Update

COSEWIC STATUS REPORT

on

Anatum Peregrine Falcon

(*Falco peregrinus anatum*)

Robin M. Johnstone

THREATENED
1999

COSEWIC
COMMITTEE ON THE STATUS
OF ENDANGERED WILDLIFE
IN CANADA

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Cover illustrations:
American Peregrine Falcon, *Anatum* - J. Crosby, *The Birds of Canada*, by W. Earl Godfrey, Canadian Museum of Nature, Ottawa, ON.

Anatum Peregrine Falcon

Reason for status: Although the subspecies has recovered in the northern part of its range, it remains a relatively rare bird and there is uncertainty about the stability of small reintroduced populations in southern Canada. [Designated endangered in 1978 and downlisted to threatened in 1999.]

Occurrence: Alberta, British Columbia, Manitoba, New Brunswick, Newfoundland, Nova Scotia, Northwest Territories, Nunavut, Ontario, Quebec, Saskatchewan and Yukon Territory

NOTES

COSEWIC status reports are working documents used in assigning status. Reports are released in their original form in the interest of making scientific information available to the public.

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COSEWIC

A committee of representatives from federal, provincial and private agencies that assigns national status to species at risk in Canada and the chairs of the scientific species specialist groups

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Un comité de représentants d'organismes féderaux, provinciaux et privés qui attribue un statut national aux espèces canadiennes en péril ainsi que des président(e)s des groupes des spécialistes scientifiques.

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on

Anatum Peregrine Falcon
(*Falco peregrinus anatum*)

by

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SPONSORS: National *Anatum* Peregrine Falcon Recovery Team
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Description

The American Peregrine Falcon is a crow-sized bird of prey with long pointed wings and a long tail. Adults are dark slaty-blue above, and light buffy white, with black barring and spotting below. The immature birds are a rich brown above, streaked and barred brown below. Both adults and immatures have a very obvious dark mark down the sides of the face, visible at a great distance.

Distribution

The American Peregrine Falcon occurs throughout much of North America, depending on the availability of nest sites and food, from the sub-arctic boreal forests of Canada and Alaska south to Mexico. In Canada its centre of abundance is the northwestern boreal region; relatively few pairs ever nested in the plains areas of Saskatchewan and Manitoba. Today, most of Canada's known breeding pairs are in the Yukon, western Northwest Territories, and northern Alberta. Captive-bred peregrines have been reintroduced to southern Alberta, Saskatchewan, Manitoba, Ontario, Quebec, and the Maritimes and established small populations.

The American Peregrine Falcon (*F. p. anatum*) intergrades in the west of its range with Peale's Peregrine Falcon (*F. p. pealei*), which nests in coastal areas north of the Columbia River in Washington State, through to the Aleutian Islands. To the north of its range, the American Peregrine Falcon intergrades with the tundra Peregrine Falcon (*F. p. tundrius*) at the borders of the taiga and the tundra.

Habitat

For nesting, peregrines prefer a cliff ledge or at least a steep embankment, or occasionally a tall building with ledges. They require a well-drained stable area for the nest bowl or scrape, which must be large enough to hold at least three large nestlings, and access to plentiful prey. Many peregrine nest sites are found near open fields and permanent water bodies, where prey species are likely to be abundant.

General biology

Peregrines lay 2 to 5 eggs (average 3) in a shallow scrape. Incubation begins with the first egg and takes about 32 days, mainly by the female. When the young hatch the female does all the brooding for several weeks, while the male hunts for food. Young are dependent upon the adult for several weeks after leaving the nest. They rarely breed before two years of age. Birds migrate to Central and South America for the winter and immatures may remain there until breeding age. Food consists primarily of shorebirds, waterfowl, seabirds, and smaller songbirds which they catch in flight.

Population size and trends

Precipitous declines in peregrine populations globally were associated with the widespread use of organochloride pesticides, such as DDT, which peaked in the 1950s and early 1960s. In the mid-1970s, no American Peregrine Falcons were found in Canada south of 60° N latitude and east of the Rocky Mountains, except for three breeding pairs. High pesticide residues accumulated in the birds and caused eggshell thinning and consequent breakage, reduced fertility of eggs, and probably changes in adult behviour leading to nest abandonment. DDT was banned in Canada and the U.S. by the early 1970s, but is still in limited use in many parts of the world, especially in developing countries.

Since the banning of DDT, peregrine populations have recovered to an encouraging extent. Over 320 pairs of American Peregrine Falcons are known to nest in Canada, part of a larger North American population of approximately 1400 known pairs. The actual breeding population in North America is estimated to be much larger - perhaps 3000 pairs or more.

Limiting factors and threats

The taking of young birds for falconry, egg collecting, shooting and to some extent just disturbance of birds at nesting sites were also limiting factors for the peregrine, but not believed to be major causes of decline. Most of these factors have declined in recent years, with the protection of the peregrine as an endangered species and with better public education and awareness.

Existing Protection

Provincial governments are responsible for providing protection for this species. All provinces provide some protection, but the level varies greatly across the country. Permits are required for most activities involving Peregrines.

Evaluation and proposed status

Although the American Peregrine Falcon has recovered in the northern part of its range, it remains a relatively rare bird and there is uncertainty about the stability of the small reintroduced populations in southern Canada. However, the likelihood of extinction or extirpation of the subspecies from Canada is very low, so in 1999 its status was downlisted from Endangered to Threatened.

Text by R.D. James 1983
Revised by C. Hyslop 1999

RÉSUMÉ

Description

Le Faucon pèlerin anatum est un rapace de la taille d'une corneille, qui a de longues ailes pointues et une longue queue. Le dos des adultes est d'un bleu ardoise foncé et leur ventre, d'un blanc rosâtre avec des rayures et des taches noires. Les oiseaux immatures ont le dos brun vif et le ventre rayé et barré de brun. Les adultes et les oiseaux immatures ont tous deux une marque foncée très évidente sur le côté du visage qui est visible à une grande distance.

Distribution

Le Faucon pèlerin anatum se retrouve dans presque toute l'Amérique du Nord, selon la disponibilité de la nourriture et des sites de nidification, à partir des forêts boréales subarctiques du Canada et de l'Alaska vers le sud jusqu'au Mexique. Au Canada, le centre de son aire de répartition où se trouve la plus grande concentration d'oiseaux se situe dans la région boréale du Nord-Ouest; très peu de couples ont niché dans les plaines de la Saskatchewan et du Manitoba. Aujourd'hui, la plupart des couples reproducteurs connus au Canada nichent au Yukon, dans l'Ouest des Territoires du Nord-Ouest et dans le Nord de l'Alberta. Des Faucons pèlerins élevés en captivité ont été réintroduits dans le Sud de l'Alberta, en Saskatchewan, au Manitoba, en Ontario, au Québec et dans les Maritimes où ils ont formé de petites populations.

Dans l'ouest de son aire de répartition, le Faucon pèlerin anatum fait graduellement place au Faucon pèlerin pealei qui niche près des côtes, allant du nord de la rivière Columbia, dans l'État de Washington, jusqu'aux îles Aléoutiennes. Au nord de son aire de répartition, le Faucon pèlerin anatum fait graduellement place au Faucon pèlerin toundra, à la limite de la taïga et de la toundra.

Habitat

Les Faucons pèlerins préfèrent nicher sur la saillie d'une falaise ou au moins d'un talus escarpé, ou parfois sur la corniche d'un immeuble élevé. Ils ont besoin d'une surface bien drainée et stable pour creuser un nid qui sera assez grand pour contenir au moins trois grands oisillons et doivent avoir accès à une abondance de proies. On trouve beaucoup de sites de nidification près de champs ouverts et de plans d'eau permanents, où les proies sont susceptibles d'être abondantes.

Biologie générale

Les Faucons pèlerins pondent de deux à cinq œufs (trois en moyenne) dans un nid peu profond creusé dans le sol. L'incubation commence après la ponte du premier œuf, dure près de 32 jours et est assurée surtout par la femelle. Pendant plusieurs semaines après l'éclosion des oeufs, la femelle veille sur la couvée pendant que le mâle chasse pour de la nourriture. Les jeunes oiseaux dépendent des adultes pendant plusieurs semaines après avoir quitté le nid et s'accouplent rarement avant l'âge de deux ans. Les oiseaux migrent vers l'Amérique centrale et l'Amérique du Sud pour l'hiver, et les oiseaux immatures peuvent y demeurer jusqu'à l'âge adulte. Les principales proies des Faucons pèlerins sont les oiseaux de rivage, les oiseaux aquatiques, les oiseaux marins et les petits oiseaux chanteurs qu'ils capturent en vol.

Taille et tendances de la population

Le déclin rapide des populations mondiales du Faucon pèlerin a été associé à l'utilisation généralisée des pesticides organochlorés, comme le DDT, laquelle a culminé dans les années 1950 et au début des années 1960. Au milieu des années 1970, on ne connaissait au Canada que trois couples reproducteurs de Faucons pèlerins anatum au sud du 60^e parallèle de latitude Nord et à l'est des

Rocheuses. Une forte concentration de résidus de pesticides se sont accumulés dans les oiseaux et ont causé l'amincissement des coquilles d'œuf et leur bris subséquent, une fertilité réduite des œufs et probablement des changements de comportement chez les adultes menant à l'abandon des nids. Au début des années 1970, on a interdit le DDT au Canada et aux États-Unis, mais celui-ci est toujours en usage, de façon limitée, dans de nombreuses parties du monde, notamment dans les pays en développement.

Depuis l'interdiction du DDT, les populations de Faucons pèlerins se sont rétablies de façon encourageante. On a relevé plus de 320 couples de Faucons pèlerins anatum nichant au Canada, et ceux-ci font partie de la population d'Amérique du Nord plus grande comprenant environ 1 400 couples. On estime qu'en Amérique du Nord la population réelle d'oiseaux reproducteurs est beaucoup plus grande – probablement supérieure à 3 000 couples.

Facteurs limitants et menaces

La capture d'oiseaux immatures pour la fauconnerie, la collecte d'œufs, la mort par balle et, jusqu'à un certain point, la perturbation des oiseaux dans les aires de nidification étaient des facteurs limitants pour le Faucon pèlerin, mais on ne croit pas que ceux-ci représentaient des causes importantes de son déclin. La plupart de ces facteurs sont devenus moins importants depuis quelques années, grâce à la protection offerte aux Faucons pèlerins en raison de sa désignation d'espèce en danger de disparition et à une plus grande sensibilisation du public.

Protection existante

Les gouvernements provinciaux sont responsables de la protection de cette espèce. Toutes les provinces offrent une certaine protection, mais le niveau de celle-ci varie beaucoup dans l'ensemble du pays. Des permis sont obligatoires pour la plupart des activités relatives au Faucon pèlerin.

Évaluation et statut proposé

Bien que le Faucon pèlerin anatum soit rétabli dans les parties du nord de son aire de répartition, il demeure un oiseau assez rare, et la stabilité des petites populations rétablies dans le Sud du Canada reste incertaine. Cependant, le danger de disparition au Canada de la sous-espèce est très faible. Par conséquent, son statut a été modifié en 1999, passant d'espèce en danger de disparition à espèce menacée.

Par : R. D. James, 1983
Révisé par : C. Hyslop, 1999

ABSTRACT

The American Peregrine Falcon (*Falco peregrinus anatum*) is a migratory raptor that formerly bred in below the treeline in North America across Canada, the United States, and south to central Mexico. Precipitous declines in peregrine populations globally were associated with the widespread, intensive use of persistent organochlorine compounds, particularly the pesticide DDT. In the mid-1970's no *anatum* peregrines were found in Canada south of latitude 60°N and east of the Rocky Mountains except for 3 breeding pairs. Levels of organochlorine contamination have declined substantially since restrictions almost three decades ago. Over 320 pairs of *anatum* peregrines are now known to breed in Canada. The size of the actual breeding population is unknown. Increased counts of breeding pairs and migration counts indicate that populations are growing. Interpretation of population productivity data is difficult because of survey biases but suggests that populations are productive. Releases of captive-bred peregrines have been important in population recovery. The recovery process is presently incomplete, but organochlorine contamination is no longer a major limiting factor and there is available habitat for further population growth. Similar positive trends in population growth are seen throughout the range, except for Mexico where the status is unknown. The likelihood of extinction or extirpation of the American peregrine is very low, and down-listing to vulnerable is recommended.

