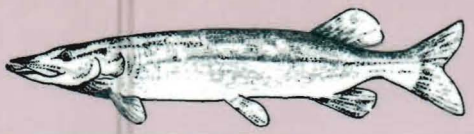

2020 VISION

MEETING THE FISH & WILDLIFE CONSERVATION CHALLENGES OF THE 21ST CENTURY

Edited by Tony J. Peterle

Alan Crossley

2020 Vision

459 Sidney

Meeting the Fish and Wildlife Conservation Challenges of the 21st Century

Tony J. Peterle, Editor
David J. Case, Symposium Chair

Sponsored by
The North Central Section of The Wildlife Society
and Co-Sponsored by the
Organization of Wildlife Planners
North Central Division of the American Fisheries Society

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PREFACE

The collection of papers presented herein were part of a symposium presented at the 53rd Midwest Fish and Wildlife Conference held in Des Moines, Iowa. The symposium, with the same title as this volume, was presented on Tuesday, December 3, 1991. The North Central Section of The Wildlife Society sponsored this symposium as a part of its continuing education program. Past symposia have considered topics such as the wood duck, white-tailed deer, Canada goose, and furbearers.

As we move into the last decade of the 20th century, we thought it might be appropriate to look ahead to consider what fish and wildlife conservation might be like in the year 2020. Appropriate authors were selected and contacted by Dave Case, the program chairperson. We are grateful for their thoughtful contributions. We also appreciate the efforts of the referees who kindly read these manuscripts and made cogent comments on how they might be improved.

The symposia was part of the conference program hosted by the state of Iowa and we are appreciative of their willingness to include this as a part of the formal program. The officers and members of the North Central Section of The Wildlife Society have continued to support this effort with a revolving publication fund. We look forward to seeing other symposia and publications as a result of this effort.

Perhaps in the year 2020, someone might review this publication to determine just how prophetic our authors have been.

FOREWORD

"These are bizarre times. If you thought it yesterday, if you're thinking it today, you won't think it tomorrow."

Those are the first two lines of a recent book by a widely respected business futurist (Popcorn 1991). Although most of us don't believe we change that fast, we do live in a rapidly, and most would say, radically changing world.

This book contains the proceedings of a symposium sponsored by the North Central Section of the Wildlife Society on December 3, 1991 at the Midwest Fish and Wildlife Conference in Des Moines, Iowa. The symposium was co-sponsored by the Organization of Wildlife Planners and the North Central Division of the American Fisheries Society. The purpose of the symposium, and this book, was to take a systematic, insightful look at what fish and wildlife managers will have to deal with in the year 2020 so they can begin preparing today.

Can anyone predict with certainty what the future is going to be? It's doubtful. But in the process of giving it our best thought, we may be able to prepare ourselves for some of the options.

It is said that there are four levels of competency:

1. Unconsciously incompetent—we're incompetent and don't have any idea why.
2. Consciously incompetent—we're incompetent and choose to remain that way.
3. Unconsciously competent—we're good at what we do, but don't have any idea why.
4. Consciously competent—we're good at what we do, and are conscious of why and how.

Although number two is easy, and in fact seems to be quite widespread, the intent of this symposium and this book is to strive for number four—to take the most conscious, well thought-out look we can at the future to help us be competent at the job of conserving fish and wildlife resources.

As difficult as it might be to "predict" the future, it's critical that those of us managing fish and wildlife resources try. On one hand, we must be responsive to the public (we live in a democracy) and its changing whims. On the other hand, we are dealing with professions and landscapes that in most cases do not

change or respond to change very quickly: it takes nine years or more of college to get a Ph.D. in fish and wildlife conservation, and seventy or more years to regenerate spotted owl habitat.

The authors of this book were asked to be thought-provoking. Based on the comments received by reviewers and the symposium attendees, the future of wildlife and the wildlife profession is a topic on which there are many strong opinions.

The symposium and resulting publication were made possible through the hard work of the North Central Section of The Wildlife Society Symposium Steering Committee: Erik Fritzell, Diana Hallett, Brian Miller, Joe O'Leary, Tony Peterle, Phil Seng, Dan Svedarsky, and Dan Witter. Special thanks are extended to Dennis Schenborn, Bruce Hawkinson, and Brian Stenquist for their help in planning and facilitating the "futuring" workshop.

We wish you well on your journey to the future.

David J. Case
Chairman
Symposium Steering Committee
North Central Section, TWS

LITERATURE CITED

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Wetland Habitats and Waterfowl in 2020: An International Conservation Challenge

By David E. Sharp and Robert I. Smith

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Abstract: *North America's rich diversity and abundance of migratory waterfowl, including ducks, geese, and swans, depend in varying degrees upon wetland habitats. Although the use of wetland habitats by waterfowl varies temporally and according to wetland type, the population status of some species can be used as indicators of the condition of wetlands. Historical patterns of regional loss or the degradation of wetlands have impacted those species or populations that during a portion of their annual cycle utilize wetland habitats for nesting, brood rearing, feeding, protection from predation, or resting. It is not known how many wetlands or waterfowl were present at the time of settlement of North America; however, we used recent estimates of wetland conversions and systematic waterfowl population surveys to determine trends and project status of these natural resources into the 21st century. Because human population growth, accompanied by more intensive agricultural and industrial use of land and water, will likely occur between the present and 2020, highly divergent scenarios of the continental status of wetlands and waterfowl can be developed. The conservation community will not be able to promote preservation and management of these natural resources without strong ecological awareness that transcends international boundaries and is fostered by all sectors of the general public. The future of wetland habitats and waterfowl will be determined by the value that society places on their importance. Proper design and successful implementation of cooperative international programs will result in informed economic, political, and social decisions that allow for protection and wise management of these types of shared natural resources.*

In Colonial times, North America contained a vast array of wetland types which supported a rich diversity and abundance of waterfowl. Although these bountiful flocks proved to be valuable staples for the early settlers, wetlands were soon regarded as a hinderance to productive land use. The earliest govern-

ment programs simply gave wetlands away on the condition that they be drained or converted to other uses. Accelerated human population growth stimulated well-intentioned public and private efforts to provide flood protection, greater agricultural production, better highways, and other potential benefits, but these efforts unfortunately have resulted in a 200-year history of wetland conversion and degradation. Collectively, these wetland losses diminished the quality of the continent's natural resource base to the point where it has now become obvious that we must carefully balance our economic, social, and environmental goals.

Beginning in the early 1900s, segments of the conservation community encouraged preservation of wetland resources for the maintenance of continental waterfowl populations. Since the 1930s, wetland protection efforts by natural resource agencies have been ongoing. In the U.S., the Migratory Bird Conservation Act, Migratory Bird Hunting and Conservation Act, the Land and Water Conservation Fund Act, and the recent North American Wetland Conservation Act have provided the Federal authority and/or funds to purchase wetlands. Although these continuing efforts have been useful in preserving key high-priority wetlands, the future of the vast majority of privately owned wetlands remains questionable as competing demands for other uses of these lands and waters increase.

Strong wetland laws and regulations are necessary to complement preservation efforts in order to maintain a functional wetland base. The foundation of current U.S. Federal wetland regulations is contained in Section 10 of the River and Harbor Act of 1889, Section 404 of the Clean Water Act of 1977, and the swamp-buster provision of the 1990 Farm Bill. Additionally, 24 states have also passed laws to regulate wetland uses. In total, these regulations have generally been ineffective in reversing long-term trends in the destruction of wetlands, but they indicate a gradual shift in the public's attitude toward the protection of wetlands. Current proposed legislation would further deplete the remaining wetlands.

By the late 1980s, dramatic changes began to occur in society's appreciation of the many values wetlands provide as integral elements of our environment. In 1986, Canada and the U.S. signed the North American Waterfowl Management Plan. This document reflected an international response to the precipitous decline of the continent's wetland and waterfowl resources. Its innovative approach advocated the establishment of federal, state, provincial, and private partnerships to restore, enhance, manage, and protect wetlands for waterfowl and other species of wetland-dependent wildlife.

In 1988, the National Wetlands Policy Forum established a U.S. goal to achieve no overall net loss of the Nation's remaining wetland base. In 1989, President Bush made a pledge for implementation of this national goal for wetlands and set up an interagency task force under the Domestic Policy Council to stop destruction of wetland habitats (Anonymous 1990). In 1991, Environment Canada established Canadian policy to maintain and enhance the health and diversity of Canada's wildlife by requiring integration of economic decisions with wildlife conservation.

Realizing that accurately predicting the future of North America's wetland and waterfowl resources would be an extremely difficult and complex task, we used available wetland and waterfowl status information and simple linear regression techniques to attempt projections into the 21st century. We recognize that trends may not be linear, but without added knowledge, this seems to be the most sensible approach.

WETLAND HABITAT STATUS AND TRENDS

The designation of wetlands can be difficult and perhaps confusing for many individuals because all wetlands do not fit the commonly shared stereotype of a permanently flooded, cattail (*Typha* spp.)-ringed depression. Wetland habitats include a wide variety of shapes and sizes and some wetland types are found in areas of transition between dry uplands and open water. Also, wetlands undergo wet/dry cycles that are essential to their productivity.

The scientific community, including hydrologists, botanists, soil scientists, and biologists, has agreed upon the identification criteria for a wetland (Federal Interagency Committee for Wetland Delineation 1989). This document classifies wetlands as having wetland vegetation, hydric soils, and wetland hydrology. Certain aspects of wetland hydrology, specifically the classification of areas that contain surface water for relatively brief periods, allow various nonscientific interpretations of these criteria.

Complete historical information of wetland status in North America is not available. However, substantial efforts are underway to improve inventory data bases. Current status information is most complete for the U.S., but rapidly improving for other regions of North America, especially Canada.

In the U.S., a National Wetland Inventory was initiated in 1974, and in 1979 studies to assimilate statistics on the current status and trends of wetlands were initiated by the U.S. Fish and Wildlife Service. Utilizing this extensive data base and incorporating supplemental sampling procedures, efforts have been made to

estimate the present acreage of wetlands and describe changes in acreage for specific time intervals. Tiner (1984) estimated wetland acreage changes between the 1950s and 1970s, while Dahl (1990) compared the status of wetlands from the 1780s to the 1980s.

Dahl (1990) estimated that as many as 221 million acres of wetlands were present in the conterminous U.S. during the 1780s. During 1850-1930, the U.S. was being rapidly settled and initial advances in technology allowed the conversion of natural environments into highly developed agricultural, industrial, and urban areas (Frayer et al. 1983). At that time, wetland habitats were widely regarded as wastelands and, with the aid of massive government programs, wetlands were lost at an alarming rate. During the 1930-80s, drainage projects became logistically and legally more difficult; however, losses continued, but at a slower pace (Tiner 1984). Tiner (1984) estimated that between the mid-1950s and mid-1970s, 9 million acres of wetlands were lost with average annual losses estimated at 458,000 acres. By the end of the 1980s, Dahl (1990) estimated that in the conterminous U.S., 53% of the original wetland acreage had been lost and that only 104 million acres remained.

The trend of losses from the mid-1950s to the 1970s was used to project the changes in wetland acreage through the year 2020 (Figure 1, page 5). If these loss rates continue, only slightly more than 80 million acres of wetlands would remain in the U.S.. In contrast, the goal established by the National Wetlands Policy Forum (1988) advocates no future loss of wetlands. Although we recognize the potential for increased loss rates, we believe these diverging trend lines represent a realistic range of wetland acreage status for the year 2020. We utilized this information to construct a theoretical long-term trend of wetland acreage for the conterminous U.S. (Figure 2, page 5).

These estimates indicate a disturbing downward trend for wetlands in the U.S.; however, significant variation occurs in regional loss rates. In Alaska, less than 1% of the original wetland acreage has been lost and 170 million acres remained in the 1980s. In the lower 48 states, California has lost the most (91%) and New Hampshire the least (9%). In total, 10 states have lost 70% or more of their original acreage and 22 states have lost 50% or more. With the exceptions of Alaska, New Hampshire, and Hawaii, no state has lost less than 20% of its original wetland acreage (Dahl 1990).

In Canada, about 14.3% of the wetlands have been lost. However, regional impacts in some southern areas have been severe. For example, it is estimated that over 40% of the wetland base has been destroyed in Prairie Canada (Canada/United States 1986). Of a total of 343 million acres in Canada, 49 million have

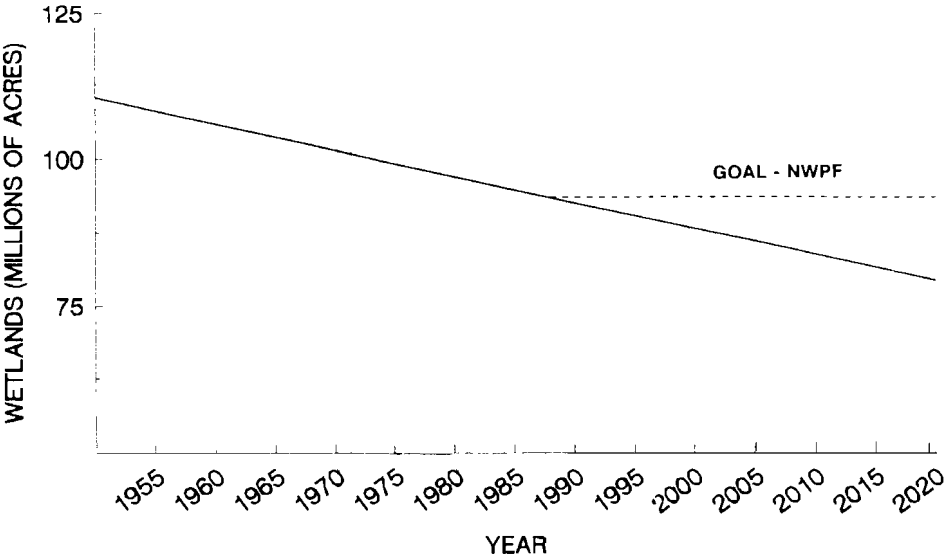

Figure 1. *Wetland trend based on acres of wetlands in the mid-1950s and mid-1970s in the conterminous U.S. (Tiner 1984) and the National Wetlands Policy Forum (NWPF) goal.*

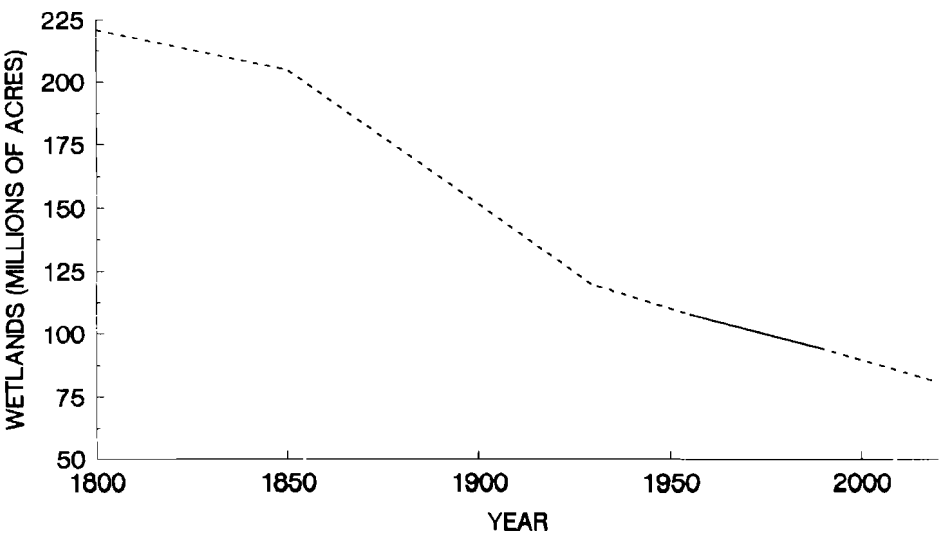

Figure 2. *Theoretical trend in wetland acreage in the conterminous U.S., 1800-2020 (Dahl 1990).*

been lost, of which 85% can be attributed to agricultural practices. Annual loss rates are currently estimated to be about 350,000 acres (C. Rubec pers. commun.).

In other portions of North America, wetland conversions have been at a much lower magnitude. In Mexico, wetland losses have not been estimated, but are believed to be substantially lower than in the conterminous U.S.. However, the recent loss rates in all other countries are believed to be increasing.

WATERFOWL POPULATION STATUS AND TRENDS

Because waterfowl are viewed as the most economically important group of migratory birds in North America, an extensive data base has been assimilated for their management. The quality and quantity of information depicting population status and long-term trends varies among species. The exact number of birds present for any given species or population is not known, but we used the best information available to determine long-term trends and to project relative changes into the 21st century.

Ducks

"More Game Birds in America" (Anonymous 1935) estimated that about 65 million ducks may have been present in North America during 1935. At that time, continental duck populations were depressed because of the widespread drought that occurred during the early 1930s. From 1935-54, efforts to assess duck abundance were mostly composed of noncoordinated regional surveys of general abundance and could not be used in any systematic way to depict trends on a continental basis. Since 1955, annual breeding population surveys encompassing more than 1.3 million square miles (3.3 million km^2) have been conducted in principal duck breeding areas in North America (Canadian Wildlife Service and U.S. Fish and Wildlife Service 1977).

Information from these operational surveys is most reliable for the more abundant species and widely distributed species, and less so for species that have nesting ranges outside the surveyed area. For our assessment of duck population trends, we used information from the surveyed area for 10 principal duck species as an index to continental trends, 1955-91 (Bortner et al. 1991)(Table 1, page 8). The resulting trend and the North American Waterfowl Management Plan population goal for these species were extended through the year 2020 (Figure 3, page 7). Although the cyclic occurrence of drought in important prairie nesting areas is particularly evident, we believe the long-term trend represents a realistic projection for duck populations.

To depict duck population trends prior to and after the 1955-90 period, we

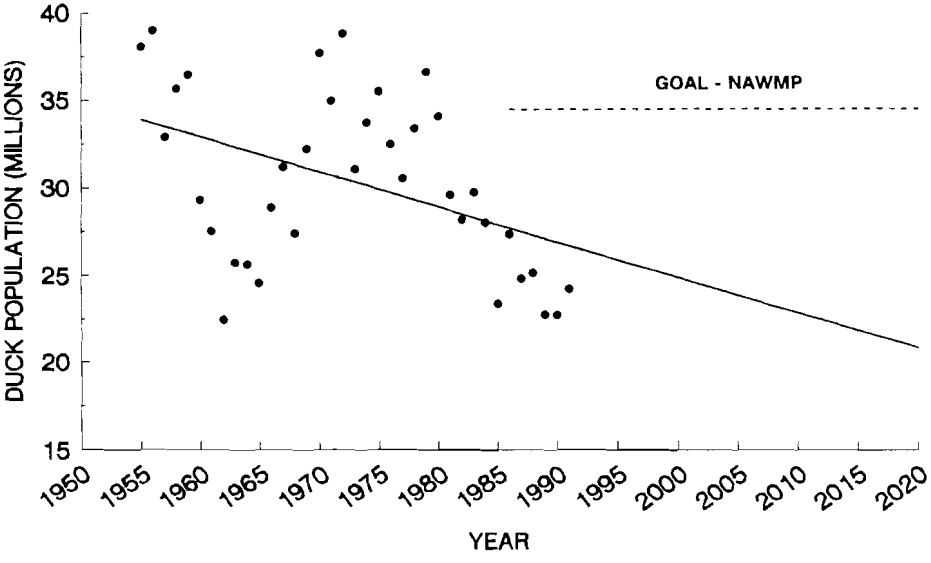

Figure 3. *Breeding population trend for the 10 principal duck species in the area annually surveyed during 1955-91 (Bortner et al. 1991) and the North American Waterfowl Management Plan (NAWMP) goal (Canada/United States 1986).*

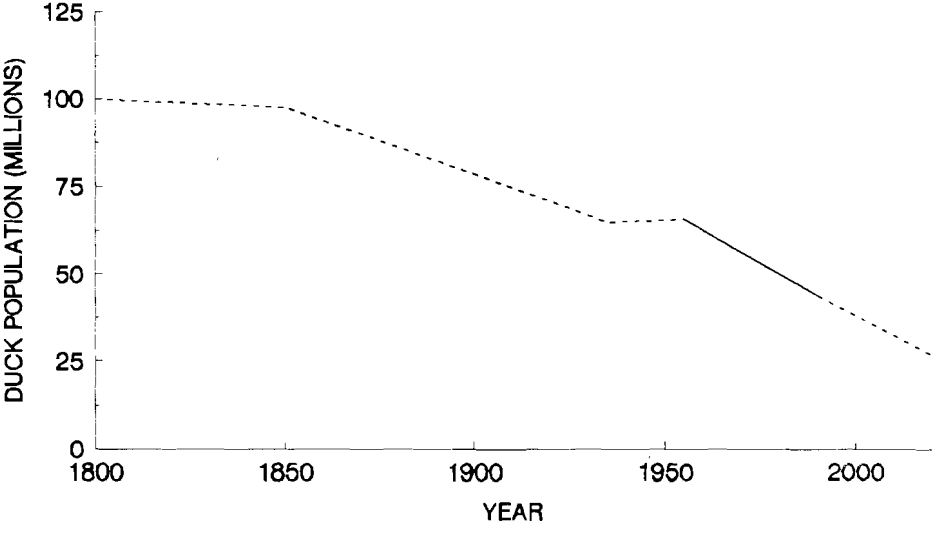

Figure 4. *Theoretical trend of North American duck breeding populations, 1800-2020.*

TABLE 1. *Breeding population estimates (thousands) for the 10 principal duck species in the area annually surveyed, 1955-91 (Bortner et al. 1991). Species abbreviations include: MAL = Mallard (*Anas platyrhynchos*), GAD = Gadwall (*A. strepera*), WIG = American Wigeon (*A. americana*), GWT = Green-winged Teal (*A. crecca*), BWT = Blue-winged Teal (*A. discors*), SHO = Shoveler (*A. clypeata*), PIN = Northern Pintail (*A. acuta*), RED = Redhead (*Athya americana*), CVB = Canvasback (*A. valisineria*), and LSC = Lesser Scaup (*A. affinis*).*

Year	MAL	GAD	WIG	GWT	BWT	SHO	PIN	RED	CVB	LSC	TOTAL
1955	8,708	692	3,142	1,795	5,547	1,665	9,520	592	599	5,816	38,076
1956	9,927	810	3,008	1,411	4,903	1,712	9,967	780	703	5,801	39,022
1957	9,226	692	2,950	1,015	4,362	1,462	6,356	544	625	5,677	32,909
1958	11,452	462	3,371	1,320	5,387	1,277	5,862	449	755	5,285	35,620
1959	9,231	529	3,780	2,582	5,148	1,507	6,610	524	499	7,018	36,428
1960	7,171	721	2,921	1,383	4,177	1,715	5,400	484	598	4,735	29,305
1961	7,237	597	3,068	1,692	3,654	1,280	3,856	318	440	5,396	27,538
1962	5,309	846	1,929	639	2,985	1,228	3,397	507	364	5,256	22,460
1963	6,683	1,094	1,783	1,135	3,747	1,311	3,616	415	523	5,415	25,722
1964	5,822	830	2,438	1,441	4,045	1,615	3,026	519	701	5,205	25,642
1965	5,261	1,273	2,332	1,235	3,646	1,406	3,677	599	522	4,609	24,560
1966	6,723	1,672	2,330	1,555	3,800	2,116	4,778	712	690	4,505	28,881
1967	7,533	1,384	2,346	1,570	4,533	2,319	5,288	737	505	4,954	31,169
1968	7,152	1,965	2,407	1,449	3,492	1,674	3,506	518	578	4,669	27,410
1969	7,590	1,579	2,955	1,508	4,145	2,177	5,915	635	508	5,170	32,182
1970	10,026	1,607	3,473	2,178	4,866	2,238	6,396	624	582	5,707	37,697
1971	9,464	1,604	3,321	1,916	4,620	2,027	5,901	540	451	5,112	34,956
1972	9,326	1,623	3,196	1,915	4,294	2,470	7,045	554	427	7,971	38,821
1973	8,152	1,251	2,887	1,970	3,350	1,629	4,355	503	627	6,312	31,036
1974	6,849	1,598	2,717	1,877	5,005	2,029	6,639	629	513	5,813	33,669
1975	7,631	1,644	2,746	1,689	5,907	1,974	5,900	833	616	6,543	35,483
1976	8,053	1,247	2,493	1,542	4,763	1,759	5,481	672	620	5,835	32,465
1977	7,561	1,319	2,583	1,328	4,628	1,508	3,948	641	690	6,303	30,509
1978	7,538	1,566	3,295	2,231	4,506	1,979	5,113	743	380	6,002	33,353
1979	8,060	1,753	3,097	2,080	4,867	2,398	5,393	696	576	7,676	36,596
1980	7,790	1,400	3,593	2,075	4,909	1,906	4,520	760	760	6,350	34,063
1981	6,569	1,412	2,934	1,865	3,757	2,333	3,483	602	627	6,014	29,596
1982	6,377	1,641	2,460	1,544	3,673	2,142	3,709	618	512	5,495	28,171
1983	6,455	1,518	2,635	1,835	3,378	1,874	3,515	713	527	7,286	29,736
1984	5,333	1,536	3,004	1,375	3,986	1,622	2,980	675	532	6,968	28,011
1985	4,839	1,308	2,045	1,441	3,470	1,700	2,513	581	385	5,083	23,365
1986	6,874	1,543	1,740	1,659	4,450	2,118	2,736	560	438	5,231	27,349
1987	5,630	1,318	1,978	1,983	3,533	1,948	2,629	502	454	4,847	24,822
1988	6,348	1,357	2,194	2,045	3,979	1,677	2,014	441	437	4,683	25,175
1989	5,503	1,382	2,009	1,846	3,192	1,483	2,098	504	455	4,281	22,753
1990	5,305	1,616	2,089	1,767	2,828	1,719	2,243	466	511	4,193	22,737
1991	5,353	1,573	2,328	1,601	3,779	1,663	1,798	437	463	5,247	24,242
Avg	7,353	1,288	2,701	1,664	4,209	1,805	4,677	587	548	5,645	30,480
NAWMP Goal	8,300	1,500	3,000	1,900	4,700	2,000	5,600	643	548	6,300	34,500

assumed that about a third of the North American duck population breeds outside the surveyed area (Canada/United States 1986). The relationship of the slope of wetland losses and duck population declines was probably similar for the 1850-1970 period, but the downward trend in duck populations is greater than the trend in wetlands for the decade of the 1980s (Figure 4, page 7). This change is probably due to the widespread drought and increases in other impacts on duck recruitment that have occurred in nesting areas. Currently,

