



# The Alberta GPI Accounts: Fish and Wildlife

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Report # 22

by

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## About the Pembina Institute

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The Pembina Institute is an independent, citizen-based organization involved in environmental education, research, public policy development and corporate environmental management services. Its mandate is to research, develop, and promote policies and programs that lead to environmental protection, resource conservation, and environmentally sound and sustainable resource management. Incorporated in 1985, the Institute's main office is in Drayton Valley, Alberta with additional offices in Calgary and Ottawa, and research associates in Edmonton, Toronto, Saskatoon, Vancouver and other locations across Canada. The Institute's mission is to implement holistic and practical solutions for a sustainable world.

The Green Economics Program is dedicated to designing and implementing practical, street-smart economic tools that would reorient society back to the original meaning of the word "economy"—the care and management of the wealth of the household. By developing new tools for measuring the true wealth or well-being of nations, we can help guide Canadians and Albertans to a sustainable future.

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## About this Report

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This is one of 28 reports that provide the background for the Genuine Progress Indicators (GPI) System of Sustainable Well-being Accounts. It explains how we derived the fish and wildlife sustainability indices that were earlier published in *"Sustainability Trends 2000: The Genuine Progress Statement for Alberta, 1961 to 1999."* The research for this report was completed early in 2001. The appendices provide further background and explanation of our methodology; additional details can be obtained by contacting the authors. Appendix A includes a list of all GPI background reports.

The Fish and Wildlife Report examines the status of species in Alberta. It puts a monetary value on fisheries and attempts to put a monetary figure on the value of wildlife. This report answers the following questions:

1. How many amphibians, reptiles, birds, mammals and fish are at risk at the present time?
2. How has the status of two indicator species, woodland caribou and grizzly bears, changed over time?
3. What is happening to fish stocks?
4. What is the trend in commercial fishing?
5. What is the economic value of fisheries?
6. How do we put an economic value on wildlife and what is it?

Unfortunately the conclusions are gloomy, with a large number of species at risk and fish stocks in dramatic decline. As the catch has fallen, the economic value of both recreational and commercial fishing has dropped. The prognosis for future woodland caribou populations is bad and for the grizzly bear it is highly uncertain.

## About the Authors

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**Mary Griffiths** joined the Pembina Institute as an Environmental Policy Analyst in May 2000. She brings strong research and policy analysis skills as well as an extensive background and in-depth understanding of a wide range of environmental issues. Mary works with the Energy Watch team on environmental and energy advocacy issues and with the Institute's Green Economics Program on genuine progress indicators for Alberta. She has long been an advocate for the protection of the environment, both in her previous employment and in her volunteer activities. Mary holds a Ph.D. (Medical Geography), University of Exeter, UK and a B.A. (Geography), University of Exeter, UK.

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The contents of this report are the responsibility of the Pembina Institute and do not necessarily reflect the views and opinions of those who are acknowledged above or the opinions or positions of Western Economic Diversification who helped fund the research.

We have made every effort to ensure the accuracy of the information contained in this document at the time of writing. However, the authors advise that they cannot guarantee that the information provided is complete or accurate and that any person relying on this publication does so at their own risk. Given the broad scope of the project and time constraints, it has not been possible to submit the entire report for peer review. The material should thus be viewed as preliminary and we welcome suggestions for improvements that can be incorporated in any later edition of the work.

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## 1. Executive Summary

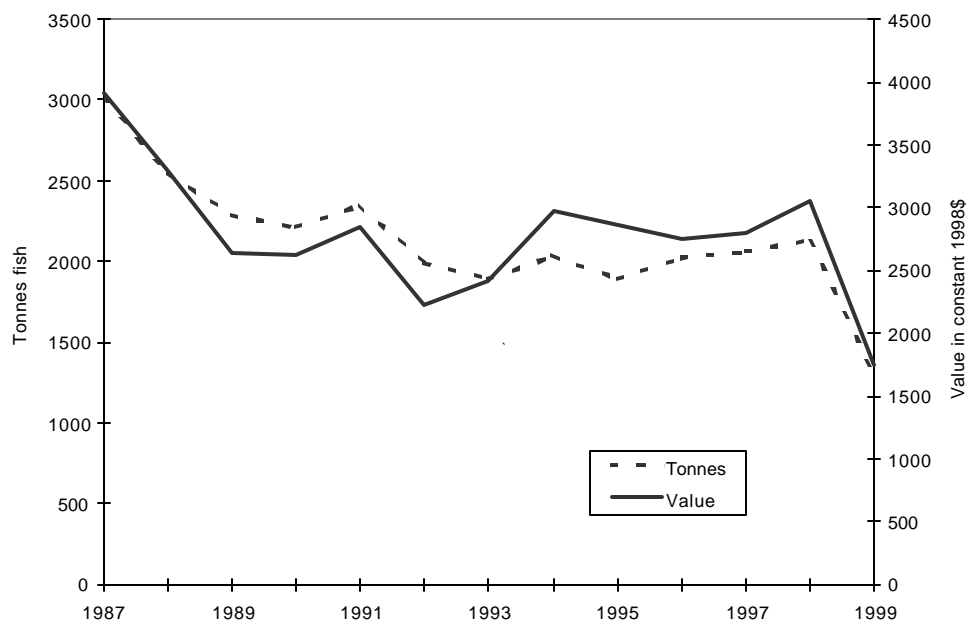
One-quarter of Alberta wildlife species are on the government's "red," "blue" or "yellow" list, which means they are at risk or may require special management or habitat protection to prevent their long-term decline. Loss of grasslands to agriculture has endangered the swift fox, burrowing owl and sage grouse. Forest fragmentation and human disturbance have affected large "keystone species" including the woodland caribou and grizzly bear whose numbers are far below historic levels and whose long-term sustainability is uncertain. Various birds, from tiny warblers to the trumpeter swan, are at risk as are some frogs, toads and snakes. One-quarter of fish species are at risk, due mainly to over-fishing. Bull trout, walleye, northern pike and perch have been seriously depleted and are subject to management plans, including "catch and release" and fishing bans. Despite government attempts to restock depleted fish populations, the number of anglers in Alberta has declined.

By 1995, the average number of fish kept per angler was half that of 1980. The decline in Alberta's commercial fish harvest is shown in the figure below.

### Noteworthy

- As the risk of extinction increases, a species moves from being classed as vulnerable to threatened, to endangered.
- The swift fox and five other species are "endangered" in Alberta.
- Wood bison are threatened.
- Woodland caribou, which once ranged over 2/3 of Alberta, were listed as a "threatened" species in 2000.
- Grizzly bears, once prolific across Alberta, are extinct on the Prairies and "vulnerable" elsewhere.
- The Alberta government has red, blue and yellow lists of species that, respectively, are at risk, may be at risk or require management to prevent their decline.
- 50% of amphibians and 38% of reptiles are on the red or blue lists.
- Loss of habitat is the main reason for species decline.
- One-quarter of fish species are at risk.
- Over-fishing is the main cause of fish stock depletions.
- The peregrine falcon has been downlisted from endangered to threatened.

### Decline in Alberta's Commercial Fish Harvest, 1987 to 1999



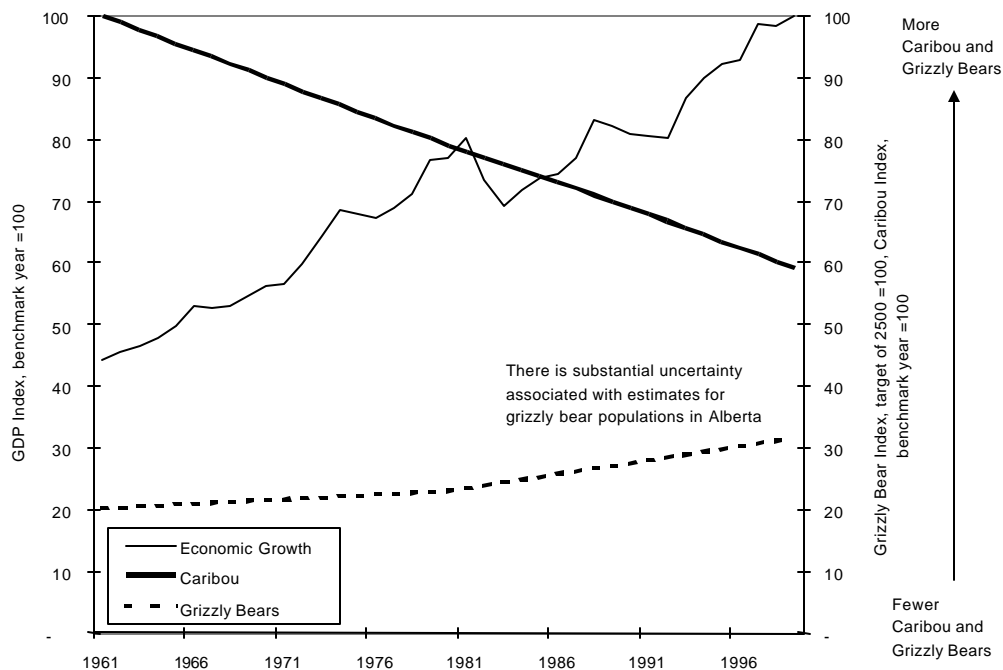
Source: Alberta Environment

## So What?

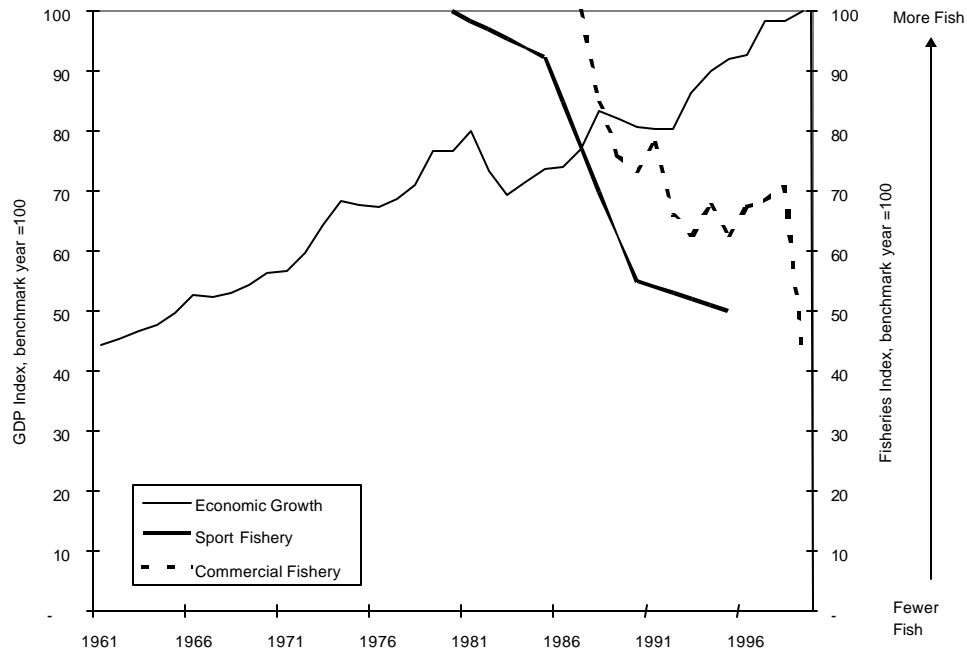
Life is priceless. Already, too many species in Alberta are at risk. The woodland caribou population has declined and grizzly bear numbers are uncertain, making it difficult to show exact trends on a chart. We need to reduce human impacts and protect habitat for vulnerable species. Alberta residents value nature highly, spending \$1.2-billion (1998\$) on nature-related activities in 1996, 20 percent more than in 1981. Yet the annual amount spent on sport fishing declined by 25 percent between 1985 and 1995 due to a decline in fish stocks. Revenues from commercial fishing have fallen by 50 percent since 1987. These are warnings to those who take nature for granted.

