations (LP) of 117 species of aquatic birds found along the St. Lawrence (not including threatened, endangered, vulnerable and controlled species). Vulnerability is assessed by averaging 8 variables. Local populations correspond to the maximum number in any given season.

Family Subfamily	Species	VULNERABILITY								LOCAL POPULATION					
		Distribution			Behaviour				Mortality	Seasonal numbers					
		B	W	L	Re	DI	Fw	Nd	Mh	VU	Psp	Ps	Pa	Pw	LP
<i>Gaviidae</i>															
	Red-throated Loon	2	2	3	5	3	1	1	0	2	1	5	1	-	1
	Common Loon	3	4	1	5	3	1	1	0	2	1	3	1	-	1
<i>Podicipedidae</i>															
	Pied-billed Grebe	2	3	3	5	3	1	1	0	2	3	3	3	-	3
<i>Procellariidae</i>															
	Northern Fulmar	4	1	3	5	3	1	5	0	3	3	5	3	1	1
	Greater Shearwater	5	1	5	5	3	1	5	0	3	3	3	3	-	3
	Sooty Shearwater	5	1	5	5	3	1	5	0	3	3	3	3	-	3
	Manx Shearwater	5	1	5	5	3	1	5	0	3	5	5	5	-	5
<i>Hydrobatidae</i>															
	Wilson's Storm-Petrel	4	1	5	5	3	3	3	0	3	5	5	5	-	5
	Leach's Storm-Petrel	4	1	5	5	3	3	5	0	3	1	1	1	-	1
<i>Sulidae</i>															
	Northern Gannet	5	1	1	5	5	3	5	0	3	1	1	1	5	1
<i>Phalacrocoracidae</i>															
	Great Cormorant	3	2	3	1	3	3	5	0	3	3	3	3	-	3
<i>Ardeidae</i>															
	American Bittern	3	4	3	1	3	1	1	0	2	5	5	5	-	5
	Great Blue Heron	3	4	3	1	3	1	3	0	2	3	3	3	-	3
	Great Egret	1	1	3	1	3	1	3	0	2	5	5	5	-	5
	Snowy Egret	3	3	3	1	3	1	5	0	2	5	5	5	-	5
	Cattle Egret	1	1	3	1	3	1	5	0	2	5	5	5	-	5
	Green Heron	1	1	3	1	3	1	1	0	1	5	5	5	-	5
	Black-crowned Night Heron	1	1	3	1	3	1	5	0	2	3	3	3	-	3
<i>Threskiornithidae</i>															
	Glossy Ibis	4	3	1	1	3	1	5	0	2	5	5	5	-	5

Table 2 (continued)

Family Subfamily Species	VULNERABILITY									LOCAL POPULATION				
	Distribution			Behaviour				Mortality		Seasonal numbers				
	B	W	L	Re	DI	Fw	Nd	Mh	VU	Psp	Ps	Pa	Pw	LP
<i>Anatidae</i>														
<i>Anserinae</i>														
Tundra Swan	3	4	3	5	5	3	1	3	3	5	5	5	-	5
Greater White-fronted Goose	3	4	3	1	1	3	1	1	2	5	5	5	-	5
Snow Goose	4	5	3	1	1	5	5	5	4	1	5	1	5	1
Ross' Goose	5	5	3	1	1	3	5	3	3	5	5	5	-	5
Brant	4	5	3	1	1	3	5	1	3	1	-	5	-	1
Canada Goose	3	5	1	1	1	5	1	5	3	1	5	1	5	1
<i>Anatinae</i>														
Wood Duck	4	5	1	1	1	1	1	5	2	3	5	3	-	3
Green-winged Teal	1	2	3	1	1	3	1	5	2	1	3	1	5	1
American Black Duck	4	5	1	1	1	3	1	5	3	1	1	1	1	1
Mallard	1	2	3	1	1	3	1	5	2	1	1	1	3	1
Northern Pintail	1	2	3	1	1	3	1	5	2	1	1	1	5	1
Blue-winged Teal	3	4	3	1	1	3	1	5	3	1	1	1	-	1
Northern Shoveler	1	2	3	1	1	1	1	5	2	3	3	3	-	3
Gadwall	2	2	1	1	1	3	1	5	2	1	1	1	5	1
Eurasian Widgeon	3	2	3	1	1	3	1	1	2	5	5	5	-	5
American Widgeon	3	4	3	1	1	3	1	5	3	1	1	1	-	1
Canvasback	4	4	3	5	3	3	1	3	3	1	5	1	5	1
Redhead	4	4	1	5	3	3	1	5	3	3	3	3	-	3
Ring-necked Duck	4	4	3	5	3	3	1	5	4	1	3	1	5	1
Greater Scaup	3	4	3	5	3	5	1	5	4	1	3	1	5	1
Lesser Scaup	4	4	3	5	3	5	1	5	4	1	3	1	5	1
Common Eider	3	4	3	5	3	3	3	5	4	1	1	1	1	1
King Eider	3	4	1	5	3	3	1	1	3	5	5	5	3	3
Oldsquaw	3	2	3	5	3	5	1	3	3	1	-	1	1	1
Black Scoter	4	2	3	5	3	5	1	3	3	1	3	1	5	1
Surf Scoter	4	4	3	5	3	5	1	3	4	1	3	1	5	1
White-winged Scoter	2	2	3	5	3	5	1	3	3	1	3	1	5	1
Common Goldeneye	1	2	3	5	3	3	1	5	3	1	3	1	1	1