ABRÉGÉ

Le Faucon pèlerin anatum est un rapace migrateur qui auparavant se reproduisait au-dessous de la limite forestière d'Amérique du Nord, soit dans tout le Canada, les États-Unis et vers le sud jusqu'au centre du Mexique. Le déclin précipité des populations de Faucons pèlerins, à l'échelle mondiale, a été relié à l'utilisation répandue et intensive de composés organochlorés persistants, notamment du pesticide DDT. Au milieu des années 1970, au Canada, seuls trois couples reproducteurs de Faucons pèlerins anatum étaient connus au sud du 60[e] parallèle de latitude Nord et à l'est des Rocheuses. Le niveau de contamination par les organochlorés a grandement diminué depuis les interdictions promulguées il y a presque trente ans. On connaît maintenant plus de 320 couples de Faucons pèlerins anatum nichant au Canada. La taille de la population réelle d'oiseaux nicheurs est inconnue. Les dénombrements accrus de couples reproducteurs et d'oiseaux migrateurs indiquent que les populations sont en croissance. En raison de différentes distorsions statistiques, l'interprétation des données de productivité de la population est difficile, mais celles-ci suggèrent que les populations se reproduisent. La mise en liberté de Faucons pèlerins élevés en captivité a joué un rôle important dans le rétablissement des populations. Le processus de rétablissement est encore incomplet, mais la contamination par les organochlorés n'est plus un facteur limitant important, et des habitats sont actuellement disponibles en vue d'une croissance des populations. Des tendances démographiques positives analogues ont été observées dans toute l'aire de répartition, sauf au Mexique, où le statut de l'espèce est inconnu. Le danger de disparition à l'échelle mondiale ou de disparition en Amérique du Nord du Faucon pèlerin anatum est très faible, et on recommande que la désignation de l'espèce soit portée de « menacée » à « vulnérable ».

SUMMARY OF STATUS INFORMATION FROM ORIGINAL REPORT

The original status report (Martin 1979) regarding the American Peregrine Falcon (*F. p. anatum*) in Canada recommended that the subspecies should be retained in Appendix I of the Convention on International Trade in Endangered Species; and the sub-species has been considered as endangered since this time. This recommendation was based on results of the 1975 North American peregrine survey which documented only 4 occupied nests in southern Canada. The subspecies was considered extirpated in interior British Columbia, and most of eastern Canada.

The Western Raptor Technical Committee was formed to develop a national *Anatum* Peregrine Falcon recovery plan; this plan was approved in 1987. The goal of this plan was "to enhance the wild *anatum* Peregrine Falcon population in Canada to a level at which it is no longer considered endangered or threatened by COSEWIC" (Erickson *et al.* 1988). The stated objectives were to establish: 1) a minimum of 10 territorial *anatum* pairs in each of zones 1 to 6 (Fig.1) by 1992, and 2) a minimum of 10 territorial *anatum* pairs naturally fledging 15 or more young annually, measured as a five-year average commencing in 1993, in each of five of those six zones. It must be clearly stated, however, that the recovery team goals do not in any way constitute down-listing criteria for COSEWIC.

Updates to status reports are meant to bring new material that has accumulated since the original status report was written to the attention of COSEWIC and the public. The original report is almost 20 years old and the situation of the Peregrine Falcon in Canada has changed dramatically in this interval. This report aims to reflect the information now available.

DISTRIBUTION

i. North America

The American Peregrine Falcon occurs throughout much of North America, from the sub-arctic boreal forests of Canada and Alaska south to Mexico. It nests from central Alaska and the Yukon, east to the central Northwest Territories, and across Canada in interior British Columbia, Alberta, Saskatchewan and Manitoba, central and southern Ontario, southern Quebec, Labrador (and possibly northern Quebec), and the Maritimes. With the exception of coastal areas north of the Columbia River in Washington State, it is found nesting throughout the United States south to Baja California, Sonora, and the highlands of central Mexico (Johnsgard 1990). The *anatum* subspecies intergrades in the west of its range with Peale's Peregrine Falcon (*F. p. pealei*), which nests in coastal areas north of the Columbia River in Washington State, through to the Aleutian Islands. To the north of its range, the American Peregrine Falcon intergrades with the tundra Peregrine Falcon (*F. p. tundrius*) at the borders of the taiga and the tundra. It must be noted that the taxonomic status of peregrines around the margins of the range (e.g., in areas of British Columbia, northern Quebec, and Labrador) is equivocal. It must be remembered that taxonomic status is not a cut-and-dry issue; instead a cline of variation between recognized sub-species is highly likely (White 1968, Court *et al.* 1988). Attempts at pigeon-holing the taxonomic status of populations along range boundaries must be cautioned against, despite the obvious convenience for management purposes.

ii. Winter distribution and migratory routes

Individuals from Canadian populations of the American peregrine are generally temperate or neotropical migrants, wintering in the southern and eastern United States south through Middle America, the West Indies, and South America (Yates *et al.* 1988, Schmutz *et al.* 1991). There are also records of peregrines remaining in Canadian cities in winter, but these represent a very small proportion of the known population.

The majority of Canadian *anatum* populations likely reach South America via the central and eastern flyways. Details of migratory routes are poorly known, however, band returns, upon which most information regarding migration is based, do provide a distorted "snapshot" of migration. In general, the migration pattern is strongly associated with waterfowl migration corridors (Bellrose 1968). Of the information already available, the most important points are that: 1) there is substantial variation in migratory routes between individuals; thus, analyses of band returns and satellite data provide equivocal support for the commonly held theory that individuals from sub-populations or sub-species winter in the same area; 2) peregrines travel over a large number of countries (i.e.,federal jurisdictions) during migration; and 3) a wide variety of habitats are occupied temporarily during migration. Rapid advances in satellite telemetry should allow us to fill many gaps in our knowledge of peregrine migration; however, until a substantial decrease in the cost of this technique allows a sample large enough to be representative of a population, the value of this powerful tool may be limited.

PROTECTION

In Canada birds of prey are excluded under the Migratory Birds Convention Act; alternately, they are afforded protection under provincial and territorial jurisdiction. Peregrines are protected in each province or territory under a Wildlife Act, or by wildlife-at-risk/endangered species regulations of a Wildlife Act.

POPULATION SIZE AND TREND

i. Population size

a. Historic population size

Historic records of nesting peregrines are derived from a wide variety of sources including early published checklists, specimen records, egg collectors, and falconers. These records did not result from systematic surveys, thus they must be regarded as better indicators of distribution than of abundance. They do provide, however, the only baseline approximation of the size of peregrine populations prior to their decline. Historic records rarely indicate how frequently a nest site was occupied by a breeding pair; some recorded sites may therefore have only been occupied occasionally, while others may have been occupied in most years. Prior to the 1970s, peregrines were reported breeding at 1,156 locations within North America (Enderson *et al.* 1995). Within Canada, historic records indicated 18 nest sites of *anatum* peregrines in interior British Columbia, over 60 in southern Alberta, 3 in Manitoba/Saskatchewan, 26 in Ontario, 18 in the Maritime Provinces and southern Quebec, and 196 in the Arctic/subarctic of which some unknown portion would be *F. p. anatum* (Court 1993, Enderson *et al.* 1995). It is difficult to extrapolate the size of the actual population from these data. Historic records create the impression that peregrines were generally rare. Moreover, they tend to underscore the success of recovery initiatives as it is difficult to extrapolate the size of the actual population from historic records.

b. Five-year survey results

Population surveys provide the most substantive set of data from which to determine population size. Counts from the Breeding Bird Survey, and the Christmas Bird Count unfortunately provide a poor index of the size of peregrine populations and, consequently, are ineffectual for determining population size and/or trends. The most extensive data for peregrines come from the five year surveys of peregrines in Canada coordinated by the *Anatum* Peregrine Falcon Recovery Team.

Surveys for peregrine falcons have been conducted at five-year intervals in Canada since 1970 (Cade and Fyfe 1970, Fyfe *et al.* 1976, Murphy 1990, White *et al.* 1990, Holroyd and Banasch 1996, Banasch and Holroyd *pers. comm.*). They provide a valuable indicator of population trends, although the relationship of known population size with the total breeding population is unknown. Population estimates from five-year surveys may be subject to a potentially large and unknown degrees of error, which are likely to vary from region to region (e.g., peregrines are much more likely to be detected and reported in densely populated areas than remote areas). Results of the five-year survey for *anatum* peregrines between 1970 and 1995 are summarized in Table 1. For comparative purposes, the results are organized by the management zones outlined in the *anatum* Peregrine Falcon Recovery Plan (Erickson *et al.* 1988; Fig.1). Also, the counts refer to the number of sites occupied by pairs, unless indicated otherwise.

Five-year survey results are best considered as an estimate of the *minimum* known number of breeding pairs, because not all available habitat is surveyed. Previously, priority was given to surveying historically known nest sites. Single adults at nest sites are reported, however, unless the individuals are known to be part of a territorial pair or they are incubating or brooding young, a cautious approach to interpretation of these data is necessary. Postupalsky (1974) suggested that the proportion of territories occupied by lone birds is an indication of the size of the non-breeding population. However, this relationship is unknown and remains unlikely to be quantified. In a growing population there may be relatively few non-breeding adults (often called "floaters") as all may have the opportunity to breed; similarly, in a declining population there may be relatively few floaters. A surplus of non-breeders may be considered a sign of a healthy population, however, the absence of observations of lone birds at nest sites may not necessarily indicate an unhealthy population. Floaters are somewhat ephemeral by nature so they may not be detected, even in a dense population, without experimentation (i.e. removal experiments, Newton 1992, Johnstone 1997). The observation of lone adult peregrines may be indicative of: 1) a surplus of breeding age birds; and 2) potential population limitation, assuming that they are capable of reproduction and that a surplus of both sexes occurs (Newton 1992). Further conclusions are tenuous.

Population decline

Five-year surveys provide important records which document the decline of the peregrine falcon, and can indicate population lows. By 1970, the *anatum* peregrine was considered extirpated in Canada south of 60°N and east of the Rocky Mountains, with the exception of unknown numbers in northern Alberta, near Ungava Bay, and along the Labrador coast (Cade and Fyfe 1970). The 1975 peregrine survey revealed only one occupied nest site in Canada south of 58°N and east of the Rockies, and severe declines of 33% and 50%, respectively, among *anatum* peregrines in the Mackenzie District and along the Yukon River (Fyfe *et al.* 1976). Of 78 historic sites surveyed in total, only 11 occupied nest sites were documented in Canada.

Present population size

Most recently the 1995 *anatum* survey counted 319 breeding pairs; more than have been recorded at any other time (Banasch and Holroyd *unpubl. data*). Of the nine management zones defined in the original *Anatum* Peregrine Recovery Plan, the goal of ten breeding pairs has been reached in each of the zones originally identified for management actions (Zones 1-6). The number of pairs in central Quebec and northern Ontario is unknown, as is the numbers in the eastern Mackenzie watershed (Zone 7). Although their presence cannot be stated unequivocally until these latter areas are surveyed; the presence of both suitable habitat and prey in these areas suggest that surveys would be extremely likely to reveal peregrines.

Overall, large numbers of breeding pairs (219) were counted in northern Canada, specifically, in the Yukon and Northwest Territories along the Yukon, Porcupine, Peel, and Mackenzie Rivers, and also in Alberta north of 58°N. These northerly breeding peregrines represent a very important portion of the Canadian *anatum* population. In total, the number of breeding pairs in northern Canada accounts for almost 70% of all known *anatum* pairs breeding in Canada. Moreover, this proportion is likely to be an underestimate as actual populations in the north may be dramatically under represented, in comparison with the south. In the north, a relatively small proportion of all available habitat is surveyed; thus, more extensive surveys would undoubtedly reveal more breeding pairs. In the south, however, the recorded numbers are likely to more closely approximate the actual breeding population, as there is a higher probability of a breeding pair being detected and recorded in areas of higher human population density.