While the economic values of fish and wildlife are reflected in the GDP, many would argue that their intrinsic value is far greater. Research indicates a “willingness to pay” of between \$46 and \$200 a year per Albertan in additional taxes to ensure sustainable caribou populations; \$43 for a program to sustain trout; and \$28 for a grassland/burrowing owl program. Annual losses in commercial fishery revenues have been incurred since 1987. The direct annual cost to the economy was \$2.2-million (1998\$) in 1999. Between 1985 and 1995, recreational fishing expenditures declined in each five-year survey. Relative to the ten-year average between 1980 and 1990 (\$383-million, 1998\$), the annual expenditures in 1995 decreased by \$51.5-million (1998\$). Assuming the downward trend continued, the lost revenues in 1999 would be \$93.4-million. However, if we compare 1995 with the peak year of 1985, the loss is \$106-million and if we assume that the same rate of decline has continued to the present day, the loss is \$148-million.

## Alberta's Keystone Species Index



### Commercial and Sport Fishing in Alberta – Index



On the index for woodland caribou, 100 is the estimated population in 1960, while for grizzly bears it is set at a target of 2,500 bears. This is higher than the government target but may still be low for long-term sustainability. On the fishing index, the benchmark of 100 is the number of fish kept by anglers in 1980, while 1987 is taken as the benchmark year for commercial fishing, with zero as no fish harvested.



## 2. Wildlife at Risk

Loss of habitat and the impact of human activity are placing pressure on a wide range of species in Alberta. This is evident from both the national classification of Canadian Species at Risk completed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC)<sup>1</sup> and from the Alberta government's reports, *The Status of Wildlife in Alberta*.<sup>2</sup>

According to the COSEWIC classification, seven species are on the "endangered" list in Alberta: the swift fox, five birds and a tiny snail found in Banff National Park. Eleven species are on the "threatened" list, which means they are likely to become endangered if limiting factors are not reversed. A further 13 species are "vulnerable" because they are particularly sensitive to human activities or natural events. This is a sad picture for a province that is not yet 100 years old and that still has a very low density of population.

Unfortunately, the plight of several species continues to worsen. The burrowing owl, sage grouse and piping plover were moved from the threatened to endangered category in recent years, and in 2000 the boreal and southern mountain populations of the woodland caribou were listed as threatened for the first time. The grizzly bear was put on the vulnerable list in 1991, due to its sensitivity to environmental changes and over-harvest, even though its population is not actually declining. In total, the status of six species in the threatened and endangered categories has worsened over the last 15 years, while the status of only three has improved. For example, the swift fox, which had been extirpated in 1978 was downlisted to endangered in 1998, as a result of human efforts to re-establish the species in Alberta, and the wood bison was downlisted from endangered to threatened. Although this is an improvement, the future of these species is still a matter of concern.

In *The Status of Wildlife in Alberta*, the Alberta government uses a different classification from COSEWIC and places species of concern on one of four lists:<sup>3</sup>

- red list species are considered to be at risk;
- blue list species may be at risk;
- yellow list A species may require special management because of concern for their long-term decline; and,
- yellow B list species may require special management because of naturally rare or deteriorating habitats.

In total, 120 species—25 percent of all wildlife species in Alberta—are listed. Table 1 identifies the species on the red and blue lists, and Table 2 shows the total number of species in each category and the proportion of each category that are listed.

**Table 1: Species At Risk and Species That May Be At Risk in Alberta, 1999**

	<b>Red List (species at risk)</b>	<b>Blue List (species may be at risk)</b>
Amphibians	Canadian Toad, Great Plains Toad, Northern Leopard Frog	Plains Spadefoot Toad, Spotted Frog
Reptiles		Prairie Rattlesnake, Short-horned Lizard, Western Hognose Snake
Birds	Burrowing Owl, Peregrine Falcon, Piping Plover, Whooping Crane	Bay-breasted Warbler, Black-throated Green Warbler, Cape May Warbler, Ferruginous Hawk, Long-billed Curlew, Sage Grouse, Short-eared Owl, Sprague's Pipit, Trumpeter Swan
Mammals	Swift Fox, Wood Bison	Grizzly Bear, Ord's Kangaroo Rat, Northern Long-eared Bat, Red-tailed Chipmunk, Woodland Caribou, Wolverine

**Table 2: Number of Species at Risk and Number that May Require Special Management in Alberta, 1999**

	Red List	Blue List	Yellow A List	Yellow B List	Total Red, Blue, Yellow	Total # Species in Alberta	Percentage of Species on Red and Blue Lists	Percentage of Species on Red, Blue, Yellow Lists
Amphibians	3	2	-	1	6	10	50%	60%
Reptiles	-	3	3	2	8	8	38%	100%
Birds	4	9	17	50	80	374	3%	21%
Mammals	2	6	4	14	26	91	9%	29%
Total	9	20	24	67	120	483	6%	25%

As Table 2 shows, all the reptiles and 60 percent of the amphibians in Alberta are listed. One-fifth of birds and nearly one-third of mammals are also listed. Amphibians are probably suffering from loss of key habitat with the decline in wetlands, which increases the impact of drought. Habitat loss affects many species, with the loss of old growth forest probably the main factor in the decline of several warblers and the long-eared bat. The reduction in the area of natural prairie grassland is likely a factor in the decline of the long-eared curlew, while the sage grouse has been affected by the reduction in sagebrush grassland habitat. Loss of habitat due to human activities was first apparent in the southern part of the province, when the grasslands that were home to species like the swift fox and burrowing owl were cultivated. However, increasing fragmentation of the boreal forests in northern Alberta is now affecting species there, as seen by the recent addition of the woodland caribou to the threatened list.

One mammal on the red list, the woodland caribou, and another on the blue list, the grizzly bear, are suffering from the loss and degradation of wilderness habitat. Loss of old growth forest, and the associated lichens that form 80 percent of the caribou's winter food, is an important factor for that species, while human interference affects both species. Provided that indicator or "keystone" species like woodland caribou and grizzly bears can survive, it is probable that many other species living in these areas will also have adequate habitat. Thus the status of these species will be taken as an index of the status of wildlife in Alberta. This index neglects species that live in the Prairie grasslands and parklands. However, if animals that live in remote areas are being affected by humans, sensitive species that inhabit more densely settled areas are probably also at risk.

Alberta Environment and the Alberta Conservation Association were reviewing the status of both the woodland caribou and grizzly bear but as of December 2000 their reports were not public. Thus the following assessment is based on older reports and personal communications from experts in the field.

Two types of woodland caribou are found in Alberta: (1) a mountain variety found in the Rocky Mountains of west central Alberta and the foothills around Grande Cache, and (2) a forest-dwelling caribou found throughout northern Alberta. Woodland caribou once ranged over two-thirds of the province, from the alpine zone through the coniferous foothills and across the boreal forest. It appears they were still plentiful at the beginning of the century and it was not until 1929 that an Alberta Fish and Game annual report indicated that caribou range was shrinking and they needed protection. The decline in caribou numbers is described in Edmonds' *Woodland Caribou Provincial Restoration Plan*.<sup>4</sup> Writing in 1986, Edmonds stated that "As recently as the mid-60s there were an estimated 7,000 to 9,000 caribou but today there are estimated to be fewer than 2,000."<sup>5</sup> Edmonds tracked the decline in numbers by citing various unpublished government reports. In 1966, Stelfox estimated there were 7,000 to 9,000 caribou in Alberta,<sup>6</sup> but by 1973 Lynch and Pall estimated the number to be only 5,000.<sup>7</sup> A further decline, to between 1,500 and

3,500 caribou was reported by Bloomfield in another internal government report in 1980.<sup>8</sup> As Edmonds pointed out, “Traditional movement patterns and an innate curiosity make caribou vulnerable to over-hunting.” Yet it was not until 1980 that a complete ban on hunting was imposed. By 1985, the woodland caribou had been designated a threatened species.

Edmonds expressed particular concern for the unique mountain caribou herds that migrated annually from the forested area to the forested foothills and the Alpine zones in the Willmore/Grande Cache areas in west central Alberta. Their numbers are thought to have declined from about 1,200 to 200 between the mid-1960s and the mid-1980s, due to loss and disruption of habitat, over-hunting and wolf predation. Edmonds considered that at least 600 mountain caribou and 4,500 woodland caribou were required to prevent the ongoing decline and concluded that “Current information suggests a trend that at best is gradual decline and at worst extinction.”<sup>9</sup>

In 1994, the decline in caribou numbers was disputed by Bradshaw and Hebert, who thought that earlier figures might be underestimates, due to the difficulty in siting the animals in aerial surveys.<sup>10</sup> They pointed out that Edmonds later revised the 1986 figures, putting the provincial population at 3,350, which was more in line with the Alberta Woodland Caribou Conservation Strategy (in preparation when they wrote), which estimated between 3,300 and 6,200 woodland caribou in Alberta. However, these estimates were based on potential woodland caribou habitat availability, estimates of population density and the professional judgement of wildlife experts. There were few surveys of the number of caribou on the ground.

The Alberta government website states “There is little data on past and current population size of caribou in Alberta, but a recent assessment estimates that 3,600 to 6,700 caribou inhabit about 113,000 km<sup>2</sup> of northern and west central Alberta.”<sup>11</sup> They also note that they are listed as an endangered species and admit “These caribou are likely to become extirpated in Alberta if the factors causing their reduction in numbers are not reversed.” Alberta Environment staff agree that we still don’t have good estimates of caribou numbers but believe that the occupied range has declined, particularly in west central Alberta and portions of northern Alberta.<sup>12</sup>