Table 2 (continued)

Family Subfamily Species	VULNERABILITY									LOCAL POPULATION					
	Distribution			Behaviour				Mortality		Seasonal numbers					
	B	W	L	Re	DI	Fw	Nd	Wh	VU	Psp	Ps	Pa	Pw	LP	
Barrow's Goldeneye	5	5	1	5	3	3	1	3	3	1	5	1	1	1	
Bufflehead	4	4	3	5	3	3	1	5	4	1	5	1	3	1	
Hooded Merganser	4	5	1	3	3	1	1	5	3	1	3	1	5	1	
Common Merganser	1	2	3	3	3	3	1	5	3	1	3	1	1	1	
Red-breasted Merganser	1	2	3	3	3	3	1	3	2	1	3	1	3	1	
Ruddy Duck	3	3	3	5	3	3	1	3	3	5	5	5	-	5	
<i>Accipitridae</i>															
Osprey	1	1	5	1	5	1	1	1	2	3	3	3	-	3	
Northern Harrier	1	2	3	1	1	1	1	0	1	5	5	5	5	5	
<i>Falconidae</i>															
Merlin	1	2	3	1	3	1	1	0	2	5	5	5	-	5	
Gyr Falcon	3	2	1	1	3	1	1	0	2	5	-	5	5	5	
<i>Rallidae</i>															
Virginia Rail	4	3	1	1	1	1	1	1	2	3	3	3	-	3	
Sora	3	4	3	1	1	1	1	1	2	3	3	3	-	3	
Common Moorhen	1	1	3	3	1	3	1	1	2	3	3	3	-	3	
American Coot	3	4	3	3	1	3	1	3	3	3	3	3	-	3	
<i>Charadriidae</i>															
Black-bellied Plover	4	1	5	1	3	3	1	1	2	1	3	1	-	1	
American Golden Plover	4	4	3	1	3	3	1	1	3	3	5	3	-	3	
Semipalmated Plover	4	3	3	1	1	3	1	1	2	1	3	1	-	1	
Killdeer	3	4	3	1	1	1	1	1	2	1	1	1	-	1	
<i>Scolopacidae</i>															
<i>Scolopacinae</i>															
Greater Yellowlegs	4	3	5	1	1	3	1	1	2	1	3	1	-	1	
Lesser Yellowlegs	4	3	5	1	1	3	1	1	2	1	3	1	-	1	
Solitary Sandpiper	4	3	5	1	1	1	1	1	2	3	5	3	-	3	
Willet	5	4	3	1	3	1	1	1	2	5	5	5	-	5	
Spotted Sandpiper	3	3	5	1	3	1	1	1	2	1	3	1	-	1	
Whimbrel	4	1	5	1	3	3	1	1	2	1	5	1	-	1	

Table 2 (continued)