The number of breeding pairs in southern Canada (101 known pairs) is relatively low by comparison. One-third (31) of the known pairs breed in Labrador. The scarcity of breeding pairs across the prairies is consistent with historic records and the suggestion that the plains area represents less suitable breeding habitat than other areas. Enderson *et al.* (1995) noted that relatively few peregrines historically bred in central North America including Saskatchewan, Manitoba, North and South Dakota, Nebraska, Kansas, Oklahoma, and areas of Texas.

Urban-nesting peregrines account for an important proportion (21%, 20/92) of known breeding pairs in southern Canada, east of the Rockies. A total of 20 urban-nesting pairs were recorded in 13 cities across Canada in 1995 (Banasch and Holroyd *unpubl. data*). One-third (4/12) of all known breeding pairs in Alberta, 28% (10/36) in Ontario, Quebec and the Maritimes, and all pairs in Saskatchewan (2) and Manitoba (4) are urban-nesting. Overall, urban-nesting peregrines constitute a numerically important section of the breeding population across North America. Enderson *et al.* (1995) noted that urban nest sites made up 58% of the regional population in the Midwest and 34% of the regional population in the eastern United States. In total, 87 pairs held territories in 60 cities across North America in 1993, mainly in the northeastern seaboard, midwestern states, and coastal southern California. It should also be noted that most urban-nesting peregrines were the result of releases occurring in cities, and not a shift of peregrines from wild nest sites to urban centers. It remains to be seen whether peregrines which were raised in urban centers will re-occupy historic wild nest sites once nesting habitat in cities is saturated.

ii. Population productivity

Productivity data have been assessed to determine whether peregrine populations are likely to recover or decline further. The underlying rationale is that the dramatic declines of peregrine populations were caused by organochlorine contamination that decreased reproductive success to a point where there were insufficient numbers of recruits to match adult mortality. Conversely, recovery of peregrine populations should therefore depend on the restoration of productivity to pre-DDT levels, assuming that adult mortality has remained constant. Newton (1979) noted that stable peregrine populations produced 1.0-1.5 young per nesting pair annually, on average. This figure has since been adopted as a baseline standard against which the productivity of populations are compared and population recovery or decline is assessed (Erickson *et al.* 1988, Holroyd and Banasch 1996).

The productivity estimate provided by Newton (1979) is a population mean, and it includes the productivity of both sink and source nests averaged out over the whole breeding population. Resources that are critical to breeding and survival are rarely evenly distributed throughout the environment, therefore the reproductive performance of individuals must be expected to vary from territory to territory. In "source" breeding habitat, a net reproductive surplus is produced (i.e., reproduction exceeds mortality on average), whereas in "sink" habitat, the opposite is true; some reproduction occurs but, on average, it is not sufficient to match mortality and a net deficit results (Danielson 1992). To produce a net reproductive surplus, Johnstone (1997) calculated that an individual would have to produce a mean of 1.7 or more young annually, based on annual adult mortality of 0.28 and an equal sex ratio at fledging, and assuming a maximum pre-breeder survival estimate of 0.33; or a mean of 2.5 young annually assuming a minimum pre-breeder survival of 0.22. *Maintenance* of the peregrine population in Canada depends on having enough "source" nests to balance the mortality of adults in the population. *Expansion* of the peregrine population in Canada, however, requires enough "source" nests to balance adult mortality in the population and produce a further surplus of young that will disperse and colonize other areas.

a. Estimates of productivity

Holroyd and Banasch (1996) noted that in 1990, "throughout Canada, productivity was 1.0 or more young per territorial pair and as high as 2.9 young, with the exception of Rankin Inlet and the North Slope". Moreover, production was greater than 1.5 wild young per territorial pair except in the Bay of Fundy, southern Quebec, southern Saskatchewan, Alberta south of 58° N, the North Slope and Rankin Inlet. They concluded that "the consistency of production over 1.5 young per territorial pair per year indicates that peregrines throughout much of Canada produced at a rate that should sustain or increase their numbers where they occur in sufficient densities."

b. Interpretation of productivity data

There can exist serious problems and biases in the interpretation of Peregrine Falcon productivity data. Such difficulties can impede our ability to accurately assess whether present levels of reproduction in a peregrine population are sufficient to achieve population growth. The primary difficulty is that productivity estimates for a population are dependent on the frequency and timing of visits to survey the population. In the absence of coordinated surveys or detailed studies, population productivity means are rarely directly comparable.

The problems inherent with five-year survey methodology may be graphically illustrated using data from Rankin Inlet, NWT where the outcome of breeding attempts by *tundrius* peregrines were intensively monitored over a 15 year period (Johnstone 1997). Of 330 breeding attempts (i.e., occasions in which a pair defended a territory) whose outcome was followed: 18% (61) had failed before any eggs were laid; 37% (122) had failed before hatch; and 46% (153) had failed before young were banded at 20-30 days old (Johnstone 1997). Moreover, complete abandonment of a territory is often associated with nest failure; members of pairs are only occasionally seen at a nest site following failure (*pers. obs.*, M. Bradley *pers. comm.*, G. Court *pers. comm.*, Holroyd and Banasch 1996). In this population, a survey which did not include a count of territorial pairs soon after territories were settled would have underestimated the number of territorial pairs by 18% on average, and consequently *over*-estimated productivity of the population. Population surveys which did not include a count before hatch would have underestimated the number of territorial pairs by 37%, on average, and population surveys which relied solely on counts at the time of banding would have underestimated the number of territorial pairs by 46% on average. Estimates of productivity, therefore, are heavily reliant on the timing of surveys.

Five-year survey summaries express productivity as the number of young produced per territorial pair, however, in nearly all cases, surveys did not include visits in early spring when territories are first occupied. The number of territorial pairs which initiated a breeding attempt but subsequently failed are consequently *under represented* in the sample. Published productivity means for many surveyed populations, therefore, tend to be overestimates as they are heavily biased towards breeding attempts which are successful. Such means cannot be compared with those derived from detailed studies where accurate numbers of *all* breeding pairs are known. Moreover, without consistency in the timing and frequency of surveys between areas (Holroyd and Banasch 1996) productivity estimates are difficult to compare.

In summary, measures of productivity are practically impossible to compare between survey areas and successive surveys due to differences, inherent with geographically extensive surveys and coordinating personnel from a large number of agencies, and in the timing of visits to determine productivity. The lack of consistency in data collection, unfortunately, invalidates attempts to determine trends in productivity, and makes interpretation of available productivity data difficult (Holroyd and Banasch 1996). It is safe to conclude, however, that productivity data from five-year surveys (Holroyd and Banasch 1996, Banasch and Holroyd *unpubl. data*) indicates that many of the nests surveyed are reproductive sources which are likely to produce young that may disperse to breed elsewhere. The status of *anatum* populations in Canada, however, depends on the ratio of source and sink nests (i.e., whether the surplus of young produced at source nests is large enough to balance or exceed annual adult mortality in both source and sink habitats, resulting in population maintenance or growth, respectively). There are limited data available to determine this unequivocally. In the Yukon, breeding densities, the number of successful nests, and the documented population expansion along river systems suggest that these populations include a high enough proportion of *source* nests to sustain population expansion. Data in southern Canada, however, are more equivocal and population growth in these areas is less certain given current knowledge.

iii. Population trend

Peregrine population trends are generally assessed by comparing successive counts from population surveys, as well as counts at raptor migration watch sites. Trends in the number of occupied historically known nest sites has also been used as a relative indicator of population recovery. To accurately evaluate population trends and provide a clear supporting rationale for this analysis of the status of the American peregrine in Canada, a brief discussion of the methods used to determine population trends, and the error associated with them, is necessary.

a. Five-year survey counts

Increased counts of breeding pairs are indicative recovering peregrine populations. Holroyd and Banasch (1996) summarized the 1990 peregrine survey and concluded that the number of occupied *anatum* nest sites increased in most regions of Canada between the 1985-86 and 1990 surveys, and was higher than any other time since the population decline. Based on the comparison of counts of occupied nests between 1980, 1985, and 1990, they estimated annual population growth rates of up to 50% or more (average 35%) in small, heavily managed populations where relatively large numbers of captive-bred young were released, and a natural recovery of 16% per annum in unmanaged populations. Moreover, counts of occupied *anatum* nests in the 1995 peregrine survey were higher than the 1990 total and are consistent with a continuing positive trend (Banasch and Holroyd, *unpubl. data*). Enderson *et al.* (1995) examined population trends of peregrines (including *F. p. tundrius* and *F. p. pealei*) and similarly noted a universal trend throughout North America toward higher counts of territorial pairs in 1980-90.

While increases in five-year counts are indicative of population expansion, counts unfortunately are not closely comparable for some areas between years. Actual population trends may consequently be obfuscated by changes in survey effort including changes in the area surveyed, time devoted to it, and changes in surveyors or surveyor experience (Enderson *et al.* 1995). For instance, in the 1985/86 survey only two known historic nest sites were occupied in Labrador; however, in 1990 a total of 25 known nest sites were surveyed (Holroyd and Banasch 1996, Banasch and Holroyd *unpubl. data*). Also, from 1990 and onwards, surveys in all regions were expanded from nest sites for which there were historic records of prior to 1970 to include all known nest sites (i.e., "known" sites included all sites known up to the year of the survey); sites found during the survey year were considered "new" (Holroyd and Banasch 1996).

Increased counts of breeding pairs in some areas undoubtedly reflect a combination of increased numbers of birds, and either increased efforts to find them or larger areas surveyed. In the absence of an analysis of this confounding effect, the annual population increases calculated by Holroyd and Banasch (1996) must be therefore considered to be possibly overly optimistic given the stated changes in survey area, terminology, and methodology between surveys. Cautious interpretation of the available data is necessary to avoid making spurious conclusions regarding the magnitude of population trends.

Limited but sufficient data exist from areas where survey effort has remained relatively constant to unequivocally assess population trends. Surveys of the Porcupine, Peel, and Yukon Rivers in the Yukon Territory have documented a steady increase in the number of breeding pairs since a low was reached in the early 1970s. Overall, these sub-populations are thought to be at least as large as they were pre-decline, and apparently continue to expand (Holroyd and Banasch 1996). In Alberta, the number of breeding pairs increased from zero to 15 between 1980 and 1996 (Stepnisky *unpubl. manuscript*). The recovery of the peregrine population in southern Alberta is not yet complete— historic records indicate at least 60 nest sites in the pre-DDT era (Court 1993), but the breeding population growth trend continues.

b. Occupancy

Originally, five-year surveys emphasized checking historic nest sites, determining whether the site was occupied or not, using percent occupancy of historic sites as an indicator of relative population, and changes in percent occupancy as a measure of changes in population size. "Recovery" of the species was suggested to have occurred when 80-90% of all historic sites were occupied, a suggested "normal" occupancy frequency (Enderson and Craig 1974, Murphy 1990, Ratcliffe 1993). Recent data from an intensive longitudinal study of peregrines at Rankin Inlet, NWT, suggest that caution is necessary in applying a baseline occupancy estimates for a stable population. Johnstone (1997) documented a *maximum* occupancy of 72%, and a *minimum* occupancy of 43% of 39 different nest sites that were used in a 15-year period; mean annual occupancy was only 60% ± 9%. Some of the variability documented is, in part, due to the intensive nature of that particular study, as the probability of territorial pairs being detected is very high. The data indicate, however, that a frequency of 80-90% occupancy should be treated as a maximum, rather than a mean expected occupancy frequency, and that annual variability must be expected.