**Figure 1: Estimates of the Number of Woodland Caribou in Alberta, 1960 to 2000**

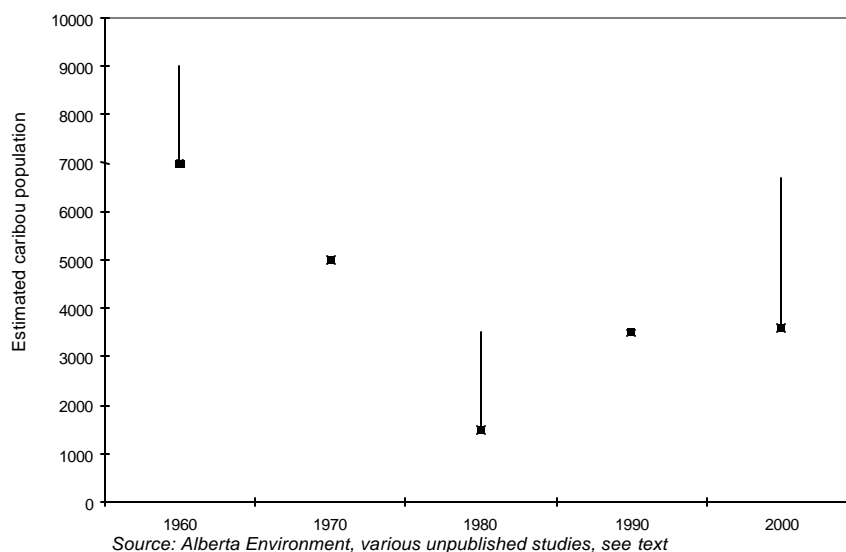


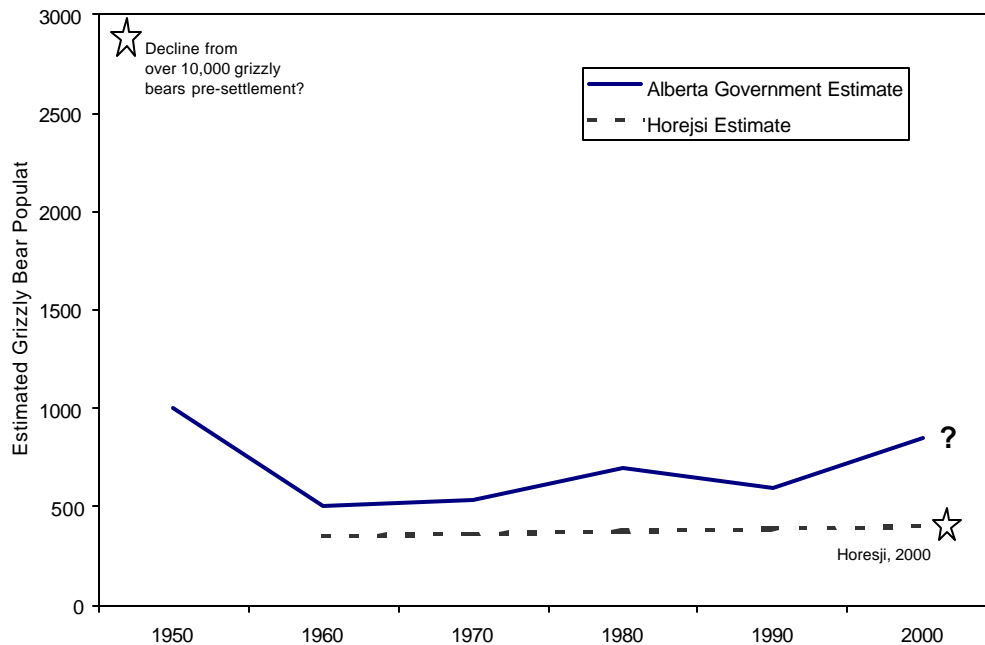
Figure 1 shows the estimated caribou population in each decade, with the lower and upper range where appropriate. Even with the wide variability in estimates, it is evident that the numbers are declining.

With respect to grizzly bear populations, there also is a great deal of uncertainty. Grizzly bears were once numerous throughout Alberta. Estimates of the number of bears in pre-settlement times are speculative, although we know that “Grizzlies were abundant in southern ‘Alberta’ until at least the 1850s, but were virtually eliminated by 1880.”<sup>13</sup> Wildlife scientist Dr. Brian Horejsi has estimated that there may have been between 9,920 and 16,525 grizzlies in Alberta when the Europeans arrived.<sup>14</sup> He points out “There were obvious ‘hot spots’ of abundance (Cypress Hills, Swan Hills, Rocky Mountain foothills) that would have contributed substantially to overall population size and may have meant that even more bears were present.”<sup>15</sup> Current grizzly bear range is restricted to about two-fifths of the province, along the western border. Grizzly bear numbers declined rapidly due to commercial and sport hunting, which led to a period of protection from the late 1920s until the 1940s. Despite the large provincial decline compared with pre-settlement times, there were still as many as 400 grizzlies in the Swan Hills area in the 1940s. However, “Protection was lax during the 1950s when killing of grizzlies was indiscriminate.”<sup>16</sup>

The first survey of hunters took place in 1968, the year that grizzly licences were introduced. At that time it is estimated there were about 500 grizzly bears in Alberta.<sup>17</sup> The fall grizzly hunt was terminated in 1969-70 and populations may have increased in the 1970s. By 1988, the Alberta government estimated there were 575 grizzlies on provincial land, with a total of 790 in all of Alberta, including the national parks.<sup>18</sup> In 1995, according to the Alberta government, “provincial lands were thought to harbour as many as 750 grizzlies; another 125 to 150 occur in the three mountain parks.”<sup>19</sup> However, estimates from independent scientists were more conservative, as shown in Figure 2. The population in the national parks is thought to have declined recently due to habitat degradation and human activities, which led to high rates of bear mortality due to human-bear conflict.

The Alberta government estimates that the provincial population is about 800 to 850 bears at the present time,<sup>20</sup> although this may better be called a “guesstimate.” It is based on extrapolation from the estimate of 575 grizzly bears in 1988, taking into consideration estimated annual mortality from hunting, poaching, accidental deaths and killing of problem wildlife as well as the translocation of bears, to provide a population figure for each region.<sup>21</sup> While DNA testing has been used to determine the number of bears in some areas, the provincial government estimates remain questionable and depend on extrapolation from these areas to the available habitat elsewhere. Sightings of bears are used to help understand over what geographical area the extrapolation should be based.<sup>22</sup> It is thus evident that there is a considerable degree of uncertainty about the current figures. If there were mistakes in the criteria used to estimate changes in the 1988 population, they will have become accentuated over time. For example, the number of bear sightings may be inflated, as the number of bears is not related to the number of sightings, but to the number of people. Thus it is not surprising that the provincial figure of around 850 bears is disputed. Horejsi considers there may be as few as 400 grizzly bears (plus or minus 100) two years of age or older in Alberta.<sup>23</sup>

**Figure 2: Estimated Grizzly Bear Population on Provincial Lands in Alberta, 1950 to 2000**



Source: Management Plan for Grizzly Bears in Alberta, 1988, Alberta Environment Grizzly Bear website and Brian Horejsi

These two estimates indicate a population density of one or two bears per 1000 km<sup>2</sup>, compared with historic densities of perhaps 15 to 25 bears per 1000 km<sup>2</sup>. While recognizing that a new government status report is expected soon, Horejsi believes there is a need for a new evaluation of the status of indicator or “keystone” species by an impartial panel of experts whose work is open to public review.<sup>24</sup> In the interim, caution is needed in interpreting the available data.

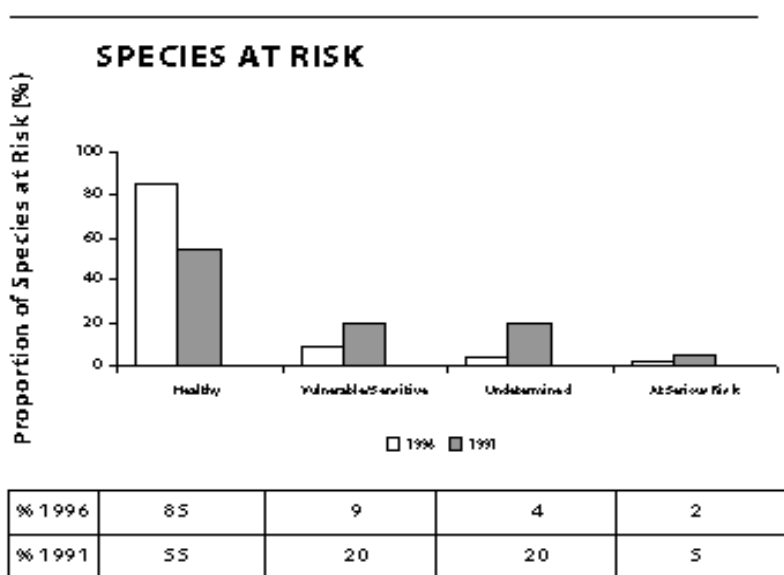
What we do know is that even the most generous estimate falls short of the government’s provincial population goal of 1000 grizzly bears<sup>25</sup> and that the future of the grizzly bear in Alberta is by no means assured. Not only is the grizzly bear now restricted to about two-fifths of its traditional territory across all Alberta, there has been a considerable increase in human activity in the areas where it is still found. This is due to the development of various natural resources (oil, gas, timber and agricultural products) as well as recreational pursuits. The question all Albertans must ask of themselves and their government is whether the continued development and export of our non-renewable and renewable natural capital is worth the price of lost grizzly and caribou populations? We also need to review, preferably through an open and public process, whether the government’s target of 1000 grizzly bears is reasonable. Horejsi asks: “If the province managed public lands according to Biodiversity Conservation Legislation, whose foundation was ecological sustainability, and whose working principles and practices required the use of the best available science, and whose specified objective was to manage wildlife and ecosystem services, such as wilderness and intact habitat, as resources of value equivalent to those commodity values presently being used under the existing strategy of preferential access by special commercial interests, what might we expect would be a reasonable management target for future bear numbers?” In response he states: “If we were to use the Province’s estimate of 354,425 km<sup>2</sup> in present day Bear Management Areas and had a very moderate expectation of only seven bears per 1000 km<sup>2</sup>, a density at which grizzly bear populations may not be viable in the long term, the

province could support 2,480 bears. If we used a density estimate of 15 bears per 1000 km<sup>2</sup>, an estimate associated with bear populations that are in some jurisdictions considered threatened, then a reasonable expectation would be 5,310 bears in Alberta.” After further discussion<sup>26</sup>, Horejsi concludes that “Given these kinds of numbers it should be obvious the government of Alberta, and the people of Alberta, have a lot of work to do. It should be equally obvious that, in setting its management target for 1,000 bears in Alberta, the equivalent of as little as 6 to 11 percent of historical numbers, the province has set its sights on the basement.”

As the number of species of concern is increasing, it could be argued that the situation summarized in Table 2 gives a better evaluation of the status of wildlife in Alberta than the figures used in the respective performance measure in the Alberta Environment Business Plan, which is shown in Figure 3.<sup>27</sup> According to the Business Plan, Figure 3 is based on 538 species (370 birds, 90 mammals, 60 fish, 10 amphibians, and 8 reptiles) and includes fish, which are not included in Table 2.<sup>28</sup> Figure 2 suggests that the proportion of healthy species increased dramatically between 1991 and 1996, but much of this change is due to the fact that the status of 20 percent of species was undetermined in 1991. When they were evaluated, the situation with respect to some species was considered healthy. Also some species (e.g., long-toed salamander) were moved to a lower category when more information was collected.<sup>29</sup>

The government target is to keep the percentage of species at serious risk below five percent and it appears that this has been achieved in Figure 3. However, many other species are at risk, even if the risk is not presently considered serious. Taking only those species on the red and blue lists, it is evident that six percent of species are or may be at risk, with the proportion being nine percent for mammals and 50 percent for amphibians. It may be too late to take action once a species is at serious risk or the cost of rehabilitation is very expensive. It is thus important to pay attention to the situation long before a species reaches the “serious risk” category and to measure changes in the situation of all species that may be suffering from deteriorating habitats. It is impossible to put a price on a species that becomes extinct and the fact that some major species are still losing ground in Alberta shows that current practices need to be changed if we are to ensure the sustainability of all species in this province.

**Figure 3: Species at Risk in Alberta, 1996**



Source: Alberta Environment Business Plan, 2000-2003<sup>30</sup>

In addition to studying the status of wildlife, it is important to record changes in the status of plants, mosses, lichens and plant communities generally. In 1996, the Alberta Natural Heritage Information Centre was set up within Alberta Environment to monitor the status of rare species, especially non-vertebrates. The geographical database records plants, plant communities, animals and landforms that are of concern, using literature sources. However, the Centre does not have the resources to systematically verify that a species is still found at the recorded locations.<sup>31</sup> It is thus not possible to evaluate what plants, mosses and lichens are currently at risk.