Family Subfamily	Species	VULNERABILITY								LOCAL POPULATION					
		Distribution			Behaviour				Mortality		Seasonal numbers				
		B	W	L	Re	DI	Fw	Nd	Mh	VU	Psp	Ps	Pa	Pw	LP
	Hudsonian Godwit	5	5	5	1	3	3	1	1	3	3	3	3	3	
	Marbled Godwit	5	4	3	1	3	3	1	1	3	5	5	5	5	
	Ruddy Turnstone	3	1	5	1	3	3	1	1	2	3	5	3	3	
	Red Knot	4	3	5	1	1	3	1	1	2	3	5	3	3	
	Sanderling	4	1	5	1	3	3	1	1	2	1	3	1	1	
	Semipalmated Sandpiper	4	4	5	1	1	5	1	1	3	1	1	1	1	
	Western Sandpiper	5	4	5	1	1	1	1	1	2	5	5	5	5	
	Least Sandpiper	4	4	5	1	1	3	1	1	3	1	1	1	1	
	White-rumped Sandpiper	4	4	5	1	1	3	1	1	3	3	5	3	3	
	Baird's Sandpiper	4	4	5	1	1	1	1	1	2	5	-	5	5	
	Pectoral Sandpiper	4	4	5	1	1	1	1	1	2	5	-	5	5	
	Purple Sandpiper	4	5	1	1	3	1	1	1	2	5	-	3	3	
	Dunlin	3	2	3	1	1	3	1	1	2	5	-	3	3	
	Stilt Sandpiper	4	4	3	1	1	1	1	1	2	5	-	5	5	
	Buff-breasted Sandpiper	4	4	5	1	1	1	1	1	2	5	-	5	5	
	Ruff	4	4	5	1	1	1	1	1	2	5	-	5	5	
	Short-billed Dowitcher	5	4	5	1	1	3	1	1	3	3	5	3	3	
	Common Snipe	1	1	3	1	1	1	1	5	2	3	5	3	5	
	<i>Phalaropodinae</i>														
	Wilson's Phalarope	5	3	5	5	5	3	1	0	3	5	5	5	5	
	Red-necked Phalarope	3	5	5	5	5	3	1	0	3	3	-	3	3	
	Red Phalarope	4	5	5	5	5	3	1	0	4	3	-	3	3	
	<i>Laridae</i>														
	<i>Stercorariinae</i>														
	Pomarine Jaeger	4	1	5	3	3	1	1	1	2	5	5	5	5	
	Parasitic Jaeger	3	1	5	3	3	1	1	1	2	5	5	5	5	
	Long-tailed Jaeger	3	1	5	3	3	1	1	1	2	5	5	5	5	
	<i>Larinae</i>														
	Laughing Gull	5	5	1	3	1	3	3	0	3	5	5	5	5	
	Franklin's Gull	5	4	5	3	1	3	3	0	3	5	5	5	5	

Table 2 (continued)

Family Subfamily	Species	VULNERABILITY								LOCAL POPULATION					
		Distribution			Behaviour				Mortality		Seasonal numbers				
		B	W	L	Re	DI	Fw	Nd	Wh	VU	Psp	Ps	Pa	Pw	LP
	Little Gull	4	4	1	3	1	3	3	0	2	5	5	5	-	5
	Common Black-headed Gull	3	1	3	3	1	3	3	0	2	5	5	5	-	5
	Bonaparte's Gull	4	4	3	3	1	3	3	0	3	1	3	1	5	1
	Herring Gull	2	1	3	1	1	3	3	0	2	1	1	1	1	1
	Iceland Gull	5	1	1	3	1	3	3	0	2	1	5	1	1	1
	Lesser Black-backed Gull	4	1	3	3	1	3	3	0	2	5	5	5	-	5
	Glaucous Gull	3	1	3	3	1	3	3	0	2	3	5	3	3	3
	Great Black-backed Gull	4	1	1	3	1	3	3	0	2	1	1	1	1	1
	Black-legged Kittiwake	3	1	3	3	3	3	5	0	3	1	1	1	5	1
	Sabine's Gull	4	5	5	3	3	3	3	0	3	5	5	5	-	5
	Ivory Gull	5	1	1	3	3	3	3	0	2	-	-	-	5	5
	<i>Sternae</i>														
	Common Tern	2	1	5	3	1	3	3	0	2	3	3	3	-	3
	Arctic Tern	3	1	5	3	1	3	3	0	2	3	5	3	-	3
	Black Tern	2	4	3	3	1	3	3	0	2	3	3	3	-	3
	<i>Alcidae</i>														
	Dovekie	5	1	1	5	5	5	5	1	4	1	-	1	1	1
	Common Murre	4	1	1	5	3	5	5	1	3	1	1	1	1	1
	Thick-billed Murre	4	1	1	5	3	5	5	1	3	1	1	1	1	1
	Razorbill	4	1	1	5	5	3	5	1	3	1	1	1	-	1
	Black Guillemot	3	1	1	5	5	3	5	1	3	3	3	3	3	3
	Atlantic Puffin	4	1	1	5	5	3	5	1	3	1	1	1	-	1

Table 3: Cleaning priority index (CPI) for 129 species of aquatic birds found along the St. Lawrence. The CPI is obtained by adding the scores in 6 categories: WP: world population; PR: productivity; VU: vulnerability; LP: local population; EV: economic value; SU: survival during cleaning.