TABLE 2. *Population indices (thousands) for Canada goose (*Branta canadensis*) populations based on surveys conducted during the fall and winter period 1969/70 - 89/90 (Bortner et al. 1991) Population abbreviations include: AFP=Atlantic Flyway Population, SJBP=Southern James Bay Population, MVP=Mississippi Valley Population, EPP=Eastern Prairie Population, WP/GP=Western Prairie/Great Plains Population, TGPP=Tall Grass Prairie Population, SGPP=Short Grass Prairie Population, H-LP=Hi-Line Population, RMP=Rocky Mountain Population, DSKY=Dusky Population, CCG=Cackling Population.*

Year	AFP	SJBP	MVP	EPP	WP/GP	TGPP	SGPP	H-LP	RMP	DSKY	CCG
1969/70	775.2	106.9	324.7	106.6			151.2	44.2		22.5	
1970/71	675.0	127.3	292.3	126.3		133.2	148.5	40.5		19.8	
1971/72	700.2	117.6	293.9	157.4		160.9	160.9	31.4		17.9	
1972/73	712.0	101.3	295.9	181.4		148.4	259.4	35.6		15.8	
1973/74	760.2	136.0	277.9	205.8		160.5	153.6	24.4		18.6	
1974/75	819.3	101.0	304.4	197.1		133.5	123.7	41.2		26.5	
1975/76	784.5	115.5	304.9	204.4		203.7	242.5	55.6		23.0	
1976/77	923.6	129.8	478.5	254.2		171.3	210.0	67.6		24.1	
1977/78	833.2	180.4	575.5	270.2		215.5	134.0	65.1	60.0	24.0	
1978/79	823.6	142.7	434.5	207.2		187.6	163.7	33.8	62.5	25.5	
1979/80	780.1	127.0	394.9	171.8		165.9	213.0	67.2	66.2	22.0	64.1
1980/81	955.0	120.3	367.4	150.9		257.7	168.2	94.3	91.0	23.0	127.4
1981/82	702.6	118.5	250.9	145.3	175.0	284.7	156.0	81.9	71.1	17.7	87.1
1982/83	888.7	129.9	303.7	210.4	242.0	171.8	173.2	75.9	73.1	17.0	54.1
1983/84	822.4	129.9	352.8	162.7	150.0	279.9	143.5	39.5	61.6	10.1	26.2
1984/85	814.2	129.3	477.2	167.6	230.0	207.0	179.1	76.4	88.4	7.5	25.8
1985/86	905.4	158.0	618.9	169.0	115.0	198.2	181.0	69.8	66.3	12.2	32.1
1986/87	754.8	129.8	514.6	182.7	324.0	163.2	190.9	98.1	66.2		51.4
1987/88	737.9	158.8	564.6	228.4	272.1	315.8	139.1	66.8	71.4	12.2	54.8
1988/89	660.7	170.2	734.6	184.5	330.3	224.2	284.8	100.1	73.9	11.8	69.9
1989/90	733.8	159.4	1098.2	324.9	271.0	159.0	378.1	105.9	102.4	11.7	76.8

many duck populations are substantially below established goals, and it is unlikely that a return to average precipitation patterns in important prairie nesting areas will bring about recovery for several of these species.

Geese, Brant, and Swans

In contrast to ducks, the main source of population information for goose, brant, and swan populations in North America is the annual Mid-winter Survey. This survey has been conducted since the mid-1930s (Martin et al. 1979, Smith et al. 1989). Because methodologies do not allow point estimates of population size, results from these surveys can best be used to determine long-term trends for various population management units.

For our assessment, we utilized trend information presented by Trost et al. (1990) and the Mid-winter Survey results to examine long-term trends for 12 Canada goose *(Branta canadensis)* populations (Table 2, above), 3 snow goose *(Chen caerulescens)* populations, 3 white-fronted goose *(Anser albifrons)* populations, 2 brant *(Branta bernicla)* populations, and 2 tundra swan *(Cygnus columbianus)* populations (Table 3, page 10).

TABLE 3. *Population indices (thousands) for snow geese (*Chen caerulescens*), greater white-fronted geese (*Anser albifrons*), brant (*Branta bernicia*), and tundra swans (*Cygnus columbianus*) based on surveys conducted during the fall and winter 1969/70-90/91 (Bortner et al. 1991). Population abbreviations include: GSG=Great Snow Goose, MCP=Mid-Continent Lesser Snow Goose Population, WMC=Western Greater White-fronted Goose Population, PF=Pacific Flyway Greater White-fronted Goose Population, ATL=Atlantic Brant Population, PAC=Pacific Brant Population, ETS=Eastern Tundra Swan Population, and the WTS=Western Tundra Swan Population.*

Year	GSG	MCP	WCF	EMC	WMC	PF	ATL	PAC	ETS	WTS
1969/70		818.7		50.6	85.4			141.7	55.0	31.0
1970/71	49.0	1067.3		39.3	128.5		151.0	149.2	58.2	98.9
1971/72	81.0	1331.8		45.8	38.6		73.0	124.8	62.8	82.9
1972/73	59.0	1025.3		43.0	131.0		41.0	125.0	57.1	33.9
1973/74	95.0	1189.7		43.2	157.5		88.0	130.7	64.2	69.8
1974/75	70.0	1096.9		40.4	133.2		88.0	123.5	66.6	54.3
1975/76	117.0	1562.4		53.4	127.0		127.0	122.1	78.6	51.4
1976/77	127.0	1150.3	34.0	50.4	204.4		74.0	147.0	76.2	46.7
1977/78	74.0	1967.0	31.0	53.1	283.6		46.0	162.9	70.2	45.6
1978/79	100.0	1285.5	29.0	49.3	250.6		44.0	129.4	78.6	53.5
1979/80	107.0	1387.7	30.0	59.0	245.0	73.1	69.0	146.4	60.4	65.2
1980/81	81.0	1406.3	37.0	67.5	71.4	93.5	97.0	194.2	92.8	83.6
1981/82	72.0	1794.0	50.0	65.6	233.9	116.5	106.0	121.0	72.9	91.3
1982/83	82.0	1755.5	76.0	62.0	201.3	91.7	124.0	109.3	86.5	67.3
1983/84	99.0	1494.4		70.3	6.6	112.9	127.0	133.4	81.1	61.9
1984/85	187.0	1973.1	63.0	81.3	72.7	100.2	146.0	144.8	93.9	48.7
1985/86	100.0	1449.3	97.0	78.6	100.4	93.8	110.0	128.5	90.9	66.2
1986/87	102.0	1913.8	64.0	71.5	144.3	107.1	111.0	128.5	94.4	52.8
1987/88	198.0	1750.5	46.2	76.7	95.4	130.6	131.0	138.6	76.2	59.2
1988/89	192.0	1956.1	74.3	116.5	99.4	161.5	138.0	128.1	90.6	78.7
1989/90	231.2	1724.2	38.7	103.3	152.5	218.8	135.4	146.0	89.6	40.1
1990/91	199.0	2135.9	104.6	135.7	115.9	240.8	147.7	127.4	95.9	47.6

To project trends for geese and brant, we combined population information for the above populations and for comparative purposes included the combined North American Waterfowl Management Plan goals (Figure 5, page 11). We conducted a similar assessment for two populations of tundra swans (Figure 6, page 12). The resulting trends project status for these populations through the year 2020.

In contrast to duck populations, current population levels are above established goals and an upward trend is evident. Although the causal factors for these trends have not been isolated, these species nest primarily in arctic and subarctic regions that have been relatively unaffected by wetland conversion. Water regimes in these northern nesting habitats are typically more stable than prairie areas and weather has been favorable for reproduction in recent years. Many populations have taken advantage of enhanced food resources in agricultural areas of migration and wintering areas. Improved interspersion of refuge areas among hunting zones has also likely increased goose survival in recent decades.

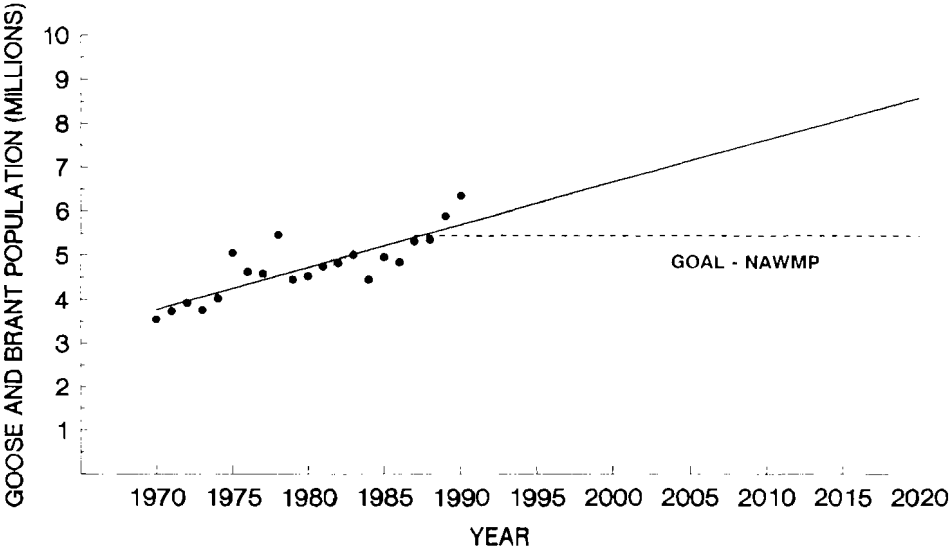

Figure 5. *Population trend for selected Canada goose, snow goose, white-fronted goose, and brant populations surveyed during winter 1979-90 (Bortner et al. 1991) and the North American Waterfowl Management Plan (NAWMP) goal (Canada/United States 1986).*

RELATIONSHIP OF WETLANDS TO WATERFOWL

North America has 45 native species of waterfowl that have evolved a complex dependence on a variety of wetland types for breeding, migration, and wintering (Bellrose 1976). Of this total, 37 species have annual migration pathways that cross international boundaries (Canada/United States 1986). These habitat linkages require that their protection and management be approached on an international basis and at the ecosystem level.

Each waterfowl species has developed elaborate adaptations for exploitation of wetland habitats in its home range. During the nesting period, some species require shallow, temporarily flooded ponds for feeding. As temperatures rise and these habitats typically become dry, usage shifts to more seasonally flooded habitats. Similar shifts to semipermanent and permanent wetlands may also occur and ultimately, virtually the entire wetland complex is used throughout the breeding season. Similar patterns of use occur during migration and wintering periods. Some species, such as diving and sea ducks, rely exclusively on wetland habitats; others, such as most geese, occasionally use uplands for feeding. Other species have developed specialized lamellae for straining emerg-

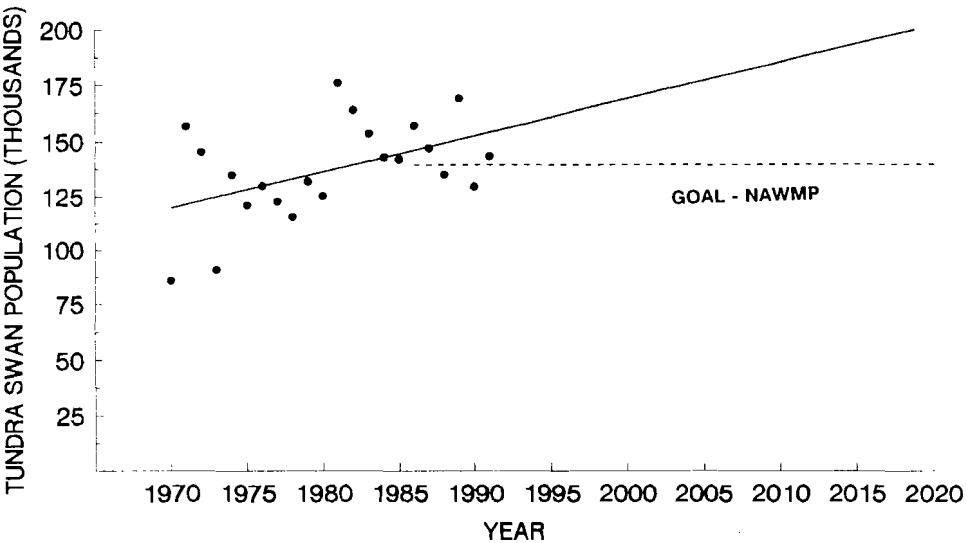

Figure 6. *Population trend for the Eastern and Western Tundra Swan Populations surveyed during winters 1970-90 (Jerry Serie pers. commun.) and the North American Waterfowl Management Plan (NAWMP) goal (Canada/United States 1986).*

ing invertebrates from the wetland surface, while others have developed specialized bills and muscular necks for probing deep into the substrate for rooted vegetation. Some have developed specialized glands to aid in feeding in saltwater habitats, while others only utilize freshwater areas. In total, each species has evolved unique relationships to wetlands that are vital to completion of specific life cycle functions.

Natural resource managers have long known of the close relationships between the number of wetlands and the distribution, abundance, and production of waterfowl (Crissey 1957, 1969; Gollop 1965; Stoudt 1969, 1971; Smith 1971; Henny et al. 1972; Pospahala et al. 1974). However, the traditional relationships of waterfowl abundance and wetland abundance have recently begun to change because of increasing impacts of agriculture on pond margins and surrounding grasslands (Bartonek et al. 1984).

Prior to the decade of the 1980s, the relationship of breeding mallard *(Anas platyrhynchos)* populations and subsequent production to wetland numbers was highly correlated. However, during two relatively wet years in the decade of the 1980s, increases in ponds were not associated with increased pioneering by

mallards (Reynolds 1987). Although most studies of wetland and waterfowl relationships have focused on wetland abundance, recent information on the impacts of wetland quality in Prairie Canada suggest that 75.9% of the parkland and 84.6% of the grassland wetland margins that remain have been adversely impacted by agricultural practices (Turner et al. 1987). Currently, efforts are underway to improve our waterfowl data bases and increase our understanding of cross-seasonal influence and of the linkage of population status to quality and quantity of wetland habitats.

Unfortunately, economic interests will likely continue to target development of the more ephemeral and seasonal wetland types that have already been converted or altered at high rates. For these reasons, we believe the future population status of those species that depend to a high degree on these intermittently flooded habitats is of great concern.

WETLAND VALUES AND PUBLIC ATTITUDES

Wetlands provide critical habitat for wildlife and a wide variety of other wetland-dependent plants and animals. They sustain nearly one-third of the endangered and threatened species. Coastal wetlands provide nursery and spawning grounds for 60-90% of commercial fish. On an acre basis, their biological productivity can exceed that of any other land use on the continent (National Wetlands Policy Forum 1988). Wetlands also provide many natural hydrologic functions, including: lessening flood damage, reducing erosion, recharging ground water, filtering sediment, and abating pollution. They serve as recreation sites, reservoirs for drinking water, productive areas for food and timber production, educational and research areas, and provide open space and aesthetic values (Anonymous 1990).

In the early 1900s, the hunting community recognized the value of wetlands for maintenance of continental waterfowl populations and encouraged their protection by natural resource agencies. The Migratory Bird Treaty in 1916 mandated Federal government responsibility for management of waterfowl resources. In the 1930s, widespread drought stimulated several important programs for wetlands and waterfowl. The Duck Stamp Act of 1934 imposed a fee on all waterfowl hunters over 16 years of age with proceeds dedicated to wetland protection. In addition, Ducks Unlimited was founded in 1937 specifically to fund wetland conservation projects in other countries, especially Canada. These humble beginnings signaled the initiation of cooperative international efforts for wetlands and waterfowl conservation.

Despite these well-intentioned efforts, wetland losses continue at high rates. These losses diminish the quality of the continent's natural resource base to the point where it becomes apparent that we must begin to cooperatively balance our economic, social, and environmental goals. The North American Waterfowl Management Plan of 1986 and the National Wetlands Policy Forum of the late 1980s set continental goals for waterfowl and established a U.S. goal for no overall net loss of wetlands.

After a 200-year history of wetland destruction, the general public's attitude appears to be shifting in favor of wetland protection. This change in sentiments was not the result of concern over declining waterfowl populations, but rather a general concern for the wetland resource.

The sales of U.S. Duck Stamps and Canadian Migratory Bird Hunting Permits show declines through the year 2020 (Figure 7, page 15). In the U.S., these revenues have been used to protect over 4 million acres of wetlands and the National Wildlife Refuge System now encompasses over 90 million acres. It was obvious that this base of support would not continue to result in political action and programs necessary to revitalize these resources.

The North American Wetland Conservation Act of 1989 will provide an additional $30 million annually for wetland projects in the U.S., Canada, and Mexico. However, stronger wetland laws and regulations will also be necessary to maintain the continent's wetland resources. Increased efforts to improve conservation education must help increase public awareness and foster sound ecological attitudes in all sectors of the general public. We believe that all wetland interests must work together to achieve a common goal, as the future status of wetland resources will depend upon the importance that society places on their value.

STATUS OF WETLANDS AND WATERFOWL IN 2020

Although projected trends (Figures 1-7) are linear, in reality the environment and human populations are not on linear courses, and trends that curve upward or downward might replace these straight lines. Similarly, it is also unlikely that wetland or waterfowl trends will follow linear paths and a wide range of future possibilities for their future status can be described for the year 2020.

Scenario 1

How will an increasing human population exert its influence on wetlands and waterfowl by the year 2020? If you are pessimistic about the future, you are thinking that most impacts will be negative. Let us follow a scenario of pessi-

FIGURE 7

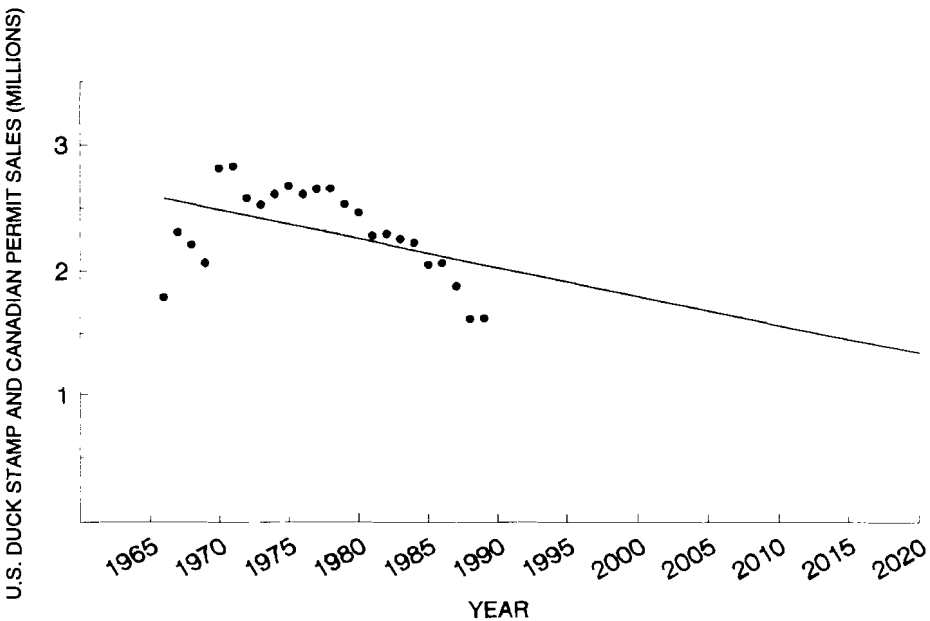

Figure 7. *Trend in Duck Stamp sales in the U.S. and Migratory Bird Hunting Permit sales in Canada, 1966-89.*

mism and examine what we might find in 2020.

In 2020, most wetlands in the lower 48 states occur in association with multipurpose impoundments or other water control systems in which water depths and distributions are managed with little, if any, consideration for waterfowl. As a result, the diversity of wetland habitats for waterfowl is more limited than it was in the 1990s. Several duck species are now considered rare. Nonmigratory mallards and resident Canada geese occur in many urban and rural areas. Canada geese and mallards are synonymous with the term "waterfowl" in the minds of many people. Migrant waterfowl remain a thrilling sight and a birdwatcher's delight. Migrating wild ducks are no longer hunted. A scarcity of several duck species makes the hunting of wild ducks an unrealistic expectation. The hunting of wild geese continues at various times and specified locations. Hunting of hand-reared mallards continues on shooting preserves. Unfortunately, the tradition of hunter-supported conservation, management, and restoration of wetlands has been lost. Hunter interests are centered around the release of hand-reared mallards at shooting preserves.

Scenario 2

Let us examine the year 2020 in a scenario that experiences the same human population growth; however, in this view we find a more promising future for wetlands and waterfowl.

In the 1990s certain wild duck species were becoming rare. It became apparent that several duck species would soon become endangered. Waterfowl managers recognized that a better distribution of wetland types throughout the range of waterfowl was essential, if they were to stop these downward population trends. A plan for the conservation, restoration, and management of a network of private and public wetlands was created. The purpose of the network was to support continuation of traditional migration patterns of waterfowl, and perpetuate a geographic distribution of each species that approximated historic distributions. To create this network, additional preservation of wetlands was required in some cases; in others, better water management; and, in a few situations, wetland restoration was the only option.

Conservation education in the 1990s resulted in improved public attitudes about wetlands, and wetlands moved into the mainstream of public awareness. Included in this awareness was an understanding of the importance of managing water levels properly to create conditions under which flora and fauna of wetlands evolved. The result is a significant advance in the manner in which impounded water is managed. The several species of waterfowl that had been in steady decline since the 1970s are no longer in decline. A secure future for these species has been achieved. In summary, future generations will be able to witness the thrill of fall and spring migrations of waterfowl, and they will have the added bonus of observing a rich display of wild duck species.

Under this more optimistic scenario, what has happened to hunting of waterfowl? Studies of hunting in the 1990s revealed many interesting aspects about the motivations and traditions of hunting. The functional aspects of hunting in modern societies was clarified, which facilitated communication and an understanding of hunting among both hunters and nonhunters. The subject as a social issue was reduced in importance. Managers of hunting areas gained insight into how the hunting experience should occur. The hunting experience became more meaningful and the ethics associated with this activity became more clearly defined.

Even under this scenario, the numbers of participants in hunting have not increased, and the space allotted for hunting has been reduced. Nevertheless, in 2020, the hunting experience survives in a form that is a legitimate part of the

human experience in a modern industrialized society. It is primarily a ritual that is atavistic or reenacts the ancient drama of subsistence hunting. In this case, it serves as a reminder of who we are and from where we have come. Additionally, it serves several important resource management functions which have ecological significance, such as keeping populations in balance with capacities of their habitats.

SUMMARY

The quality and quantity of wetland habitats present in 2020 will determine the distribution, diversity, and abundance of wetland-dependent species. Migratory bird species, such as waterfowl, are dependent upon wetland ecosystems throughout their annual cycle for breeding, migration, and wintering. For many of these highly mobile species that transverse national or international political boundaries, habitat requirements must be addressed during their entire annual cycle and proper management into the 21st century must be approached on a cooperative basis. In this respect, proper design and successful implementation of cooperative international management programs, such as the North American Waterfowl Management Plan, are vital for guiding political decisions that will establish programs for protection and management of shared natural resources.