Results of the 1995 Canadian *Anatum* Peregrine Survey (Banasch and Holroyd *unpubl. data*) document a mean occupancy of known nest sites that were checked of 68% ± 31%. In the Bay of Fundy, southern Manitoba, southern Saskatchewan, and the Porcupine River, Yukon, all of the known nest sites that were checked were occupied, indicative of population recovery. Occupancy of known nest sites in Labrador (61%, 20/33), southern Quebec (82%, 14/17), northern Alberta (58%, 18/31), the Peel and Yukon River in the Yukon Territory (88%, 21/24; 91%, 39/41, respectively), and the Mackenzie River, NWT (62%, 72/117) were also consistent with recovering or recovered populations. Occupancy of known nest sites checked was below the mean, however, in southern Ontario (46%, 7/15), interior British Columbia (45%, 17/38), and southern Alberta (15%, 9/62) indicative of incomplete population recovery. Occupancy was lowest in the Southern Lakes areas of the Yukon, where the three historic nest sites remained unoccupied.

Overall, occupancy data can be a poor indicator of population recovery in that historic nests are not necessarily preferentially occupied during population recovery. The reasons why expanding populations behave differently are unknown, although long-term changes in habitat may be a factor (Newton 1991). Occupancy data therefore underestimates population recovery, as newly established or detected nest sites are not included. In all areas surveyed, except southern Saskatchewan and the Bay of Fundy, surveys have revealed newly occupied nest sites other than historic sites. In some areas, new nest sites constitute a significant proportion of the total known population. The 1995 survey of the Peel River, Yukon Territory documented 21 occupied sites out of the 24 known nest sites and another 16 new sites. The total known breeding population (37 pairs) actually exceeded the number of known historic nest sites (32).

c. Migration counts

Counts of peregrines collected at raptor migration watch sites in the eastern United States (Minnesota, Michigan, eastern Pennsylvania, central and southern New Jersey) provide indices of population size and may be used to evaluate population trends. Although the proportions are unknown, some of those peregrines counted at raptor migration watch sites will be of the *anatum* subspecies, some from Canadian breeding populations.

Recent counts of migrating peregrine falcons indicate a recovery of the species in comparison with the precipitous declines noted in the 1950s, and 1960s. In an analysis of data pooled from six hawk look-outs in eastern North America, Titus and Fuller (1990) documented a 15.3% annual increase in counts of peregrines between 1972-1987. Counts of migrating peregrines at Hawk Mountain in Pennsylvania showed a significant negative trend from 1934 to 1986, with a stabilization in the latter part of the 1980's (Bednarz et al. 1990). A population recovery was also indicated by peregrine counts between 1974-1989 for both Grimsby, Ontario (27.8% annual increase) and Duluth, Minnesota (6.1% increase; Hussell and Brown 1992).

While providing a wealth of long-term data, the utility of raptor migration counts for monitoring population trends has been much debated. Briefly, the major criticism is that the statistical treatment of the data is complicated by inconsistencies in data collection. Counts may be affected by weather conditions or changes in migration route, and long term population trends may erroneously indicate population growth rather than increases in survey effort or observer competence. A 1996 raptor monitoring workshop on developing a North American raptor monitoring strategy succinctly summarized: "Although limited or indirect efforts to assess the validity of migration counts indicate that this technique reflects population changes, at least qualitatively, there is no known method to directly validate trends derived from migration counts, and the relationship between the population and the count at a particular site is unknown".

It is also unclear the extent to which increases detected at migration count stations reflect increases in *anatum* peregrines, or mainly in the *tundrius* subspecies, or in both. Considering the latitude of the raptor migration watch sites mentioned here, a substantial proportion of the peregrines counted are likely to be *F. p. tundrius* breeding in the Canadian Arctic and Greenland. Population trends in the more numerous *tundrius* sub-species may overwhelm population changes in *anatum* peregrines.

In summary, migration counts provide at least qualitative evidence of a population recovery of the peregrine falcon. Biases inherent with migration counts, however, make it difficult to quantify the recovery. Published estimates of annual increases in peregrines are likely to be *over-estimates*, although it is uncertain, to what degree. Substantial efforts have been made to standardize migration counts and recent trends in counts probably best reflect actual population changes.

iv. Influence of management initiatives on population size and recovery

Intensive management programs were initiated in the 1970s to establish self-sustaining populations of peregrines in southern Canada east of the Rockies (Holroyd and Banasch 1990). At that time, no peregrines were known to be breeding in this area. In order to assess the status of the *anatum* peregrine it is necessary to determine what contribution, if any, management initiatives have made to the recovery of populations, and the relative importance of continued human intervention to the future status of the subspecies. The most important question of all is: to what extent is sustained population growth dependent on continued management?

Captive breeding programs were initiated in 1972 at the Canadian Wildlife Service Facility at Wainwright, Alberta. Additional facilities were established later at the University of Saskatchewan, Saskatoon and Macdonald College, McGill University, Montreal, Quebec. In 1975, government and non-governmental agencies began releasing young *anatum* falcons into the wild and, up to 1996 inclusive, a total of 1752 captive-bred peregrines had been released in Canada; 924 in the southeast and 828 in the prairies and the west (U. Banasch *unpubl. data*). Captive-bred peregrines released in the U.S. may also have been a source of some of the birds seen in southern Canada. It is important to note that releases pertain only to southern populations, and that population increases in northern populations are attributable to natural increases.

Two release techniques were used in Canada: 1) hacking, an old falconry technique in which captive raised young were released at an artificial eyrie and food was provided for them until they reached independence; and 2) fostering, in which captive raised young were placed in the nests of already breeding peregrines either to augment their brood, or to replace broken, cracked, and/or potentially thin-shelled eggs. Of 563 young released into the wild in Canada between 1976 and 1987, most (95%) were hack-released birds (Holroyd and Banasch 1990). Urban releases constituted a significant proportion of all releases; almost half of the young (264/563) were released from buildings in 10 cities (Holroyd and Banasch 1990).

The success of release programs has been measured by the ratio of total releases to known breeding pairs (Enderson *et al.* 1995). Enderson *et al.* (1995) documented a national average for Canadian programs of 36 releases to every known pair. Programs in the United States, in comparison, recorded ratios of 11:1 for the East, 13:1 for the Midwest, and 17:1 for Wyoming, Montana and Idaho combined (Enderson *et al.* 1995). The high ratio apparent for Canadian programs, relative to U.S. release programs, is partly due to the inherent problem of early Canadian releases involving small numbers of birds at widely separated sites (Holroyd and Banasch 1996). Stepnisky (1996), for instance, documented a ratio of 18:1 for the release program in southern Alberta between 1992 and 1996 (176 releases for an increase of 5 to 15 known pairs).

The success of releases is equally well determined by the survival of released peregrines to breeding age. Peregrine release programs in Canada have documented that approximately 10% of the young released are subsequently recorded in the breeding population as adults (Holroyd and Banasch 1990, Stepnisky 1996). This is quite a reasonable success rate considering: 1) this is a underestimate of the actual number that have survived to breed, as not all surviving captive-bred released birds are likely to be counted—some are likely to have survived and dispersed to remote or inaccessible areas where they are not counted; and 2) estimates of pre-breeder mortality from studies of wild peregrines suggest that only about 1 in 5 fledglings are likely to survive to breed as adults anyway (Newton and Mearns 1988).

The success and relative importance of release programs to the current status of peregrine populations may be established from the proportion of breeding individuals that were captive raised. By convention, captive-bred peregrines are colour banded with a *red* anodized aluminum leg band which makes them distinguishable from naturally produced young (including young produced by captive-bred peregrines in the wild) which are also colour banded but with a *black* leg band. Captive-raised individuals and their offspring form an important component of the present-day peregrine population in the prairie region. Of the known population of 15 breeding pairs and another 7 individuals in southern Alberta in 1996: 18 (49%) originated from hack releases, 3 (8%) had been captive raised and fostered at a wild nest, 13 (35%) had fledged naturally from a wild nest, and the origins of the remaining 3 individuals were unknown (Stepnisky 1996). Of the individuals that had fledged from wild nests, a maximum of 7 (54%) could have been first generation offspring of captive-bred hack release or fostered individuals (D. Stepnisky *unpubl. data*). In total, 57% to a maximum of 76% of the current known adult population in southern Alberta are the direct or indirect product of management initiatives.

In Saskatchewan and Manitoba, most individuals in the breeding population of 5 pairs are captive-bred released individuals (P. Thompson, B. Jones *unpubl. data*). In Manitoba, an increasing proportion of the breeding population are naturally produced individuals, including the first generation offspring of captive-bred released individuals. From 1989 to 1991 all adults in the population were hacked birds, however, the proportion has gradually decreased. In 1996, only 4 of 11 adults observed at nest sites were hacked birds (B. Jones *unpubl. data*).

In Québec, captive-bred released adults are outnumbered in the breeding population by unbanded wild produced birds, on average, by 5:1 between 1990 and 1995 inclusive (M. Lepage, *unpubl. data*). A large number of individuals in the population whose banding status (i.e., unbanded or banded with red, black or aluminum band only) has not been determined, however, prevents an accurate assessment of the relative contribution of captive-bred released birds to the provincial population.

The proportion of present-day breeding peregrines that were originally captive-bred is a measure of the relative contribution of management initiatives to current population size. Following this rationale, it must be concluded that the release of captive-bred birds has played a definitive role in the establishment of breeding pairs of peregrines at least across the prairies, if not the rest of southern Canada, with the exception of British Columbia.

Sub-populations of peregrines in southern Canada today exist because of releases of captive-bred birds into relatively pollutant-free environments. It is important to establish, therefore, the future of the *anatum* subspecies in Canada in the absence of further releases—will population growth be sustained?

Now that small breeding populations have been established, continued population growth without further releases depends on whether the production of the current breeding population is great enough that there is a net reproductive surplus which may disperse to breed themselves. The rate of population growth will depend on the magnitude of the net surplus, and will be further assisted by the recruitment of dispersed young produced at unknown nests to the breeding population.

The current annual production of captive-bred peregrines in the wild is, on average, high enough that they may be expected to be replaced in the breeding population by their offspring (Stepnisky 1996). Assuming that the offspring of captive-bred and wild peregrines have equal chances of surviving to produce young themselves—a reasonable assumption but one which cannot be tested due to a paucity of data; it may be predicted that populations which are or were originally based on captive-bred peregrines will show a gradual increase in the absence of further releases, assuming there is suitable habitat and available prey.

An analysis of population viability of the southern Alberta peregrine population using predictive population modeling concluded that continued growth of the population is expected without further releases, based on present levels of natural production (1.37 young per territorial pair), and pre-breeder survival of 0.34 (Stepnisky *unpubl. manuscript*). It was cautioned that continued management via fostering of captive-bred young would be necessary to ensure population growth, but only if pre-breeder survival was very low (0.13).

While the presence of banded adults in a population is indicative of the contribution of management to population recovery; the presence of unbanded individuals in the breeding population, conversely, is indicative of production at unknown wild nests or inaccessible nest sites. Unbanded individuals are young which have dispersed from unknown wild nests, as the majority of young at known nests are banded prior to fledging. The number of unbanded individuals (6- D. Stepnisky *unpubl. data*) in the southern Alberta breeding population in 1996 suggests an unknown breeding population within the province, or dispersal from distant unknown nests. The presence of such adults in the breeding population suggests that about 27 young were fledged which equals the expected production of approximately 18 breeding attempts or 18 territorial pairs, based on the assumptions that all the adults had fledged in the same year, that pre-breeder survival was 0.22 (Newton and Mearns 1988), and that mean production was 1.5 young per territorial pair. Banding information from Quebec shows a minimum of 7 unbanded birds in the population, on average, between 1992 and 1995 which is also indicative of a similar level of wild production.