Family Subfamily	Species	WP	PR	VU	LP	EV	SU	CPI
<i>Gaviidae</i>								
	Red-throated Loon (<i>Gavia stellata</i>)	4	5	2	1	1	3	16
	Common Loon (<i>Gavia immer</i>)	3	5	2	1	1	3	15
<i>Podicipedidae</i>								
	Pied-billed Grebe (<i>Podilymbus podiceps</i>)	3	3	2	3	1	3	15
	Horned Grebe (<i>Podiceps auritus</i>)				30			30
	Red-necked Grebe (<i>Podiceps grisegena</i>)				30			30
<i>Procellariidae</i>								
	Northern Fulmar (<i>Fulmarus glacialis</i>)	1	5	3	1	1	1	12
	Greater Shearwater (<i>Puffinus gravis</i>)	1	5	3	3	1	1	14
	Sooty Shearwater (<i>Puffinus griseus</i>)	2	5	3	3	1	1	15
	Manx Shearwater (<i>Puffinus puffinus</i>)	3	5	3	5	1	1	18
<i>Hydrobatidae</i>								
	Wilson's Storm-Petrel (<i>Oceanites oceanicus</i>)	1	5	3	5	1	1	16
	Leach's Storm-Petrel (<i>Oceanodroma leucorhoa</i>)	1	5	3	1	1	1	12
<i>Sulidae</i>								
	Northern Gannet (<i>Sula bassanus</i>)	3	5	3	1	3	1	16
<i>Phalacrocoracidae</i>								
	Great Cormorant (<i>Phalacrocorax carbo</i>)	3	3	3	3	1	1	14
	Double-crested Cormorant (<i>Phalacrocorax auritus</i>)				0			0
<i>Ardeidae</i>								
	American Bittern (<i>Botaurus lentiginosus</i>)	4	3	2	5	1	3	18
	Least Bittern (<i>Ixobrychus exilis</i>)				30			30
	Great Blue Heron (<i>Ardea herodias</i>)	4	3	2	3	1	3	16
	Great Egret (<i>Casmerodius albus</i>)	3	3	2	5	1	3	17
	Snowy Egret (<i>Egretta thula</i>)	3	3	2	5	1	3	17
	Cattle Egret (<i>Bubulcus ibis</i>)	3	3	2	5	1	3	17
	Green Heron (<i>Butorides striatus</i>)	4	3	1	5	1	3	17
	Black-crowned Night Heron (<i>Nycticorax nycticorax</i>)	3	3	2	3	1	3	15
<i>Threskiomithidae</i>								
	Glossy Ibis (<i>Plegadis falcinellus</i>)	3	3	2	5	1	3	17
<i>Anatidae</i>								
<i>Anserinae</i>								
	Tundra Swan (<i>Cygnus columbianus</i>)	3	3	3	5	1	5	20
	Greater White-fronted Goose (<i>Anser albifrons</i>)	3	3	2	5	3	5	21
	Snow Goose (<i>Chen caerulescens</i>)	2	3	4	1	5	5	20
	Ross' Goose (<i>Chen rossii</i>)	4	3	3	5	3	5	23
	Brant (<i>Branta bernicla</i>)	3	3	3	1	3	5	18
	Canada Goose (<i>Branta canadensis</i>)	2	3	3	1	5	5	19

Table 3 (continued)