While this section focuses on species at risk, the status and future prospects of a species are closely tied to its habitat requirements. Further attention is paid to this aspect in *GPI Report 21: Parks and Wilderness*.

### 3. Declining Fish Stocks in Alberta

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*“Healthy, well-balanced fish communities in Alberta lakes should not only provide something to be harvested, but serve as an excellent measure of the quality of our aquatic environment and thus as a barometer for our own health and well-being.”<sup>32</sup>*

Unfortunately, the barometer has been reading low for several decades. According to the national COSEWIC classification, one species of fish has become extinct and three species have been extirpated from their habitat in Alberta (i.e., they no longer exist in Alberta, but are still found elsewhere).<sup>33</sup> Alberta Environment statistics show that of the 51 native fish species in Alberta, 12 are considered at risk, with three of those species at serious risk.<sup>34</sup> There are also nine exotic or introduced species in the province, bringing the total to 60.

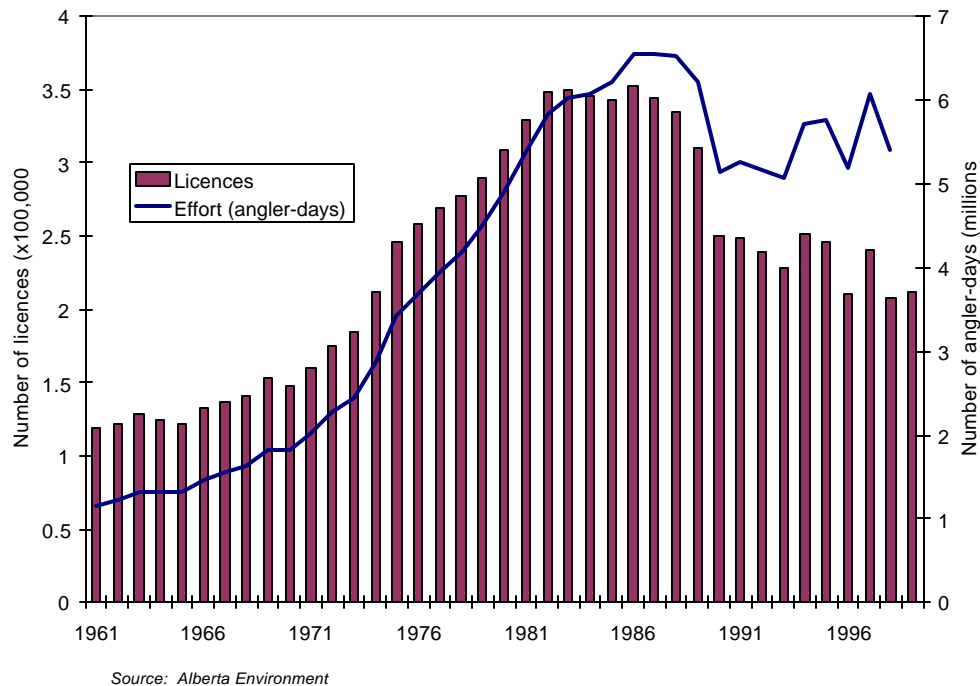
Bull trout was once the most abundant and widely distributed native trout species in Alberta. However, during the last century, its distribution and abundance have declined so dramatically that it is now classed as a vulnerable species.<sup>35</sup> In 1995, a management and recovery plan was introduced, requiring the release of any bull trout that are caught. In the following year, management plans were introduced for two other vulnerable species, lake sturgeon and arctic grayling.

Populations of the most popular cool water fish—walleye, northern pike and perch—have also been seriously depleted as a result of over-fishing. The Alberta government introduced size limits for walleye in the 1980s, then catch-and-release programs at many lakes in 1996. Following extensive public consultation, management plans for northern pike were introduced in 1999. Spring 2000 saw extensive closure of water bodies to protect spawning walleye, pike and perch in the Parkland and Boreal regions, and trout in the Eastern Slopes area.

In some lakes, especially in the mountain parks, the introduction of non-native species such as brook trout has eliminated the native bull trout. Parks Canada is considering the eradication of non-native species so that the indigenous fish populations can be re-established.

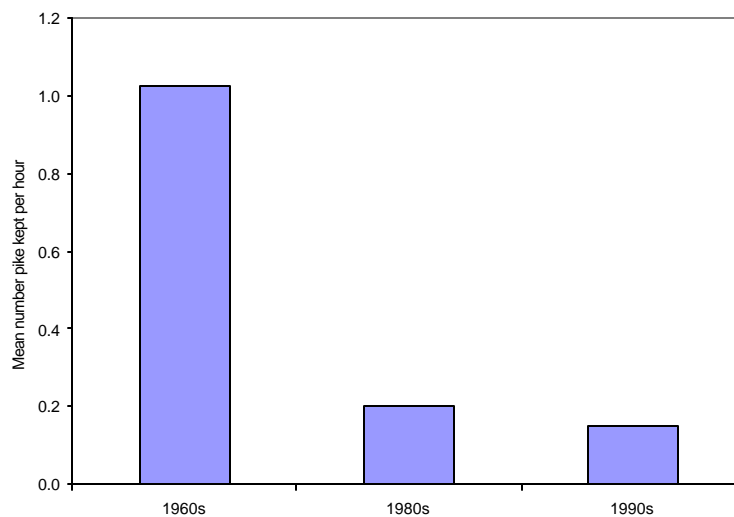
The decline in fish stocks has resulted in a decline in recreational fishing. The number of licensed anglers in Alberta appeared to peak in 1983/84 at 357,000. The actual number of anglers at that time was even higher—about 450,000—since seniors and those under 16, who are not required to have a licence, make up about 27 percent of the total sport angler population. The number of licensed anglers has since declined by 40 percent, to 212,000 in 1999 (Figure 4). However, the pressure on fish populations did not decrease as much as the drop in licences would suggest because, on average, anglers increased the time spent fishing. The angler effort, or average number of days an angler spends fishing each year, doubled between the mid-1970s and the mid-1990s (Figure 4).

**Figure 4: Number of Licensed Anglers and Fishing Pressure in Alberta, 1961 to 1999**



The decline in fish catches, as measured by the catch per unit effort, is clearly shown by the drop in the pike catch rate for nine major lakes in the boreal forest region of central Alberta (Figure 5). Each of these lakes showed a comparable decline. A similar story holds for other lakes and for other fish, such as walleye.

**Figure 5: Changes in Pike Catch Rate in Nine Alberta Boreal Lakes, 1960s to 1990s**



Source: Alberta Environment Data for Cold, Floatingstone, Hilda, Kehiwin, Ironwood, Moose, N. Buck, Pinehurst and Wolf Lakes



In a 1990 federal/provincial survey, 66 percent of anglers stated that the quality of fishing had declined between 1985 and 1990.<sup>36</sup> Unfortunately the same question was not asked in the 1995 Sport Fishing Survey. While both the 1990 and the 1995 surveys asked anglers to rate the current state of the Alberta fisheries, the questions were not identical so comparison between the surveys cannot be exact. In 1990, 46 percent of anglers stated that the fisheries were only fair or poor (compared with 20 percent who said they were very good or excellent). By 1995, it appears the situation had improved slightly, but 38 percent of anglers still considered that the fisheries were only fair or poor (while 28 percent classed them as good or excellent).<sup>37</sup> Thus even though the situation may have improved slightly, it is still grave and anglers continue to raise concerns about the state of Alberta's fisheries.<sup>38</sup>

It is evident that the main cause for the decline in fish stocks is not loss of habitat, as is the case with wildlife, but over-fishing. Alberta has the highest ratio of anglers to lakes in Canada, yet because of its northerly position, species mature and breed relatively slowly. Alberta Environment staff have compared the fish stocks in lakes on the Cold Lake Air Weapons Range, where there are few anglers, with lakes immediately adjacent that have identical physical conditions, but where there are a lot of anglers. The fish populations were much higher on the Cold Lake Range, suggesting the degree of fishing pressure is the reason for the difference in fish populations. While there has been a general decline in stream water quality in agricultural areas, and some sedimentation at specific sites, the major declines in walleye and pike populations in Alberta are widespread throughout both agricultural and relatively pristine boreal areas.<sup>39</sup>

Changes in fish population demography observed in Alberta also indicate that over-fishing is the problem. Stocks of older fish are lost first, followed by an increase in the numbers of young fish. As adult numbers decline further, the numbers of young fish then fall drastically. This pattern of fish loss has been observed as due to over-fishing, not as a result of habitat loss. Habitat changes (e.g., sedimentation, water quality decline) usually cause a loss of younger fish (or eggs) first, which then causes an overall population decline. This has not generally been noted in Alberta.

Over-fishing and the concomitant decline in fish stocks not only affect the pleasure of angling, they have several financial repercussions. First, there are costs to the local economy when anglers no longer come to fish. For example, as fish stocks were depleted at Floatingstone and Skeleton Lakes, the number of angler trips declined by 93 percent between 1985 and 1997. When the anglers left, the campground at Skeleton Lake closed.<sup>40</sup>

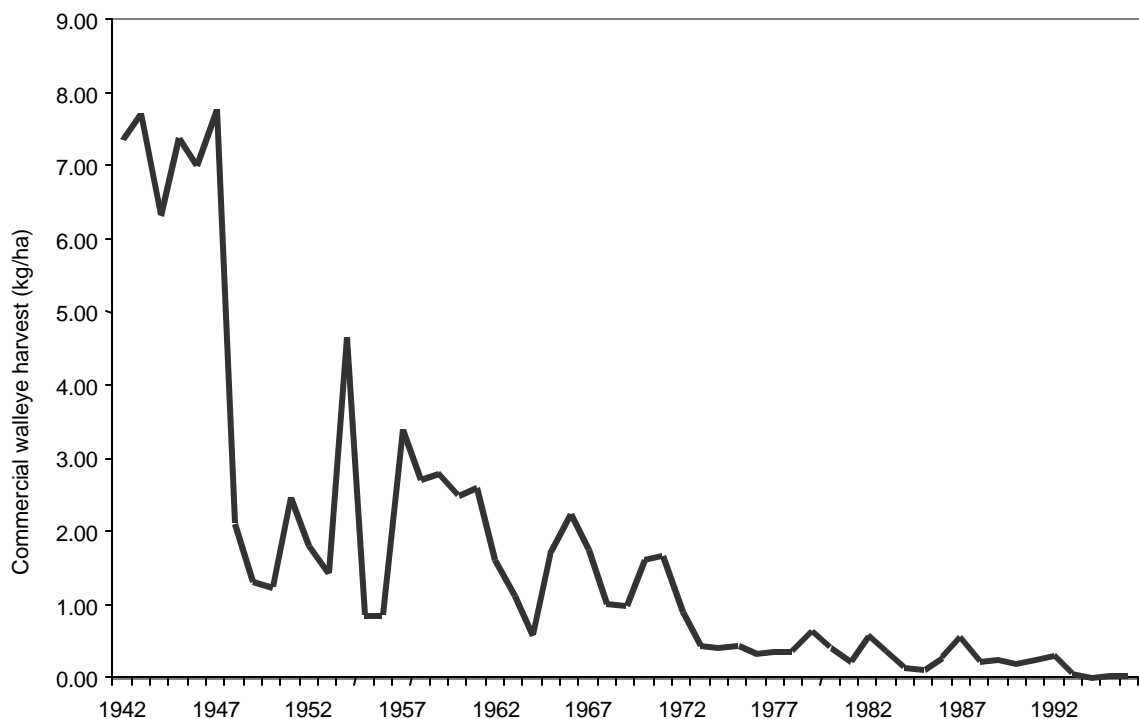
Secondly, there are costs to government as it attempts to maintain sport fishing by stocking selected lakes with millions of trout and walleye fry and fingerlings each year. In 1998, lakes were stocked with over 20 million walleye; in 1999, over 4.6 million trout and walleye were released from hatcheries. The cost of the total restocking program for walleye and trout was nearly \$3-million per year in the 1990s.<sup>41</sup> This program has helped compensate for declines in fish but was not enough to prevent a decline in sport fishing.