With respect to waterfowl population status, it is unlikely that any single factor is responsible for long-term population changes. Recovery of duck populations to former levels will require initiation of comprehensive, multifaceted, continental strategies for land use planning. Reversing the trend in wetland losses must be accompanied by substantial efforts to address recent low recruitment rates across important prairie nesting areas. A return to normal precipitation patterns across important nesting areas will benefit many depressed populations; however, we are doubtful that some species, especially those that depend on heavily converted, intermittently flooded wetlands, can attain former population levels.

The future looks bright for those species of geese and swans that nest in the arctic and subarctic regions of North America. Apparently, wetlands in these remote production areas have not been greatly impacted by man. In addition, the use of larger water areas that have been less susceptible to destruction in migration and wintering areas, combined with increased availability of agricultural crop residues and recent weather patterns favoring production, have all had positive effects on these populations.

Although we are concerned over present trends in wetland losses and population levels of some species of waterfowl, we are encouraged by recent changes in public attitudes. These sentiments seem to be shifting in favor of wetland protection, restoration, and management; however, ecological awareness must continue to increase by improved conservation education. But important social issues such as the role of hunting also need to be clarified and incorporated into continental management programs that are acceptable to the general public. Finally, in order to maintain continental wetland ecosystems and healthy waterfowl populations, we believe that society must carefully balance and integrate our economic, social and environmental goals in wise, long-term, landscape planning.

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Managing Midwest Forest Ecosystems and Wildlife in the 21st Century

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Abstract: *Natural resource management agencies will have to respond to changes in forest habitats, wildlife populations, and public demands in the 21st century. Recent inventories in the north-central region of the U.S. suggest that the amount of forest habitat will remain relatively stable. The nature of these forests will change as they mature and are increasingly selectively harvested instead of clearcut, or reserved from harvest. Forests will be more fragmented by expansion of urban centers and suburban development. Most forest game populations will remain stable or increase. Some nongame populations such as migrant birds may be declining, and this is likely to be exacerbated by increasing forest fragmentation and destruction of wintering habitats. Recreation use will increase and conflict with other established uses of public lands. Current public scrutiny of management on federal lands will spill over to state and private lands.*

More effort will probably be devoted to management for biological diversity, ecosystem integrity, and non-consumptive uses. A shift in focus from selected species to biological diversity demands that we manage ecosystems instead of single species. Management must acknowledge that ecosystems are dynamic, particularly in environments changing due to global climate change, pollution, and other anthropogenic factors. New tools and information will help managers focus on landscapes rather than individual habitats and on ecosystem processes, structure, and composition. The greatest challenge to future managers will probably be dealing with conflicting public demands for limited forest resources.

Certain aspects of the future of our forests and their wildlife are more predictable than others. We know which direction succession proceeds. We can guess that ubiquitous species such as the white-tailed deer *(Odocoileus virginianus)* will be common in the midwest U.S. well into the foreseeable future. However, it is more difficult to predict what will happen to migrant forest birds that are affected by deforestation and fragmentation in both the Midwest and the neotropics. It is difficult to predict if we will slow the rate of loss of biological diversity in the next 50 years. It is also difficult to guess what the effect of increased public participation in forest planning will be when many current national forest management plans seem hopelessly stalled by demands

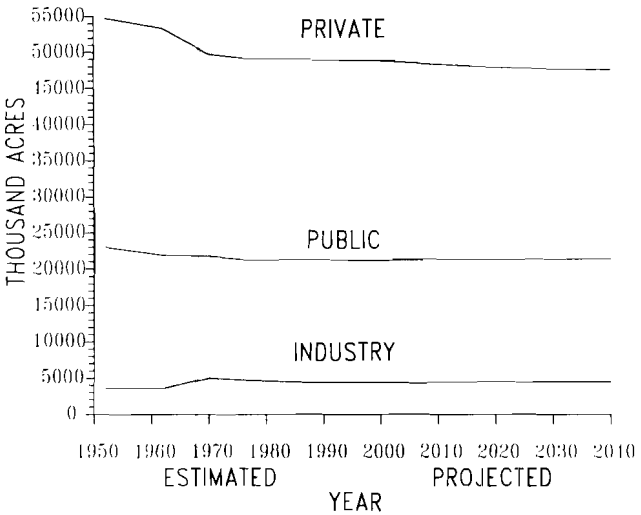

Figure 1. *Trend in area of forest land in the North Central U.S., 1952-1987, and projections to 2040 (data for Mo., Ill., Ind., Ohio, Mich., Minn., Wis., and Iowa [from Alig et al. 1990).*

of special interest groups that are polarized at opposite ends of the resource management spectrum.

I do not try to predict the future here nor offer solutions management agencies might need. Rather, I use some current trend data and predictions by modelers and planners to suggest what our future forests might be like and what public expectations are likely to be. Then I outline what I think some of the biggest challenges are for natural resource managers in the near future.

FUTURE RESOURCE LEVELS AND DEMANDS

Forest Habitats

Long-term trends in the amount of forest land, its age or size class, and forest types or habitats can indicate what future forest habitats will be like in the Midwest. The amount of forest in the Midwest has been declining throughout the last half of this century, but there are indications this decline has leveled off and is reversing in some parts of the region (Figure 1, this page). Recent forest inventories of central hardwood states show the following increases in forest land: Missouri, 8.1% from 1972 to 1989 (Hahn and Spencer 1991); Illinois, 7.5% from 1962 to 1985 (Raile and Leatherberry 1988); Indiana, 10% from

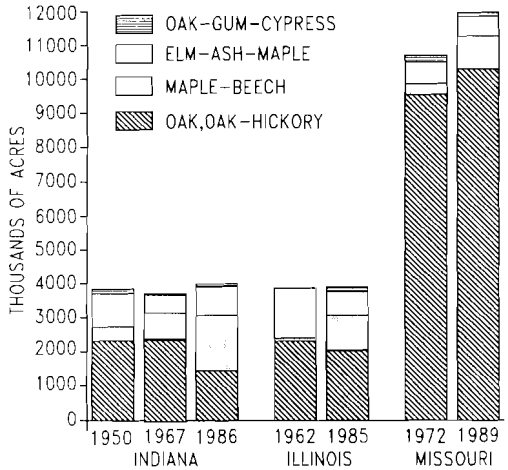

Figure 2. *Trend in area of dominant forest types in three states in the central hardwood region (data from Smith and Golitz 1988, Raile and Leatherberry 1988, Hahn and Spencer 1991).*

1967 to 1986 (Smith and Golitz 1988); and Iowa, 31% from 1974 to 1990 (Brand and Walkowiak 1991). Within certain subsections of this region, increases have been even more dramatic—on the order of 30 to 40%. The increase in forest land is primarily the result of farmland and pasture reverting to forest. Within a similar time frame Minnesota, Wisconsin, and Michigan showed small declines of 1 to 7% (Spencer 1983, Hahn and Smith 1987, Smith and Hahn 1989). These trends suggest there will be small or moderate increases in the amount of forest land in the central hardwood region, and small declines or no change in northern forests.

By the 21st century, there will be changes not only in the amount of forest land, but also in its age distribution and composition. On average, Midwest forests probably will be older, contain larger trees, and be composed of more shade tolerant, late-successional species. Some of these changes are indicated by the increase in maple *(Acer)* -beech *(Fagus)* forests in the central hardwood region (Figure 2, this page). In many cases the increase in maple-beech is associated with a decline in oak *(Quercus)* -hickory *(Carya)* because undisturbed oak-hickory forests are succeeding into maple beech forests (Smith and Golitz 1988). There are other indications that central hardwood forests are maturing. For instance, in Indiana the area of sawtimber stands increased 36% and

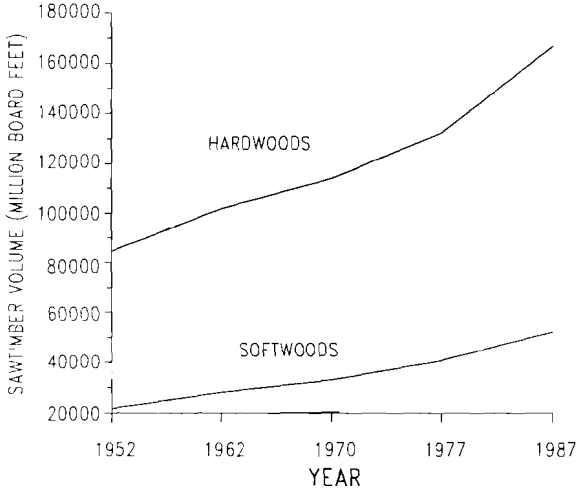

Figure 3. *Trends in sawtimber volume in the Midwest, 1952-1987 (data for Mo., Ill., Ind., Ohio, Mich., Minn., Wis., Iowa, Kan., Neb., S.D., N.D. [from Waddell et al. 1989]).*

poletimber stands decreased 22% between 1967 and 1986 (Smith and Golitz 1988). This pattern is seen throughout the Midwest; sawtimber volume has continued to increase in the region since 1952 (Figure 3, above).

Lake states' forests do not show large or consistent changes in forest type, but they do share the trend of increased forest maturity and size with forests in the central hardwood states. However, for certain forest types such as aspen (*Populus* spp.), potential major industrial expansion in the waferboard and pulp industry could result in increased timber harvest, more regenerating forests, and less sawtimber.

Current trends in forest management will also help determine what forest habitats will be like in the 21st century. Timber harvest on national forest lands in the central hardwoods region is being reduced, and selection cutting, as opposed to clearcutting, will become the predominant management method (U.S. For. Serv. 1986, 1990, 1991). These management techniques will reinforce the ongoing succession of these forests to more shade tolerant species and will result in uneven-aged stands. Uneven-aged stands will have a persistent big tree component in them and more within-stand diversity, but less among-stand diversity than even-aged stands managed by clearcutting. Even-aged timber management on national forest lands in the Lake states probably will continue

because of the commercial importance of aspen. Throughout the region there probably will be an increase in amount of forest land reserved from timber harvest. This trend is already evident—forest reserved from harvest increased from 2 to 3.7% of potential commercial forest land from 1977 to 1987 (Waddell et al. 1989), and additional set-asides have occurred since then (U.S. For. Serv. 1990, 1991). These changes in forest management probably will spill over onto other public lands, particularly those without an emphasis on commodity production.

Forest Wildlife Populations

Flather and Hoekstra (1989) predicted future wildlife inventories from projections of state fish and game agencies. Estimates considered historical population trends, future land-use changes, and proposed management practices. They summarized state estimates by regions; their "North region" encompasses the north-central and northeastern United States. State agencies were generally optimistic, predicting increases for big and small game. In the North region, all forest game was predicted to increase between 1985 and 2040. Populations of wild turkeys *(Meleagris gallopavo)* were projected to be 214% of their 1985 levels, white-tailed deer 97%, black bear *(Ursus americanus)* 107%, forest grouse (Tetraoninae) 101%, and squirrels (Sciuridae) 120%. National forests within the same region have predicted similar increases in forest wildlife. Populations of wild turkeys in the year 2040 were predicted to be 165% of their mid 1980 levels, white-tailed deer 108%, moose *(Alces alces)* 105%, and black bear 106%.

Population trends of other wildlife are of greater concern. For example, Robbins et al. (1989) determined that most neotropical migrant bird species that breed in the forests of the eastern U.S. declined in abundance during 1978-1987. Four to 21 neotropical migrants declined in each of the north-central states between 1980 and 1989 (unpublished Breeding Bird Survey state trend data, U.S. Fish and Wildl. Serv.). These declines have been attributed to habitat loss and fragmentation on the wintering and breeding grounds (Askins et al. 1990). Because habitat loss and fragmentation are likely to continue in North America and the neotropics, populations of these species probably will continue to decline. No equivalent data on regional population trends are available for other taxa such as small mammals, reptiles, amphibians, insects, or plants. However, there are some concerns about potentially widespread declines of amphibians (Wyman 1990). The number of federally endangered or threatened

species probably will increase as some species decline in numbers, but also because better information will be available for more species.

Some of the predicted changes in forest habitats for the 21st century will tend to offset, while others exacerbate, these trends or projections for wildlife populations. Increases in the amount of forest land will benefit forest wildlife, but increased forest fragmentation will offset that benefit for some species. Decreases in timber harvest on public lands and a switch in emphasis from clearcutting to selection cutting might reduce habitat for some early successional species, particularly in the central hardwood region. This might be partially balanced by increased harvesting on private lands and by edge habitat created by increased forest fragmentation. However, species that require young even-aged stands will probably be left with less habitat in the central hardwood region.

Fish and Wildlife Affiliated Recreation

Recent national surveys of fish and wildlife- associated recreation indicate declining numbers of hunters and increasing numbers of anglers and non-consumptive users (U.S. Fish and Wildl. Serv. 1988). Large increases in non-consumptive uses and fishing are projected for the future, as well as small increases or decreases in hunting (Flather and Hoekstra 1989). Increased non-consumptive use will include activities such as sightseeing, day hiking, wildlife observation, and nature study. Non-recreational use of wilderness also will increase, which includes off-site or intrinsic values, such as knowing wilderness will be there for future generations (Cordell et al. 1990). These projections suggest that most people looking towards forests for recreation will no longer be rural- dwelling hunters, but urban-dwelling, non-consumptive users.

CHALLENGES FOR THE 21ST CENTURY

Conservation of Biological Diversity

Forests are one of the dominant ecosystems of the Midwest and are tremendous resources of biological diversity. There is increasing scientific and public concern about the loss of biological diversity (Probst and Crow 1990). Agencies are realizing they must work to conserve biological diversity in order to maintain long-term sustainability of our resources and for numerous other reasons ranging from economical to ethical. Major new agency programs are being developed to address biological diversity, such as the U.S. Forest Service's New Perspectives program. Biological diversity, ecosystem integrity, and ecological health will become the principal objectives of public lands management, with

commodity production considered a benefit of good land management. The degree to which resource managers succeed in maintaining biological diversity will depend on our ability to practice ecosystem level management that accommodates ecological values as well as commodity production on public and private lands. We cannot preserve diversity simply by turning public lands into preserves and intensively producing commodities on private lands.

Ecosystem Management

The expansion of management goals from a limited number of species or commodities to the conservation of biological diversity demands that we take a regional perspective, manage over large areas, and manage ecosystems (Probst and Crow 1990). Land management agencies should focus on landscape and ecosystem features that affect populations; it would be an impossible task to individually assess and manage population viability for the approximately 2500 vertebrates in the U.S. (Probst and Crow 1990), let alone manage for lower taxa.

Most resource management agencies realize the need for ecosystem management, but have been slow to adopt it. Resource managers and agencies will face a number of challenges as they become ecosystem managers:

(1) Ecosystem management demands that we work on larger scales. In the future many of the technological limitations will be removed. Widespread adoption of geographic information systems (GIS), increased computer compatibility, and information sharing will eliminate the current technological problems of managing, analyzing, and viewing data at various scales (population, ecosystem, landscape, or region). GIS workstations will be just another tool in field offices.

(2) The species approach, which has been standard practice for a long time, is expanding through increased emphasis on endangered and threatened species. Agencies have limited personnel and funds, and ecosystem and species programs will compete for time and money.

(3) Ecosystem management requires the collaboration of foresters, wildlife biologists, ecologists, botanists, recreation specialists, engineers, and others. However, it may be difficult for these people to collaborate because they are often in different organizations or divisions.

(4) Working on larger scales requires us to think beyond the boundaries of specific ownerships. Technology will help some through GIS and satellite imagery. However, greater interagency cooperation and integration will be required, as well as partnerships with non-government groups. This type of cooperation can already be seen in the Upper Great Lakes States Biodiversity

Committee and the interagency Partners in Flight program to conserve neotropical migrant birds.

(5) We need to manage processes or functions, not just composition and structure. Ecosystem processes or functions include productivity, herbivory, predation, species turnover, patch dynamics, disturbance regimes, etc. (Noss 1990). A focus on functions is necessary because composition can be dynamic, particularly given scenarios for long term environmental change due to global warming.

(6) We lack a common currency. Few, if any, agencies (state and federal) have universally adopted ecological classification systems, let alone interagency or multistate systems.

Forest Fragmentation

Increasing rural development, the expanding urban/forest interface, and patterns of land ownership in the Midwest indicate forest fragmentation will be an increasing problem into the 21st century. It will threaten area, edge, or human sensitive wildlife and biological diversity. It may hinder access to public lands for recreation, and may limit management alternatives or uses due to the juxtaposition of different values or incompatible demands. Because public forest lands are usually the largest and least fragmented forests in the east, land managers will be pressured to manage them for those things that more fragmented private lands cannot provide.

Technology and Information Overload

A wide array of new technologies is being made available to resource managers (GIS, satellite imagery, global positioning systems, computers and dataloggers, etc.). Many of these tools are also generating large amounts of data. These tools and information will become available at an even faster rate in the future. Agencies will need specialized personnel to deal with these technologies and manage databases, and they will also need to train field personnel. Research will be needed to evaluate and learn how to use these data.

Resource Conflicts

As demands increase for a relatively constant amount of forest land, conflicts over forest uses will increase. This is already evident in public involvement in the national forest planning process. Jakes et al. (1990) surveyed national forest supervisors and a sample of district rangers to determine which issues in national forest management and use will be most important in the near future,

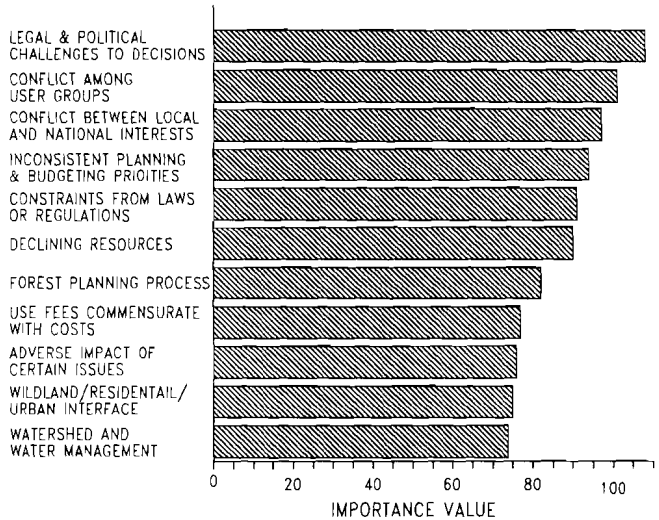

Figure 4. *Average importance assigned by forest supervisors and district rangers (U.S. For. Serv.) to emerging issues in national forest management and use, 1988 (reproduced from Jakes et al. 1990).*

and they summarized and ranked their responses (Figure 4, this page). Issues were predominantly people-oriented, reflecting the high degree of interaction between the U.S. Forest Service and its diverse clients. The top ranked issues were challenges to agency decisions an resource conflicts. Few of the key issues concerned technical aspects of resource management.

In the future, the important questions in forest management will not be simply how to choose among management techniques or products and uses, but how to allocate resources among competing demands. As the diversity of forest values and uses increases, along with demand, conflict over resource allocations and incompatible uses will increase. Scientists or resource managers should not be surprised that they are no longer trusted as the authority for allocating natural resources; science does not produce the only right answer or the rationale for certain actions (Knopp and Caldbeck 1990). Science has an essential role in resource management, but public policy and direction in a democratic society ultimately come from a political process that weighs scientific information with societal values (Salwasser 1990).

So, how will public agencies allocate our forest resources in the future, given increased demands for often incompatible uses by special interest groups? The

days when the forester made these decisions with little public input appear to be gone. Knopp and Caldbeck (1990) suggest that the obvious solution is to involve the public more directly. Behan (1988) has also strongly advocated constituency-based management. Yet, many resource managers and planners appear frustrated by the current involvement of the public in forest planning, perhaps because we lack effective processes for public participation (Knopp and Caldbeck 1990). An important challenge to resource planners in the future will be to develop processes that involve the public in resource allocation decisions.

Expanding Urban/Forest Interface

Although the urban-forest interface was not identified by Jakes et al. (1990) as one of the top-ranked future resource issues, it may contribute to some of the higher ranked issues. Between 1950 and 1987, the number of people in the U.S. grew nearly 100 million. The number of people living in metropolitan areas increased from 134.6 million to 187 million; the amount of land taken up by urbanization increased from 5.9% to 16.2% (U.S. Bur. of the Census 1989). There has also been movement of people from the cities to areas outside the metropolitan areas and their suburbs. Between 1980 and 1984, populations in outlying metropolitan counties grew 7.0% compared to 4.2% for metropolitan areas (Starsinic 1985). Remote areas are also growing, counties with federally designated wilderness or national forests grew approximately two to three times that of all non-metropolitan counties (Shands 1991). These recent trends have complicated land use in and around forests. More people and smaller parcels greatly increase interaction. The development of rural areas has removed the buffers between forest land and residential or urban areas (Shands 1991). These new forest neighbors often have different expectations or values for the forest than the traditional rural neighbors, and create pressure for change in land allocation and management emphasis, from timber to recreation or visual amenities (Shands 1991).

CONCLUSIONS

Although the area of forest land in the Midwest appears to be fairly stable, the nature of the forest and human use and values associated with it are changing. The challenge to land managers will be to maintain the biological diversity and ecological integrity of the forest, while accommodating traditional and new uses and values. Although significant scientific challenges are associated with the challenge of maintaining diversity and ecological integrity, perhaps the

greatest challenge will be to evaluate trade-offs and conflicts between competing uses and values of the forest. This will take what Thomas (1990) has called "holistic management", that recognizes the societal, economic, and ecological trade-offs of management alternatives. The current public uproar about management of public forests suggests that society's values and uses of the forest are changing faster than management agencies can respond. Advocacy groups appear to be leading the debate because agencies have not offered an acceptable alternative. Resource management agencies will have to more effectively determine what the public wants, use the best science available to educate the public on the consequences of their demands and to evaluate management alternatives, and then take the lead and offer alternatives that address public and ecological values.

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Fisheries Futures: What's on Line for 2020?

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Abstract: *Midwestern fisheries are noteworthy for their diversity, not only in users and uses, but also in species and genetic stocks. This diversity is the foundation of current fisheries, and must be maintained to ensure continued quality fisheries in the Midwest over the next three decades. Fisheries in this region will face continued change during the next 30 years, in response to changes in human population characteristics, changes in fish habitats, and changes in the fish fauna. Changes in the human population likely will increase interest in fishing, but those who fish are likely to have different interests from those who fish today. Greater interest in catch-and-release fishing and in fishing near urban areas is likely to develop. Fisheries managers and scientists must be prepared to provide a high quality product to this new generation of fishers, a challenge which will involve issues of access, species preference, sizes, and safety. Fish habitats will change in response to land-use practices that likely will deteriorate habitat quality. Recreational and commercial fisheries interests must be prepared to fight for buffers between agricultural, residential, or industrial land-use practices and streams, rivers, ponds, and lakes. For example, greater emphasis on protection of stream banks and riparian vegetation is needed to maintain stream fisheries. Loss of water from streams and lakes to consumptive uses, such as irrigation, may be particularly difficult challenges to fisheries interests during the next 30 years. Fisheries managers and scientists must be prepared to adapt new and innovative approaches to maintain or enhance fishery diversity, fish habitats, and fishing opportunities.*

One of the most prominent features of fisheries in the midwestern United States and Canada is that they are diverse. Fisheries range from northern lakes with walleye *(Stizostedion vitreum)*, lake trout *(Salvelinus namaycush)*, and northern pike *(Esox lucius)* to southern impoundments with largemouth bass *(Micropterus salmoides)* and blue catfish *(Ictalurus furcatus)*, and these fisheries provide food, income, and recreation for millions of people. Cold trout streams are scattered from the Nebraska Sand Hills to the Missouri Ozarks and Michigan's Upper Peninsula. Large rivers provide the greatest diversity of fishes for fisheries that are commercial and recreational. The Great Lakes yield harvests for commercial, tribal, and recreational fishers based on native and introduced

salmonids, percids, catostomids and other groups. Small impoundments still provide some of the easiest access for anglers to the most frequently caught fish in the region, bluegill *(Lepomis macrochirus)*, and these can still be taken on tackle as simple as a cane pole, line, hook, and bait. Others choose to spend (and occasionally win) tens of thousands of dollars on boats and tackle that allow them to fish over vast areas for walleye or largemouth and smallmouth bass (*Micropterus dolomieui*) in tournament series that run from the time ice leaves the lakes to the time it settles back over the waves (Schramm et al. 1991).

The diversity of fisheries in the Midwest is the feature that is most important to their popularity today, and projecting the future of these fisheries in the year 2020 must begin with a recognition of this feature. In anticipating the future of midwestern fisheries, it is more important to identify the changes that will influence the fisheries than it is to predict the state of the fisheries. The state of the fisheries will depend largely on how the users and the agencies given the charge of stewardship react to the challenges they face. This article identifies the forces that will influence the state of midwestern fisheries in 2020 and suggests actions that will prepare the users and the stewards for these challenges.