Family Subfamily	Species	WP	PR	VU	LP	EV	SU	CPI
<i>Anatinae</i>								
	Wood Duck (<i>Aix sponsa</i>)	2	1	2	3	3	3	14
	Green-winged Teal (<i>Anas crecca carolinensis</i>)	2	1	2	1	3	3	12
	American Black Duck (<i>Anas rubripes</i>)	2	1	3	1	3	3	13
	Mallard (<i>Anas platyrhynchos</i>)	1	1	2	1	3	3	11
	Northern Pintail (<i>Anas acuta</i>)	1	1	2	1	3	3	11
	Blue-winged Teal (<i>Anas discors</i>)	2	1	3	1	3	3	13
	Northern Shoveler (<i>Anas clypeata</i>)	2	1	2	3	3	3	14
	Gadwall (<i>Anas strepera</i>)	2	1	2	1	3	3	12
	Eurasian Widgeon (<i>Anas penelope</i>)	2	1	2	5	3	3	16
	American Widgeon (<i>Anas americana</i>)	2	1	3	1	3	3	13
	Canvasback (<i>Aythya valisineria</i>)	3	1	3	1	3	3	14
	Redhead (<i>Aythya americana</i>)	3	1	3	3	3	3	16
	Ring-necked Duck (<i>Aythya collaris</i>)	3	1	4	1	3	3	15
	Greater Scaup (<i>Aythya marila</i>)	2	1	4	1	3	3	14
	Lesser Scaup (<i>Aythya affinis</i>)	2	1	4	1	3	3	14
	Common Eider (<i>Somateria mollissima</i>)	2	1	4	1	5	3	16
	King Eider (<i>Somateria spectabilis</i>)	2	1	3	3	3	3	15
	Harlequin Duck (<i>Histrionicus histrionicus</i>)				30			30
	Oldsquaw (<i>Clangula hyemalis</i>)	1	1	3	1	3	3	12
	Black Scoter (<i>Melanitta nigra</i>)	2	1	3	1	3	3	13
	Surf Scoter (<i>Melanitta perspicillata</i>)	3	1	4	1	3	3	15
	White-winged Scoter (<i>Melanitta fusca</i>)	2	1	3	1	3	3	13
	Common Goldeneye (<i>Bucephala clangula</i>)	2	1	3	1	3	3	13
	Barrow's Goldeneye (<i>Bucephala islandica</i>)	3	1	3	1	3	3	14
	Bufflehead (<i>Bucephala albeola</i>)	3	1	4	1	3	3	15
	Hooded Merganser (<i>Lophodytes cucullatus</i>)	4	1	3	1	3	3	15
	Common Merganser (<i>Mergus merganser</i>)	3	1	3	1	3	3	14
	Red-breasted Merganser (<i>Mergus serrator</i>)	3	1	2	1	3	3	13
	Ruddy Duck (<i>Oxyura jamaicensis</i>)	3	1	3	5	3	3	18
<i>Accipitridae</i>								
	Osprey (<i>Pandion haliaetus</i>)	5	5	2	3	1	5	21
	Bald Eagle (<i>Haliaeetus leucocephalus</i>)				30			30
	Northern Harrier (<i>Circus cyaneus</i>)	5	5	1	5	1	5	22
<i>Falconidae</i>								
	Merlin (<i>Falco columbarius</i>)	4	5	2	5	1	3	20
	Peregrine Falcon (<i>Falco peregrinus</i>)				30			30
	Gyrfalcon (<i>Falco rusticolus</i>)	5	5	2	5	1	5	23

Table 3 (continued)