Further consideration is given to the economic impact of the decline in sport fishing later in this report.

## 4. Commercial Fishing

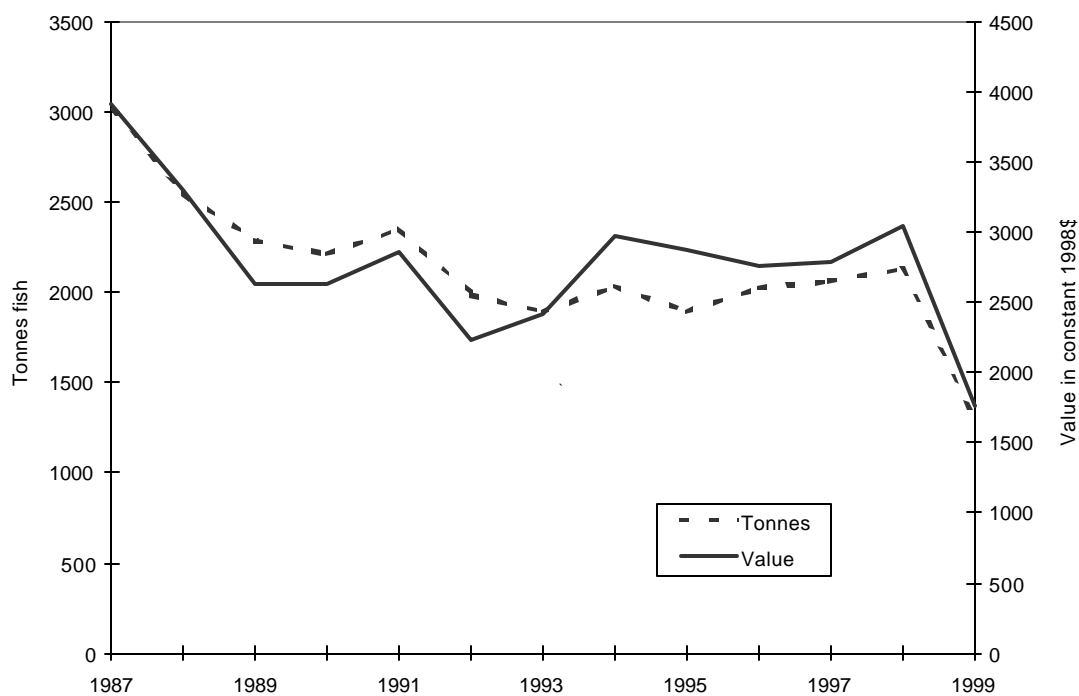
The effects of declining fish stocks have also been felt in the commercial fishery. Figure 6 shows how the commercial harvest of walleye in Alberta has declined in five major Alberta lakes since 1942. The decline is even more serious than the chart indicates, as figures for the 1940s are low compared with reports of yields at the beginning of the century.<sup>42</sup> The main commercial fish is now whitefish, a species that is lower on the food chain than the walleye. The value and volume of the total commercial fish harvest has not dropped like that of the walleye, but both the tonnage and the value (in constant dollars) show a downward trend since 1988/89, as seen in Figure 7.<sup>43</sup> The annual value of the commercial fish harvest declined by over half between 1987 and 1999, from \$3.9-million to \$1.7-million, in constant 1998 dollars.

**Figure 6: Commercial Walleye Harvest in Five Alberta Boreal Lakes, 1942 to 1996**



Source: Alberta Environment Data for Beaver, Calling, Lac La Biche, Touchwood and Wolf Lakes

**Figure 7: Alberta Commercial Fish Harvest, 1987 to 1999**



Source: Alberta Environment

The situation remains extremely serious for both sport and commercial fishing in Alberta, but there is a glimmer of hope. Sport angler success rates for catching walleye have increased at some lakes where strong restrictions on harvest were imposed in time. If stringent restrictions are kept in place, perhaps the barometer that measures the state of Alberta's lakes will start moving up.

## 5. The Economic Value of Fisheries in Alberta

Over the last 20 years, economists have developed several techniques for estimating the value of a fishery. These studies have sometimes been carried out as part of the review process to evaluate the impact of some new development. They have also been done to estimate the financial values for recreation, where amenities are provided free of charge.

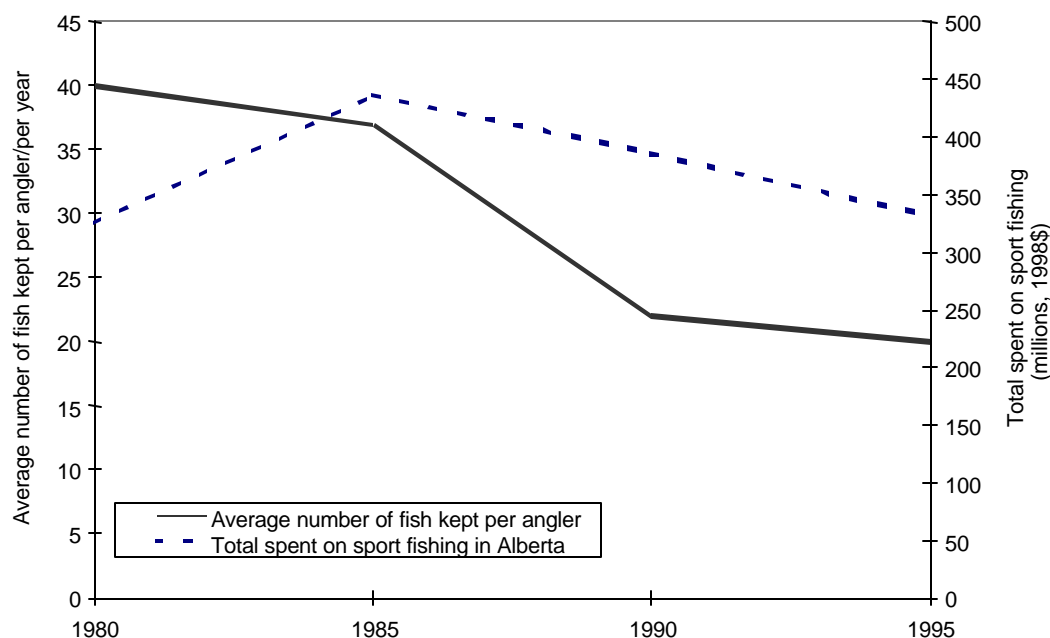
Surveys of sport fishing in Alberta have been done every five years since 1980. Data collected in these surveys are summarized in Table 3 (which was also used to create Figure 8).<sup>44</sup>

**Table 3: Sport Fishing in Alberta, 1980 to 1995**

	1980	1985	1990	1995
Total fish caught (millions)	n/a	19.6	13.7	15.3
Total days fished (millions)	4.5	5.4	3.3	3.7
Average number of fish kept per angler	40	37	22	20
Total spent on sport fishing (million\$)	155	295	321	312
Total spent in constant 1998\$ (millions) <sup>45</sup>	325	437	386	331

Source: Sport Fishing in Alberta, 1995<sup>46</sup>

**Figure 8: Total Expenditures on Sport Fishing and Number of Fish Kept per Angler in Alberta, 1980 to 1995**



Source: Sport Fishing in Alberta, 1995, Alberta Environment, and David K. Berry, Alberta Environment

The amount spent on sport fishing in Alberta, expressed in constant 1998\$, peaked in 1985 and has since declined to approximately the same level as in 1980. Therefore, as a result of declining fish stocks, the contribution of recreational fishing to the economy has decreased.

While the average number of fish kept per angler has fallen since 1980, the amount spent on sport fishing began declining after 1985. The amount spent on sport fishing in 1995 was 24 percent lower than in 1985 (as measured in constant 1998\$<sup>47</sup>), having declined from \$437-million to \$331-million. The average annual expenditure between 1980 and 1990 was \$383-million (1998\$). Relative to this 10-year average, the annual expenditures in 1995 decreased by \$51.5-million (1998\$), resulting in a loss of direct revenues. If we assume that expenditures have remained steady since 1995, the cost due to loss in revenues in 1999 was also \$51.5-million. However, if the rate of decline in spending observed between 1985 and 1995 continued, the amount spent on sport fishing in 1999 would be as low as \$290-million, only two-thirds of the peak level in 1985 (\$148 million less), and \$93.4-million less than the 10-year average (1998\$).

Although the amount spent in 1995 had fallen back to the 1980 level (in constant 1998\$), the average number of fish kept was only half the number kept per angler in 1980, so it could be argued that the average angler was getting only half the return on expenditure that was obtained in 1980 (Figure 8). While the amount spent on sport fishing may have declined by one-third between 1985 and 1999 (based on extrapolation from 1995 to 1999), we know for certain that the revenue from commercial fishing fell by half between 1987 and 1999 (in constant 1998\$). Combining the total estimated value of sport fishing (\$290-million) with the revenue from commercial fishing (\$1.75-million), it appears that the total economic value of fishing in Alberta in 1999 was well under \$300-million. Against these revenues must be put the costs incurred by government in attempting to replenish fish stocks. The total restocking program for walleye and trout was nearly \$3-million per year in the 1990s.

The above figures are based on the *Sport Fishing in Alberta* surveys conducted across Canada every five years by the federal Department of Fisheries and Oceans (DFO). The survey focuses on about 5,000 licensed anglers in Alberta and has a response rate of around 50 percent. It includes both resident anglers and anglers from outside the province who come to Alberta to fish. As a result, the DFO study is the most comprehensive survey for the province of Alberta.

The total amount spent on sport fishing in Alberta according to the 1995 *Sport Fishing in Alberta* survey is approximately double that estimated in another survey conducted by Environment Canada in 1996 on *The Importance of Nature to Canadians: The Economic Significance of Nature-Related Activities*. The Environment Canada study estimates the expenditures by Alberta residents only. It estimated total expenditures of \$148-million on recreational fishing, including expenditures for accommodation, transportation, food and equipment (in 1996\$). There is no immediate explanation for the difference and it is beyond the scope of the present study to undertake an in-depth comparison of sampling techniques used to conduct these surveys. However, there is less discrepancy in the estimate of the average spent per participant per year. In this case the Environment Canada figure is higher, with an estimated \$409 being spent per participant in 1996 (in 1996\$), compared with \$312 for the 1995 DFO Survey (in 1995\$).

The above surveys estimate the total value of fishing in Alberta, but some studies attempt to provide a more detailed assessment of the value of fisheries in specific locations.