In summary, the rate of population growth in southern Canada will be more gradual without further releases of captive-bred young, and many release programs have ended at a time when breeding pairs are low. The lack of accurate productivity and adult mortality data makes predicting the future of meta-populations difficult. In the absence of such data, and considering the low numbers and dispersed nature of breeding pairs, caution dictates that it must be concluded that the future of the peregrine in southern Canada is unclear.

v. Population Size and Trend (North America)

Accurately estimating even the most basic population parameters for a species remains one of the greatest challenges facing biologists, and this has certainly proved to be the case for peregrine falcons, one of the most studied avian species ever. The most recent summaries of survey data conclude that the total known breeding population in Canada and the United States of *anatum* peregrines is approximately 1400 breeding pairs (Enderson *et al.* 1995, Cade *et al.* in press, Holroyd and Banasch *unpubl. data*). In 1975, by comparison, the known number was only 159 breeding pairs from a total of 906 eyries (Fyfe *et al.* 1976). Recent studies estimate the total breeding population (i.e. known and unknown pairs) of *anatum* peregrines in its range to be over 3000 territorial pairs or occupied eyries, with more than 4000 fledglings produced annually (Enderson *et al.* 1995, Cade *et al.* in press). While providing a very encouraging perception of population size and trend for the species, these 'educated guess' estimates must be interpreted cautiously, as the unknown degree of error associated with the estimate is potentially very large and cannot be verified without prohibitively expensive extensive surveys (Enderson *et al.* 1995).

a. United States of America

Recent analyses indicate that population trends of American peregrines in the United States are similar to that documented in Canada. The perceived recovery of the peregrine in a number of states prompted the call for a review of the subspecies "Endangered" status in the United States (Mesta *et al.* 1995) which is currently underway, although it appears stalled at present because of concerns regarding a lack of quantitative data (G. Court, Review Committee member *pers. comm.*).

The population decline documented in Canadian *anatum* populations was paralleled by populations in the United States. At the time that peregrine recovery plans were drafted between 1979-1982, the known United States population was only about 242 pairs, including Alaska. The decline resulted in almost the complete loss of the subspecies in the northern states in the East, a breeding population in California approximately one-tenth of the historic size, and a breeding population of less than 100 known pairs in the West (Enderson *et al.* 1995).

Population recovery has also parallelled that of Canadian populations, although surveys in the United States are also similarly plagued by methodological biases (Enderson *et al.* 1995, Mesta *et al.* 1995, Page *et al.* 1996). Enderson *et al.* (1995) noted a universal trend toward higher counts of pairs on territory in 1980-1990; however, it was cautioned that the "higher counts were no doubt owing to both increased search effort and more birds", and that "the relative importance of these effects cannot be estimated".

Enderson *et al.* (1995) concluded that "in temperate United States from 1980, the number of known pairs (1980-1990) or estimated pairs (1994) roughly doubled every five years, with a conservative 1994 population estimate of 1094 (pairs), compared with 99 pairs in 1980". Mesta *et al.* (1995) recorded breeding populations of 69 known breeding pairs in Alaska, with an estimated population for the state of at least 300 pairs; a population of 224 breeding pairs for the Pacific states (California, Oregon, Washington and Nevada); 559 breeding pairs for the Rocky Mountain/Southwest population (Arizona, Colorado, Idaho, Montana, Nebraska, New Mexico, North Dakota, South Dakota, Texas, Utah, and Wyoming); and in excess of 150 pairs for the Eastern population (mid-Atlantic coast, northern New York, Great Lakes, southern and central Appalachians, and southern New England). Enderson *et al.* (1995) attributed the remarkable change to release programs; approximately 4680 captive-bred peregrines were released in that period. Ultimately, Enderson *et al.* (1995) concluded that "the peregrine was no longer threatened with extinction in the West and should be delisted". Given current population levels, it seems likely that the American Peregrine Review Committee will recommend that the subspecies is delisted or down-listed within the next year (G. Court, American Peregrine Review Committee member, *pers. comm.*).

b. Mexico

A lack of data, both historic and recent, prevents an accurate assessment of the current status of this subspecies in Mexico. Mesta *et al.* (1995), in the U.S. Federal Register document which proposed that the *anatum* subspecies should be de-listed in the United States, speculated that the status of the Mexican subpopulation is likely to be similar to that of the subpopulation occupying similar habitat in nearby Arizona. The population there, has met recovery goals for that State. Moreover, Mesta *et al.* (1995) concluded that "there are no recent data available to the Service that indicate local American Peregrine Falcon populations in Mexico are declining, are imperiled by organochlorine pesticides, or have not recovered in recent years similarly to local populations in the United States and Canada".

vi. Population size and trend summary

Increased migration counts and counts of breeding pairs are indicative that *anatum* peregrine sub-populations in Canada and elsewhere have grown considerably since a continent-wide population crash associated with the widespread use of persistent organochlorine compounds. The size of the "pre-organochlorine era" peregrine population is not known accurately , so it is difficult to assess whether populations have "recovered" in comparison with these population levels. Sub-populations in southern Canada all show some room for continued growth. The size and productivity of present known populations suggest that they may be considered to be "recovering" or in some cases "recovered". Notably, significant declines in sub-populations are not apparent.

There is a known breeding population of 320 breeding pairs in Canada. This is an underestimate of the actual breeding population, but the degree of error is unknown. The breeding population in Canada is part of a known breeding population of ca. 1400 territorial pairs, and an estimated total of 3000 pairs (Enderson *et al.* 1995, Cade *et al.* in press). Over 220 of the breeding pairs are in western boreal Canada. The established populations in Canada south of 58°N appear productive, which predicts that population growth is likely to continue. The number of breeding pairs are relatively low, and highly dispersed, however, so there is some question regarding their future, in my opinion. The observed population growth in the south has largely been dependent on release programs. Many release programs have recently ended, and it is too soon to confidently predict the future of these meta-populations.

Large remote areas of suitable breeding habitat throughout Canada have not yet been surveyed for peregrines. Notably, of all of the nine management zones defined by the *Anatum* Peregrine Falcon Recovery Team, the Eastern Mackenzie watershed, Northern Ontario, and Northern Quebec (Zone 7-9, respectively) have not been surveyed. The large amount of suitable habitat available prompts speculation of the presence of (potentially substantial) breeding populations in these areas from which naturally produced young may disperse to colonize unoccupied habitat or be recruited into known breeding populations. Intensive banding and band-reading programs in southern peregrine populations may help elucidate the contribution that these young may make to known breeding populations.

Surveys in western boreal Canada north of 58°N indicate large populations. Moreover, the areas surveyed represent a small portion of the available habitat, and the known breeding population probably represents a relatively small proportion of the actual breeding population. Population trends documented in the Yukon, constitute the best available data in Canada (i.e., survey effort has remained relatively consistent) by which to assess trends, and unequivocally demonstrate population growth. Notably this sustained population growth has occurred without human intervention.

Population size and trends are virtually unknown in British Columbia; however, a recent limited survey indicates a known population of 19 breeding pairs. Further determination of the status of the subspecies in this province cannot be assessed objectively without further survey effort. In southern Alberta, the present breeding population (12 pairs) is only at one-fifth of historic levels, and captive-bred individuals constitute a large part of the population. While small, it is a viable self-sustaining population and population growth is projected to continue with or without future releases at present levels of production, although growth will be more gradual without further releases (Stepnisky *unpubl. manuscript*). Populations in Manitoba and Saskatchewan are small, but consistent with historic population sizes and only a few more breeding pairs should be expected, if any. In southern Quebec peregrine populations closely approximate the cumulative number of nest sites used historically. Known peregrine populations in Ontario and the Bay of Fundy are still below historic estimates and further population increases are desired. Surveys in Labrador have documented a large (31 pairs in 1995) and productive peregrine population; further survey effort would likely reveal more breeding pairs.

vii. Factors associated with population changes

The precipitous decline of peregrine populations in North America and Europe has been demonstrably linked to the widespread use of organochlorines (Hickey 1969, Newton 1979, Cade *et al.* 1988, Ratcliffe 1993). Organochlorines are a group of related chemicals which were heavily used throughout the world in agricultural and industrial applications following World War II. Their popularity was, in part, due to their persistence once applied, and their low direct toxicity to man. Use of these chemicals peaked in the 1950's and early 1960's; however, recognition of the problems associated with their widespread use subsequently resulted in restrictions and bans on their use within Canada and the United States by the early 1970's. The insecticide dichlorodiphenyltrichloroethane (DDT) is still used in many parts of the world, especially in developing countries, mainly to prevent insect damage to crops or control disease-carrying insects. DDT is presently used within the migratory range of the *anatum* Peregrine Falcon in Mexico, and Central/South America (López-Corrillo 1996).

viii. Effects of persistent organochlorine pollutants on peregrines and other wildlife.

In the 1960's, the insidious side-effects of these synthetic chemicals on wildlife became apparent (Ratcliffe 1993). The problems were mainly the result of their resistance to degradation, therefore they were present in the environment long after they were applied initially. Their tendency to bio-accumulate in lipid reserves, and subsequently bio-magnify through trophic levels of the food chain; and their lethal and sub-lethal effects posed a serious threat to terminal carnivores. Carnivores at the top of the food chain, such as the Peregrine Falcon and many other birds of prey, thus accumulated much higher levels of organochlorines than those in their prey species. Many raptors proved highly sensitive to these chemicals, even at trace levels.

Reproductive problems such as reduced hatching success through eggshell thinning and embryo death were associated with elevated levels of certain organochlorines in egg contents, the blood and other body tissues of peregrines (Newton 1979). Abnormal adult behaviour was also associated with elevated organochlorine levels, although the association is less certain (Newton 1979). In Great Britain, enhanced adult mortality through indirect poisoning was directly associated with organochlorine use, particularly with the pesticide dieldrin (Ratcliffe 1993). Research on other species have associated organochlorine contamination with sub-lethal effects such as congenital deformities in embryos and hatched young, biochemical changes including abnormal liver function, suppressed immune function, and endocrine disruption including possible feminization of males (Gilbertson *et al.* 1991, Colborn *et al.* 1996, Grasman *et al.* 1996). Research on toxicological effects on peregrines, however, has remained primarily focused on eggshell thinning; other effects have been poorly investigated, if at all.

It has been concluded that only three compounds: the pesticide dieldrin, DDE (the primary metabolite of the pesticide DDT), and industrial polychlorinated biphenyls (PCBs) are likely to affect peregrine reproduction (Baril *et al.* 1990). Individual peregrines are usually exposed to these and other organochlorine contaminants collectively (i.e., an egg found to have high levels of DDE is likely to have similarly elevated PCB and dieldrin residues) (Newton *et al.* 1989, Court *et al.* 1990, Johnstone *et al.* 1996). The effects of such contaminant "cocktails" remain to be determined.

Reproductive success among highly contaminated peregrines was poor as eggshell thickness was inversely proportional to DDE levels in females. Few young survived to breed, because of cracked or broken thin-shelled eggs, and peregrine populations declined globally as the environment became increasingly contaminated with organochlorines (Cade *et al.* 1988). Peregrine populations were at their lowest when levels of organochlorine contaminants in the environment were at their highest (Newton 1979, Ratcliffe 1993).

ix. Present organochlorine contamination of peregrines and temporal trends

Toxicological studies conducted in the 1980's revealed that contaminant levels in peregrines, their eggs and prey: 1) were no longer in the range associated with population decline; 2) had decreased from the previous decade, and 3) were predicted to decrease further in the 1990's (Cade *et al.* 1988; Newton *et al.* 1989; Peakall *et al.* 1990). While population counts and estimates of productivity indicate that organochlorine contamination has greatly reduced over the last few decades, there is a limited data set available, however, by which to directly assess the present organochlorine contamination on peregrine populations. There are very limited current data on organochlorine levels in *anatum* peregrines and their prey in Canada. Only two published toxicological studies of Canadian peregrines or their prey include samples from this decade (Court 1993, Johnstone *et al.* 1996), and only Court (1993) concerns *anatum* peregrines. Temporal trends in organochlorine residues have been measured in the blood plasma of migrant peregrines (Henny *et al.* 1996), and trends in DDE residues in Alaskan *anatum* peregrines were summarized by Mesta *et al.* (1995).