In writing this, I have been guided by a vision that is partly personal, and partly developed from discussions with a variety of current fisheries experts and users. Value judgments are scattered throughout the paper, but they are based primarily on values that hearken from Leopold's (1949:224-225), "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise." The diversity and sustainability of midwestern fisheries resources are the most important qualities to protect and enhance over the next 30 years.

The changes that midwestern fisheries will experience over the next 30 years will be directed by changes in landscapes and faunas, but more importantly by changes in the human populations of the region and their success at finding a balance between use and protection. The habitats that support fisheries will change as a result of landscape processes triggered primarily by human activity. The species and hybrids available for users will depend on the quality of habitats that remain, and the ability of managers to foster their maintenance in the face of habitat changes and exploitation. Finally, the values, numbers and distribution of people throughout the Midwest will directly influence land-use practices and biodiversity.

HABITAT CHALLENGES

The most important changes in habitat will be those that involve water use, land use, and the production and release of toxic contaminants. Over the next 30 years, the demand for use of surface water is likely to increase, particularly for use in irrigation, power generation, and municipal uses (Dzurik 1990), and this is likely to trigger changes in water allocation practices. Irrigation demands will be extremely important because they are consumptive. However the potential impacts of power generation and municipal uses on water quality may be just as critical in the more limited supply of water that will remain for fisheries.

Irrigation Development

Over the past four decades, growth in irrigated crop acreage has been modest in the eastern portion of the Midwest (east of the plains states and prairie provinces), but dramatic in the western portion, particularly in Kansas and Nebraska (Postel 1990). Much of the increase in irrigation in the plains states was supplied by groundwater mining, however surface waters have been tapped as well, e.g., the Arkansas, Republican and Platte Rivers (Postel 1990). These changes were largely a response to the semi-arid climate of the region, and secondarily to the increased value of irrigated crops. In the eastern portion of the Midwest, economic changes are likely to dictate a move towards more irrigation. Agriculture is becoming more centralized in this region, with each owner staking a higher investment in larger acreage. These businesses also have greater access to the capital needed to invest in irrigation, and are likely to use it as a hedge against climatic variation and its effects on profits. Growers probably will not irrigate every crop every year, but rather will use it most in drought years, when it can make a difference between having a harvest or not.

Global climate warming is likely to further move midwestern growers to use irrigation for their crops. Increased temperature and decreased precipitation will increase the need for irrigation throughout the Midwest (Peterson and Keller 1990). The models developed by Peterson and Keller (1990) predicted that irrigation use of surface waters east of the 100th Meridian will increase 5 to 10 times over current levels of use.

Changes in Michigan use of irrigation are respresentative of the types of changes that may develop throughout the eastern Midwest. During the past 20 years, the use of irrigation grew rapidly in Michigan, not only for high value table crops, but also for grain crops that entered the global marketplace (Kevern and Gowan 1984, Wallace and Pawloski 1984, Fulcher et al. 1986). Currently,

three proposals are being reviewed to establish irrigation districts in the Saginaw Bay area of Michigan, and these would be the first irrigation districts in the state (Auernhamer and Protasiewicz 1990).

Increased irrigation in the Midwest is likely to come first from the more easily exploited surface waters and later from groundwater. Furthermore, Peterson and Keller (1990) showed that for much of Iowa, Illinois, and South Dakota, ground water sources are of poor quality or are prohibitively deep, and surface waters are likely to be more important in these areas. Fisheries depend first on the availability of surface waters, and are most vulnerable to water loss during drought. State and federal agencies must act now to develop policies and water laws that will prevent irrigators from depleting surface waters and their shallow aquifers to produce the crops of 2020 (Kevern and Gowan 1984). Policies need to ensure greater dependence on deep aquifers in times of drought and should allow surface water use only to the extent that it removes a small proportion of the surface water, especially during droughts. Economic incentives also are needed to encourage careful, efficient application of that water to sustain water resources over the long term (Postel 1990). Overhead irrigation for example, uses much greater volumes of water than either ditch or subsurface irrigation practices (Belcher 1990, Dzurik 1990).

Hydroelectric Development

Hydroelectric power is becoming more appealing to consumers and utilities as the supply of fossil fuels dwindles, and as concern for environmental impacts of fossil fuel and nuclear generation increase, even though the most easily developed hydroelectric sources have been tapped already. More efficient designs for small local facilities may become more cost-effective to municipal utilities, and large hydroelectric developments similar to Hydro Quebec may entice large utilities. The water resources of central Canada may be most vulnerable to the large projects, but the high cost of expanding the extensive hydroelectric systems already established in states like Missouri may become recoverable as supply works its side of the fossil fuel market.

Previous hydroelectric projects have created new fish habitat, although it was at the expense of riverine habitats. New hydroelectric projects may expand fishing opportunities, but this time fisheries advocates must use their experience to develop systems that do not tax riverine fisheries. Use of fish passage systems for migratory species and operation modes that mimic the natural variation in river discharge, lake level, and water temperature must be as integral in the planning

of these new facilities as selection of the proper turbine design and materials.

Perhaps the ideal vision for 2020 is that there will be no more hydroelectric development, and that as old facilities wear out, they will be removed to restore open river flow. More realistically, hydroelectric generation is likely to at least stay level over the next 30 years, as evidenced by the number of power companies that are currently applying for 50-year licenses on their hydroelectric facilities (G. Whelan, Mich. Dep. Nat. Resour., unpub. data). Fisheries agencies must be prepared to have fisheries experts involved in the planning and design of hydroelectric projects, and fisheries researchers need to develop optimal designs for fisheries concerns. Agencies also must be ready to bargain. For every acre of impoundment that is created, resource agencies should require an acre of restored floodplain downstream of the dam. This will provide flood management benefits as well as fisheries benefits.

Municipal Supply and Wastewater Development

Municipal uses of water for water supply and wastewater disposal will create greater demands on surface waters in 30 years. As urban and suburban areas grow and spread, regulatory agencies must remain vigilant in protecting surface waters from unhygienic and hypertrophic conditions. Some forecast that wastewater systems will continue to improve, for example by greater use of closed, recirculating water supply and waste systems (Dzurik 1990). However, the costs for these technologies may be used as reasons for continued reliance on disposal of treated wastes into surface waters. Urban and industrial users, planners, and engineers must be encouraged to continue improvements of wastewater treatment and reduce use of surface waters for waste disposal. Fisheries users also must begin to search for opportunities to use the nutrients from wastewaters where they may enhance fish production. Where modest nutrient enrichment is needed and controllable, fisheries managers should be ready to incorporate wastewater to increase production of recreational and commercial fisheries. Properly treated wastewater may even become an ally in replenishing flow to small streams that have been depleted of flow by urban or agricultural drainage.

Land-Use Conflicts

A variety of landscape changes will provide challenges to those who manage midwestern fisheries in 2020. The major threats to aquatic habitats will be the same threats of concern today: erosion, stream channel constriction, lake shore

instability, and amplification of extremes in surface runoff. Fisheries advocates must be prepared to work for legal and policy changes and to work with land owners to minimize the impacts of land use on aquatic habitats. The principle that must be incorporated into land uses is that buffers are needed between intensively used landscapes and aquatic ecosystems. Certainly, continued improvement in erosion control in agricultural practices, construction practices and recreational practices is essential. But to minimize the effects of urban or agricultural land uses on water quality, buffer zones are needed between intensively modified land surfaces and surface waters.

Buffer zones are needed on either side of stream and river reaches to act not only as filters between the upland and the water (Schlosser and Karr 1981), but also to provide for the natural movement of stream channels across their floodplains (Morisawa 1985). The U.S. Food Security Acts of 1985 and 1990 have provisions to pay farmers for protecting stream banks, but enrollment in this program has been light. The U.S. Forest Service has incorporated buffer strips into some of their Forest Management Plans in the Midwest, but this varies among districts. Hunter (1991) documented the improvements in stream habitats that have resulted from protecting riparian vegetation from grazing in a variety of western streams. Efforts by the Missouri Department of Conservation (Wehnes et al. 1991) and the Illinois Department of Conservation (Roseboom et al. 1992) to improve riparian and instream habitats in warmwater streams illustrate the variety of approaches that agencies can take to improve stream habitats in midwestern streams.

Buffers around lakes are important to maintain stable shorelines and water quality. Many small inland lakes in the Midwest are being over-used by vacationers. Cottages, their lawns, and the associated golf courses and amusement parks reduce shore stability and add nutrients from lawn fertilizers, road runoff, and inadequate septic systems. Lake associations and regional planning agencies must become more familiar with fisheries agencies by seeking their advice in planning. Fisheries experts must call attention to the problems of over-development of lake shores, and agencies can help by providing alternatives for lawn management, house construction, and wastewater treatment that will protect these lake fisheries.

Fisheries agencies need to become more involved in land-use decisions in urban areas as well as rural areas. Urban planners view stormwater management as a system for buffering the effects of land use on aquatic habitats (Dzurik 1990). Fisheries experts need to work with urban planners in developing these

systems so that small streams and ponds can be protected from unnaturally rapid runoff events, and to prevent human communities and fish faunas from experiencing catastrophic floods (Imhof et al. 1991). In the process, fisheries advocates need to keep alert to opportunities for creating new fishing opportunities in stormwater retention systems and floodplain ecosystems.

Floodplains, like wetlands, are natural stormwater retention systems. To the extent that these have been confined, restoration of these habitats is needed for fisheries and for stormwater control. The return of the Rapid Creek floodplain in South Dakota to its natural floodplain functions after the catastrophic flood of 1972 illustrates the benefits of restoration (Hunter 1991).

Toxin Effects

The toxins that recent generations have applied to midwestern lands and waters in the forms of pesticides, herbicides, and industrial wastes remain in many lakes and streams. Many states and provinces have advisories about the risk of consuming certain fish species from certain water bodies because the fish carry potentially dangerous concentrations of toxins (Reinert et al. 1991). By 2020, the more persistent toxins, e.g. polychlorinated biphenyls and chlorinated pesticides, will still be in the sediments and organisms of aquatic systems, though current control measures may help to reduce their concentrations. But what other toxins will be "discovered" in aquatic environments by 2020? And what will be the risks of their toxic effect? Contaminant control and regulation is still retroactive. Proactive means of limiting contaminant release into rivers and lakes are needed to prevent future surprises of newly discovered contaminants. Similarly, developments in the rapidly growing field of environmental toxicology should help to make more reliable and accurate estimates of risk (Reinert et al. 1991).

Even if U.S. fish consumption continues to increase as it has since 1980 (Gordon 1990), it is doubtful that the increase will be reflected in consumption of wild fish from midwestern waters. Most of the increase is expected to come from aquaculture production (Gordon 1990). The risks of eating wild fish in 2020 may be even greater than current assessments, and the prospects are poor that agencies can inform consumers on the intricacies of how one species in a lake may be contaminated but another species with different feeding and life history patterns is safe. People who fish in 2020 will be less likely to consume their catch than they are today, and fisheries agencies must be better prepared to inform users about the risks involved in consuming fish and the types of fish

and locations that pose the greatest risks. It may even be useful to harvest fish for disposal to remove toxins from an ecosystem. But use of fish as biological filters makes sense only if the flow of toxins onto the lands and waters of the Midwest is curbed.

BIODIVERSITY CHALLENGES

Many of the habitat changes described previously will lead to or complicate changes in midwestern fish faunas. This region was rich with a fauna of nearly 400 species only 100 years ago (Burr and Page 1986, Underhill 1986). Some of those species, such as some of the Great Lakes ciscoes *(Coregonus spp.)*, are extinct, and others, such as lake sturgeon *(Acipenser fulvescens)*, paddlefish *(Polyodon spathula)*, and several minnow *(Notropis spp.)* and darter *(Etheostoma spp.)* species are threatened with local extirpation, if not extinction (Burr and Page 1986, Underhill 1986, Johnson 1987). Even more insidious is the loss of genetic diversity within species (Hughes and Noss 1992). The Lake Erie blue pike *(Stizostedion vitreum glaucum)*, the many races of lake trout *(Salvelinus namaycush)* in Lakes Michigan, Huron, and Superior, and lake and river races of muskellunge *(Esox masquinongy)*, northern pike, walleye, and other game and commercial species all have been threatened or extinguished (Underhill 1986).

Additional species may be lost from the region's fauna over the next 30 years, even if impacts on landscapes are tempered. Species with isolated distributions in the Midwest, such as redside dace *(Clinostomus elongatus)* or Niangua darter *(Etheostoma nianguae)*, are most vulnerable (Pflieger 1975, Becker 1983). Others that once were common and widespread, but are sensitive to environmental change, such as rainbow darters *(E. caeruleum)* or orange-spotted sunfish *(Lepomis humilis)*, may become threatened (Trautman 1981). Further, the introduction and mixing of hatchery stocks may continue to compromise the genetic integrity of exploited species (Goodman 1990). Lower reliance on hatchery production of exploited species will enhance the prospects for maintaining the genetic diversity that allows wild fish populations to survive environmental change (Hilborn 1992).

Species Introductions

More aquatic species are likely to be introduced by accident, as midwestern economies become more tightly linked with the global economy. The ruffe *(Gymnocephalus cernuus)* and the tubenose goby *(Proterorhinus marmoratus)*, along with *Bythotrephes cederstroemi* and zebra mussel *(Dreissena polymorpha)*

have joined sea lamprey *(Petromyzon marinus)* and alewife *(Alosa pseudoharengus)*, and may be just the beginning of a new wave of introductions (Carlton 1989, Moyle 1991). Prevention will remain the first line of defense, and it must be improved tremendously much sooner than 2020. Agencies also must become better prepared to respond to introductions by developing information sources on potential invaders and action plans to control these invaders if and when they arrive. Cooperation across state and provincial as well as federal and international jurisdictions will be especially important. Some suggest that new biotechnologies will be available by 2020 that will help to remove introduced species where needed (Soule 1989). Agencies must be quick to adopt these technologies when they have been proved safe and effective.

Genetic Engineering

Genetic manipulation of plant domesticates has had a profound impact on the growth of the world human population, and especially on the economies of the Midwest. Genetic manipulation holds the same promise for revolutionizing the production of captive fish for human consumption (Hallerman and Kapuscinski 1990). However, application of these techniques to wild populations must be approached with extreme caution (Scott et al. 1990). Over the next 30 years, biotechnological development will allow tremendous advancement in abilities to introduce new genetic traits into captive stocks. These developments must be accompanied by techniques to prevent the introduction of these traits from captive stocks into wild stocks and the loss of genetic diversity in wild stocks (Kapuscinski and Hallerman 1990). These same developments may prove to be helpful in restoring genetic diversity into depleted stocks such as the lake trout stocks of the Great Lakes (Soule 1989).

Managing for Dynamic Ecosystems

Finally, in all of these biodiversity concerns, new understandings and approaches to balance in aquatic ecosystems are essential. Swingle (1950) viewed balance as a fixed state of equilibrium between predator and prey. But recent developments in resource management and ecology have made it clear that ecosystems often change in unpredictable ways, entirely from natural causes. Fisheries managers must become adept at managing with natural variation rather than attempting to force it out of ecosystems (Walker 1989, Botkin 1990). Just as the concept of dynamic equilibrium is central to understanding the formation and evolution of stream channels (Morisawa 1985), it

should become central to management of fish communities. A balance between largemouth bass and bluegill in a farm pond must change as that pond fills with sediment or receives a different amount of inflowing nutrients. The balance between commercial and recreational fisheries on large rivers and the Great Lakes may need to change as habitat becomes more critically limiting or as user interests change. The balance between consumptive and nonconsumptive uses may change with user interest. For example, the increased abundance of large piscivores that results from catch and release fishing may affect the quality of panfish fishing in a lake. Also, efforts to depend more on wild reproduction of fish may require unique harvest restrictions that protect previously harvested sizes of fish (e.g., Scarnecchia et al. 1989, Hunt 1991).

HUMAN CHALLENGES

Implicit in all of the challenges that I have discussed are anticipated challenges from the users of fishery resources. The past 30 years of consistent growth in fishing pressure is reason enough to expect continued increases, although it is difficult to anticipate the magnitude of change that will occur. Gordon (1990) predicted a 2 to 4 % annual rate of increase in fishing effort, but others expect slower growth (Murdock et al. 1992). Furthermore, although the size of the angler population will increase, the rate of increase will decline between now and 2020 (Murdock et al. 1992). Their analysis shows that most of the change (78%) in the number of anglers will be due to change in the age distribution of the human population, and that population growth and ethnic composition will be less important in causing this change.

To some extent, fisheries agencies control the amount of increase in fishing activity. If agencies provide a good, inexpensive, and accessible product, they can expect continued growth in fishing effort. Providing that quality product will remain resource agencies' major challenge, and will depend on innovative (e.g. biomanipulation, Shapiro and Wright 1984) and adaptive (Walters 1986) management approaches.

If they are to meet the demand, fisheries interests have three alternatives to pursue, none of which is exclusive. First, they must be creative in finding new venues for fishing, such as the stormwater systems and restored floodplains mentioned earlier. The prospects for new impoundments, either large or small, are few for the next three decades (Gordon 1990). Much of the increased access to fishing waters must be in those areas in which it is most difficult to provide access, near urban and suburban areas (Murdock et al. 1992). The access

needed for the increase in the senior fishing population can be met most effectively with fishing opportunities near anglers' homes, most of which will be near urban centers. In addition, facilities that are more universally accessible, i.e. to those with or without boats and to those with limited mobility, will be needed.

Second, agencies and private fisheries groups must be vigilant in protecting and enhancing the habitats that currently exist. Most critical are floodplains and headwaters, which serve as reservoirs of diversity and refuges from community change. The Upper Mississippi National Wildlife Refuge is a good example of a floodplain ecosystem that has been set aside to protect floodplain diversity. Similar refuges on the Missouri and Ohio Rivers, reclaimed from agricultural or urban uses, are needed. Private protection, either by conservation-minded land owners or by conservation groups, such as the Nature Conservancy, of unique headwater landscapes may be especially effective and achievable means of protecting these important ecosystems. Although these types of habitats may not be as accessible as prescribed above, and may not provide the desired fishing opportunities for 2020, they will help to reduce habitat deterioration in lakes and streams that support anglers, and will provide managers with genetic and species diversity and an information base to call upon for support of deteriorating exploited fisheries. Citizen monitoring efforts in aquatic habitats may help to foster a greater sense of stewardship towards aquatic resources, a notion which has gained support from programs from the U.S. Environmental Protection Agency (Alm 1991) and several state agencies, such as the Ohio Environmental Protection Agency and the Missouri Department of Conservation (Rankin 1989, Wehnes et al. 1991).

Finally, agencies and user groups must encourage more non-consumptive means of using fishery resources. Catch-and-release fishing is an obvious and successful option for sharing the wealth of fishing resources (Behnke 1987). The success of catch-and-release in bass and trout fishing shows promise for further extension to other trophy-based fisheries. Another potential non-consumptive use is a fish analog to that popular terrestrial pastime: birding. In many midwestern streams and lakes, visibility simply may not allow for visual exploration of aquatic habitats. But in those regions of the Midwest where clear water does occur at least periodically, there is great potential for involving more people in underwater observation of fish. Recreational SCUBA diving in the Great Lakes region has grown rapidly over the past decade (K. Vrana, Mich. Sea Grant Prog., unpub. data). Much of the popularity of snorkeling in coral reef areas is due to the color and diversity of fishes that are present on the reefs.

Midwestern waters may not match the diversity of coral reefs, yet the color and behavioral diversity of their native fishes is surprising.

OPPORTUNITIES FROM CHALLENGES

Many of the challenges outlined in this paper will test the ability of resource agencies and private fisheries interests to respond in innovative ways. Each challenge will provide an opportunity not just to maintain fishery quality, but to improve it. Fisheries interests must keep alert to solutions that will seek to enhance the diversity and integrity of midwestern fisheries. Several examples of challenges and possible responses that meet this goal follow.

Public access is likely to become more limited as vacation homes and resorts sprout along lake shores and stream banks. It will be important for state, provincial, and federal agencies to purchase access where possible, but they should expect to find greater use of paid access. The prospect of limited access in a market of growing demand finds a textbook outcome in fee-fishing, not just for lakes and ponds with a single land owner, but also for access to lakes and streams with multiple adjacent land owners. The demand for guided fishing services is likely to increase as well in an increasingly urban population. Privatization of fishing access is made even more likely as budgets for fishery agencies decline.

The growth of the animal rights movement has shown no signs of abating, and is likely to continue. Managers and scientists of wildlife resources are facing this challenge sooner that in fisheries, and fisheries interests must learn from the experience of wildlife interests. Although much of what goes on as fishing is not lethal, the fact remains that many fish caught are killed. Even in no-kill fisheries though, the use of multiple or barbed hooks (or even unbarbed hooks) may be challenged. This debate may not develop in the immediate future, but is likely to before 2020.

If hook-and-line fishing is limited for humanitarian reasons, the tackle manufacturers will be quick to develop velcro-like alternatives that still place a premium on skills of presentation and capture. Even if a ban on the use of hooks is avoided, anglers may still find themselves limited to catch-and-release fishing in most cases, and this may only come with improvements in current practices of catch-and-release. For example, the habit of carrying bass or walleye around in a boat's live well all day for tournament fishing may be replaced with other fail-safe means of documenting fish species and size on the boat at the time of capture that allow for immediate release, such as those used in marine

billfish (Istiophoridae) tournaments (Qualia 1987, Witzell 1987).

As societies, landscapes, and faunas change, fisheries management will change. Fisheries agencies are likely to become leaner, as required by leaner budgets. Budgetary constraints will place a premium on efficiency, non-duplication of effort and technological advances. Fisheries management must be integrated more tightly with other resource management practices, not only with wildlife and forest management, but also with land-use planners, urban developers, farmers, and their agencies of support. Watershed-based management with teams that include people trained in these different disciplines provides the greatest potential in coordinating and integrating fisheries needs with the landscape and water uses that limit fisheries (Imhof et al. 1991). The practice of separating water quality management from fisheries management among agencies is outdated today, and will be even more anachronistic three decades from now.

Agencies need to work together not only within jurisdictions, but also across them. The Mississippi Interstate Cooperative Resource Association (MICRA), an interstate consortium recently initiated to coordinate management and research efforts on the riverine fisheries that cross state jurisdictions (Montgomery 1991) and the international efforts of the Great Lakes Fisheries Commission to control sea lamprey (Spangler and Jacobson 1985) are examples of the kind of inter-jurisdictional cooperation that is needed. Ventures like these must be given more inter-jurisdictional authority and responsibility to ensure that they will reach their potential contributions to fisheries management. Cooperation must include planning, information sharing and implementation of regulations and other management applications. The days in which border states have different harvest limits on common waters should end long before 2020.

Research across jurisdictions also is essential (Hinch 1991). The cooperative effort to study shad (*Alosa* sp.) across states, originated by the Reservoir Committee of the Southeastern Association of Fish and Wildlife Agencies is one example of interstate cooperation in research that should save time and funds by avoiding unneeded duplication of effort (Boxrucker 1992). The small impoundments workshop is another example from this region (e.g., Novinger and Dillard 1978), and the cooperative efforts being developed by technical committees in the North Central Division of the American Fisheries Society (e.g., Sauer 1990) also promise better coordination of research and management across state, provincial and national lines.

Further delegation of research to cooperating universities and contract firms provides another means to stretch limited agency funds towards their intended

target: improved quality of fishing. The Cooperative Fish and Wildlife Research Units still are among the most efficient and productive research organizations in federal, state and university bureaucracies (Clark and Baskett 1986). The Cooperative Unit program should be extended and emulated in the U.S., and in Canada, if appropriate, to develop new links and produce cost-effective research.

It will be extremely important to incorporate technological advances into assessment and modeling of fisheries resources. Nielsen (1991) provided a vision of fisheries assessment technology that may have seemed fanciful, but his vision shows where efforts should be directed. Monitoring systems are needed that are simple, inexpensive and easy to use, yet yield a more reliable supply of information than currently available. Every fishery manager can argue for needing more information, but each must become satisfied more by quality and consistency of information than by volume. More careful design of monitoring and assessment programs is likely to yield more cost-effective data collection. And as Nielsen (1991) argued, no technological magic can make up for insufficient planning for fisheries protection and development.

Private firms are likely to be more involved in fishery management in 2020 as use becomes more privatized and public agencies become more limited by budgets. Agencies need to anticipate how they will coordinate with and regulate these private ventures, and view them as potential benefits to their program, and not as nuisances.

Will midwestern fisheries be as diverse and productive in 2020 as they are today? If fisheries professionals and advocates stand ready for the types of changes described here, and prepare to meet those challenges with new ideas about organization, management, research, and cooperation, midwestern fisheries can become even better than they are today. If agencies and private groups procrastinate and wait for more funding to continue doing what they do in 1991, the baby boom generation will have a retirement that is short not only on fishing, but on the quality of life that we associate with good fishing.