Family Subfamily	Species	WP	PR	VU	LP	EV	SU	CPI
<i>Rallidae</i>								
	Yellow Rail (<i>Coturnicops noveboracensis</i>)				30			30
	Virginia Rail (<i>Rallus limicola</i>)	4	1	2	3	1	1	12
	Sora (<i>Porzana carolina</i>)	4	1	2	3	1	1	12
	Common Moorhen (<i>Gallinula chloropus</i>)	2	1	2	3	1	1	10
	American Coot (<i>Fulica americana</i>)	2	1	3	3	3	1	13
<i>Charadriidae</i>								
	Black-bellied Plover (<i>Pluvialis squatarola</i>)	4	3	2	1	1	1	12
	American Golden Plover (<i>Pluvialis dominica</i>)	4	3	3	3	1	1	15
	Semipalmated Plover (<i>Charadrius semipalmatus</i>)	4	3	2	1	1	1	12
	Piping Plover (<i>Charadrius melodus</i>)				30			30
	Killdeer (<i>Charadrius vociferus</i>)	2	3	2	1	1	1	10
<i>Scolopacidae</i>								
<i>Scolopacinae</i>								
	Greater Yellowlegs (<i>Tringa melanoleuca</i>)	4	3	2	1	1	1	12
	Lesser Yellowlegs (<i>Tringa flavipes</i>)	3	3	2	1	1	1	11
	Solitary Sandpiper (<i>Tringa solitaria</i>)	4	3	2	3	1	1	14
	Willet (<i>Catoptrophorus semipalmatus</i>)	4	3	2	5	1	1	16
	Spotted Sandpiper (<i>Actitis macularia</i>)	4	3	2	1	1	1	12
	Whimbrel (<i>Numenius phaeopus</i>)	4	3	2	1	1	1	12
	Hudsonian Godwit (<i>Limosa haemastica</i>)	4	3	3	3	1	1	15
	Marbled Godwit (<i>Limosa fedoa</i>)	4	3	3	5	1	1	17
	Ruddy Turnstone (<i>Arenaria interpres</i>)	3	3	2	3	1	1	13
	Red Knot (<i>Calidris canutus</i>)	3	3	2	3	1	1	13
	Sanderling (<i>Calidris alba</i>)	3	3	2	1	1	1	11
	Semipalmated Sandpiper (<i>Calidris pusilla</i>)	2	3	3	1	1	1	11
	Western Sandpiper (<i>Calidris mauri</i>)	3	3	2	5	1	1	15
	Least Sandpiper (<i>Calidris minutilla</i>)	3	3	3	1	1	1	12
	White-rumped Sandpiper (<i>Calidris fuscicollis</i>)	4	3	3	3	1	1	15
	Baird's Sandpiper (<i>Calidris bairdii</i>)	4	3	2	5	1	1	16
	Pectoral Sandpiper (<i>Calidris melanotos</i>)	4	3	2	5	1	1	16
	Purple Sandpiper (<i>Calidris maritima</i>)	4	3	2	3	1	1	14
	Dunlin (<i>Calidris alpina</i>)	2	3	2	3	1	1	12
	Stilt Sandpiper (<i>Calidris himantopus</i>)	4	3	2	5	1	1	16
	Buff-breasted Sandpiper (<i>Tryngites subruficollis</i>)	5	3	2	5	1	1	17
	Ruff (<i>Philomachus pugnax</i>)	3	3	2	5	1	1	15
	Short-billed Dowitcher (<i>Limnodromus griseus</i>)	3	3	3	3	1	1	14
	Common Snipe (<i>Gallinago gallinago</i>)	2	3	2	3	3	1	14
<i>Phalaropodinae</i>								
	Wilson's Phalarope (<i>Phalaropus tricolor</i>)	3	3	3	5	1	1	16
	Red-necked Phalarope (<i>Phalaropus lobatus</i>)	2	3	3	3	1	1	13
	Red Phalarope (<i>Phalaropus fulicaria</i>)	3	3	4	3	1	1	15

Table 3 (continued)

Family Subfamily	Species	WP	PR	VU	LP	EV	SU	CPI
<i>Laridae</i>								
<i>Stercorariinae</i>								
	Pomarine Jaeger (<i>Stercorarius pomarinus</i>)	4	3	2	5	1	3	18
	Parasitic Jaeger (<i>Stercorarius parasiticus</i>)	4	3	2	5	1	3	18
	Long-tailed Jaeger (<i>Stercorarius longicaudus</i>)	4	3	2	5	1	3	18
<i>Larinae</i>								
	Laughing Gull (<i>Larus atricilla</i>)	3	3	3	5	1	3	18
	Franklin's Gull (<i>Larus pipixcan</i>)	3	3	3	5	1	3	18
	Little Gull (<i>Larus minutus</i>)	5	3	2	5	1	3	19
	Common Black-headed Gull (<i>Larus ridibundus</i>)	2	3	2	5	1	3	16
	Bonaparte's Gull (<i>Larus philadelphia</i>)	4	3	3	1	1	3	15
	Ring-billed Gull (<i>Larus delawarensis</i>)				0			0
	Herring Gull (<i>Larus argentatus</i>)	2	3	2	1	1	3	12
	Iceland Gull (<i>Larus glaucooides</i>)	4	3	2	1	1	3	14
	Lesser Black-backed Gull (<i>Larus fuscus</i>)	3	3	2	5	1	3	17
	Glaucous Gull (<i>Larus hyperboreus</i>)	3	3	2	3	1	3	15
	Great Black-backed Gull (<i>Larus marinus</i>)	3	3	2	1	1	3	13
	Black-legged Kittiwake (<i>Rissa tridactyla</i>)	2	3	3	1	1	3	13
	Sabine's Gull (<i>Xema sabini</i>)	4	3	3	5	1	3	19
	Ivory Gull (<i>Pagophila eburnea</i>)	5	3	2	5	1	3	19
<i>Sterninae</i>								
	Caspian Tern (<i>Sterna caspia</i>)				30			30
	Roseate Tern (<i>Sterna dougallii</i>)				30			30
	Common Tern (<i>Sterna hirundo</i>)	3	3	2	3	1	1	13
	Arctic Tern (<i>Sterna paradisaea</i>)	2	3	2	3	1	1	12
	Black Tern (<i>Chlidonias niger</i>)	4	3	2	3	1	1	14
<i>Alcidae</i>								
	Dovekie (<i>Alle alle</i>)	1	5	4	1	3	1	15
	Common Murre (<i>Uria aalge</i>)	1	5	3	1	3	3	16
	Thick-billed Murre (<i>Uria lomvia</i>)	2	5	3	1	3	3	17
	Razorbill (<i>Alca torda</i>)	3	5	3	1	3	3	18
	Black Guillemot (<i>Cepphus grylle</i>)	3	5	3	3	3	3	20
	Atlantic Puffin (<i>Fraterecula arctica</i>)	1	5	3	1	3	3	16