*The Bow River Recreation Study: Assessment of Recreational Use and Economic Benefits*<sup>48</sup> is based on a sample survey of those using the river between the Bearspaw Dam in the west and the Blackfoot Indian Reserve in the east, between May 1986 and May 1987. Fishing on this major

southern Alberta river was by far the most important aspect of water-based recreation, with 58 to 97 percent of all water-based activities involving fishing. The average expenditure on recreation was \$22.12 per user-day and total expenditures for water-based recreation were estimated to be \$2.22-million. The survey asked respondents how much they would be willing to pay to access the river, if it were not free. The benefit of river use or “consumer surplus” amounted to approximately \$7.61 per user per day for water-based recreation, with a total value of \$0.85-million.

Another study on the socio-economic value of native trout species makes use of a stated preference model to assess the recreational impacts of the proposed Little Bow River Project/Highwood Diversion plan.<sup>49</sup> The main finding was that the public at large seems to be relatively indifferent as to whether a stream contains native or non-native trout species. Despite the problems with the model used, the author claims that stated preference models give economists a new and more valid tool for assessing the economic implications of changes in fisheries management practice.

However, while recognizing that there are other values not covered by the actual amount spent on sport fishing or the economic value of the commercial fish catch, these alternative evaluations do not cover the whole province. There was insufficient time for us to further investigate the full value of fisheries in Alberta, but future research could address this issue. While it is possible to measure some losses in monetary terms, as has been done here and in an earlier section, it is not possible to put a price on what is lost with the decline in the integrity of the ecosystem. These “existence” values, which are the most important of all, are priceless.

## 6. The Economic Value of Wildlife in Alberta

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Since 1981, Environment Canada has conducted four surveys on the importance of wildlife and nature to Canadians. The 1996 report on *The Importance of Nature to Canadians: The Economic Significance of Nature-Related Activities* provides a recent picture of the importance of wildlife and wildlife-related activities in Alberta.<sup>50</sup> This report states that residents of Alberta spent \$1.17-billion (\$1.21-billion in 1998\$), on nature-related activities during 1996, including expenditures on accommodation, transportation, food, equipment and other costs associated with nature-related activities. The breakdown shows that they spent \$902-million on outdoor activities in natural areas, \$172-million on wildlife viewing, \$148-million on recreational fishing and \$71-million on hunting. The report warns that these sums cannot be added together to create the total, due to the manner in which secondary expenditures were calculated.

The Environment Canada study also measured the amount that Alberta residents were willing to pay, in addition to their 1996 expenditures, before deciding to forgo nature-related activities. This part of the survey was intended to derive the value of the activities that were not reflected in the market expenditures, as natural areas and wildlife are common property areas and nature activities often take place outside of the marketplace.<sup>51</sup> Albertans indicated they would be willing to pay an additional \$219.4-million (\$227.8-million in 1998\$) before deciding to forgo their nature-related recreation. This willingness-to-pay approach provides a measure of the direct benefits participants derive from their recreational activities. The study points out that “Knowledge of the magnitude of the economic benefits derived from the enjoyment of natural assets ... contributes to assessing the benefits that may be lost if these assets are degraded.”<sup>52</sup> The measure also provides a standard against which to measure future performance. “Because natural areas and wildlife are renewable resources managed by the current generation in trust, management activities should strive to maintain the annual direct benefits of \$219.4-million nature-related activities provide to residents of Alberta in perpetuity.”<sup>53</sup>

The “Importance of Nature to Canadians” Survey has been undertaken every five years since 1981. Unfortunately, the surveys are not completely comparable because the questions have varied somewhat. However, to give a general estimate of trends it can be noted that in 1981, the amount spent on accommodation, transport, food, equipment, and other items for wildlife-related activities totaled \$550-million (\$1.039-billion in constant 1998\$).<sup>54</sup> In 1996, this increased to \$1.2-billion (\$1.25-billion in constant 1998\$) or an increase of 20 percent in constant dollars. If one adds to this the estimated \$219.4-million in direct benefits (\$227.8-million in 1998\$), the total value of wildlife in Alberta in 1996 was \$1.39-billion (\$1.44-billion in 1998\$).

Further economic benefits due to expenditures on nature-related activities in Alberta have been determined using Statistics Canada’s Input-Output model. The following economic impacts were generated based on the 1996 expenditures in Alberta:<sup>55</sup>

- \$2.78-billion (\$2.89-billion 1998\$) in gross business production;
- \$1.59-billion (\$1.65-billion 1998\$) in gross domestic product;
- \$360-million (\$373.8-million 1998\$) in government revenue from taxes;
- \$707.9-million (\$735.1-million 1998\$) in personal income; and
- 23,590 jobs were sustained.

The total value of wildlife is probably higher than the amount indicated by nature-related expenditures and the additional direct benefit derived from participants’ willingness-to-pay, which focuses on the recreational or “consumptive” values of wildlife, such as hiking, wildlife viewing, hunting and fishing. In fact, wildlife also has ecological, educational, spiritual and historical values that are not reflected in the willingness-to-pay figures (which cover only what people are willing to pay for activities they can undertake). Even if one can estimate a value for the “consumptive” uses of wildlife, based on willingness-to-pay, it is easy to ignore the value of species that have no apparent economic price tag.

In this current analysis, we propose using indicator or “keystone” species\* as an indicator of the integrity of an ecoregion and as a means to put a value on wildlife for the GPI. A few attempts have been made to put a price tag on keystone species. In 1995, a sample of Edmonton residents was asked to provide a “willingness-to-pay” estimate for management plans that would increase the populations of mountain-dwelling woodland caribou.<sup>56</sup> The results indicated that those surveyed were willing to pay higher taxes, experience restrictions on recreation and see decreases in employment in the region to improve the sustainability of woodland caribou. The most conservative estimates indicated that respondents would be willing to pay about \$75 a year more tax per household to ensure sustainable caribou populations, and up to \$200 under some scenarios.

Another trade-off analysis was conducted to determine the willingness to pay for three preservation programs involving old growth forests that provide habitat for woodland caribou in west central Alberta, prairie grasslands that contain habitat for the burrowing owl, and a mountain/foothill stream that provides habitat for the vulnerable bull trout.<sup>57</sup> Respondents in this study were willing to pay \$46 a year in taxes for the boreal forest/woodland caribou program (considerably less than in the study cited above). The average estimated “extra tax” value for the aquatic/trout program was \$43 a year and \$28 a year for the grassland/burrowing owl program. The difference in results between the two surveys indicates how difficult it is to put a value on wildlife, even using a relatively similar “willingness-to-pay” technique in both studies. Measuring the real value of a species to an ecosystem would be far more complex.

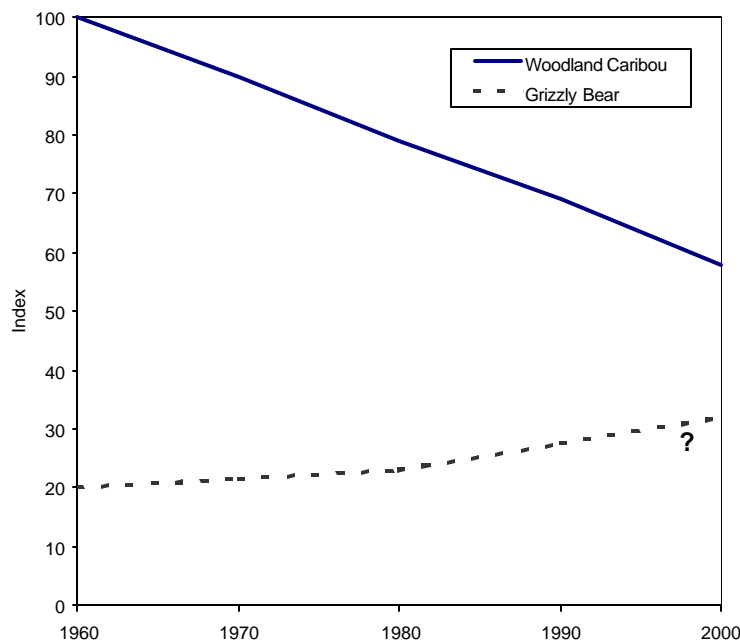
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\* A “keystone” species is one that has an effect on its system beyond the scope of its relative population.

## 7. Indices for Fish and Wildlife

As indicated above, woodland caribou and grizzly bears are “keystone” or “indicator” species. If there is enough habitat for these species to thrive, then it is likely that there is sufficient habitat for other species to thrive. The status of these two indicator species is used to create the wildlife index, although it does not include species that live in settled areas of the province. However, if species that live in the most remote areas of the province are at risk, then the status of species of concern in other more populous areas is not likely to be any better. The index is based on the estimated populations of woodland caribou and grizzly bears in 1960 and at the present time. As indicated in the text above, these indices should be regarded with extreme caution. We do not know for certain whether the status of grizzly bears has improved since the last estimate in 1988, as figures are based on extrapolation using a relatively simple formula. We may have a better idea of the current situation when the government’s new status report is released, provided it is subject to peer scientific and public review. Even the best estimate puts the numbers at less than the government target of 1000 grizzly bears and, given the pressures on habitat, the science and history of bear conservation clearly indicate that numbers will not be sustainable in the long term. The value of 100 on the grizzly bear index is set at a target of 2,500 bears. This is higher than the government target, but is Horejsi’s lower value for a long-term target (see above). As he points out, even 2,500 bears may not be a viable population for long-term sustainability. In 1960, the index stood at 20; by 2000 it may have risen to 32, but its actual position is a matter of debate.

**Figure 9: Indices for Keystone Species in Alberta, Woodland Caribou and Grizzly Bear, from 1960 to 2000**



Because of the variation in estimates of caribou population, the caribou index is based only on estimates for 1960 and the current time period with the line indicating the general trend. For woodland caribou, 100 on the index is the benchmark year, 1960. By 2000 it had declined to 58.

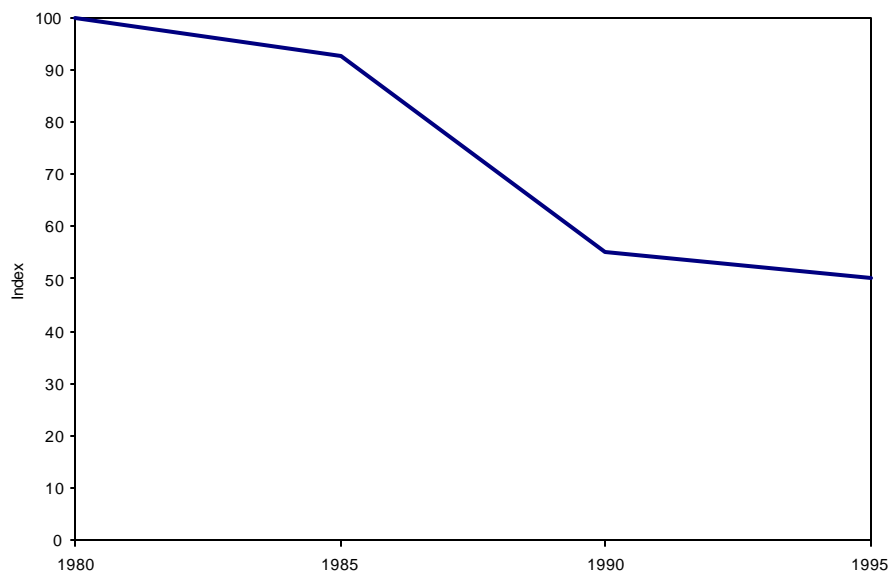


Continued habitat loss and fragmentation due to land use for both forestry and oil and gas development are the main reasons for concern over the future status of many other species and are described in further detail in *GPI Report #20 on Forests*.