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Endangered and Nongame Wildlife Conservation in the Year 2020

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Abstract: *Diminishing quantity and quality of wildlife habitat threaten many species of nongame and endangered species. Intensification of forestry and agriculture, urban sprawl, increasing human population, pollution, and poaching all will continue as problems into the next century. If wildlife managers are to meet the challenges, there will need to be increasing efforts to improve education, data base management, funding, and habitat management and preservation with strategies that are based on biodiversity and integrated resource management.*

The profession of wildlife management is often filled with so many daily challenges and distractions that it is frequently difficult to see the broad view beyond the scope of the current state or federal funding cycle.

If we are to use our time, money, and talent effectively, however, it is essential to take the time to "step back" and understand the broad variety of factors that are shaping the future of wildlife conservation in the next 30 years. Many of these factors are beyond the control of wildlife biologists and wildlife managers.

But they are factors to which we must adjust if we are to keep from getting left behind in the wake of biased wildlife interest groups and wildlife users that have the ability to out-compete us and subvert our efforts to manage wildlife populations on a scientific basis.

Some of these general wildlife problems and trends will be amply discussed by the other presenters. I will focus specifically on how future developments can affect and shape the conservation of nongame and endangered wildlife species.

Probably the best way to understand where we have been and where we are going in the management of nongame and endangered species is to review the five-step process described by Butler (1983). His paper was entitled "Challenges and Changing Perspectives in the Management of Fish and Wildlife Resources." Butler identified five stages in the evolution of wildlife management.

First was the "Protection Phase" in which refuges were designated or acquired and initiatives were taken toward the protection of highly visible declining species. This occurred largely from the early 1900s with wetland habitats and with game species like the white-tailed deer *(Odocoileus virginianus)* and wild

turkey *(Meleagris gallopavo)*.

Second was the "Regulation Phase" in which game laws were established to allow for limited wildlife harvest after these species had become abundant enough for hunting seasons.

Third was the "Biological Phase" in which research was used to provide the knowledge necessary for setting game seasons. Primary emphasis is still on game species, and most wildlife biologists entered this profession at that time as a result of growing up in a rural area where they had a childhood hobby of hunting, fishing, or trapping. The creation of the 10% Pittman-Robertson federal excise tax for funding of wildlife research and management was a major catalyst for this phase.

Fourth is the "Ecological Phase". It is marked by the expansion of wildlife management to the full spectrum of wildlife species—game, endangered species, and nongame (birds, mammals, reptiles, amphibians, fish and wildflowers) and then eventually invertebrates. The key attitude is one of providing a holistic environmental approach to wildlife management. Now we refer to this as "integrated resource management." This phase is first exemplified by changing names of state game departments to Departments of Natural Resources or Wildlife Conservation Departments. Natural Heritage Programs and Nongame Wildlife Programs help broaden the scope of traditional game management agencies.

Concurrently, many of the new recruits into the ranks of wildlife management do not consider themselves game managers, but rather as wildlife ecologists, and many are women. Many of these people acquired their love of wildlife through activities other than hunting and fishing, and many have urban backgrounds. One characteristic of this phase is concern about the introduction of exotic species. There is a concurrent increase in the control of exotic plant and animal species and in the maintenance and re-establishment of native plant and animal communities. This has especially been true of restoring native prairies and wetlands.

The eventual focus of this natural resource management effort is maintenance, preservation and re-establishment of biological diversity. The Nature Conservancy's film *Garden of Eden* was a classic statement about this concept. I'm not sure that our state wildlife agencies have yet recognized biodiversity as the foundation upon which our future natural resources programs must be based—not "hunter-use days" or the number of white-tailed deer we can harvest each year. Both hunting traditions and harvest of game species will be an integral part of future wildlife conservation programs—but not its focal point.

The final, fifth, wildlife management phase identified by Butler (1983) is the "Sociological Phase". This phase may be concurrent with the ecological phase. It moves beyond the tendency to simply study wildlife species, and begins to perform research on natural resource users—their attitudes, expectations, values and needs. Stephen Kellert from Yale University has conducted a considerable amount of pioneering research in this area. (Kellert and Brown 1985, Kellert 1987).

It is particularly exciting to see that wildlife management is in such a dynamic state. But, it is up to us, however, to see that the change is for the better, and to perceive long term trends. Sometimes these trends are difficult to understand because daily "brushfire" management obscures our perceptions.

One such trend is the significant increase in support for and participation in nonconsumptive forms of wildlife recreation: birdwatching, wildlife photography, bird feeding, wildlife tourism, building nest boxes, and landscaping for wildlife. All generate much more enthusiasm and economic impact than we formerly realized. They offer new clientele for wildlife managers.

The problem with this clientele is that they generate $20 billion annually through their expenditures on bird-related activities, but wildlife conservation agencies do not receive a penny of benefit from that activity. In contrast, such revenue in a Pittman-Robertson excise tax situation would generate $2 billion in excise taxes for conservation (Weidner and Kerlinger 1989). Until all those people become "paying partners" in conservation, they will basically be looked upon as "freeloaders" by state wildlife agencies. If and when those user-groups become financially involved with conservation efforts there is an enormous potential for significant progress in all aspects of wildlife support base for those efforts.

This trend in nonconsumptive use appears to have been foreseen by Aldo Leopold (1949). In the last paragraph of his book *A Sand County Almanac*, in the essay "Conservation Esthetic," is the following statement (pp. 176): "It would appear, in short, that the rudimentary grades of outdoor recreation consume their resource-base; the higher grades, at least to a degree, create their own satisfactions with little or no attrition of land or life."

The amount spent for the nonconsumptive enjoyment of wildlife in Minnesota is $238,650,000 per year according to the results of the 1985 Survey of Hunting, Fishing and Wildlife-Related Recreation (U.S. Fish and Wildlife Service 1989). This is in addition to an estimated $994 million of annual economic benefit in Minnesota from hunting and fishing.

The major problem that we all face currently is that the whole field of nonconsumptive use of wildlife has developed without any mechanism for

channeling money back to state or federal governments for wildlife conservation purposes. Why should we promote bird feeding, bird watching, or wildlife tourism if there is no financial return to support those programs? Unfortunately, the people who participate in those activities have not come rushing forward to offer their support to establish a funding mechanism.

The biggest funding success so far is the state nongame wildlife checkoff that has been established in 34 states. Checkoffs now generate $10 million per year for nongame species, but national projections show that the states need at least $50 million per year to manage nongame wildlife species. Missouri and Florida have also developed other innovative funding approaches for wildlife.

Unfortunately, the checkoff as a funding mechanism is very inadequate. The percentage of people who actually donate is only about 7%, whereas the number of people who participate in nonconsumptive forms of wildlife recreation is 90% in Minnesota. Also, checkoff income usually declines after the third year for a variety of reasons, including competition from other new checkoffs. The state nongame wildlife checkoff should be viewed only as an important first step toward eventual higher plateaus of funding for all wildlife.

Ultimately, midwestern states will need to find matching supplements that will provide minimum budgets of $1.5 million per state per year for their nongame wildlife programs, and an equal amount for state programs to conserve endangered plants and wildlife.

Assuming increased funding for nongame and endangered species conservation, what emphasis needs to exist in the next 30 years? Following are ten possibilities:

1. The biological data base is the "power base" from which a broad array of natural resources planners, foresters, wildlife managers, park managers, agricultural specialists and environmental review specialists will depend for future decision-making. In most states this will be the Natural Heritage data base. Much of the initial information on these data bases came from historical information that was 30 to 50 years old.

   The Minnesota County Biological Survey has become a standard for doing a systematic survey, county-by-county, for rare, threatened, and endangered plants and wildlife, including selected groups of invertebrates. This kind of survey generates thorough, up-to-date data that will greatly increase the stature of state Nongame Wildlife/Natural Heritage programs because the data is *so* useful for resource planning efforts. This ultimately increases the incorporation of nongame and endangered species data into

that decision-making process. Another benefit of this in the longterm is that it shifts endangered species conservation from after-the-fact crisis management to "preventative conservation."

2. The concept of "Integrated Resource Management" is becoming a modern "buzzword." Included in its meaning is that traditional game managers, foresters, park planners, and hydrologists must include consideration of nongame and endangered species in their land management decisions.
3. There must be more emphasis and management effort directed at neotropical migrant birds. We need to provide enough high quality nesting areas for the most sensitive and declining species. There must be a companion effort by the federal government, including substantial foreign aid, to Latin American countries to protect significant wintering habitats.
4. State resource agencies should take the lead in guiding the development of ethics and use patterns for "nonconsumptive" wildlife recreational use.
5. We must continue to discourage the introduction of exotic plant and animal species, eliminate nuisance exotics where feasible, control the expansion of others, and educate the public about how they can become involved.
6. We need to create partnerships between landscape architects, horticulturists, nursery people, and wildlife managers to promote the use of local origin native plant species for landscaping and wildlife restoration purposes. This reduces the use and dependence on exotic plants for landscaping purposes.
7. We must become more effective and sophisticated in learning how to identify our publics, how to reach them, and how to generate support from them for our wildlife funding and management initiatives. We need to work more effectively with the media.
8. Habitat management and preservation will continue to be the foundation of future wildlife conservation efforts. In contrast, so called "developers" will continue to find new and inventive ways to acquire and destroy valuable wildlife habitats. State and federal agencies will need to identify minimum critical habitat areas for important species and ecosystems for intensive preservation efforts. We must assume that virtually everything else will be either converted to residences, industrial sites, or monocultures for forestry or agricultural purposes.
9. Lastly, we are going to see some incredible "high tech" equipment and

techniques become available to wildlife managers for everything from population control of nuisance species to new radio-telemetry techniques for monitoring migrations and life cycles. We will need to be careful to pick our projects carefully so that we invest research management monies in species and habitats that genuinely deserve our attention. Preference should be given to research projects that have significant management relevance.

10. Wildlife biologists and managers tend to think primarily in terms of research and habitat management. Their goals are often in terms of species numbers and habitat goals. One factor that is frequently overlooked is the value of wildlife-related environmental education as a foundation for wildlife management. Wildlife education programs are usually the first items cut in wildlife agency budgets when funding declines. If wildlife conservation is to compete effectively with other natural resource uses in the future it is extremely important to provide a continuing flow of wildlife-related environmental education programs and materials to the public. This includes national level programs like Project WILD but it must also include state level initiatives focusing on special species and habitats.

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Urban Wildlife Management in 2020*

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Abstract: *Demographic and socioeconomic changes underway in U.S. cities will result in large dispersed urban regions covering several hundred square kilometers. These regions will incorporate inner city, suburban, and wildland areas. Successful urban wildlife programs will focus on two areas: conservation programs designed to maintain biodiversity at a regional level, and programs that provide local residents contact with wildlife as part of their day-to-day lives.*

INTRODUCTION

Wildlife managers have a problem with urban areas and urban people. Many resource managers regard urbanization and urban people as a deviation from traditional rural land uses, lifestyles, and attitudes. This deviation is viewed as either a problem or a threat.

Human dimensions specialists use knowledge about wildlife and active participation in wildlife related activities as measures of appreciation and concern for nature. These researchers are concerned that some groups of urban residents hold unconventional attitudes toward wildlife. Kellert (1984) found that urban blacks had lower levels of knowledge, appreciation, interest, and concern for wildlife and the natural environment than other demographic groups. A study by the Missouri Department of Conservation (1990) claimed that black residents of St. Louis disliked and feared nature and the outdoors. By viewing the responses of white, suburban, middle-class, and well-educated residents as being correct, these studies imply that other demographic groups have problems that must be addressed by those holding more appropriate views of nature and wildlife.

Urbanization is viewed by some resource managers as an imposition of alien values on wildlife-loving rural people. Hesselton (1991) described urbanization as a serious and insidious encroachment on wildlands. This encroachment is accompanied by new residents who are unfamiliar with rural lifestyles and are

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opposed to hunting and trapping. These new residents promote local laws that prohibit or limit traditional uses of wildlife. In response to this trend, Hesselton (1991) recommended that state wildlife agencies end all programs and activities in these communities.

Some prominent ecologists also view urbanization as the ultimate evil. Murphy (1988) stated that urban areas are synonymous with ecosystem destruction and the erosion of biological diversity. Within these urban areas, local governments are under the control of development interests and are incapable of protecting areas of biological diversity. Murphy (1988) recommended the application of portions of the Endangered Species Act as the only effective strategy for protecting habitats and maintaining biodiversity in urban areas.

The common theme to these views of urban areas and urban people is that urbanization is bad for wildlife habitat and wildlife management programs. Implicit in this view is that a more urban future, with associated changes in demographics and land use, will inevitably lead to a loss of wildlife and wildlife-associated values.

Biologists that study and work in urban areas have very different views of cities and people. Managing cities to benefit wildlife and people is viewed as an opportunity and a challenge rather than as a problem. Urban wildlife managers recognize that urban areas are ecosystems with predictable properties (McDonnell and Pickett 1990, Sukopp 1990), and that these properties have physical and social aspects (Douglas 1983, McDonnell and Pickett 1990). Most importantly they recognize that urban residents are not a uniform mass of similar individuals but a diverse collection of groups that impact urban ecosystems in a variety of ways.

During the next 30 years a number of changes will occur in cities in North America. These changes will alter the size and shape of urban areas and influence the people that live in them. Spatial, social, and economic changes will also impact wildlife habitats. In this paper I will describe these changes, discuss their impacts on wildlife habitats and wildlife management programs, and describe the types of efforts needed to effectively manage wildlife in these evolving cities.

WHAT IS URBAN?

Although the U.S. Census Bureau defines urban areas as populated areas with a density of 1600 people/km^2 and a minimum population of 2500, it is clear that this definition alone does not adequately describe the areas that cause

TABLE 1. *Percentage of population (1987) living in metropolitan statistical areas by state (Starsinic and Forstall 1989).*

State	Percent of population in MSA (%)
Illinois	82.5
Michigan	80.2
Ohio	78.9
Indiana	68.0
Wisconsin	66.5
Minnesota	66.2
Missouri	66.0
Kansas	52.8
Nebraska	47.2
Iowa	43.1
North Dakota	38.0
South Dakota	28.7

wildlife biologists so many problems. Recognizing that cities influence the region around them, the Census Bureau has designated large urban regions in the U.S. as Metropolitan Statistical Areas (MSA), defined as central cities with a minimum population of 50,000, the county containing the central city, and additional counties with well-defined links to the central city based on commuting patterns (Starsinic and Forstall 1989). In most midwestern states the majority of residents live within MSA's. Only four states, Nebraska, Iowa, North Dakota, and South Dakota, have fewer than 50 % of their population living in MSA's (Table 1, above).

Because metropolitan areas reflect the influence of large concentrations of people on lands that surround central cities, MSA's also incorporate suburban and rural lands creating a pattern of land uses and cover types that have important impacts on wildlife habitats. In general, large cities have a greater impact on surrounding lands than small cities. Two MSA's in Kansas illustrate this. Fifty-eight percent of the 500,000 residents of the Kansas City MSA live outside of central cities; in contrast, 78 % of the 73,000 residents of the Lawrence MSA live in the central city. The presence of these distinct zones within metropolitan

areas is important in viewing cities as ecological systems and in understanding how demographic changes in cities will impact wildlife and wildlife agency programs.

URBAN ECOSYSTEMS

Recently, ecologists have used ecosystem concepts to understand urban areas. Interactions among the physical, biological, and social components of cities can be used to understand the structure and function of urban ecosystems (McDonnell and Pickett 1990).

Within urban ecosystems there are general patterns of species richness and community composition that are associated with the geography of cities. Distinct plant and animal communities are found in inner city, suburban, and urban fringe zones of metropolitan areas (Adams and Dove 1989, Sukopp 1990). Nilon and VanDruff (1987) found that these communities are defined in part by the land use, land cover, and landscape pattern characteristics of different urban zones.

Changes in urban ecosystems occur at three scales (McDonnell and Pickett 1990). Regional level changes incorporate several counties at the level of metropolitan areas. Changes at the landscape level occur within neighborhoods or other subunits of a city. Site scale changes occur at specific locations within a neighborhood. Changes at each scale, that will impact wildlife habitats, communities and agency programs, are directly tied to changes occurring in North American cities that will have major impacts on the spatial form of cities during the next 30 years.

HOW CITIES WILL CHANGE IN THE NEXT THIRTY YEARS

Several papers in this symposium have included predictions on demographic changes that will occur in the U.S. during the next 30 years. In addition, a number of social and economic changes are occurring in U.S. cities that will alter the physical and social landscape of urban areas.

Knox (1987) has summarized the views of many urban geographers and planners on the future of cities. He noted that the shift from manufacturing industries to a service economy has triggered changes in cities that will have a profound influence on the future of U.S. urban areas. The interaction of economic, technological, demographic, cultural and political factors will lead to changes in the scale and physical layout of cities.

Economic changes are linked to the deindustrialization of cities, the decen-

tralization of employment within metropolitan regions, and stratification of the labor market into high-paying and low-paying jobs. In contrast to this trend of decentralization, larger cities are becoming centers for communications and information transfer. These changes result in metropolitan areas with major employment centers scattered throughout the region. Within these areas, residents will be segregated largely by job type and income.

Technological changes are related primarily to the processing and management of information. Advances in these areas mean that a number of jobs and businesses no longer require a central city location. More workers will work out of their homes or at offices located far from central cities. This decentralization of workplace and residential areas results in a scattering of housing and businesses throughout metropolitan areas.

Economic and technological changes will impact family structure. There will be increases in the number of single parent households, households with two wage earners, the number of women working outside the home, and in the percentage of older adults in the population. These demographic changes will require special services and facilities such as day care centers and retirement communities.

Cultural and political change are the end products, of changes in technology, economics, and family structure. Knox (1987) predicted that economic changes will result in an attitude of voluntary austerity among many urban residents. This will be demonstrated by an increased focus on home ownership as an expression of status. Political changes will be linked to the new spatial pattern of cities. The politics of neighborhoods and communities will be increasingly defined by the job status and income of residents.

These changes should result in urbanized regions that contain several population centers within areas larger than current metropolitan regions (Knox 1987). These large regions with populations of 2 to 10 million, will be spread across 200-500 km^2. Rather than a continuous pattern of urban development, population centers will be located near areas for work, shopping and leisure activities. Some of these population centers will be associated with wildland areas and other sites that provide outdoor recreation.

Large urban areas will be similar in size and scale to the metropolitan groups recognized by the U.S. Census Bureau (Starsinic and Forstall 1989). Metropolitan groups are decentralized regions made up of several metropolitan areas that cover large areas of one or more states. The Chicago-Milwaukee Metropolitan Group is an example of this type of urban region. The region includes three MSA's

(Chicago-Gary-Lake County, Milwaukee-Racine, and Kankakee), covers parts of Illinois, Indiana and Wisconsin, and is home to 9.8 million residents (Starsinic and Forstall 1989). The scale of this and similar regions will have a number of impacts on wildlife habitats and populations and on wildlife management programs.

IMPACTS OF CHANGE ON WILDLIFE HABITATS AND POPULATIONS

Large dispersed cities mean that urban land uses are spread over a wide region. Because cities are where people live, residential land use decisions will be the major factor defining the ecological characteristics of cities. Cultural, economic, and social values all influence these decisions. Schmid (1975) and Whitney and Adams (1980) found that neighborhoods in cities are different ecologically and that these differences are related in part to the landscaping preferences and practices of residents. Landowner decisions about the size and shape of new developments, greenspace management, and removal or preservation of native vegetation are factors that help determine wildlife habitat structure.

Residential land use practices have direct impacts on wildlife habitats and communities. DeGraaf and Wentworth (1986) found that three types of suburban development; an older neighborhood with mature trees, a 15-year-old subdivision built on open agricultural land, and a 15-year-old subdivision built in small clearings within a second growth woodland, have very different bird communities. Johnsen and VanDruff (1987) found that greenspace patterns and building styles influence the distribution of native and non-native bird species in inner city neighborhoods.

Land use changes associated with urbanization can have more subtle impacts on wildlife habitats. The values that urban residents place on greenspaces mean that undeveloped lands are managed differently than in rural areas. Farms are taken out of production and forests are no longer cut. A study of landscape change in Onondaga County, N.Y., found that as the county became more urban, many agricultural lands were taken out of production and converted to home sites. The amount of forested land in the county increased, but the size of forest parcels decreased (Nyland et al. 1986).

As cities change a variety of processes will occur including the fragmentation and isolation of some habitat types, the maturing of urban forests, and the continuing development of unique habitats in inner city areas. The overall impact on wildlife will be similar to that documented by Matthews et al. (1988), who identified 37 habitat types in urban areas in New York State that were the

result of human activities and natural processes. These habitats include intact portions of larger ecosystems at the urban fringe, isolated remnants surrounded by developed lands, and a range of greenspaces associated with other activities and land uses. Conserving these habitats and the wildlife species associated with them will involve a number of strategies, some geared toward protecting rare sites and species, others focusing on managing areas for public use and enjoyment.

IMPACTS OF CHANGE ON URBAN WILDLIFE PROGRAMS

Urban wildlife programs have been shaped by the widely held belief that residents of cities have little or no contact with nature, and therefore lack a knowledge and appreciation of wildlife. Current programs place little value on the ways that most urbanites encounter wildlife and how they feel about these encounters. Recent studies indicate that rather than being separated from nature, urban residents have strong feelings about their day-to-day encounters with the natural world. These studies have important implications for future urban wildlife management efforts.

Kaplan and Talbot's (1988) studies of residents of suburban and inner city areas in Michigan concluded that urbanites felt that contact with nature in their nearby environment was important, and that areas providing this contact are highly valued. Pudelkewicz's (1981) study of residents living next to urban open spaces found that these areas were valued because they provide tranquility and relaxation. Seventy percent of the residents reported that they enjoyed viewing wildlife as part of their day-to-day lives.

Harrison et al. (1987) interviewed residents of inner city neighborhoods in London to determine their views of nearby open spaces. The study focused on the relationship between knowledge of nature and appreciation of nature. Indepth interviews found that the residents had positive contacts with wildlife that occurred as part of daily life in a mix of built and natural environments. These positive contacts were independent of the residents knowledge of wildlife and wildlife-related issues. Harrison et al. (1987) made three conclusions from the study: urban residents had a spontaneous and naive involvement with wildlife that is linked to childhood experiences; wildlife and wildness had a symbolic cultural value that was recognized by inner city residents; and city people were in touch with wildlife and encountered wildlife in commonplace environments as part of daily life.

These studies suggest that urban residents value wildlife for a number of intangible benefits that have little to do with knowledge of a particular species or

with conscious participation in wildlife-related recreation. However the values of contact with wildlife are recognized by urban residents and are an important part of their daily lives. Because resource managers and residents view wildlife differently, wildlife values will be the focus of conflict.

These conflicts will occur most frequently in wildland areas. Decentralized and dispersed urban areas mean that an increasing number of urban residents live adjacent to wildland areas and encounter a number of wildlife-related problems. People living next to wildland areas think of these sites as a part of their day-to-day environment. Their views on the value of wildlife and their feelings about wildlife management issues are likely to differ from those of managers who view the sites as wildlife habitat that is compromised by development.

Berris (1987) studied how residents of Estes Park, Colo., a rapidly growing community adjacent to Rocky Mountain National Park, felt about local elk *(Cervus elaphus)* populations. Large numbers of elk migrate through Estes Park causing significant property damage. The survey found that Estes Park residents viewed elk as reminders of nature and wilderness. The residents enjoyed viewing elk, even to the extent of having them close to their residence. Although most residents were concerned about property damage caused by elk, and supported hunting in rural areas, they were opposed to hunting the local population. In contrast to the views of local wildlife managers, Estes Park residents' feelings about elk management were shaped by their views of what the animals symbolized and by contact with elk on a daily basis. The managers' view that elk were a resource had little influence on local views of elk management.

Large cities will be economically, culturally, and ethnically diverse. Differences in the preferences and perceptions of groups of residents for nearby greenspaces will also influence urban wildlife management programs. Kaplan and Talbot (1988) found that different ethnic groups shared common values for greenspaces near their homes. Over 70% of black and white residents of Michigan cities considered contact with nature a frequent concern of their daily lives. However, the two groups had substantial differences in preference for the type of greenspace and greenspace management practices. Black residents preferred sites that were manicured and open with a few large trees. White residents preferred densely wooded sites with low branches. These findings indicate that different groups view nature in a wide range of contexts. Managers must be sensitive to the ways residents of diverse cities expect and wish to encounter nature and wildlife.