The most recent analysis of organochlorine residues in *anatum* peregrines in Canada comes from southern Alberta. Court *et al.* (1996) concluded that peregrines in southern Alberta continue to accumulate organochlorine contaminants from their prey, but the levels recorded were below those considered critical. Levels of 15 to 20 mg/kg (wet weight) DDE, 1 mg/kg (wet weight) dieldrin, and above 40 mg/kg (wet weight) PCBs in egg contents are considered critical (Peakall *et al.* 1990). Court *et al.* (1996) recorded geometric mean levels (mg/kg wet weight) of 6.21 DDE, 3.06 total PCBs, and 0.12 dieldrin in a sample of eggs representing 17 different clutches, collected between 1990 and 1992. Mesta *et al.* (1995) reported that egg content DDE residue levels for *anatum* peregrines in Alaska in 1991 were slightly lower (4.2 mg/kg). In Alberta, DDE residue levels in eggs had decreased significantly from the previous decade, but PCB levels increased. Geometric mean levels (mg/kg wet weight) of 8.31 DDE, 3.95 total PCBs, and 0.13 dieldrin were recorded in a sample of eggs representing 55 different clutches collected between 1980 and 1989 (Court *et al.* 1996). Contaminant levels in prey species in 1991 were generally low, although mean DDE levels in eared grebes *Podiceps caspicus*, swallow species, American crow *Corvus brachyrhynchos*, California gulls *Larus californicus*, and Bonaparte's gulls *Larus philadelphia* were close to, or greater than, the dietary level considered critical (1 mg/kg - Peakall *et al.* 1990). Consistent with these relatively low residues levels in peregrine eggs, Court (1993) calculated that mean shell thickness in Alberta between 1983 and 1992 was 12.9% thinner than under DDT-free conditions, less than the critical 17% thinning associated with population decline (Peakall and Kiff 1988). Overall, Court (1993) concluded that a proportion of breeding pairs in Alberta may continue to suffer reproductive failures as a direct result of contaminants; however, pollutant levels were low enough that overall population productivity should not be limited.

Levels of contamination and the trends observed in the Albertan sub-population of *anatum* peregrines may not necessarily be representative of the present contamination of *anatum* peregrines throughout its geographical range within Canada, and elsewhere. Contaminant levels may be expected to vary between sub-populations of peregrines as dietary intake of contaminants may differ between sub-populations of peregrines, mainly because of differences in prey species availability and abundance (Johnstone *et al.* 1996). For example, Johnstone *et al.* (1996) documented that contamination of *tundrius* peregrines at Rankin Inlet was different from sub-populations of Greenland and Alaskan peregrines, recording higher contaminant levels and the lack of a strong decline in levels between the 1980's and 1990's. The difference was attributed to the importance of relatively highly contaminated marine and aquatic prey species in the diet of peregrines at Rankin Inlet. The results of this study suggest that variability in contaminant levels must also be expected in *anatum* peregrines across Canada. Moreover, sub-populations whose diet largely consists (by biomass) of higher trophic level prey species (Frank and Braun 1990), such as those found in marine and aquatic species—especially piscivorous species, are likely to have the highest contaminant levels and show the least decline in levels. The continued presence of peregrines in such sink habitats will depend on the dispersal of breeders from source populations, or on long-term management efforts.

In the absence of recent contaminant data on *anatum* peregrines from across a broad geographical range, it is necessary to review alternative data which may be used to directly or indirectly assess the present impact of organochlorine contamination on the productivity of peregrines at a population level, and predict future effects.

A recent study noted significant decreases between 1978 and 1994 in the levels of organochlorine residues found in the blood plasma of spring migrant female peregrines sampled along coastal Texas (Henny *et al.* 1996). The sub-specific status of the individuals sampled was not unknown. Henny *et al.* (1996) concluded that mean DDE residues in plasma of adult and subadult females had decreased significantly over the study period. Between 1984 and 1994, DDE residue levels had decreased 25% in adult females, and 42% in second year females returning north from Latin America for their first time. Moreover, residues of DDT, DDD (another metabolite of DDT), heptachlor epoxide, dieldrin, oxychlordane, and mirex, which were frequently encountered in samples in the late 1970's and the early 1980's, were no longer detected in 1994. Changes in PCBs, unfortunately, were not possible to assess.

Recent data from *tundrius* peregrines in Canada and Alaska provide a useful body of information to assess relative trends in organochlorine contaminant levels. In Alaska, organochlorine residues in *tundrius* egg contents in the 1990's were well below levels considered critical, and clear decreases within the last decade were documented (Swem 1994). DDE residues in *tundrius* peregrine eggs from 13 clutches averaged 3.3 mg/kg with a maximum level of 5.3 mg/kg (Swem 1994). In arctic Canada, Johnstone *et al.* (1996) recorded low residue levels in *tundrius* eggs representing 20 clutches collected between 1991 and 1994: 4.45 for DDE, 8.31 for total PCBs, and 0.36 mg/kg wet weight for dieldrin. There was no significant change in PCB or dieldrin levels found in peregrine eggs at Rankin Inlet between the 1980's (Court *et al.* 1990) and the 1990's. Mean DDE levels in egg contents decreased between decades from 7.6 to 4.5 mg/kg (wet weight). Residue levels in avian prey were generally low, although elevated levels were noted in migrant species occupying marine and aquatic habitats. Critical dietary levels for PCBs, DDE, and dieldrin were exceeded in only one species; the long-tailed duck, *Clangula hyemalis.* It was concluded that mean levels of contamination and eggshell thinning were below critical levels; this concurred with the productive nature of the population. The maximum residue and eggshell thinning levels recorded in the samples, however, were such that a portion (10%) of breeding attempts were likely to fail each year because of organochlorine contamination.

Despite documented decreases in DDE, eggshell thickness has shown little increase among peregrine populations over the last decade; it continues to be around the 12-15% of 'normal' (Cade *et al.* in press), and still close to mean levels associated with population decline (17%; Peakall and Kiff 1988). In the United States, eggshell thinning levels for *anatum* peregrines were recorded at 15-16% pre-DDT thickness in New Jersey between 1990 and 1996, and 13-16% thinner than normal in New England (Burns *et al.* 1994). At Rankin Inlet, thinning of *tundrius* eggs was calculated as 15% that of pre-DDT thickness, and thickness did not improve between the 1980's and 1990's, despite a decrease in DDE levels (Johnstone *et al.* 1996). The lack of an improvement in eggshell thickness, however, is not unexpected considering the magnitude of changes in contaminant levels. Eggshell thickness is inversely related to the log of DDE levels; therefore, very substantial changes in contaminant levels are required to affect changes in eggshell thickness. For instance, only a 3% increase in eggshell thickness was predicted from the 41% decline in DDE residues documented between the 1980's and 1990's by Johnstone *et al.* (1996). Conversely, for the degree of eggshell thinning currently observed in Alberta (12.9%) to increase to the level associated with population decline (17%), DDE levels in egg contents would have to increase approximately 48% (Court *et al.* 1990).

Research from a variety of marine and terrestrial ecosystems and species indicates that levels of persistent organochlorines in the environment have decreased substantially over the last three decades (Elliott *et al.* 1989, Government of Canada 1991, Newton *et al.* 1993, Beck *et al.* 1994, Muir *et al.* 1996a, b). In general, relatively rapid declines of most contaminant levels were observed in the mid- to late 1970's, subsequent to the broad restrictions in the use or production of persistent organochlorines. Over the past decade, however, there has been a leveling off in the trend, with slow rates of declines or no declines observed among residues in some species and ecosystems (Government of Canada 1991, Muir *et al.* 1996a, b). The lack of a continuing strong decline is best explained by sustained contaminant loads in ecosystems, in part, due to continuing atmospheric deposition, and release from contaminated bottom sediments. Some peregrine sub-populations may continue to suffer impaired reproductive performance related to these sustained loads of contaminants in the environment. Without further declines, these habitat will remain reproductive "sinks", and the continued presence of peregrines there will depend on the dispersal of breeders from other sub-populations, or long-term management efforts. It must be clearly stated that such contaminated sub-populations, if they exist at all, are the exception. *Anatum* peregrine populations throughout their range, in general, suffer significantly less reproductive problems than they did two decades ago primarily because of a reduction in their dietary intake of contaminants. While organochlorine residues will continue to be detected in peregrines for years to come, they are no longer found at levels associated with population decline; instead, peregrine populations have grown despite their presence.

a. Trends in organochlorine use

Levels and associated trends of eggshell thinning, and organochlorine residue levels in egg contents, blood plasma, and prey species provide great optimism regarding the present and future impact of these chemicals on the reproductive success of peregrine falcons in North America. Very substantial increases in organochlorine contaminant levels would have to occur to bring about population declines of peregrines. Such dramatic increases would be only be foreseeable if organochlorine insecticides were to be used within North America in the same quantities that they were between World War II and the early 1970's. This is highly unlikely as: 1) organochlorine use globally has greatly decreased since restrictions and bans in the 1970's; 2) the amount presently used is relatively small, in comparison with historic levels, and present peregrine population trends and productivity indicate that contamination presently has few effects at a population level; 3) further substantial decreases in global use are predicted.

The total amount of DDT used in the world today is not known accurately, however, estimates show a great reduction over the past couple of decades. DDT is used mainly in developing countries, however, developed countries play a large part in the continued use. In 1989, the World Bank allocated US $51 million to spread 2700 tonnes of DDT over the Amazon Basin over a five-year period (Treakle 1989). The United States has also exported 27 tons of DDT to Mexico between 1990 and 1996 (Pesticide Action Network North America Update Service (PANUPS) 1996). Mexico is presently the largest user of DDT in Latin America, with the estimated annual use being greater than the total for Venezuela, Argentina, Columbia, Ecuador, and Brazil combined (Lopez-Carrillo *et al.* 1996). In 1993/1994, Mexico used approximately 2360 tonnes for malaria control, followed by Brazil (1110 tonnes), and Ecuador (360 tonnes); Venezuela, Columbia and Argentina used about 135 tonnes each (PAHO 1994, Lopez-Carrillo *et al.* 1996). Whilst of concern, these amounts are relatively small in comparison with previous usage. In 1978 Mexico, Brazil, Argentina, and Columbia used a total of approximately 14500 tonnes of DDT (Peakall 1990). To give these figures a more global perspective, Peakall (1990) estimated that a total of 5750 tonnes of DDT were used in New Brunswick alone over the period 1952-1965, a province less than 1% the land area of Brazil. Nisbet (1988) estimated that approximately 650000 tonnes of DDT and 20000 tonnes of dieldrin were used in the United States between 1944 and 1972.

Further decreases in DDT use are predicted (Burton and Philogene 1988). At a 1996 meeting on persistent organic pollutants in Manila, Mexican government officials announced important plans to reduce DDT use by 80% of volume by 2001, and to entirely eliminate its use by 2006 (PANUPS 1996). In addition, efforts to enforce restrictions against DDT use in agriculture, which is reported to continue despite having been made illegal in 1990, would be stepped up. As Mexico is the largest user of DDT within the Americas, this initiative represents a very substantial and important reduction in DDT use within the range of the *anatum* peregrine falcon.

b. Conclusions

Organochlorine contaminants are still found in peregrines and their prey, almost three decades after restrictions in their use within North America. The continuing contamination mainly results from: 1) the present use of organochlorines within the *anatum* peregrine's wintering range, and that of the migrant prey species it uses on it's breeding grounds; 2) long-range atmospheric transport and deposition of contaminants; and 3) sustained loads of contaminants within ecosystems. Current contaminant levels and the degree of eggshell thinning, on average, are below ranges associated with population decline. Moreover, peregrine populations continue to persist and grow despite the presence of contaminants. Very substantial increases in organochlorine use would be necessary for critical levels to be reached, however, this is an event extremely unlikely to occur. Organochlorine use has decreased over the last decade, and further substantial decreases are predicted. Sub-populations in regions associated with organochlorine "hotspots" may continue to suffer impaired reproductive performance because of organochlorine contamination for some years; however, these represent exceptions, and growth of the overall *anatum* population will continue. All indicators (i.e., present and predicted organochlorine use, long-term temporal trends in organochlorine pollutants found in a variety of species and ecosystems, present levels and temporal trends of contaminant levels and eggshell thinning in peregrines and their prey, productivity and population trends noted in contaminated populations) suggest that organochlorine pollutants are no longer a factor limiting growth of the North American population of either *anatum* or *tundrius* peregrines, and are unlikely to become a factor, on the *proviso* that bans on organochlorine use within North America are not lifted.