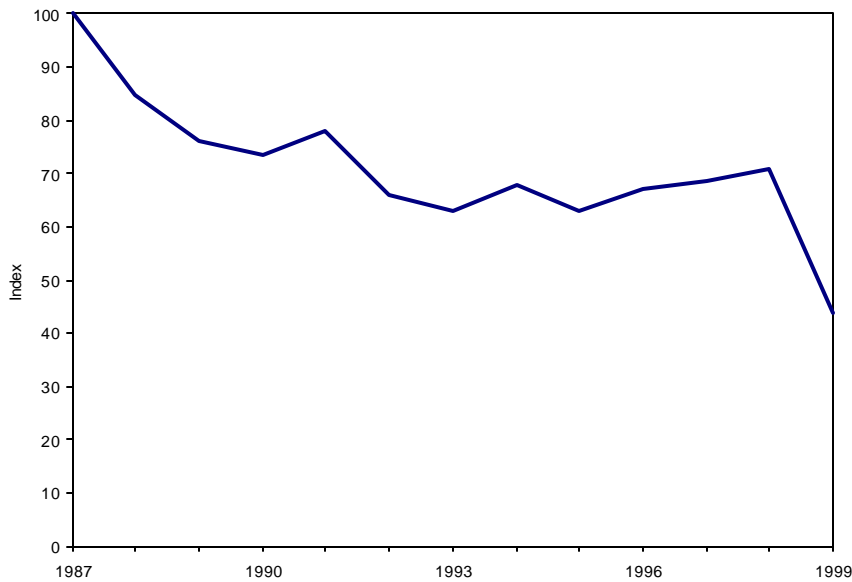
As an alternative to an index based on two keystone species we considered creating an index of the current status of all wildlife data. However, because the status of many species was undetermined in the Alberta government's 1991 evaluation of the Status of Wildlife in Alberta, there was no suitable time series for construction of a meaningful index based on the Alberta classification system. A similar problem exists with the COSEWIC list, for as new species are evaluated and added over the years, the base number changes. The best way to obtain a valid index for the future would be to closely monitor the actual populations of grizzly bear, woodland caribou and other selected keystone species that live in other natural regions, and to relate changes in their actual population with evidence of land use and human disturbance that may have an impact on the area of their effective habitat.

The viability of fish species is also a matter of concern. If we consider the total number of fish kept per angler, with 1980 as the target year (100) and zero on the index as the point when no fish are kept, the index is 50 for 1999 (Figure 10). If the index is based on the volume of the commercial fish harvest, with 1987 as the target year and zero as zero commercial fish harvest, the status is 44 for 1999 (Figure 11). However, if the commercial walleye harvest were used as the basis for the index, the status would be zero. These trends indicate that the current status of fishing in Alberta is not sustainable.

**Figure 10: Status of Fishing Index Based on Number of Fish Kept per Angler in Alberta**

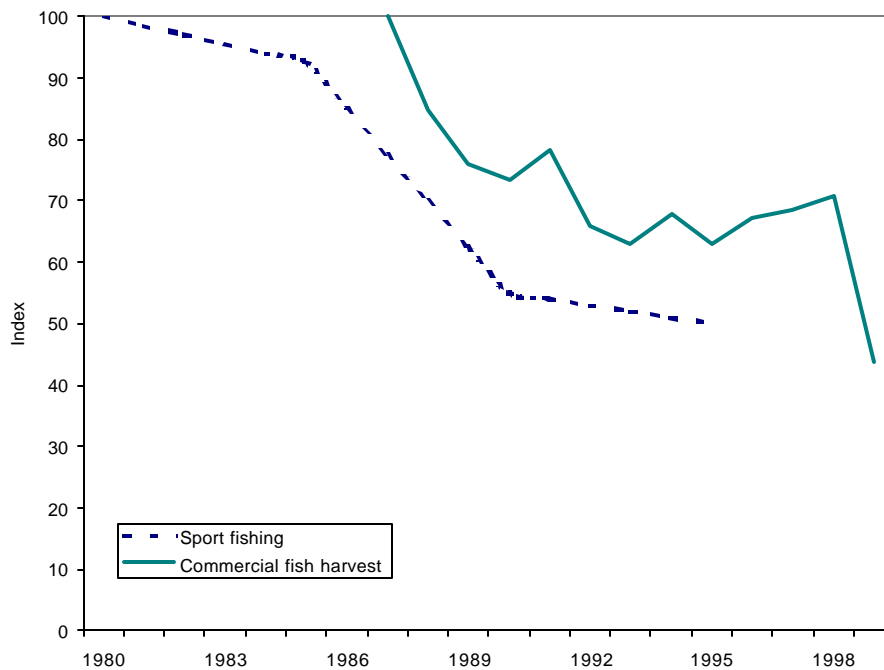


**Figure 11: Status of Fishing Index Based on Size of Commercial Fish Harvest in Alberta**



The two indices can be combined on one chart, as shown in Figure 12.

**Figure 12: Status of Fishing Indices for Sport and Commercial Fishing in Alberta**



## Appendix A. List of Alberta GPI Background Reports

A series of Alberta GPI background reports accompanies the *Alberta Sustainability Trends 2000* report and this report. These documents are being released in late 2001 and early 2002 and will be available on the Pembina Institute's website at [www.pembina.org](http://www.pembina.org).

### Alberta GPI Background Reports and Sustainability Indicators

GPI Background Reports	GPI Accounts Covered by Report
1. Economy, GDP, and Trade	<ul style="list-style-type: none"><li>• Economic growth (GDP)</li><li>• Economic diversity</li><li>• Trade</li></ul>
2. Personal Consumption Expenditures, Disposable Income and Savings	<ul style="list-style-type: none"><li>• Disposable income</li><li>• Personal expenditures</li><li>• Taxes</li><li>• Savings rate</li></ul>
3. Money, Debt, Assets and Net Worth	<ul style="list-style-type: none"><li>• Household debt</li></ul>
4. Income Inequality, Poverty and Living Wages	<ul style="list-style-type: none"><li>• Income distribution</li><li>• Poverty</li></ul>
5. Household and Public Infrastructure	<ul style="list-style-type: none"><li>• Public infrastructure</li><li>• Household infrastructure</li></ul>
6. Employment	<ul style="list-style-type: none"><li>• Weekly wage rate</li><li>• Unemployment</li><li>• Underemployment</li></ul>
7. Transportation	<ul style="list-style-type: none"><li>• Transportation expenditures</li></ul>
8. Time Use	<ul style="list-style-type: none"><li>• Paid work time</li><li>• Household work</li><li>• Parenting and eldercare</li><li>• Free time</li><li>• Volunteerism</li><li>• Commuting time</li></ul>
9. Human Health and Wellness	<ul style="list-style-type: none"><li>• Life expectancy</li><li>• Premature mortality</li><li>• Infant mortality</li><li>• Obesity</li></ul>
10. Suicide	<ul style="list-style-type: none"><li>• Suicide</li></ul>
11. Substance Abuse; Alcohol, Drugs and Tobacco	<ul style="list-style-type: none"><li>• Drug use (youth)</li></ul>
12. Auto Crashes and Injuries	<ul style="list-style-type: none"><li>• Auto crashes</li></ul>
13. Family Breakdown	<ul style="list-style-type: none"><li>• Divorce</li></ul>
14. Crime	<ul style="list-style-type: none"><li>• Crime</li></ul>
15. Gambling	<ul style="list-style-type: none"><li>• Problem gambling</li></ul>
16. Democracy	<ul style="list-style-type: none"><li>• Voter participation</li></ul>
17. Intellectual Capital and Educational Attainment	<ul style="list-style-type: none"><li>• Educational attainment</li></ul>
18. Energy (Oil, Gas, Coal and Renewable)	<ul style="list-style-type: none"><li>• Oil and gas reserve life</li><li>• Oilsands reserve life</li></ul>
19. Agriculture	<ul style="list-style-type: none"><li>• Agricultural sustainability</li></ul>
20. Forests	<ul style="list-style-type: none"><li>• Timber sustainability</li><li>• Forest fragmentation</li></ul>
21. Parks and Wilderness	<ul style="list-style-type: none"><li>• Parks and wilderness</li></ul>

<b>GPI Background Reports</b>	<b>GPI Accounts Covered by Report</b>
22. Fish and Wildlife	<ul style="list-style-type: none"><li>• Fish and wildlife</li></ul>
23. Wetlands and Peatlands	<ul style="list-style-type: none"><li>• Wetlands</li><li>• Peatlands</li></ul>
24. Water Resource and Quality	<ul style="list-style-type: none"><li>• Water quality</li></ul>
25. Energy Use Intensity, Greenhouse Gas Emissions and Air Quality	<ul style="list-style-type: none"><li>• Energy use intensity</li><li>• Air quality-related emissions</li><li>• Greenhouse gas emissions</li></ul>
26. Carbon Budget	<ul style="list-style-type: none"><li>• Carbon budget deficit</li></ul>
27. Municipal and Hazardous Waste	<ul style="list-style-type: none"><li>• Hazardous waste</li><li>• Landfill waste</li></ul>
28. Ecological Footprint	<ul style="list-style-type: none"><li>• Ecological footprint</li></ul>

## Appendix B. Fish and Wildlife Index Data

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**Estimated Grizzly Bear Population from Alberta Environment and Brian Horejsi and Index, where target is 2,500 bears**

	<b>Grizzly Bear Estimated Population</b>		
	<b>Alberta Environment</b>	<b>B. Horejsi</b>	<b>Index</b>
1950	1000		
1960	500	350	20
1970	530	362.5	21.5
1980	700	375	23
1990	600	387.5	27.5
2000	850	400	32

**Estimated Woodland Caribou Population, from various studies and Index, where target is mean 1960 population estimate of 8,000 woodland caribou**

<b>Woodland Caribou - estimated population from various studies described in text</b>				
	<b>High</b>	<b>Mean</b>	<b>Low</b>	<b>Index*</b>
1960	9000	8000	7000	100
1970	5000	5000	5000	90
1980	3500	2000	1500	79
1990	3500	3500	3500	69
2000	6700	4650	3600	58

\* As there was so much uncertainty about the woodland caribou population, the index is based on the mean values for 1960 and 2000, with interpolation for the intervening years. Please see text for more information.