The issue of access to wildlife programs and facilities will be critical to future

agency urban wildlife management efforts. Managers have assumed that all urban residents have equal access to agency programs. However personal mobility is not equally shared by all demographic groups. Knox (1987) noted that middle-class and middle-aged males enjoyed personal mobility in disproportionate numbers to other urban residents. Thirty percent of urban people lack access to a car; these are likely to be inner city residents, women, old, poor, or black. Programs or facilities that can be reached only by car will exclude these individuals.

Wichita, Kansas, census data compiled by the Nongame Program of the Kansas Department of Wildlife and Parks (unpublished), illustrates this issue. Urban wildlife programs in Wichita have included a backyard wildlife habitat program targeted toward homeowners and management and interpretive programs in the cities larger parks. In several neighborhoods in the city, 22 to 42% of the residents lacked access to a vehicle. These neighborhoods were dominated by people of color and low income residents.

Effective access is defined as a resident's ability to find the time and resources required for participation in an activity (Knox 1987). This can serve as an additional barrier to participation in wildlife-related activities. Simply put, to have full access to a program or facility, urban residents must have the time to participate and an interest in the activity.

The concept of effective access is illustrated by Dargitz's (1988) study of angling activity in the Indianapolis, Indiana, area. He considered race, gender, place of residence, and socialization as factors influencing angling participation. Being introduced to fishing by a family member was the most important factor influencing angling activity. Black youth had fewer opportunities to be introduced to fishing as leisure activity by people in their household. Females were less likely to be introduced to fishing than males. These results indicate that in the future wildlife agencies will have to find new ways of introducing wildlife-related activities to urban residents.

WILDLIFE MANAGEMENT IN 2020

In this paper I've described the socioeconomic and demographic changes that are occurring in U.S. cities and discussed the implications these changes will have on wildlife habitats and wildlife agency programs. Urban areas will incorporate inner cities, suburban neighborhoods, and wildland areas as well as people, habitats, and wildlife. Management efforts must address the needs of wildlife and people in these areas. Managers in 2020 will deal with complex

issues ranging from conserving populations of rare species, to providing programs that fit the needs of children living in single parent households. To understand the types of changes that will occur in management programs it is useful to look at urban wildlife management efforts already underway in intensely urban areas.

Urban wildlife conservation in British cities places less emphasis on the conservation of rare and endangered species and more on providing wildlife benefits to local residents (Goode 1989). Extensive efforts are made to inventory habitats and populations in ways that are useful to local residents and planners. The London Ecology Unit classifies and uses wildlife habitats as sites of metropolitan importance, borough importance, local importance, wildlife corridors, and countryside conservation areas. Results from the inventory have been incorporated into plans to protect rare habitats (Hare 1988) and to identify and manage sites that provide opportunities for contact with wildlife as part of people's day-to-day lives (Johnston 1990). Similar habitat inventories in other cities have been incorporated into local land use planning programs (Andrews et al. 1989). A key component of British urban conservation efforts has been the involvement of local residents in all aspects of urban programs (Goode 1989). A variety of local conservation groups ranging from nature study groups to self-help groups for ethnic minorities are actively involved in all aspects of urban wildlife management programs (Johnston 1990).

Some aspects of these programs will be found in successful management programs in the U.S. Management programs will focus on two areas: conservation efforts aimed at maintaining biodiversity on a regional level, and site-based programs based on providing day-to-day contact with wildlife.

Conservation programs will require close cooperation between wildlife agencies and the local governments that control land use. Because local governments will represent a variety of demographic groups and economic interests, agencies must relate the benefits of habitat protection and species conservation to the broader concerns of local residents.

Programs that focus on peoples' experiences with wildlife will provide the greatest challenge. Developing programs that cater to the needs of different groups of urban residents will require interaction with people, a skill most wildlife managers lack. Successful programs will often be developed by local organizations with the assistance of a manager, and may not be focused solely on wildlife-related activities. Education and interpretation are the keys to these programs. Agencies must find ways to educate a wide range of people and break

down the barriers of effective access.

Urban wildlife management is and will continue to be a people-based field. Successful programs will continue to be those that recognize that cities are homes for people and for wildlife. Urban areas are an integral part of the natural world.

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Agriculture and Wildlife in 2020

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Abstract: *Three main issues will likely be of growing importance in the decades ahead: sustainable farming, global warming, and federal farm programs. The movement toward a more environmentally sound agricultural system appears to be growing stronger, and bodes well for wildlife due to emphases on greater crop diversity, soil erosion reductions and curtailed use of pesticides. It can also provide resiliency to better withstand ecological upheavals such as global warming. Forecasts of global warming have serious implications for rural wildlife. Some experts predict agriculture will easily adjust and even benefit. However, dislocations would disrupt wildlife and habitat, and consideration of a number of likely problems caution against over-optimism. To what degree natural resources will be buffered from potential disasters, such as global warming, depends on the evolution of agricultural institutions. If political trends continue, farmers will likely receive less direct government support and markets will be even more globally influenced. Problems with this include loss of regulatory leverage on which conservation measures such as swampbuster, sodbuster and conservation compliance rely. Potential benefits include reduced economic incentive for farmers to use chemicals and expand acreage. Whatever resource challenges confront us in the year 2020, willingness to listen, communicate and collaborate may be key to engendering a willingness by landowners to do their part for natural resources. Agriculture is a crossroads where a number of environmental and social issues intersect. It is the industry that supplies our food. Spread over the face of the countryside, it also dictates much of what we see in the landscape.*

Agriculture itself is in a time of transition, which makes it difficult to prognosticate about the decades ahead. Farms are still growing larger, and farmers are growing older and fewer.

After decades of crop surpluses, stocks of major commodities are down. Worldwide efforts are afoot to cut governmental support for farm programs. The public is more aware of environmental problems related to farming, and farmers fear growing sentiments for regulations to protect food quality, water quality and wetlands. Some trends, such as the continuing industrialization and consolidation of farms, lead to visions of a sterile rural landscape dominated more than now by megafarms and mega environmental problems. Other

trends, such as the movement toward ways of farming modeled more closely on natural systems offer brighter images.

I want to focus on three main issues in agriculture and discuss some of their implications for wildlife and fisheries: sustainable farming, global warming and federal farm programs. My best forecast is that these will be of growing importance in the decades ahead, shaping agriculture and its impacts on the environment. My comments emphasize the Midwest, though these issues are truly national and global in scope.

SUSTAINABLE AGRICULTURE: FARMING THAT RESPECTS NATURE

Sustainability provides a useful window through which to view the future of fish and wildlife in rural America. The degree to which alternative, sustainable practices are incorporated into mainstream farming will likely be a critical factor influencing a range of wildlife-related concerns—from water quality and soil erosion to preservation of biodiversity.

The movement toward a more environmentally sound agricultural system is gaining interest and respectability. According to the National Research Council Board on Agriculture (1989:8), this approach encompasses "a range of technological and management options used on farms striving to reduce costs, protect health and environmental quality, and enhance beneficial biological interactions and natural processes."

To understand how this way of farming benefits wildlife, it is useful to review how it differs from what has become known as conventional agriculture. On conventional farms, the scale of fields and equipment tends to be large. Usually, one or two crops are grown every year. Fewer of these farms have livestock. Erosion levels are often high, as are the levels of pesticides applied to control weeds, insects and diseases. Chemicals are often aerially applied, exposing wide areas to harmful drift when pesticides travel beyond the targeted crops (Grue et al. 1988). Fence rows, woods, and wetland habitats have also been eradicated on many conventional farms in an effort to maximize production and accommodate large machinery.

In contrast, the alternative approach is to work with nature. Farmers practicing alternative methods try to avoid many problems by maintaining healthy soil and plants and, when possible, to harness biological mechanisms like natural predators and seasonal rhythms that exploit pests' life cycles. The goal is, in most cases, not to eliminate chemicals but to significantly reduce the need for them. To achieve this reduction, farmers typically use selected rotations and

cover crops to maintain soil "balance" and organic matter; they substitute legumes, careful manure management, and biological controls for chemicals, and cut use of synthetic nitrogen to prevent possible disruption of soil biota and to save energy (Robinson 1990b).

Adherents of sustainable agriculture are more likely than their conventional counterparts to voice respect and concern for the nonhuman components of the rural landscape (Anderson 1990). For example, holistic resource management, an alternative approach that has been applied primarily to western lands but is gaining interest in the Midwest, stresses that wildlife helps gauge the general health of ecosystems and enriches the countryside with economic opportunity (Savory 1988). The structure of federal farm programs has generally skewed economics against alternative methods, suggesting that current practitioners hold a relatively high degree of commitment to noneconomic goals, such as improving their own health and protecting ground water quality and wildlife (Anderson 1990; Faeth et al. 1991; Gillespie and Buttel 1989).

A move toward alternative agricultural systems holds real promise for wildlife and fish. For one thing, a greater diversity of crops and increased cover on fields could benefit a wide array of animals, particularly grassland birds. Because sedimentation from soil erosion is a serious threat to aquatic systems, an agriculture that takes better care of the land would be a boon to fish. Soil stewardship techniques, including rotations, cover crops, filter strips and maintenance of small fields, also benefit terrestrial wildlife (Robinson 1990a).

In addition, pesticides can be very damaging to fish, birds, and other animals. Today's organophosphate and carbamate insecticides are much less persistent in the environment than the old organochlorines, but both can be acutely toxic, even in small doses (Stinson and Bromley 1991). Those that are relatively nontoxic to vertebrates at normal application rates are often poisonous to aquatic invertebrates, a vital link in the food chain for fish and waterfowl (Tome and Grue 1990). Insecticides used on or near wetlands have been shown to reduce ducks' reproductive success and kill ducklings, as well as to modify behaviors, making the ducks more vulnerable to predation (Martin and Solomon 1990; Grue et al. 1988; Brewer et al. 1988). Herbicides are less toxic, but still may harm fish and aquatic invertebrates (Buhl and Faerber 1990; Finlayson and Fagella 1989). Herbicides also eliminate many of the plants on which ducks feed and which birds and fish depend on for cover.

Past conservation programs have operated primarily to patch up some of the undesired consequences of conventional farming practices. Many have had

limited longterm success, generally working at odds with farm programs and tax and credit policies that rewarded land clearing, farm expansion, drainage and monoculture. The sodbuster, swampbuster, and conservation compliance provisions of the 1985 and 1990 farm bills have removed some of these incentives for resource degradation. However, as is often the case with regulatory-type fixes, implementation has been stymied by politics and institutional constraints. History suggests that regulation will never be successful enough to adequately safeguard natural resources, particularly when the regulated activities are widely dispersed on private lands where the vast majority of wildlife are found (Gunkel 1988; Hyde 1988).

The focus of sustainable agriculture is to prevent problems related to natural resource degradation. This alternative path could alleviate the need for many new regulations. An important step to prevention is to reform federal farm programs to support and reward landowners who use environmentally sound practices. Small progress toward this has been made in the last two farm bills.

Wildlife professionals can assist in a variety of ways. One avenue would be to become more actively involved in farm policy discussions. I believe that this is happening, as evidenced by the activities surrounding the last two farm bills. Another way to foster positive change could be to increase communication with agricultural leaders, including agricultural educators and farm managers and consultants. Those in farming or farm-related businesses are often surprisingly unaware of wildlife concerns or how habitat enhancement can be integrated into farming operations. Many schools that offer agricultural classes at the secondary or college level have expanded their curricula to include environmental topics, but consideration of farming's impacts on wildlife may still be neglected. Wildlife advocates can serve as a resource to help those who farm and who control farms better understand wildlife needs and even recognize potential economic benefits from maintaining wildlife species and habitat. Don't forget farm and range consultants, whose influence on private land is becoming increasingly important as farms grow larger and are often the property of absentee landowners (Appropriate Technology Transfer for Rural Areas 1991).

Perhaps this is the "teachable moment" that can enable decades of positive change. The challenge is to find ways, in the policy arena and in the field, of encouraging mainstream producers to adopt methods and systems that are profitable, yet more compatible with nature.

There is plenty of middle ground. For example, while a landowner may not choose to discontinue pesticide use, modifications that reduce its impacts are

often possible and may also reduce costs. Britain's conservation headlands provide a model. There, research documented that populations of gamebirds in rural areas had suffered declines of up to 80%. Further studies identified pesticide use as one of the primary culprits. As a result, many landowners were convinced to use a technique known as conservation headlands, where pesticides were selectively used or completely avoided along the edges of crop fields. Besides dramatically increasing survival rates of gamebirds, the use of headlands often reduced chemical costs, and may offer other, less obvious benefits, including serving as refugia for beneficial insects and wildlife species that prey on crop pests (Council for Agricultural Science and Technology 1990; Sotherton and Robertson 1990; Stinson and Bromley 1991).

One compelling reason for taking the sustainable path in agriculture may well be the added resiliency and flexibility it provides (Batie and Taylor 1990). By spreading landowners' risks over more crops and enterprises, and building up rather than using up natural capital, sustainable systems are better designed to withstand ecological upheaval.

GLOBAL WARMING: WHAT COULD IT MEAN FOR FARM WILDLIFE?

Several years of drought in the 1980s served as a grim reminder that despite all our modern technologies, farmers are still at the mercy of the weather. And wildlife is often at the mercy of both the weather and the farmer.

Concentrations of infrared absorptive gases are increasing in the earth's atmosphere. These gases allow more of the sun's radiation to pass through, but restrict escaping heat. Human activities have been liberating enormous quantities of carbon in the form of carbon dioxide (CO_2), one of the primary "greenhouse gases." Methane and nitrous oxide also contribute to the problem. While there is disagreement on whether a warming trend has arrived and whether it contributed to droughts in the 1980s, over the last half century the mean global temperature appears to be rising, consistent with climate change forecasts (Brown and Young 1988; Easterling 1990). Increasingly, the scientific community is of the opinion that this warming demands urgent attention. Anyone looking at the potential impacts on American agriculture or on wildlife would have to agree.

As the effects of climate change become more discernible, humans' need for resources such as water, forests and agricultural land would increase or shift geographically, causing extensive habitat loss, depletion of water supplies and blockage of migration paths (Marshall-Forbes 1991). A recent study using a

Goddard Institute for Space Science (GISS) model predicts a 19 to 25% decline in duck productivity in North Dakota as a result of the direct effects of climate change and a corresponding 423,000 acre increase of cropland in the state, with related decreases in wetland acreage (LeBlanc et al. 1990).

Climate change could actually increase the average global precipitation, however there are strong indications that rising world temperatures would, at the same time, increase climate variability and change rainfall patterns (Easterling 1990). The United States, especially its central and north central regions, is expected to be a rainfall loser. Even if this were not so, rising temperatures alone can devastate crops. Elevated temperatures also correspond to increased concentrations of ozone in the lower atmosphere, a confirmed plant toxin (Hansen 1990; Ward et al. 1989).

Carbon dioxide is basic to plant life. It has been shown to increase plant growth rates by accelerating the rate of photosynthesis and it aids some crops in using water more efficiently. This has lead to some very favorable and dramatic predictions of crop production increases in a world of rising CO_2 (Easterling 1990). However, several potential problems caution against over-optimism. The benefits of CO_2 decline as temperatures increase and even mild water stress can nullify the yield enhancement from CO_2. Weeds also thrive in a CO_2-enriched environment, and plant leaves would contain a higher carbon ratio, encouraging insect predation (Brown and Young 1988; Ward et al. 1989). Resulting yield reductions could mean that producers expand acreage and increase pesticide use, in turn putting greater pressure on wildlife and wildlife habitat.

It has been speculated that agriculture would adapt to climate warming by moving northward and increasing irrigation. Here too are other environmental factors to consider. The soil characteristics of much of the northern United States and Great Lakes region are poorly suited for intensive crop production because of low organic matter and inferior water-holding capacity (Bouwman 1990; Ward et al. 1989). Soils developed under forests are not as productive as prairie soils, and are more prone to erosion. Sediments would thus become a greater water quality problem in northern streams and lakes, threatening fisheries.

Even now, farmers in many parts of the country are mining ground, and in some cases, surface water. Particularly in the western states, there is intense competition for water and wildlife is usually the big loser. As stream flows drop and water pollution increases, fisheries decline. Low flows also disrupt water regimes necessary to sustain wetlands, riparian areas and woody draws (Reisner and Bates 1989). Unless a good deal of careful, advance planning occurs to

manage future water shortages, competition among water users may be the norm across the Midwest by 2020, and wildlife will often be robbed to provide short-term amelioration for human needs.

The threats to our agricultural system and to wildlife make a compelling case for doing everything possible to abate the greenhouse effect, and to prepare for managing the results.

Stewardship of soil and water resources should be given a higher priority than ever. A flexible, resource-conserving agriculture will be best suited to cope with a changing climate or other calamities (Batie and Taylor 1990). Will we heed the messages of the climate forecasters, and implement policies and plans to buffer natural resources from potential disasters, such as global warming? In part that depends on whether the evolution of agricultural institutions will help or hinder adaptation to environmental stress.

CHANGES IN FEDERAL FARM PROGRAMS

By the year 2020, agricultural programs and market distribution may look a lot different. If political trends continue, farmers will receive less direct government support, and markets for major crops will be even more globally influenced than now—a "free market" direction strongly favored by recent administrations. Such a move to a more laissez-faire international economic system can be expected to have an impact on natural resources, including wildlife.

Reduced market intervention could offer environmental benefits. Some claim that eliminating subsidies would encourage alternative practices. They argue that landowners would shift away from expensive, chemically intensive farming as prices drop to "natural" market levels, and that marginal land would shift out of production when price supports and production controls are removed (Carr et al. 1988). Given time, this might prove correct, though in the short term, many farmers can be expected to intensify and expand production, trying to stay in business as prices fall (National Farmers Union 1989).

Reducing the influence of the crop "base" could be a major advantage of getting the government out of farm markets. This would remove a longstanding obstacle to crop diversification and an incentive for maximizing row crop acreage, yields and pesticide and fertilizer use (Batie and Taylor 1990; National Research Council 1989; Berner 1988).

On the other hand, if farm program benefits disappear, the conservation community loses the type of leverage introduced in the 1985 Farm Bill—in swampbuster, sodbuster and conservation compliance. The laws prohibit farmers from receiving program benefits if they do not comply with certain

federal regulations pertaining to erosion control and wetland alteration. These provisions have undoubtedly encouraged improved behavior by many landowners, and slowed the rate of wetland drainage and sodbusting (Esseks and Kraft 1991). Such policy "sticks" also serve to make incentive-type "carrots," including the Conservation Reserve Program, more appealing to landowners.

Free markets might also signal the end of production control set-aside programs. While set-asides have had many problems over the years, they nevertheless have potential for enabling wise resource management (Berner 1988). For example, they offer an economical opportunity to implement rotations and plant cover crops that break up pest cycles, protect land from erosion and provide needed wildlife habitat (Council for Agricultural Science and Technology 1990).

If the demise of existing farm programs is on the horizon, conservationists will have to rely on other policy tools, including more direct regulation. As stated earlier, farm program reform could greatly reduce the need for regulations, which are politically difficult to maintain and often go unenforced. Incentives will also continue to be needed, to make regulations more palatable to landowners by demonstrating that society is willing to share the costs of environmental protection.

Long-term and perpetual easements that protect valuable habitat on private land, such as the Reinvest in Minnesota (RIM) and the new federal Wetland Reserve programs, are an encouraging development for the future. Successfully tailoring and managing longterm easements will be an ongoing effort requiring considerable time and energy, but the rewards promise to last well into the next century. Pressure to incorporate more economic uses into easements will be a continuing issue. More economic incentive undoubtedly increases landowners' willingness to participate, but how much can be allowed without undermining the resource values for which the public is paying?

The trend toward free-er markets offers some potential benefits for wildlife and natural resources. However, unless new policy tools develop to replace existing farm programs, a period of laissez-faire opportunism could spell disaster for wildlife and other natural resources.

ALLIES FOR THE CHALLENGES AHEAD

The challenges ahead are daunting, but along with the potential disasters lurking in change are some exciting opportunities. Crises can be useful for motivating people to exchange old habits for new, more adaptive behavior. For

example, the excesses of conventional agriculture were necessary, in terms of threats to ground and surface water quality, wildlife habitat and soils, to justify the important conservation measures in the 1985 and 1990 farm bills, and to advance serious consideration of agricultural alternatives.

Sustainable agriculture holds a great deal of hope for those who consider it important that the countryside be a habitable place for a diversity of wildlife. It can also help prevent or soften the impact of worst case scenarios posed by changes such as global warming or unfettered production under international free markets.

Increased regulation of agricultural practices will likely be needed. Farms will probably continue to get larger, and pressure to "feed the world" will foster environmental abuses in the future as it has in the past. The farm community as a whole may never support the regulatory approach, no matter how needed. However, many farmers already support reasonable constraints, if the case for them is well documented and rules are developed with landowner input. Top consideration should be given to policies that will prevent environmental ills. This latter approach can help limit the growing list of police duties assigned to natural resource agencies, duties often as unpopular with agency staff as with landowners.

Whatever resource challenges end up confronting us in the year 2020, we will be better prepared if we can improve our cooperation quotient. The wildlife community must, of course, place top priority on natural resources, but a willingness to listen, communicate and collaborate may be key to engendering a reciprocal willingness by landowners to do their part. I'm not suggesting it is a new approach, but it is one that must be even more strongly emphasized and widely practiced if we hope to preserve our precious wildlife heritage into the next century.

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Fisheries and Wildlife Education in the 21st Century *

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Abstract: *Education in fisheries and wildlife will be shaped by developments within the profession and higher education as both adapt to a changing world. Especially important trends will be: changing demographics, globalization, information/technology explosion, and redefinition of public and private roles.*

Demands on public universities will grow faster than funding to support them, resulting in changes in university infrastructure and faculty expectations. Nontenure-track and temporary faculty will assume greater importance; issue-oriented, interdisciplinary activity will increase; and accountability for faculty performance will intensify.

New demands on faculty will influence time and effort devoted to professional education. Nationally, undergraduate education will emphasize comprehensive literacy in arts and humanities, social and natural sciences, math, and communications. Specialized coursework will diminish, but environmental education for all undergraduates will expand greatly. Successful faculty will be competent in multiple areas and flexible in their career patterns.

What is taught in fisheries and wildlife curricula will change less than how it is taught. Pedagogy will evolve to incorporate participatory methods that promote critical-thinking; effective communication; accessing, evaluating, and synthesizing information; problem-solving; and working effectively in a culturally diverse, global society. Attitudes and values of an urban, culturally-diverse student body will have been shaped largely by the media. Providing students exposure to fish, wildlife, and their habitats will be a significant challenge. Graduate education will diversify. More programs will adopt successful management-oriented MS degrees, but not at the expense of science-based degrees. Doctoral programs will demand competence in multiple subdisciplines; breadth and resourcefulness will be highly-valued among new PhD's.

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Evolution within the university will depend on the values, needs, and commitments of various participants. More cooperation among university programs will emerge because all demands cannot be met locally.

"The line between those who will be winners and those who will be losers seems sharper than ever, and the line is the product of education."
David Halberstam - *The Next Century* - 1991

Freshmen entering this nation's universities in the year 2020 will be the children of today's junior high school students. Faculty will be led by a senior professoriate comprised of the young Ph.D.s now just beginning their academic careers. What will be the nature of the interaction between these groups? How will it be shaped? We believe changes in professional education will be more dramatic than those experienced between the 1960s and today.

The purpose of this paper is to predict the status of higher education in fisheries and wildlife in the year 2020 based on expected demographic and cultural trends. The view we present will be of fisheries and wildlife programs in relatively-large, state-supported (often land-grant) universities. We recognize that other institutions of higher education, both public and private, will continue to contribute to the future of our profession. Yet we will emphasize trends affecting state-supported universities because of their relatively large influence on the fisheries and wildlife professions today—a situation we expect will continue, although perhaps in a different form.

Fisheries and wildlife professionals systematically reexamine their educational systems at irregular intervals—the late 1980s were good years for this. Publications resulting from such reexaminations take the form of committee reports (Post et al. 1983, Adelman, et al. 1990); survey results (Cookingham et al. 1980, Anderson 1982, Schmidly et al. 1990); or thoughtful arguments for curricular changes (Kevern 1973, Crawford 1976, Kadlec and Eastmond 1977, Knuth 1987, Nielsen 1987, Adams 1989, Nielsen et al. 1989, Oglesby and Kruger 1989, Peek 1989, Adelman 1990, Crowfoot 1990, Teer et al. 1990). Most tend to focus on "what should be"; the purpose of this article is to speculate on "what will be." Our speculations are derived from interpretations of current trends and emerging issues within academia and the fisheries and wildlife professions. Insofar as possible we have tried to purge our own biases and dispassionately interpret "the meaning of the stars". We have tried to refrain from offering judgments about the possible effects of our predictions.