HABITAT

The global decline of peregrine populations was unusual, in comparison with the plight of many extinct or other endangered species, in that it was not related to habitat destruction or loss. Consequently, habitat availability is not generally considered as a factor limiting recovery of the *anatum* peregrine falcon; it is assumed that recovery will occur via the re-occupation of previously occupied habitat. Habitat-related questions pertinent to an assessment of the status of the *anatum* Peregrine Falcon include: 1) Is available habitat sufficient for population recovery, or will it limit the recovery of the subspecies? 2) Is the present level of protection afforded to habitat adequate to sustain population growth? 3) Do long-term habitat changes threaten the subspecies?

Attempts at identifying specific habitat requirements for the Peregrine Falcon have been, and will continue to be, confounded by the sheer multiplicity of factors involved with habitat selection for a cosmopolitan species with a varied diet. The Peregrine Falcon is one of the most cosmopolitan of all bird species, being found breeding on most major islands, and on every continent, except Antarctica; it occupies a correspondingly broad variety of habitat (Cade *et al.* 1988, Ratcliffe 1993). Most habitat descriptions are consequently simplistic.

i. Breeding habitat

Traditionally, precipitous cliffs have been considered as ideal nesting habitat for peregrines, and nearly every attempt at defining "high quality" sites focus on the requirement of a high nesting cliff. Associations between reproductive performance and some characteristics of nest sites (e.g., cliff height, orientation, distance to water, size of nesting ledge, shelter (exposed or sheltered), presence/absence of vegetation, and type of substrate) have been described. These attempts at identifying characteristics of "critical" or "high quality" nesting habitat, however, fail to explain good reproductive performance and consistent occupancy of peregrines breeding in the complete antithesis of what is considered "ideal" habitat. Cliffs do provide the preferred nesting habitat, by far, and in some regions, the availability of cliffs appears to limit or even exclude breeding attempts (Hickey and Anderson 1969, Newton 1979, Newton 1988). Peregrines may consistently occupy and successfully breed in an infinite variety of habitat. Individual breeding pairs and/or whole sub-populations have successfully bred on: tall cliffs, flat ground, tall buildings, quarries, flat bog, clay cut-banks, small boulders, eskers, low tundra hummocks, sand dunes, sink-holes, industrial smoke stacks, trees, cavities in trees, churches, castles, Egyptian pyramids, and bridges (Hickey and Anderson 1969, Cade and Bird 1990, Ratcliffe 1993, *pers. obs.*). The most basic requirements of suitable breeding habitat for a peregrine are: 1) a well drained stable area (i.e., bowl or scrape on firm substrate, or a disused stick nest) which is large enough for at least 3 large nestlings to lie down in, and which is preferably, but not necessarily, 10m or more off the ground; and 2) access to abundant prey (Newton 1988, Ratcliffe 1993).

The loss of breeding habitat is generally not considered a factor limiting the recovery of the *anatum* peregrine, in part, because: 1) the variety of habitat they occupy; and 2) the availability of historically used nest sites. For example, the recent phenomenon of peregrines breeding on man-made structures in urban centers implies an increase in the range of breeding habitat used by peregrines. It is noteworthy that in southern Canada, population recovery has generally started with pairs breeding in cities leaving many historic rural nest sites to remain unoccupied. This indicates that there is sufficient habitat available for continued population growth to some unknown maximum, which is determined by prey densities and the utilized habitat. Long-term habitat changes, such as weathering and erosion, may mean that some historic sites may no longer be suitable for breeding attempts but, in general, these natural losses are likely to be balanced by the creation of new habitat by the same processes. Additionally, the current favorable public perception of raptors, especially peregrines, means that nest sites are likely to be treated to a greater level of respect and protection, in comparison with the persecution they were sometimes exposed to a few decades ago. The protection of breeding pairs from disturbance, and nesting habitat, both presently occupied and historic, from alteration or destruction, is a priority which should be achieved primarily through public education, and through enforcement of present legislation.

ii. Migratory and wintering habitat

Anatum peregrines breeding in Canada spend seven months of the year outside of Canada. Migratory or wintering habitat critical to the sub-species is even more difficult to identify than breeding habitat, due to the extensive migration of the *anatum* peregrine, and inherent variation in migratory route and wintering area within the sub-species. Band returns provide some general information on migratory routes and wintering area, but insufficient data exist to identify critical habitat used along the way. Satellite telemetry may provide some hope of quantifying migratory and wintering habitat critical to the species. Unfortunately, the current cost of a research program which would provide enough data to quantitatively assess habitat use for a sub-species would be prohibitively expensive. Interpretation of the masses of data produced would be difficult, and the results would be extraordinarily difficult to extrapolate to the protection of peregrines at a sub-species level, because of the variety of prey species used and the habitats they occupy.

iii. Habitat use and prey availability

As raptor biologist Ian Newton commented: "almost every aspect of a natural population of a given raptor species can be explained in terms of food" (Newton 1979). The lives of peregrines are inextricably linked to their prey species, and habitat selection is no exception. Peregrines must consequently breed in places with easy access to abundant food. Their migratory routes must include places of abundant food or will coincide with those of their prey species, and they will winter in areas where they can find enough food.

The almost global distribution of the Peregrine Falcon is, in part, due to its broad diet. The list of species taken by peregrines is so long (Erickson *et al.* 1988, Fyfe *et al.* 1990, Bradley and Oliphant 1991, Ratcliffe 1993, Stepnisky 1996) that it is almost easier to list species that are unlikely to be taken as prey. Prey species as heavy as 1200g may occasionally be taken (by females, at least), although the peregrine feeds mainly on birds in the 50-500g weight range (Ratcliffe 1993). Species composition, and the relative contribution of species to diet, by biomass and percentage of numbers taken, varies in relation to local prey availability. Such a varied diet compounds the problems of identifying habitat of peregrine prey species that should be protected specifically. In general, however, wetlands, lakes, sandbars, seashores, and rivers support relatively large numbers of peregrine prey species including waterfowl, shorebirds, and marsh birds, and provide conditions which suit the peregrines hunting style.

Many peregrine nest sites in Canada and elsewhere are found in close proximity to permanent water bodies. This association suggests that protection of wetlands within peregrine's breeding range, on its migratory routes, and within its wintering range, is a reasonable identifiable priority for long-term conservation of the species. Moreover, wetlands may be very important to pairs in urban centers. Dietary studies in Canada indicate that prey species associated with aquatic habitat constitute an important part of the diet of urban-nesting peregrines despite high abundance and availability of rock doves (pigeons) (Cade and Bird 1990, Follinsbee 1992, Stepnisky 1996). It must be noted that long-term population level effects resulting directly, or indirectly, from wetland loss and other long-term habitat changes related to human activity including agriculture, urban expansion, forestry, and mining are difficult to predict. Peregrine falcons do prey upon an incredibly broad variety of species, and a shift in species composition of the diet may act to buffer the effects of wetland or other habitat loss at a sub-species level to some unknown extent. Dramatic areas of wetlands have been lost within the last century throughout the *anatum* peregrine's breeding range and migratory routes in North America (Dahl 1990), and on its wintering grounds in South America, and they continue to be lost. The North American Waterfowl Management Plan, the Western Hemisphere Shorebird Reserve Network, and Wetlands for the Americas, are all important large scale conservation initiatives that will afford protection of migratory and wintering habitat for peregrine prey.

iv. Summary

In summary, further growth and eventual recovery of the *anatum* Peregrine Falcon population in Canada is not limited by any lack of available, suitable habitat. Urban centers provide many suitable opportunities for nesting peregrines, and many historic nest sites remain vacant. Favorable public perception of the Peregrine Falcon enhances protection of breeding peregrines and their nests from disturbance or destruction as they are no longer generally considered pests. Protection of breeding peregrines and their nests is presently adequate via public education and legislation. Historically used nest sites are insufficiently protected and this should be achieved through public education. Peregrines are probably most susceptible to deleterious effects at a population level by the destruction of their prey species habitat, most notably wetlands. These habitats are vulnerable within the peregrine's breeding and wintering range, and along their migratory routes. The potential consequences to peregrine populations of long-term changes to the habitat of prey are extremely difficult to predict. The Peregrine Falcon is one of the most cosmopolitan species because it utilizes a broad variety of habitat and prey species. A reduction or complete loss from the diet of one or more species may possibly be compensated for by a subsequent shift in diet. In the absence of more information, protection of wetlands both nationally and internationally is a reasonable priority for long-term conservation of the peregrine falcon. National and international wetland conservation initiatives already underway should be vigorously supported.

EVALUATION AND PROPOSED STATUS

A change to the current endangered status of the American peregrine falcon, *F. p. anatum*, is warranted. At the time that it was listed as endangered, only four pairs of *anatum* peregrine falcons were known to be breeding in Canada south of 58°N and the sub-species was considered extirpated in B.C. and eastern Canada. Over 320 pairs of *anatum* peregrines now breed in Canada, part of a larger North American population of approximately 1400 known pairs; in North America the actual breeding population is estimated to be much larger (3000 pairs). Population trends are positive and many surveyed pairs are productive. Furthermore, organochlorine contamination, the causative factor of peregrine population decline, is no longer limiting population growth. Persistent organochlorine pollutants will be found in detectable quantities in peregrine tissue for decades to come, however, levels have gradually reduced in peregrines, their prey, and ecosystems, and are well below levels associated with widespread reproductive failure and population decline. While these substances are still used within the peregrine's wintering range, current usage is apparently not great enough to limit peregrine population growth. Also, there is an abundance of unoccupied habitat available for population growth. Favorable public perception of peregrines decreases the risk of human disturbance and current legislation also provides protection of breeding peregrines. Peregrines are found, at least in small numbers, throughout their historic range in Canada. Considering all of the above factors, the author considers that there is a very low probability of imminent extinction or extirpation of this species within Canada and, therefore, recommends down-listing the *anatum* peregrine from its endangered status.

The *anatum* peregrine in Canada faces a very low threat of extinction or extirpation mainly because of the size and health of the *anatum* population in western boreal Canada north of 58°N. Almost 70% (over 200 pairs) of the entire *anatum* population known in Canada is found there, and it has shown steady growth, consistent with a reversal in limiting factors, over the last decade. Also, more extensive surveys would undoubtedly detect further breeding pairs. Moreover, population recovery here has occurred without management and the future of this large population of peregrines is secure without intervention.

The long-term viability of the *anatum* population in southern Canada, however, is far from certain. The breeding population is small (only 100 known pairs) and widely dispersed, and is consequently inherently susceptible to deleterious stochastic events. Also, the population was founded through release of captive-bred young, programs which have ended recently. Moreover, there are no data showing that the productive northern *anatum* populations represent sources of breeding adults through which the southern population might be maintained or grow. In the absence of unequivocal long-term population growth, it is still too soon to predict, in my opinion, the fate of this small population without management (including more releases) with an acceptable degree of confidence.

The distinct differences in the certainty of fates between southern and western boreal peregrine populations thus creates a dilemma in designating a national status for the subspecies. COSEWIC must decide upon the importance of southern meta-populations to the national status of the subspecies. In the author's opinion, the future of the *anatum* peregrine is presently secure at a national level and on that basis I recommend that the subspecies be down-listed to vulnerable in Canada. I respectfully suggest that COSEWIC carefully considers the following options in designating the status of the *anatum* peregrine.

1) Vulnerable

A *vulnerable* species is one "of special concern because of characteristics that make it particularly susceptible to human activities or natural events" and several factors make the peregrine of special concern. The long-term future of the *anatum* peregrine in Canada is secure, in the author's opinion, however, I also consider that the species is inherently susceptible to becoming threatened or endangered. The threat to peregrines posed by organochlorine contaminants has not been eliminated entirely. Declining trends in contamination have generally leveled off in the last decade, and close monitoring of levels is warranted, although levels are unlikely to increase. The species may also be inherently at risk to newer biocides, other than organochlorines, because of its position at the terminal end of the food chain. Furthermore, the effects of long-term habitat changes throughout its breeding and migratory range are unknown and difficult to predict. Considering that the species has never been common, these factors may make it inherently susceptible to population decline. De-listing the *anatum* peregrine is not appropriate considering these factors and a known breeding population of only 320 breeding pairs.