Table 4. Classification of 129 species of aquatic birds found along the St. Lawrence in five categories of cleaning priorities according to their CPI.

Very high priority 25-30	High priority 19-24	Medium priority 13-18	Medium priority 13-18
0 Harlequin Duck Peregrine Falcon Horned Grebe Red-necked Grebe Least Bittern Piping Plover Bald Eagle Yellow Rail Caspian Tern Roseate Tern	23 Gyrfalcon Ross' Goose 22 Northern Harrier 21 Osprey Greater White-fronted Goose 20 Tundra Swan Merlin Black Guillemot Snow Goose 19 Canada Goose Ivory Gull Sabine's Gull Little Gull	18 Brant American Bittern Ruddy Duck Long-tailed Jaeger Parasitic Jaeger Pomarine Jaeger Laughing Gull Franklin's Gull Razorbill Manx Shearwater 17 Snowy Egret Marbled Godwit Buff-breasted Sandpiper Lesser Black-backed Gull Great Egret Cattle Egret Green Heron Glossy Ibis Thick-billed Murre 16 Stilt Sandpiper Pectoral Sandpiper Baird's Sandpiper Eurasian Widgeon Willet Common Eider Northern Gannet Great Blue Heron Red-throated Loon	16 Atlantic Puffin Common Murre Redhead Common Black-headed Gull Wilson's Storm-Petrel Wilson's Phalarope 15 Hudsonian Godwit Hooded Merganser White-rumped Sandpiper Ruff Western Sandpiper Black-crowned Night Heron King Eider Glaucous Gull Pied-billed Grebe Common Loon Surf Scoter Dovekie Ring-necked Duck Bonaparte's Gull Bufflehead Red Phalarope American Golden Plover Sooty Shearwater

Table 4. cont'd.

Medium priority 13-18	Low priority 1-12	Zero priority 0
<p>14 Short-billed Dowitcher Purple Sandpiper Common Snipe Wood Duck Northern Shoveler Solitary Sandpiper Barrow's Goldeneye Iceland Gull Common Merganser Great Cormorant Greater Scaup Black Tern Canvasback Lesser Scaup Greater Shearwater</p>	<p>12 Least Sandpiper Dunlin Gadwall Oldsquaw Spotted Sandpiper Whimbrel Northern Fulmar Herring Gull Greater Yellowlegs Leach's Storm-Petrel Black-bellied Plover Semipalmated Plover Sora Virginia Rail Green-winged Teal Arctic Tern</p>	<p>0 Double-crested Cormorant Ring-billed Gull</p>
<p>13 Red-breasted Merganser Red Knot American Black Duck American Widgeon American Coot Common Goldeneye Great Black-backed Gull White-winged Scoter Black Scoter Black-legged Kittiwake Red-necked Phalarope Blue-winged Teal Common Tern Ruddy Turnstone</p>	<p>11 Sanderling Semipalmated Sandpiper Mallard Northern Pintail Lesser Yellowlegs</p> <p>10 Killdeer Common Moorhen</p>	

6. ANALYSIS BY FAMILY

6.1 Very high priority

The CPI was designed to ensure that species classified as vulnerable, endangered or threatened in Quebec are given top priority. Such priority is crucial since, from the point of view of conservation, saving even a single individual is important.

6.2 High priority

Raptors (Accipitridae and Falconidae) were classified as high priority. They have a good survival record since they usually do not become severely oiled. In addition, their local and worldwide populations are small and their productivity is low.

Members of the subfamily Anserinae were also given high priority. Because of their large size, they have good survival rates during rehabilitation. However, the Brant is considered medium priority since local numbers are high, reducing its score. Furthermore, unlike flocks of Snow and Canada Geese, flocks of Brants are not a significant public attraction.