MAJOR TRENDS INFLUENCING PROFESSIONAL EDUCATION

Professional education in fisheries and wildlife (or any other field) is shaped by developments within the profession and within academia in general. Developments within each also reflect evolution in social values. Just as the fisheries and wildlife fields are planning to cope with a fast-changing world, so is higher education. We believe four major trends will be especially important in shaping professional education in the future.

Changing Public Demographics and the Social Mosaic

The public will be more multi-cultural and urban. Women will have more prominent roles in the workplace and in decision-making of society. A greater proportion of the population will be older and retired. Demands for services will multiply from an increasing number of special interest groups.

Globalization of the Economy and World Society

Global thinking will permeate society, including education. The global economy will be driven by competition among ecumenical companies. The source of a nation's wealth will be based on the contribution of its "symbolic-analysts", rather than the location of corporate headquarters (Reich 1991). Knowledge and skills of a nation's work force will become the foundation of national capital—the source of wealth. Therefore universities will be highly valued as creators and purveyors of knowledge. A nation's universities increasingly will be sought out by the citizens of the world willing to learn.

Information/Technology Explosion

The quantity of information affecting natural resource management will multiply and electronic technology will facilitate its use. Concern for information quality and the need to appropriately integrate and use information will become major issues affecting both resource management and education. Major advances in science and technology will greatly expand our knowledge of fish, wildlife, and the ecosystems of which they are a part. Educating people to effectively use vast quantities of information will become an even greater challenge than it is today.

Redefinition of Public and Private Roles

The roles of public and private sectors will evolve. Citizens will continue to be increasingly involved in decisions affecting resource management and public higher education. The relative level of public funding for both higher education

and natural resource management will not increase proportionately to new demands. Accountability and efficiency will be of great concern in all institutions.

The effects of these major societal trends will influence education in three fundamental, but interrelated, areas—changing university infrastructure, changing demands, and changing curricula. The first two are affected more by trends in higher education in general and by the "bureaucracy" of education. The latter is affected more by trends within the fisheries and wildlife profession, but influenced and constrained by the total higher education environment. We will include in our discusssion those aspects of higher education which we believe will most influence the type of professional education offered in 2020.

CHANGING INFRASTRUCTURE

The ability of state-supported universities to address and meet the educational needs of the fish and wildlife profession will be largely affected by the conflict created by demands on academia growing much faster than the funding base to support it. Over the next 10-20 years at least, costs associated with managing the federal budget deficit and addressing public crises, such as the savings and loan problem and health care, will limit new federal funding targeted for higher education. Funding for all services from state governments also will be limited because of competing demands for state services. It is unlikely state governments will provide proportionately more support to state universities, but this will vary among states. Increases in tuition will be unable to make up the difference.

Efficiency and accountability will play a large role in determining the kinds of education provided by public universities. Debate will center around the value of state universities in educating youth. Attempts to measure "output" or "productivity" of educational programs to quantify efficiency of university programs largely will fail. Yet efforts to define the educational value and effectiveness to a cost-conscious public (and especially their elected or appointed officials) will assume a greater role in determining the kinds of public education offered. Maintaining high quality programs with limited increases in resources will cause some universities to eliminate fisheries and wildlife programs or consolidate them with other compatible programs.

Demands for well-qualified environmental scientists and educators will increase across the country as Americans awaken to the dilemma of sustaining life on this planet. Yet, the need for efficiency within the university makes it unlikely that numbers of tenure-track faculty in fisheries and wildlife programs will increase proportionately to new demands. Qualified professors in other

disciplines will participate more actively in natural resource education. Non-tenure track and temporary faculty and doctoral students will assume greater importance in teaching, research, and extension functions. All faculty will be expected to participate in a variety of teaching situations. It will become increasingly difficult to perform within narrow subdisciplines, except when one's research is temporarily in vogue and well-funded. Accountability for faculty performance in teaching, research, and other scholarly activities will intensify. The tenure and promotion system will likely be examined, and perhaps modified, in some institutions.

Concurrent with relatively static government support for education, opportunities for corporate and foundation funding for infrastructure needs and creative educational programs should increase. More emphasis is likely to be placed on partnerships with government or businesses; and universities will be useful and willing partners. Some universities will find significant funding support from the corporate community—some focusing on global environmental issues and the education of the world's population. Some fisheries and wildlife programs will emerge larger and stronger because of their leadership in addressing global problems.

Despite a gloomy prognosis for significant increases in federal funding for higher education in general, new opportunities for competitive research grants may emerge. Applied ecologists, including fisheries and wildlife faculty, often have been discouraged in seeking competitive funding from traditional federal sources because funding programs lacked the appropriate "niche" (e.g. National Science Foundation, USDA programs). Noncompetitive funding from federal agencies has been common in the fisheries and wildlife fields, but often dependent on short-term agency needs. We believe new opportunities to redirect some federal funding into longer-term applied ecological research will emerge. The proposed National Institutes of the Environment or other structures may evolve as the public's recognition and understanding of the environmental crisis grows.

The coming decades will see attempts to reorganize universities, both academically and administratively, in response to demands for efficiency and educational reform. Desolving or blending traditional academic disciplines likely will receive attention. For example, Daly and Cobb (1989) have offered a new economic model sensitive to society's need for community and a sustainable future. They argued that "disciplinolatry"—the religious devotion to disciplinary organization of knowledge (op. cit.:125)—is one of the most potent causes of the ineffectiveness of contemporary economics to deal with important human issues (e.g. environmental problems). They contend that breaking down or integrating

the diverse academic disciplines within universities may contribute to better comprehension of the human situation and redirecting the economy toward a sustainable future. A more prominent stage for conservation ideals may result from this or similar models.

Departments likely will remain the fundamental unit in most universities, yet the traditional functioning of departments will change—demanding greater cooperation and coordination with teachers, scholars and practitioners outside the departmental area of expertise. Debate about the roles and relationships between conservation biology and fisheries and wildlife (e.g. Bolen 1989, Capen 1989, Thomas and Salwasser 1989), will be resolved and forgotten as common concerns are addressed. Faculty will have more opportunities to participate in multidisciplinary centers, institutes, and consortiums focusing on important issues. Much of this effort will be research, but issue-oriented teaching also will orient students to comprehensive problem-solving. Complex natural resources and environmental problems provide excellent foci for students in biology, economics, political science, and other fields to learn together.

CHANGING DEMANDS

New educational demands and opportunities for fisheries and wildlife faculty will emerge during the next 30 years. Meeting these demands will influence the time and effort devoted to professional education.

Several best-selling books have recently drawn public attention to the role of higher education in America, most notably Bloom (1987) and Sykes (1988). For example, Sykes (op. cit.:5) argues that professors: 1) are grossly overpaid, underworked architects of vast empires of waste; 2) have abandoned their teaching responsibilities in pursuit of trivial, valueless research; 3) have frustrated every effort at meaningful reform; and 4) have turned American universities into vast factories of "junkthink", among other unequivocal criticisms. Weakly-documented, but attention-grabbing, such diatribes have helped stimulate discussion about reform in higher education today. For example, serious efforts to elevate the status and importance of undergraduate level teaching can be found on most campuses. The reemergence of campuswide core curricula is one example of fundamental change in higher education.

The trend toward a more comprehensive undergraduate education with an emphasis on fundamental knowledge will likely continue. In the next decade, all undergraduates will be expected to be literate in arts and humanities, social and natural sciences, math, and communications. Class time to achieve this mastery

may diminish the available credits for specialized coursework in fields such as fisheries and wildlife. In addition, "new" expectations will emerge. For example, all university graduates will be expected to have been educated with a global, multicultural perspective. A foreign language may again become a requirement for graduation.

Importantly, a knowledge of ecology and human/environmental relationships will also be considered essential for an educated citizen of the world. Opportunities to educate the multitudes in the values and activities of our profession will be found on every campus. Some fisheries and wildlife programs will be key participants in this education; but some programs may not seize the opportunity.

Demand for stimulating, environmentally-oriented, advanced coursework for "non-majors" and older citizens returning to campuses will increase as well. Disciplines, such as business and engineering, will require students to be knowledgable and sensitive to environmental concerns. A growing concern about ethics will provide opportunities to present the environmental values our professions espouse. And as the public becomes increasingly involved in resource decision-making, specific courses in resource management, land-use planning, and environmental regulation will become popular or required among "non-majors". The role of fisheries and wildlife professors in meeting these demands also will likely vary among campuses.

Fisheries and wildlife programs will continue to be expected to play an important role in disciplines peripheral to traditional fisheries and wildlife ecology and management; these include: commercial aquaculture, zoo management, wildlife rehabilitation, environmental education, urban planning, contaminant assessment, wildlife damage management, zoonotic disease control, and others. The demands and opportunities as teachers of students outside our fields will affect our ambitions as educators of fisheries and wildlife professionals.

By 2020, many state and federal resource agencies will find it difficult financially to support up-to-date research functions demanding a broad spectrum of expertise. In this case, however, our profession is ahead of other fields. Cooperative Fisheries and Wildlife Research Units will serve as models for government/university research collaboration. The partnerships that have evolved in the unit system will be strengthened and expanded. Other government agencies will investigate establishing similar arrangements because they can no longer support an efficient research function. Yet the Co-op Units will require greater infrastructure support and overhead from participating agencies

as the cost of highly technical research increases. Co-op Unit research will continue to emphasize the immediate information needs of the cooperating agencies. Students will benefit as they experience the "real world" within their graduate education experience. A significantly greater portion of research administered and conducted by Co-op Units will be highly technical, multidisciplinary, expensive research. Therefore post-doctoral students and/or technicians will be more prominent in the Unit function; and faculty and students in fields outside of fisheries and wildlife will be increasingly involved. Co-op units will also assume a greater role in continuing education, working closely with extension personnel to support the professionals within cooperating agencies. In response to the increasing influence of agencies, however, university faculty and administrators may be challenged to preserve the independent scholarship characteristic of universities in America.

The daily lives of fisheries and wildlife professors will continue to blend activities in teaching and research. Being an effective faculty member in tomorrow's rapidly changing world will be more challenging. Keeping up with the information in a narrow discipline and being conversant in new developments will become more taxing. As in other fields of science, multidisciplinary, interdisciplinary, and cross-disciplinary will be "buzz words" of the next two decades. Solutions to important human problems will require interdisciplinary research by teams of scientists. Productive fisheries and wildife scientists will need to be competent in areas not traditionally associated with our field and be able to bridge disciplines or change focus within the course of their careers. Holden (1991:1117) predicted "scientists will need to become more flexible...and...willing to deviate not only from conventional career patterns but–more difficult–from one's own expectations and preconceptions."

Educational preparation for doctoral students will broaden and continuing development of teaching and research skills will be essential for all faculty. Short-term development activities for faculty will be common. Faculty who teach applied aspects of the curricula will need to spend time within agencies to understand the dimensions and scope of the changing management milieu. Mutually beneficial partnerships for staff and faculty development between agencies and university programs will develop further. Learning new fields of expertise will become essential (not just new analytical techniques to support research analysis, but broader areas of knowledge–population genetics or international resource policy, for example.) Appreciating and understanding resource management in other cultures will be essential for some educators.

Progressive administrations will help provide resources necessary for such faculty development.

Changes in the roles and expectations of faculty will be accompanied by changes in the reward system. For example, elements of the scholarship model recently proposed by Boyer (1990) may be adopted by some universities. He considered the multiple roles of faculty to be associated with: scholarship of discovery, scholarship of integration, scholarship of application, and scholarship of teaching. The importance of these roles may often change during the careers of faculty. Evaluation and reward systems (including tenure and promotion) will need to account for these changing roles for higher education to progress and sustain its value to society.

CHANGING CURRICULA

Given the above changes in structure and function of the university, how will professional education in fisheries and wildlife emerge?

We believe that *what* we teach in fisheries and wildlife curricula will not change as much as *how* we teach. Of course, material will be added and deleted to elements of instruction as the fields evolve. For example, we expect significant advances in genetics, economics, landscape analysis, and other fields will alter the foundations of fisheries and wildlife. During the next decade, human dimensions of fisheries and wildlife will expand its role in course content. Wherever it has not occurred already, the distinction between game and nongame will disappear and ecosystem perspectives will predominate. As computer usage becomes standard in elementary and secondary education, universities will alter their curricula accordingly. But the need for better ways of thinking and learning will override changes in knowledge. Importantly, both academics and professionals are calling for an emphasis on these skills and abilities within the context of a science-based education.

New roles of agencies in regulation and management now demand broadly-educated professionals capable of solving complex, multidisciplinary problems as members of issued-oriented teams. Intellectual and interpersonal skills will increase in value relative to disciplinary knowledge and skills. The effective professional must be able to: think critically; access, analyze, and synthesize diverse information; work with others as a team; solve complex problems; and work effectively in a culturally diverse, global society. Yet fisheries and wildlife biologists will continue to need basic biological knowledge to competently collect and interpret specialized information.

A bachelor's degree that results in students obtaining and developing fundamental knowledge in these areas requires a broad outlook and little room for specialization. The "liberal art of science" (AAAS 1990) will be emphasized with limited expectations that the first degree completely prepares the student for entering the fisheries and wildlife profession. Competancy will be judged by the ability to reason, think clearly, and effectively evaluate and use information to solve relevant fish and wildlife resource problems.

Today the architecture of most fisheries and wildlife B.S. curricula contains the elements of a broad education—by definition resource management includes a diverse array of sciences, social sciences and humanities. But today's bachelor's degree curricula are typically built on the "string of pearls" model. Courses are strung together with the student largely responsible for integrating and finding relevance in the content. Educational requirements for certification as a Fishery Scientist and Wildlife Biologist are constructed on such a concept—one needs so many credits of x and so many of y. Attempts to design and modify curricula in the future will be, more or less, on the "pearl brooch" model. The "pearls" of information will be integrated into a design—each pearl contributing synergistically to the collective beauty of the entire piece. More emphasis will be placed on the arrangement and pattern than on the pearls themselves. Course names will assume less importance than essential elements of education incorporated into new packages. Holistic science and management courses will become standard fare because they are better pedagogy and are more efficient in constrained curricula. Learning fundamental skills also will be integrated into other coursework. For example, "writing across the curriculum," has recently emerged as a common method of teaching rhetoric on many campuses. Here development of writing skills is systematically incorporated into disciplinary coursework.

Holistic teaching can effectively be incorporated into the resource management disciplines (Jacobson and Robinson 1990). We expect that coursework in 2020 will involve pedagogy of case-studies, management-design projects, seminars, discussions, and practicums (Nielsen, 1987). Many programs have already adopted capstone practicum courses. Learning emphasis here will not be on "what is right," but on the processes used to reach sound conclusions. Working interactively in groups will continue to become more common than individual learning. These methods of teaching all demand more active participation by the student. Preparation for life-long learning will improve.

The expansion of the information base and enhanced technology to access and use it will mean that less time will be spent on teaching facts. Students will

need to learn skills in accessing and using information within the vast data bases to be developed. Once developed these skills can help accomplish objectives of holistic coursework above. The application of technology to education will enhance the educator's ability to deliver essential information. The electronic classroom and laboratory will be standard in the fisheries and wildlife departments of 2020. Training faculty and staff to use them in teaching will emerge as issues in the decades ahead.

Many entering undergraduate students will have limited personal exposure to the natural world. The student body will be more diverse in its cultural and ethnic upbringing. The proportion of urban students will continue to grow. Their attitudes and values toward fish and wildlife will have been largely shaped by the media when they enter the classroom. Students with rural backgrounds and exposure to fish and wildlife in natural habitats will be in the minority. Yet the undergraduate student body probably will have better secondary school preparation in science and ecological/environmental awareness than today's students (assuming a significant societal committment will be made to primary and secondary education in the 1990s). Providing exposure to fish and wildlife will become a challenge. Field activities in university courses will assume special significance. Extracurricular activities, summer employment, internships, and field course experiences will be important not only because they provide exposure to the profession, but also because they allow students to observe first-hand the fish, wildlife, and habitats they are studying. Many universities will adopt an experiential requirement.

The well-educated professional in 2020 will be expected to appreciate the relevance of his or her field in the context of the global society. Understanding the ecological and management principles of Missouri ponds or Minnesota grouse (Tetraoninae) populations may be useful in day-to-day job decisions, but true professionals also will be able to understand their role in the global context—as a component of the biosphere and as citizens in the world. Fisheries and wildife professionals—practitioners and university faculty alike—will have an important job to understand and transmit to others the interconnected nature of things. Leopold's land ethic will be more relevant than ever; we all have special responsibilities to infuse it into global thinking. Thus knowledge of other lands, cultures, and resources will become an integral part of a college education. Again, however, incorporating global aspects of our fields will be relatively easy within the context of holistic curricula and courses. Ponds in Zambia and grouse in Scotland are also useful models.

While the above characteristics may be found in the education leading to all degrees—B.S., M.S. and Ph.D.—other changes may occur within graduate education. In the coming decades, universities will seek alternate models to a research-based master's degree without abandoning it altogether. All alternatives will provide more study, activity, and coursework relevant to the critical-thinking, problem-solving, team-building needs identified above. The trend will be toward providing a degree that systematically and thoroughly develops resource decision-making knowledge and abilities. A thesis will be incorporated into these new programs, but it is apt to be based on Hammond's quasi-scientific or strong quasi-rational thought, reflecting the interface of management and science (Nielsen et.al. 1989). Appropriately, scholars in other fields will have significant input into these programs. University faculty will reluctantly give up the traditional science-based MS as the only model, but increasing curricular demands at the bachelor's level and incentives from potential employers and the students themselves will foster opportunities for reform. A spectrum of different approaches will emerge depending on the leadership, aspirations, and expectations within the specific university and its faculty. As public universities redefine their missions in response to tightening budgets and expanding demands, different emphases will evolve—often centering around the relative values of research and teaching. Where the climate promotes and rewards attention to professional education, the "management-oriented" master's degree will develop as a complement to the "research track". As successes emerge—in the form of talented, well-qualified graduates and important theses and publications—these master's program will become broadly recognized. At other institutions, faculty will not find incentives to divert their attention away from focused research activity. There, master's graduates will receive excellent and rigorous science education. Some institutions will provide both.

The doctoral degree will maintain and expand upon its rigorous, specialized research focus. Yet the new scientist will be expected to be "a politician, a savvy businessperson, a communications expert, a skilled grantsman, financially alert, computer-wise, and adept at human relations....Breadth and resourcefulness [will] count for more than narrow expertise as knowledge accumulates so rapidly that old fields die and new ones are born practically overnight" (Holden 1991:1117). The educational and intellectual expectations for scholars will be immense—including qualifications in more than one subdiscipline. Experience and training in teaching also will be clear assets, if not requirements, to enter academia. Fortunately, opportunities to receive post-doctoral training should

increase as teaching demands are increasingly met with non-tenured faculty and as government-sponsored research increases. It is likely that some individuals will become career "post-docs", assuming different temporary teaching or research positions throughout their academic careers.

PROCESS OF CHANGE

The nature of a public university's work is governed by a loose interaction of: external influences (often political), available resources (often not enough), leadership and management by the adminstration (often short-sighted), the minds and hearts of the faculty (often intractible), and the capabilities of students (often inadequate). Gaining movement from all parts in one direction may be more a product of chance than we care to imagine. Much inertia is imbedded into the system—with both positive and negative effects. We suggest that the system of professional education we have described will evolve; its rate of change will vary from place to place depending on the selective forces. How will teaching and research be valued? Will there be enough funding for faculty to develop new skills? Will administrators support fisheries and wildlife education? Will faculty have the collective convictions that changes are necessary and appropriate? Will we continue to attract a talented student body? In the opinions of many, change will not occur fast enough; for others it will occur too fast.

Because it is unlikely all the educational demands can be met at any institution, a diversity of responses is expected. Enhanced diversity of educational programs, however, will—in the long run—be better for our professions. There will be more choices for students, employers, seekers of research, and other clients. To effectively provide education, research, and other services, regional cooperation among universities will evolve. For example, one university may choose to develop a strong Geographical Information Systems program while another emphasizes aquatic contaminant assessment. Exchanges of students, faculty, and even money will assist in cementing cooperation.

Change will come, but not without costs. For example, the availability of education within any one state may not be consistent with current expectations. State resource agencies and civil service offices may need to adapt hiring expectations and procedures to meet their needs. If the educational needs we describe (and others have called for) are accurate, a professional fisheries and wildlife education will require 5 or 6 years beyond high school. Are employers willing to upgrade salary and benefits to attract the talented students we need in this field? Despite an apparent desire for extended training (Teer et al. 1990), entry-level

positions still maintain bachelor's degree requirements, salaries, and benefits (Schmidly et al. 1990). For effective change to occur, agencies, professional societies, and universities will need to communicate and cooperate to meet our collective goals.

By 2020, sustaining the world's population will present demands that few of us can imagine today. The higher education and resource management professions will face many obstacles to sustain their roles in a changing society. Coping with a more diverse clientele, new technologies, overwhelming amounts of information, and other major changes will be challenging. Success in meeting challenges will depend on the talent, creativity, effectiveness, and commitment of a new generation of fisheries and wildlife professionals. The education they receive as students will be different from that of today; its form will depend on the wisdom, commitment, activity, and leadership of those who will shape it. With some optimism, we expect it will evolve to effectively help society face the challenges and opportunities ahead.

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Wildlife-Related Recreation in a "New Age"

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Abstract: *Wildlife-related recreation now enjoys wide acceptance in U.S. popular culture. Which wildlife activities will prosper and which will fade in the 21st century? Much is at stake for contemporary wildlife management. Several countercultural factors that could diminish the present importance of fishing, hunting, and even non-consumptive recreation are wide-scale acceptance of animal rightists' thinking; isolation of U.S. citizenry from sources of natural production due to urbanization, urban upheaval, growth of an urban under-class, and loss of leisure time; and growth in a "New Age Movement" that venerates or worships nature. Agencies can help assure that folkways of fishing and hunting continue into the 21st century by diversifying the fish and wildlife "product" and producers, cultivating new clienteles and cooperators in fish and wildlife conservation, providing exemplary public service, providing accountability by preparing strategic and operational plans for public inspection, and monitoring public satisfaction.*

Significant milestones in time prompt reflection on the past and speculation about the future. Passage from one century to another is cause enough for discussion. But the year 2000 A.D. marks not only a new century but a new millennium for modern civilization, and heralds what some argue should be a period of unprecedented human achievement in technology, business, health science, leisure, fine arts, ecological awareness—a "new age" for U.S. lifestyle, and perhaps world culture (cf., issues of *The Futurist*).

What will be the place of wildlife-related recreation in new millennium lifestyles? The relationship or relatedness between the U.S. citizenry and wildlife obviously will differ from early settlement times when wild animal flesh and fur satisfied a wide range of frontier needs (Trefethen 1975). The latter-half of the 20th century has seen the virtual disappearance of large-scale commercial uses of wildlife (except for saltwater resources), and the emergence of many citizen interest groups attentive to the recreational uses and welfare of wild animals (Witter 1990).

Not so obvious, however, is which wildlife activities will prosper and which will fade in the 21st century. Much is at stake for contemporary wildlife conservation. Will citizens of the early-21st century value or even condone harvest-

oriented activities? What will be the nature and extent of non-consumptive or aesthetic-oriented wildlife recreation in 21st century lifestyles? Will the year 2020 A.D. find wildlife conservation agencies flourishing or faltering?

This paper (1) discusses the importance of wildlife-related recreation in contemporary U.S. culture, and (2) explores cultural factors likely to help explain the place of wildlife in U.S. lifestyles of the early-21st century. Sociocultural issues or human dimensions in wildlife are analyzed, rather than matters of biology or habitat.

WILDLIFE RECREATION IN 1991

Three out of four U.S. citizens say they have fulfilled most or all of their material needs, according to a *Wall Street Journal* survey, and with essential needs satisfied, Americans are looking for "a good time" (Russell 1990). Based on their spending patterns, Americans spare little expense in pursuit of enjoyment (recessionary and inflationary episodes notwithstanding). The recreation and leisure industry has become the fifth biggest category of U.S. personal consumption at nearly $250 billion in 1987, surpassed only by essentials of housing, food, medical care, and transportation, but exceeding spending on clothing (Russell 1990).

Among the recreational pursuits to which Americans devote discretionary income are outdoor recreation in general and wildlife-related recreation in particular. The President's Commission on Americans Outdoors concluded that wildlife-associated recreation was one of the country's most popular forms of outdoor recreation (Lohmann 1987). Brief review of the magnitude of participation, expenditures, and economic values indicates this popularity.

Wildlife-Related Participation

Wildlife-related recreation now enjoys wide acceptance in our popular culture. Of 196 million Americans 12 years and older in 1985, 23.2% went fishing, 8.4% went hunting, and 61.9% participated in non-consumptive wildlife recreation (U.S. Dep. Int. 1988).