2) Split vulnerable/threatened designation

The uncertain fate of peregrines in southern Canada provides a rationale for splitting the subspecies into northern and southern populations and designating status along those lines. The underlying rationale for this split is that population recovery in western boreal Canada occurred without management and the future of this relatively large population of peregrines is secure without intervention, whereas peregrines in southern Canada were the direct result of intensive management initiatives which have recently ended and the fate of the population is not certain because of low numbers and widely dispersed breeding pairs. This supports downlisting the *anatum* peregrine to 'vulnerable' in western boreal Canada (i.e., Zones 4, 5, and 7) and 'threatened' in southern Canada (i.e., Zones 1, 2, 3, 6, 8, and 9) until unequivocal sustained population growth in the absence of further management has been documented. Zones 6, 8, and 9 are included for downlisting to threatened since there are little or no data regarding population size in these areas (with the exception of Labrador where 31 pairs are unknown) and on the assumption that limiting factors probably compare with their neighbouring zones. In the author's opinion, this is the most appropriate alternative to "vulnerable in Canada" in that it adequately treats the problem of the questionable future of peregrines in southern Canada.

3) Threatened

While peregrine populations have increased substantially over the last two decades, the known population is still small. With only 320 breeding pairs, it ranks closely in numbers to other endangered species which, in part, supports the rationale for down-listing to threatened in Canada. There is also some risk that peregrines may become extirpated from southern Canada and, therefore, if COSEWIC considers that the long-term presence of peregrines in southern Canada is critical to the national status of the *anatum* peregrine in Canada, then threatened is appropriately conservative designation.

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BIOGRAPHICAL SUMMARY OF AUTHOR

Colleen Hyslop, Co-chair, Birds Species Specialist Group has lost touch with the author, so no biographical summary is available.

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Table 1. Total Peregrine Falcon pairs present in Canada from 1970 to 1995, by management zone[a].

Zone	1970[b]	1975[b]	1980[b]	1985[b]	1990 [b]	1995[c]
1	2	0	1	4	38	50
2	0	0	0	0	2	14
3	1	0	0	4	5	18
4	7	24	24	50	86	106
5	5	13	35	39	83	112
6	0	0	0	0	0	18

[a] From Erickson et. al. 1988.

[b] From Holyrod and Banasch 1996.

[c] From Banasch and Holroyd, unpubl. data.

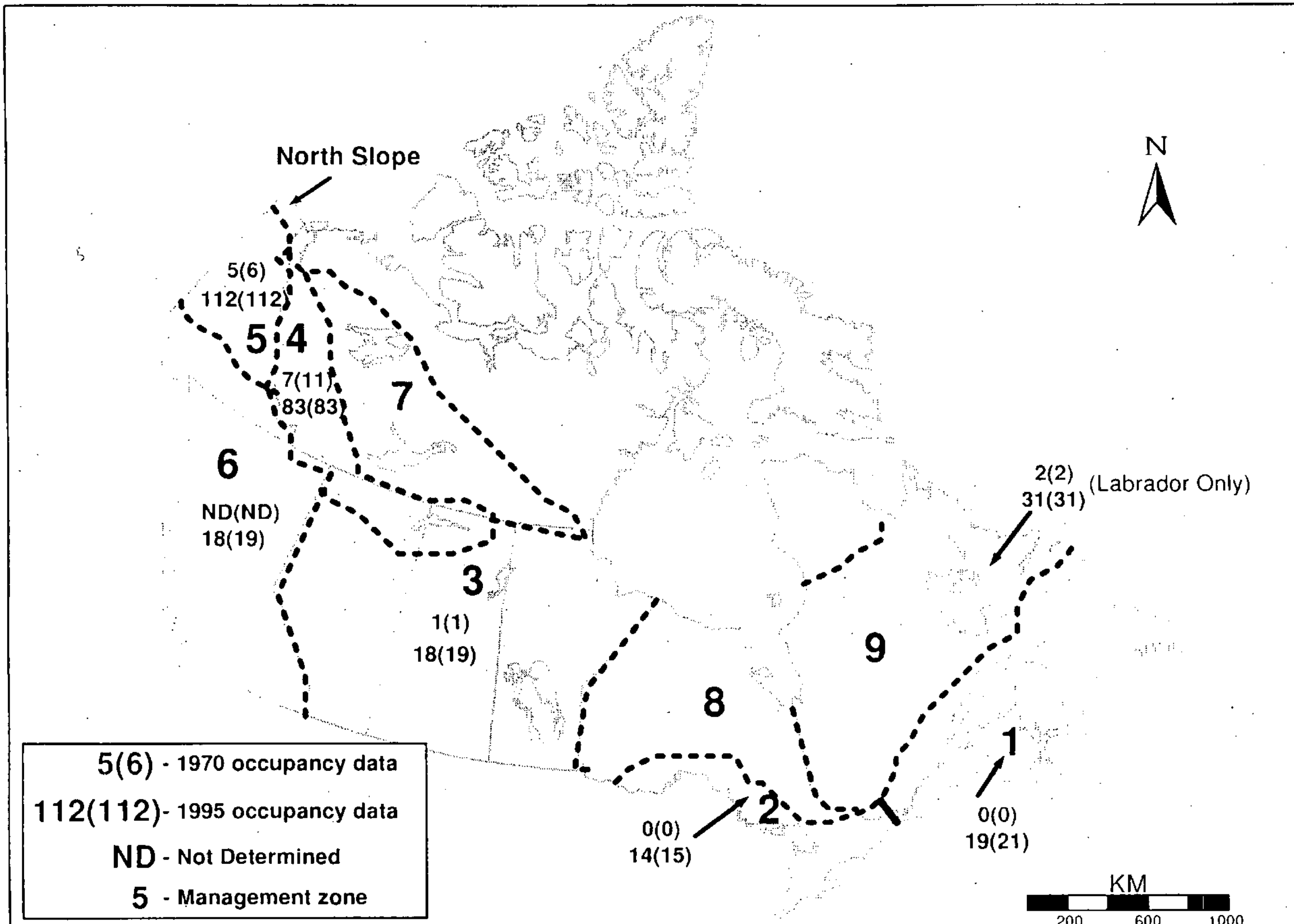

Figure 1. Anatum peregrine falcon management zones indicating the number of known territories occupied by pairs in 1970 and in 1995 with total known occupied territories in parentheses (Erickson et. al. 1988).

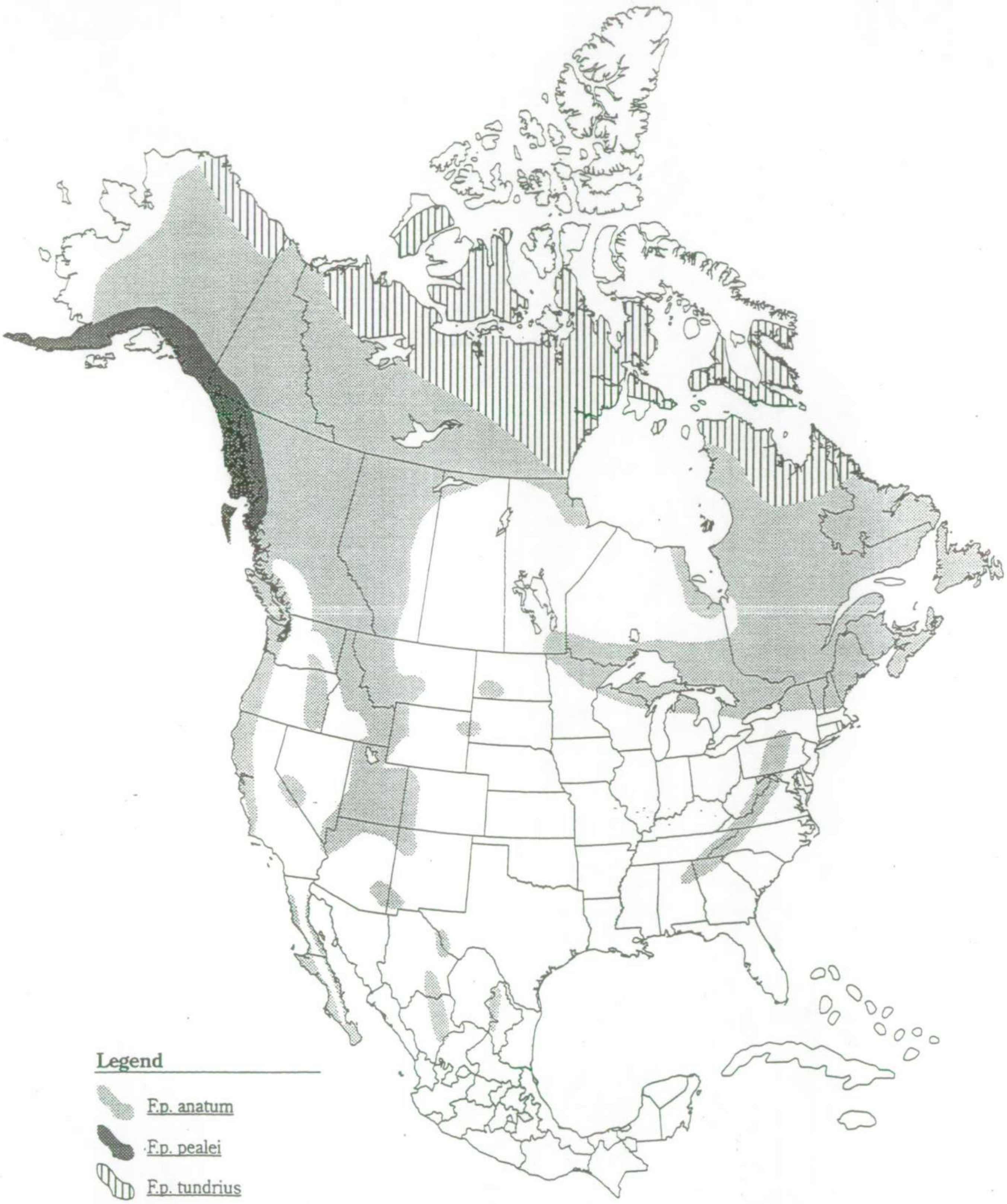

Figure 2. Historical breeding range of three subspecies of the Peregrine Falcon in North America. From: Rowell, P. and D.P. Stepnisky. 1997. Status of the Peregrine Falcon (Falco peregrinus anatum) in Alberta. Alberta Environmental Protection, Wildlife Management Division, Wildlife Status Report No. 8, Edmonton, AB. 23 pp.

Figure 3. Approximate current range of the anatum Peregrine Falcon in Canada. From: Peregrine Falcon (anatum) Recovery Update, RENEW Report No. 8, 1998-99, p. 26. Text researched and coordinated by L. Twolan and S. Nadeau, Canadian Wildlife Service, map created by D. Phillips. Minister of Public Works and Government Services/1998.

MANDATE

COSEWIC determines the national status of wild species, subspecies, varieties and nationally significant populations that are considered to be at risk in Canada. Designations are made on all native species for the following groups: fish, amphibians, reptiles, birds, mammals, molluscs, lepidoptera, vascular plants, mosses and lichens.

MEMBERSHIP

COSEWIC is comprised of representatives from each provincial and territorial government wildlife agency, four federal agencies (Canadian Wildlife Service, Parks Canada, Fisheries and Oceans, Canadian Museum of Nature), three national conservation organizations (Canadian Nature Federation, Canadian Wildlife Federation, and World Wildlife Fund Canada) and the chairs of the scientific species specialist groups. The Committee meets annually in April to consider status reports on candidate species.

DEFINITIONS

Species	- Any indigenous species, subspecies, variety or geographically defined population of wild fauna and flora.
Extinct (X)	- A species that no longer exists.
Extirpated (XT)	- A species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	- A species facing imminent extirpation or extinction.
Threatened (T)	- A species likely to become endangered if limiting factors are not reversed.
Vulnerable (V)	- A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.
Not at Risk (NAR)	- A species that has been evaluated and found to be not at risk.
Indeterminate (I)	- A species for which there is insufficient scientific information to support status designation.

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. COSEWIC meets annually in April each year. Species designated at this meeting are added to the list.

Environment Canada
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The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.