Three species among the Laridae (subfamily Larinae)--the Ivory Gull, Sabine's Gull and Little Gull--have a high cleaning priority. Their numbers are low both locally and worldwide. The size of world populations in this family varies a great deal and the other Laridae species are mainly medium priority.

The Black Guillemot was the only alcid given high priority since local numbers were lower than those of other members of the family. The other alcids were classified as medium priority.

In all, 13 species were classified as high priority. Although their status is not as precarious as those in the very high priority category, in the event of an oil spill, concerted efforts must be made to rehabilitate them since they are vulnerable to oiling and cleaning is usually fairly successful.

6.3 Medium and low priority

As mentioned above, most alcids and larids were classified as medium priority. Alcids have low productivity, but very large world and local populations, particularly the latter. The larids tend to have average scores for most criteria, except for a low economic value.

Despite their low productivity, members of the families Gaviidae, Procellariidae, Hydrobatidae and Sulidae all have a medium priority. Most of the Podicipedidae, Phalacrocoracidae, Ardeidae, Threskiornithidae and Anatinae were also classified as medium priority. All received medium scores in most categories, except for the Anatinae--which have a high productivity in almost all cases and large local populations in some cases--and the Podicipedidae, Phalacrocoracidae, Ardeidae and Threskiornithidae--which have a low economic value.

The Charadriidae and the Scolopacidae were classified as medium (20/31) and low (11/31) priority. Generally, the size of their world populations, their productivity and their vulnerability are all in the medium range, but their economic value and survival during cleaning operations are low. The size of local populations is highly variable, depending on the species. The Rallidae were classified as low priority, since members of this family are very productive, and have a low economic value and poor survival rates during cleaning operation.

In general, most species (81/129) were classified as medium priority, while only 23 species were classified as low priority. The impact of a serious oil spill on their populations should not be catastrophic. Therefore, rehabilitation efforts should not be undertaken in their case until species of greater priority have been treated.

6.4 Zero priority

Since the Double-crested Cormorant and Ring-billed Gull, which belong to different families, are the object of programs to control their populations along the St. Lawrence, they were classified as zero priority. In their case, euthanasia would be appropriate for oiled birds.

7. LIMITS OF MODEL AND FUTURE IMPROVEMENTS

The CPI was determined as objectively and fairly as possible, according to the information available at the time. A great deal of effort was put into amassing as much data as possible on the 129 species included in the study to obtain uniform coverage whenever possible. The use of three or four different scores (0, 1, 3, 5) for most criteria allowed adequate separation to be achieved between species, while avoiding making finer distinctions than the information would allow. The size of the world population and the extent of breeding and wintering areas were the only three categories in which five scores (1, 2, 3, 4, 5) were used. In this case, five scores were required to reflect the information available. Ornithologists specializing in a particular species may find some of the criteria over- or underestimated, but should keep in mind the scale at which our evaluation was carried out. Each species is compared with 128 others. The points awarded in each category are relative scores, determined according to a precise scale.

The accuracy and usefulness of the CPI is limited by the quality and quantity of information available. For example, productivity is well documented in most species while survival rates during rehabilitation operations are only known in a few species and are often based on experiences with only a few individuals. The CPI must be updated and improved as we expand our knowledge in this field. The weighting of the various criteria could also be reevaluated should a significant amount of data become available, particularly with respect to survival rates during cleaning. When more and higher-quality information is available, this criterion should be given additional weight since it is directly linked to the action being undertaken.

The CPI should be considered as a basic tool in selecting species to be captured and rehabilitated after an oil spill. However, it cannot replace rehabilitators' judgement. The general condition of each bird must be evaluated in the field. A study on the Ruddy Duck has shown that survival rates in cleaned birds increase when, during cleaning, body weight and/or temperature are equal to or greater than average values for the species (Frink 1987). The condition of each individual bird must be taken into account when selecting birds to be cleaned and could be integrated with the CPI when sufficient information becomes available. This would result in an individual of a medium-priority species being selected before an individual of a high-priority species if the latter were badly oiled and appeared to be untreatable.

The CPI was developed for species found in the St. Lawrence River system in Québec, but could easily be adapted to other regions. Most of the criteria and variables are general and the scoring could be applied to most populations of the species. However, scores for the size of local populations (LP), hunting mortality (Mh) and economic value (EV) apply specifically to the populations found along the St. Lawrence, and therefore would have to be modified for the CPI to be used in other regions.

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