**Commercial Fish Harvest in Tonnes and Number of Fish Kept Per Angler in Sport Fishing. Commercial Fish Index has fish harvest in 1987 as benchmark of 100 and Sport Fishing has number of fish caught in 1980 as benchmark of 100**

	Commercial Harvest in Tonnes	Index	Sportfishing - # of Fish Kept per Angler	Index
1980			40	100
1981				98.5
1982				97
1983				95.5
1984				94
1985			37	92.5
1986				85
1987	3006	100		77.5
1988	2548	85		70
1989	2286	76		62.5
1990	2209	73	22	55
1991	2350	78		54
1992	1986	66		53
1993	1889	63		52
1994	2035	68		51
1995	1888	63	20	50
1996	2023	67		
1997	2061	69		
1998	2129	71		
1999	1312	44		

## Endnotes

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- <sup>1</sup> Committee on the Status of Endangered Wildlife in Canada (COSEWIC), April 1999 and May 2000. *Canadian Species at Risk*.
- <sup>2</sup> Alberta Environment, 1996. *The Status of Wildlife in Alberta* and Alberta Environment website at <http://www.gov.ab.ca/env/fw/status/>
- <sup>3</sup> Alberta Environment, 1996. *The Status of Wildlife in Alberta* and Alberta Environment website at <http://www.gov.ab.ca/env/fw/status/>
- <sup>4</sup> Edmonds, J. 1986. *Woodland Caribou Provincial Restoration Plan*, Alberta Forestry, Lands and Wildlife, Fish and Wildlife Division. Draft not for public distribution, but read with permission.
- <sup>5</sup> Edmonds, J. 1986. *Woodland Caribou Provincial Restoration Plan*, Alberta Forestry, Lands and Wildlife, Fish and Wildlife Division, p.1.
- <sup>6</sup> Stelfox, J.G. 1966. *Caribou Abundance and Distribution in North Western Alberta and Proposal*. Alberta Department of Lands and Forests. Typewritten report, cited by Edmonds, 1986.
- <sup>7</sup> Lynch, G.M. and O.G. Pall. 1973. *Status of Caribou Management in Alberta*. Alberta Fish and Wildlife Division, unpublished report, cited by Edmonds, 1986.
- <sup>8</sup> Bloomfield, M. 1980. *Closure of the Caribou Hunting Season in Alberta: Management of a Threatened Species*. Alberta Energy and Natural Resources, Fish and Wildlife Division. Unpublished report, cited by Edmonds, 1986.
- <sup>9</sup> Edmonds, J. 1986. *Woodland Caribou Provincial Restoration Plan*. Alberta Forestry, Lands and Wildlife, Fish and Wildlife Division, p. 21.
- <sup>10</sup> Bradshaw, A. and D.M. Hebert. 1996. "Woodland Caribou Population Decline in Alberta: Fact or Fiction?", *Rangifer*. Special Issue No. 9, pp. 23-24.
- <sup>11</sup> Alberta Environment, 2000. *Woodland Caribou Status* at: [www.gov.ab.ca/env/fw/threatsp/caribou/sta.html](http://www.gov.ab.ca/env/fw/threatsp/caribou/sta.html)
- <sup>12</sup> Hervieux, D. 2000. Area Wildlife Biologist, Alberta Environment, Natural Resource Service, Grande Prairie, personal communication.
- <sup>13</sup> Alberta Forestry, Lands and Wildlife. 1990. *Management Plan for Grizzly Bears in Alberta*, Wildlife Management Planning Series, Fish and Wildlife Division, p. 6.
- <sup>14</sup> Horejsi, B. 2000. Personal communication. Horejsi states: "Any estimate of historical numbers is speculative but even a conservative estimate using a range of 15 to 25 bears per 1000 km<sup>2</sup>, the upper end of bear densities now reported across interior north America in ecosystems substantially altered by man, would produce a crude estimate of between 9,920 and 16,525 grizzly bears."
- <sup>15</sup> Horejsi, B. 2000. Personal communication.
- <sup>16</sup> Alberta Forestry, Lands and Wildlife. 1990. *Management Plan for Grizzly Bears in Alberta*, Wildlife Management Planning Series, Fish and Wildlife Division.
- <sup>17</sup> Alberta Forestry, Lands and Wildlife. 1990. *Management Plan for Grizzly Bears in Alberta*, Wildlife Management Planning Series, Fish and Wildlife Division, Bear population estimated from Figure 1, Trends in the grizzly bear population in Alberta.
- <sup>18</sup> Alberta Forestry, Lands and Wildlife. 1990. *Management Plan for Grizzly Bears in Alberta*, Wildlife Management Planning Series, Fish and Wildlife Division, p. iv.
- <sup>19</sup> Alberta Environment. 2000. *Present Status of Bears* on website at: <http://www.gov.ab.ca/env/fw/bears/present.html>
- <sup>20</sup> Alberta Environment. 2000. *Present Status of Bears* on website at: <http://www.gov.ab.ca/env/fw/bears/present.html>
- <sup>21</sup> Alberta Forestry, Lands and Wildlife. 1990. *Management Plan for Grizzly Bears in Alberta*, Wildlife Management Planning Series, Fish and Wildlife Division, especially pp. 76-83.
- <sup>22</sup> James, A. 2000. Area Wildlife Biologist, Alberta Environment, Natural Resource Service, Grande Prairie, personal communication.
- <sup>23</sup> Horejsi, B. 2000. Personal communication.
- <sup>24</sup> Horejsi, B. 2000. Personal communication.
- <sup>25</sup> Alberta Forestry, Lands and Wildlife. 1990. *Management Plan for Grizzly Bears in Alberta*, Wildlife Management Planning Series, Fish and Wildlife Division, p. 132.
- <sup>26</sup> Horejsi, B. 2000. Horejsi adds that "Various permutations and combination are possible in any estimation exercise, but let's make a very generous concession that only one half the area now in Bear Management

Units were to be managed for the maintenance of biological diversity: in other words a huge piece of publicly owned land would be sacrificed to special interest uses such as oil and gas exploration and exploitation, industrial scale recreation, agriculture, off road vehicles, forestry and mining. Only 168,962 km<sup>2</sup> would be available for grizzly bear occupation. Under these significantly modified circumstances, and using a density of 15 bears per 1000 km<sup>2</sup>, the province could support 2,530 grizzly bears. With higher standards and greater regard for the public interest in management of public lands, and with an ecologically sound and visionary conservation strategy, more public land would be available and a higher degree of habitat effectiveness would be mandated, bringing a management target for grizzly bears in Alberta back towards a reasonable expectation of somewhere in the vicinity of 2,480 to 5,310 grizzly bears projected above.” Personal communication.

<sup>27</sup> Government of Alberta. 2000. Business Plan 2000-2003, at Alberta Treasury website at <http://www.treas.gov.ab.ca/publications/budget/budget2000/envir7.gif>

<sup>28</sup> It should be noted that the numbers do not correspond exactly with those given in Table 2, with 4 fewer birds and 1 less mammal species being included in the Business Plan statistics than in The Status of Wildlife figures from 1996 given in Table 2.

<sup>29</sup> Alberta Environment. 2000. *The Status of Wildlife: The Status Document and Endangered/Threatened Species Designation* on Alberta Environment website at <http://www.gov.ab.ca/env/fw/status/intro.html>

<sup>30</sup> Government of Alberta. 2000. Business Plan 2000-2003, at Alberta Treasury website at <http://www.treas.gov.ab.ca/publications/budget/budget2000/envir7.gif>

<sup>31</sup> Gould, J. 2000. Alberta Environment, Alberta Natural Heritage Information Centre, personal communication.

<sup>32</sup> Tonn, W.M. 1990. *Atlas of Alberta Lakes*, edited by P. Mitchell and E. Prepas, University of Alberta, 1990, p. 52.

<sup>33</sup> Committee on the Status of Endangered Wildlife in Canada (COSEWIC). April 1999 and May 2000. *Canadian Species at Risk*.

<sup>34</sup> Alberta Environment. 1999. *The Status of Fish in Alberta* on Alberta Environment website at <http://www.gov.ab.ca/env/fw/status/>

<sup>35</sup> Trout Unlimited Canada, Alberta Council, January 12, 2000. News release.

<sup>36</sup> Berry, D. 2000. Alberta Environment, Provincial Recreational Fisheries Specialist, personal communication.

<sup>37</sup> Alberta Environment. 1995. *Sport Fish Survey*. Also David Berry, Alberta Environment, personal communication.

<sup>38</sup> Trout Unlimited Canada and Alberta Fish and Game Association, June 21, 1999. News release: *Fish Groups Concerned about State of Alberta's Fisheries*.

<sup>39</sup> Sullivan, M. 2000. Alberta Environment, Fisheries Biologist, personal communication.

<sup>40</sup> Sullivan, M. 2000. Alberta Environment, Fisheries Biologist, personal communication.

<sup>41</sup> Wagner, J. 2000. Alberta Environment, Fisheries Biologist, personal communication.

<sup>42</sup> Sullivan, M. 2000. Alberta Environment, Fisheries Biologist, personal communication.

<sup>43</sup> Values of commercial fish harvest are adjusted to 1998\$ using the Alberta Implicit Price Index for GDP and Market Prices.

<sup>44</sup> Berry, D. 1997. *Sport Fishing in Alberta 1995*. Alberta Environment, Natural Resource Services, Fisheries and Wildlife Management Division, September 1997.

<sup>45</sup> Expenditures are adjusted to 1998\$ using the Alberta Implicit Price Index for Personal Expenditures on Consumer Goods and Services.

<sup>46</sup> Alberta Environment. 1997. *Sport Fishing in Alberta*. The Alberta report is compiled by David K. Berry, Natural Resource Services, Fisheries and Wildlife Management Division, but the data is collected as part of the 1995 *Survey of Recreational Fishing in Canada*, Department of Fisheries and Oceans, Economic and Policy Analysis Directorate.

<sup>47</sup> Expenditures are adjusted to 1998\$ using the Alberta Implicit Price Index for Personal Expenditures on Consumer Goods and Services.

<sup>48</sup> Thompson, J.P., A.R. Sen and R.C. Scace. 1987. *Bow River Recreation Study: Assessment of Recreational Use and Economic Benefits*, Alberta Forest, Lands and Wildlife.

<sup>49</sup> Thompson, J. P. 1997. *Assessing the Socio-Economic Value of Native Trout Species: An Alberta Perspective*, in Friends of the Bull Trout Conference Proceedings, W.C. Mackay, M.K. Brewin, and M.



Monita. pp. 37-43. See also *The Highwood/Little Bow Diversion Plan*, Alberta Environmental Protection et al. 1994.

<sup>50</sup> Environment Canada. 2000. *The Importance of Nature to Canadians: The Economic Significance of Nature-related Activities*, Federal-Provincial-Territorial Task Force on the Importance of Nature to Canadians, pp. 32-33.

<sup>51</sup> Environment Canada. 2000. *The Importance of Nature to Canadians: The Economic Significance of Nature-related Activities*, Federal-Provincial-Territorial Task Force on the Importance of Nature to Canadians, p. 15.

<sup>52</sup> Environment Canada. 2000. *The Importance of Nature to Canadians: The Economic Significance of Nature-related Activities*, Federal-Provincial-Territorial Task Force on the Importance of Nature to Canadians, p. 15.

<sup>53</sup> Environment Canada. 2000. *The Importance of Nature to Canadians: The Economic Significance of Nature-related Activities*, Federal-Provincial-Territorial Task Force on the Importance of Nature to Canadians, p. 33.

<sup>54</sup> Environment Canada. 1985. *The Importance of Wildlife to Canadians. 1981*. Expenditures are adjusted to 1998\$ using the Alberta Implicit Price Index for Personal Expenditures on Consumer Goods and Services.

<sup>55</sup> Environment Canada. 2000. *The Importance of Nature to Canadians: The Economic Significance of Nature-related Activities*, Federal-Provincial-Territorial Task Force on the Importance of Nature to Canadians, p. 33.

<sup>56</sup> Adamowicz, W.L., P.C. Boxall, M. Williams, and J. Louviere. 1998. "Stated Preference Approaches for Measuring Passive Use Values: Choice Experiments and Contingent Valuation," *American Journal of Agricultural Economics*, 80(1): 64-75.

<sup>57</sup> Hailu, A., W.L. Adamowicz, and P.C. Boxall. 2000. "Complements, Substitutes, Budget Constraints and Valuation: Application of a Multi-Program Environmental Valuation Model," *Environmental and Resource Economics* 16(1): 51-68.