Midwesterners' interest in wildlife-related recreation is rivaled only by people from the Mountain region. The proportion of the population in the West North Central Census Region (the upper Midwest) participating in fishing in 1985 (33%) far exceeds angling in the populous New England (18%), Middle Atlantic (16%), and Pacific (20%) Regions. Proportionally, hunting participation in the West North Central Region (14%) is at least double the estimates for

these same east and west coast regions (U.S. Dep. Int. 1988).

Fishing ranked second only to swimming in leisure preferences of U.S. adults in 1989 (Gallup and Newport 1990). Among men, fishing ranked first of 50 pursuits, and among women, third. Analysts observed, "Fishing apparently cuts across class and status lines, exhibiting few major differences in participation by income, education or occupational status" (Gallup and Newport 1990, p. 28).

Hunting has a narrower participant base than angling, with highest recruitment and involvement from young to middle-aged males of rural background (U.S. Dep. Int. 1988). Hunting ranked 21st among recreational interests of U.S. adults in 1989 (Gallup and Newport 1990), falling from 15th a year earlier (Gallup 1989). This drop in participation was confirmed by hunting license sales figures (L. Ference, National Shooting Sports Foundation, unpubl. data). However, the license sales trend for the 1980s also revealed that hunting has a loyal participant base, with sales varying slightly from a high of 16.7 million licenses sold in 1982, to the most recent figure of 15.8 million in 1990. The dollar value of hunting licenses sold in 1990 exceeded $400 million, a convincing sign of participant interest (Wildlife Management Institute 1991*b*).

The popularity and growth of wildlife-related recreation and allied activities were detailed in two surveys conducted in Missouri over the last decade (Witter et al. 1981, Mo. Dep. Conserv. 1990*b*). Participation in selected outdoor activities was measured for Missouri urbanites in 1980, and in 1990, for urbanites and all other Missourians. Constant across the decade was urban involvement in nature TV-viewing, backyard bird-feeding, hunting, and gathering nuts, berries, herbs, and greens (Table 1, page 96). Angling showed an increase in participation, as did pistol and rifle target shooting. Nonconsumptive activities showing strong increases over the decade among Missouri urbanites were backyard bird-watching, camping, boating, hiking, canoeing, and membership in nature-oriented organizations. Combining rural participation with urban involvement produced statewide participation estimates equal or exceeding urban estimates (Table 1). An exception was canoeing, which held greater appeal for urbanites than rural residents.

The survey revealed that four in every five Missourians have some outdoor-oriented interests, whether passive like viewing nature TV, or active like going afield for bird-watching. Conversely, about 20% of the state's citizenry is uninterested in the products and services of Missouri Dep. of Conservation (MDC) and perhaps can never be enticed to develop interest.

Missourians revealed tolerance for fishing and hunting when asked to

TABLE 1. *Percent participation*[a] *in selected wildlife-related activities, Missouri, 1980 and 1990.*

Activity	Urban Missourians(%) 1980 (n=1,520)	1990 (n=3,427)	Increase	Missouri(%) 1990 (n=6,118)
Backyard bird-feeding	59	59	0	63
Backyard bird-watching	53	70	32	73
Camping	48	57	19	60
Canoeing	25	40	60	37
Fishing	49	53	8	60
Gathering nuts, berries, herbs, and greens	30	30	0	33
Hiking in the woods	40	50	25	50
Hunting	20	20	0	27
Motor-boating	42	53	26	53
Nature group membership	8	17	113	17
Nature TV-viewing	80	80	0	80
Pistol/rifle target shooting	16	20	25	23
Wildlife photography	27	37	37	37

[a]Question wording, "How many people in your household have *ever* participated in....?"

express their approval or disapproval. Approval of angling was practically unanimous (95%), and hunting received clear statewide approval as well (75%). Even urban Missourians—presumably, that population most isolated from routine contact with animal and plant husbandry and most prone to anti-harvest sentiment—expressed majority approval of hunting (66%). Four in 10 urban Missourians surveyed in 1990 said they grew up in a small town or rural area, perhaps helping to explain their high tolerance of fishing and hunting.

Wildlife-Related Expenditures and Economic Values

Financial evidence provides final proof of the importance of fish and wildlife in U.S. culture. Expenditures in 1985 for wildlife-associated equipment, travel, food and lodging, and permits totalled $56 billion (U.S. Dep. Int. 1988).

The formidable economic impact of wildlife-associated expenditures can be

TABLE 2. *Dollar benefits[a] of recreational activities at Missouri Department of Conservation wildlife management areas ($/trip).*

Activity	Whetstone[b]	Ted Shanks[c]	Weldon Spring[d]
Fishing	$9.77	$7.43	$3.07
Small game hunting	$14.31	$16.39	$7.22
Deer/turkey hunting	$15.63	$23.04	$7.22
Waterfowl hunting	NAe	$38.68	NAe
Sightseeing	$7.80	$17.74	$6.81
Camping	$12.04	$14.12	NA[e]
Hiking	NA[e]	NA[e]	$4.28
Bicycling	NA[e]	NA[e]	$9.85

[a]Dollar benefits (unpaid-for values or proxy turnstile fees) in 1990 dollars.
[b]Whetstone is an upland wildlife management area 2 hr drive west of St. Louis, Mo.
[c]Ted Shanks is a wetland wildlife management area 2 hr drive north of St. Louis, Mo.
[d]Weldon Spring is a forest wildlife management area in the metro-fringe of southwestern St. Louis, Mo.
[e]NA=activity unavailable or insufficient participation to estimate consumer surplus

illustrated at a state level. In Missouri in 1985, resident and non-resident outdoor recreationists spent nearly $1.5 billion in fish and wildlife activities, which generated nearly $3 billion in statewide business activity, supported over 56,000 jobs statewide, and produced over $100 million in tax revenue for Missouri, of which $60 million was state sales tax revenue (Brown 1991*a*). The MDC received about $40 million in revenue in 1985 from a unique 0.125% sales tax approved by the Missouri citizenry in 1976 to help fund the agency's fish, forest, and wildlife programs. This earmarked tax is the only one of its kind in the nation able to capture some of the sales tax income generated by wildlife recreation and return the funds to the managing agency; yet even the Missouri program reclaims only part of the revenues attributable to wildlife-related recreation.

User or turnstile fees for wildlife recreation usually are unavailable because the experiences are public sector services, not exchanged in a market setting. Lacking such estimates of "willingness to pay," well-intentioned advocates of fish and wildlife try to describe the worth of wildlife recreation using the word

"priceless", which is transmogrified in the minds of cynics as "worthless" (Brown 1991*b*).

Estimates of user fees are being compiled at several sites in Missouri using travel cost methodology (Brown 1991*a*). These values show that willingness to pay for aesthetic-oriented and harvest-oriented wildlife recreation equal or surpass turnstile fees at commercial amusements like bowling alleys and swimming pools, and even golf courses, ski areas, and theme parks (Table 2, page 97).

WILDLIFE-RELATED RECREATION IN 2020

The opposite of knowledge is conjecture. Preceding discussion established the contemporary importance of wildlife-related recreation in American and Midwestern culture based on what is known about citizen behavior. Following discussion considers the unknown, first describing countercultural developments that could diminish the importance of wildlife-associated recreation in American lifestyles over the next 30 years, and second, describing developments that could buffer change and perhaps enhance prevailing uses of fish and wildlife.

Countercultural Developments

Strictly defined, counterculture refers to the social movement that arose in the United States among young people during the 1960s (Kamin 1991). The movement sought to expose "...bourgeois decadence of Western society", and emphasized social liberty, personal libertarianism, and "...spiritual discovery" (Kamin 1991, p. 3). Counterculture here includes any movement, condition, or trend that could weaken the traditional Western concept of natural resource management—wise use of fish and wildlife by humans.

Tempering upbeat reports of the solid place wildlife-related recreation occupies in the social and economic life of U.S. culture are instances of decreasing or stagnating participation, and outright opposition to some activities. For example, national surveys showed a decline in U.S. hunting from 16.4% of the population in 1955 to 8.4% in 1985 (U.S. Dep. Int. 1988). Others found, "Hunting has dropped to an all-time low of 10% [in 1989], off from the 16% registered in 1959" (Gallup and Newport 1990, p. 28). Even fishing has shown declining or static license sales in some states (Sport Fish. Inst. 1991).

In Missouri, public opinion of trapping, another activity endorsed by fish and wildlife agencies, received only 41% approval in a statewide survey (Mo. Dept. Conserv. 1990b). This sentiment confirmed a latent anti-trapping leaning of the U.S. citizenry identified in a national survey as early as a decade ago. In a

1979 study of American attitudes toward wildlife issues (Kellert 1979), 41% approved of killing an animal to make a fur coat, and 18% approved of using "steel traps to capture wild animals".

These examples of flagging interest in or opposition to traditional harvest-oriented wildlife activities are causes enough for concern among fish and wildlife agencies. But several countercultural factors could worsen matters.

Animal Rights—Proponents of animal rights seek civil liberties for domestic and wild animals (Regan and Singer 1976, McCabe 1986). Humane treatment of animals within human culture is insufficient in their view. Individual animals must be extended rights and justice comparable to human conditions. Recreational uses of animals, including fishing, hunting, and even zoo displays are seen as cruel vestiges of humankind's exploitive past. Some assert that consumption of meat and medical experimentation on animals are other evidences of a Homo-centric, immoral, and environmentally wasteful lifestyle (Richards and Krannich 1991).

A survey of animal rightists stereotyped them as, "...highly educated, relatively well-to-do female professionals. Their involvement in, or sympathy with, other social movements indicates liberal orientations to other political and social issues, especially environmentalism" (Richards and Krannich 1991, p. 370).

Nine of 10 Americans do not endorse the agenda of the animal rights movement, according to a recent Gallup poll (Ahlstrand 1990), and the movement falls outside even the more accommodating definitions of environmentalism (Knox 1991, Conniff 1990). However, the efforts and aims of this group persistently surface in national media, fueling anxieties of conservation agencies and outdoor recreationists over possible growth in animal rightist sentiment in the 21st century (Int. Assoc. Fish Wildl. Agencies 1991). Though not an immediate threat to traditional resource management, and perhaps accounting for only a minuscule part of stagnating or falling participation in angling and hunting, wider acceptance of animal rightists' thinking over the next quarter-century would have dramatic implications for producing harvestable surpluses of fish, timber, and wildlife for human benefit.

Advocating individual rights for animals is evocative of libertarian counterculture of the 1960s and 1970s; what one conservative social critic called "radical individualism" (Colson 1989). Ironically, individualists like animal rightists seem willing to unite for a common cause, illustrated by the "plethora" of militant, single-interest "rights" organizations that emerged in U.S. society during the 1980s in a movement described by the Yankelovich public relations firm as "New

Tribalism" (Hochstein 1991, p. 3). With some social observers proclaiming the death of America's cultural melting pot (St. Louis Post-Dispatch 1991*a,b*), the societal landscape of the early 21st century promises to be dominated by unprecedented factionalism, where political adroitness and media militancy could place even the most unconventional minority views on America's cultural agenda (Hochstein 1991).

Folkways like fishing and hunting will require articulation in coming years equal to "new tribalistic" arguments of animal rightists if society is to have enough information on which to base decisions about harvest activities. Hunter rights bills introduced at state and federal levels take animal rightists seriously (Wildlife Management Institute 1991*a*). Conservation advocacy plans, or proactive strategies accentuating the social benefits of fish and wildlife management, are emerging within conservation agencies (Int. Assoc. Fish and Wildl. Agencies 1991). And establishment of the United Conservation Alliance (Jahn 1991), a group of 150 conservation, biomedical, outdoor media, and sportsmen's organizations, promotes advocacy for use of plant and animal resources.

Preservation Versus Conservation—Just shy of the animal rights position is a battle line between natural resource "preservationists" and "conservationists" (Knox 1990). Both groups have been described in positive and negative ways. Preservationists are positively stereotyped as "environmentalists" or "backpackers" simply wanting government to establish wilderness areas. A negative portrayal casts them as social elitists unconcerned with the economic and recreational limitations accompanying restricted access to wild lands. Conservationists either are portrayed as "wise use" advocates, arguing for balance between land development and land regulations, or as exploiters interested only in plundering America's natural resources, reminiscent of the U.S.'s expansionist period (Baum 1991).

The negative extremes of both groups are countercultural. The preservationist pole threatens to make wilderness areas inaccessible to many; the National Rifle Association has studied the impacts of wilderness designation on hunting, expressing concern over possible limitations on participants (Knox 1990). The conservationist or wise use extreme would act only in the interests of economic development, sacrificing the very wildlife and aesthetic amenities that the group purports to protect. Fish and wildlife recreation of the 21st century will suffer if either extreme dominates.

Isolation based on Place—Urban areas are the centers of world and American population growth. In the U.S., 78% of residents now live in metropolitan areas claiming only 17% of the land, and the urbanization trend is expected to continue (Edmondson and Fost 1991). In Missouri, about two-thirds of the citizenry resides in about 5% of the land.

Describing urbanization as countercultural may overdramatize the apparently natural progression of society from agrarian to urban. And in fact, urban populations can be an unexpected political ally of fish, forests, and wildlife. Missouri urbanites played a key role in establishing one of the most effective funding mechanisms of fish, forest, and wildlife programs in the country. Missouri's 0.125% sales tax earmarked for conservation passed on the strength of heavy urban endorsement of the tax (Brohn 1977).

Despite possible benefits of urban political might, evidence shows that urbanites participate less in outdoor recreation than rural dwellers, and are less supportive of harvest activities than rural citizens (Mo. Dept. Conserv. 1990*b*). Many animal rights organizations emerged during the 1980s in urban centers of the east and west coasts, suggesting an association between urbanization, isolation from sources of natural production, and the anti-harvest sentiment (T. Bujakowski, Fur Retailers Inf. Counc., unpubl. data). Presumably, each successive generation raised in urban settings grows increasingly uninterested in traditional fish and wildlife uses. Hunting, a sport that appeals largely to young to middle aged men of rural background, almost surely will experience decreasing participation as urbanization continues.

Isolation based on Social Underprivilege/Unrest—A study of urban non-whites in Missouri revealed outdoor participation lower than urban whites (Mo. Dept. Conserv. 1990*b*). Fleishman-Hillard Research of Missouri conducted small-group research ("focus groups") on black residents of St. Louis to explore lower outdoor participation among non-whites. Focus group findings revealed that most black participants had some interest in outdoor activities, but these interests were stifled by three fears. First was fear of racial intimidation to self or family in outdoor settings. Second was lack of experience, interest, and confidence in undertaking outdoor pursuits. Third was the fear of random violence while in rural settings (Mo. Dept. Conserv. 1990*b*).

One sobering reminder of focus group findings was that outdoor involvement can be limited by past social injustices and underprivileged status—countercultural maladies—including racial, ethnic, and economic oppression. Likely, the growing immigrant groups in the U.S., including Asians, Mexicans,

Latin Americans, and Caribbean residents, have limited familiarity with recreational traditions in America, including those related to fish and wildlife. These immigrant groups have been called "nations within a nation," and their growing cultural influence on the U.S. described as "far-reaching" (Business Week 1989, p. 144). As these populations struggle to achieve their economic and political place in American society in coming decades, fish and wildlife recreation might hold low or no priority in their lifestyles. The result could be a growing segment of the U.S. citizenry unfamiliar with traditional wildlife uses.

Urban blacks interviewed in the Missouri focus groups expressed concern about random violence in rural settings. Violence and crime have become overwhelming urban problems, representing countercultural instabilities of dangerous proportion. Even Kansas City, the heartland of the U.S., suffers social upheavals like crime, urban blight, gang warfare, homelessness, drug abuse, and a permanent and growing urban under-class (McCormick and Turque 1991). These urban ills will demand remedial action well into the 21st century, requiring staggering commitments of human energy and money. Discussion of the role of fish and wildlife recreation in lifestyles battered by such human tragedies is absurd, unless, of course, fish and wildlife recreation can be proposed as part of the long-term solution to improving quality of urban life (Cohn 1991).

Isolation based on Time—The underprivileged in the U.S. may have more idle time for leisure and recreation than actually desirable or necessary, but lack the base of experience and financial resources. Middle and upper income Americans may have the base of experience and financial resources, but lack the time. And the time shortage for middle and upper America is growing more severe (Gibbs 1989), representing a countercultural development of unanticipated severity.

Futurists in the 1960s predicted dramatic decreases in the hours in the U.S. work-week, and associated increases in leisure time (Papson 1979). In 1967, testimony before a Senate subcommittee predicted that by 1985 Americans could be working 22 hours a week, for 27 weeks a year, with retirement at 38 (Gibbs 1989). These predictions, however, incorrectly harkened to the sharp contrast between the 70 hour work-week of the industrial 1860s and the 40 hour work-week of the post-industrial 20th century, and assumed that professions of the emerging information-age would demand even less time.

In reality, a Harris survey discovered the amount of leisure time enjoyed by the average American has shrunk 37% since 1973. Over the same period, the

average workweek, including commuting, has jumped from 41 hours to nearly 47 hours. Some professions, including law, finance, and medicine, regularly demand commitments of 80 or more hours a week. Vacations for many Americans have shortened to long weekends, and sabbath for many Americans is not for rest, but is "shopping day" (Gibbs 1989).

Two reasons explain this time-crunch expected to continue into the 21st century. First, technology and associated information explosion have increased efficiency in production, but paradoxically increased demands for greater production. And second, the middle class economic squeeze has forced 57% of U.S. families to send both spouses to work seeking two paychecks to maintain the household's lifestyle, dramatically increasing time pressures and conflicts. Moreover, this financial squeeze places even sharper time demands on the large number of single-parent householders (Gibbs 1989).

Fish and wildlife recreation requires time. Research conducted at wildlife management areas in Missouri has bracketed the time required for common fish and wildlife outings in a midwestern setting (hours include travel by car): fishing trip, 4 to 7 hours; small game hunting trip, 4 to 7 hours; deer or turkey hunting trip, 8 to 11 hours, and a sightseeing or nature study trip, 2 to 5 hours. (Mo. Dep. Conserv. 1989, 1990*a*, 1991).

Will participants continue to give fish and wildlife recreation priority as lifestyle pressures increase? At least one group, boat manufacturers and marketers, fear the time crunch will take its toll on angling. These boating interests welcome the growth in tournament angling across the nation because of calendar implications: "What a tournament can do for the busy person is give him or her a target date, way down the road, that isn't booked up yet and that they can set aside for fishing. Tournaments give people a chance to say 'whoa!' to their busy schedules and to have some fun on the water with friends" (Stermer 1990, p. 64). So, too, demands upon MDC to set dates for major hunting seasons at least a year in advance reflect time pressures citizens are experiencing (K. Babbock, Asst. Director, Mo. Dep. Conserv., pers. commun.). If clock and calendar pressures grow too severe, fish and wildlife recreation could be among the first activities foregone.

Nature and Primitives as Objects of Adoration/Worship—The "New Age Movement" (NAM) is a countercultural variation only now starting to effect contemporary resource management. "'New age' is a term popularized in the mid-1980s to describe a nebulous, quasi-religious set of beliefs that are an outgrowth of the 1960s counterculture and the 1970s 'human potential move-

ment'" (Acad. Am. Encyclopedia 1991). On one hand, NAM lauds human intellect and technology, and on the other, reveres or worships the natural environment, primitive cultures, and planet earth ("Mother"), and posits a spiritual link between non-human life forms and humankind (Wauck 1990).

The extent to which NAM represents any threat to traditional uses of fish and wildlife is not yet clear. Politically, NAM thinking may emerge in establishment of a third party, the Greens, in which environmentalism and spiritualism have been linked in at least one description of party interests (Keller 1991). So far, there are no indications of contemporary fish and wildlife conservation running afoul of "Green" thinking in parties active in the Midwest, which emphasize women's and workers' rights, conversion of defense industries to peaceful uses, and environmental pollution (Keller 1991).

Conflicts have occurred between NAM practitioners and forest managers in Arizona (Leerhsen and Gordon 1991). NAM worshippers seeking to rebuild stone medicine wheels in a National Forest claimed, "nature is a temple to us," and sought only "reawakening of ... Native American wisdom" in themselves (Leerhsen and Gordon 1991, p. 26). Forest managers described NAM practitioners as urban "yuppies" and "wanna-be-type Indians" who are "lousing up the landscape" (Leerhsen and Gordon 1991, p. 26).

Seeking to supplant the foolishness of modern man with the wisdom of the ancients may be jumping from the proverbial frying pan into the fire. The spiritual "oneness" of ancient natives and the natural environment appears to be more a product of modern yearnings than historical truth, with evidence suggesting that primitive man's convergence with the natural world was not nearly as harmonious as NAM adherents like to imagine. The paleontological record provides an "incriminating case" that the human colonization of North and South America around 11,000 years ago was accompanied by the prompt loss of 73% of the genera of large mammals in North America, and loss of 80% of large mammal genera in South America, likely due to fire and hunting, though climatic changes could have contributed (Diamond 1989, p. 38).

Even more indicting is the archaeological record of interaction between humans and wildlife during colonization of the oceanic islands between 1,500 and 3,000 years ago. Human-kind earned the dubious title, "Man the Exterminator" (Diamond 1989, p. 38). Eyewitness accounts of some native peoples of the modern era hunting marine mammals with late-20th century technology describe wasteful practices unsupportive of the noble-primitive stereotype (J. Gadamus, professional trapper, Sequim, Wash, pers. commun.). The ultimate effect of NAM

in the coming decades may be difficult to isolate because of similarities among NAM, environmental preservationism, and the animal rights movement.

Buffering Countercultural Developments—Countercultural factors present an intimidating specter of the future for fish and wildlife recreation in a new age, if the factors develop unbuffered by mainstream public sentiment and actions of conservation agencies. Similar, however, to someone awakening from a bad dream with relief that the dreaded experience or outcome has not yet happened and is avoidable, so too can fish and wildlife agencies set to work with renewed vigor to be sure wildlife conservation in 2020 will incorporate today's folkways as well as tomorrow's innovations. Central to this effort is drawing people into a relationship with the natural world, rather than allowing circumstances to draw them away from natural things. Several actions are clear.

Diversify the Fish and Wildlife Product and Producers—Agencies that narrowly define their roles as producers of game and fish probably have much to fear from public sentiment over the next quarter century; not that providing citizenries with game and fish for harvest-oriented experiences is inappropriate, but that such activities are not enough. Agencies should seriously undertake the arduous task of moving from sportsmen's organizations to broad-based wildlife agencies with a variety of products.

Agencies that aspire to be providers of nature-oriented experiences and information will endure and likely prosper; those offering permit sales only will fade (Arrandale 1990). Rather than providing just opening day, agencies might provide Eagle Day, Day in the Forest, Prairie Day, Waterfowl Day, Day in the Cave, Day with Wildlife, Day on a Trail, or any number of interpretive events that will appeal to the nonconsumptive or aesthetic-oriented interests of the majority of the public that does not hunt or fish. A nature center showcasing a wide range of fish, forest, and wildlife topics has broad public appeal and high visibility (Wallace and Witter 1991). Videos, TV programs, conservation seedlings, statewide maps suggesting sites for aesthetic-oriented and harvest-oriented recreation, conservation education materials for pre-school through college—the list is endless of innovative nature programs that could help keep the citizenry in touch with the natural world and appeal to a wide spectrum of society.

Just as product diversification would produce a richer agency environment, so too would diversifying the sociocultural mix of agency personnel. Gender, race, and outdoor interests of the general public can be most fairly represented if agencies aggressively seek a varied professional staff.

Diversification of agency products and producers will cost money. Who will pay?

Cultivate New Clienteles and Cooperators—Over half a century ago, Aldo Leopold prophetically observed that, despite the unarguably pivotal role sportsmen played in reversing the downward spiral of fish and wildlife populations in the U.S., sportsmen alone would be unable to fund the type of broad-based fish and wildlife programs necessary for continued achievement in conservation. He called for a coalition among a wide range of aesthetic-oriented and harvest-oriented outdoor enthusiasts (Leopold 1971[1930]).

Today, however, such coalitions are scarce. These unions take years to forge (Brohn 1977), and demand uncommon tolerance among wildlife interest groups (Steinhart 1990). Fish and wildlife professionals themselves are somewhat accountable for lack of outreach to other outdoor interests. For roughly half a century during the developmental years of fisheries and wildlife biology, agency staffs were largely and understandably limited to biologists conducting life history research on fish and wildlife. However, these professionals appeared quite content to remain isolated from public contact, occasionally answering to interested sportsmen's groups (Witter 1990). Indeed, few efforts were made to cultivate wildlife stakeholders beyond the fishing and hunting communities. Even now, Proactive Strategies being encouraged within fish and wildlife agencies (Int. Assoc. Fish and Wildl. Agencies 1991) should be more than plans to defend hunting and fishing. Proactive strategies must include recommendations on innovative ways to bring as many outdoor interests as possible into a wildlife coalition, like minorities and ethnic groups, elders, single parents, the disabled (or those with varying abilities), urban dwellers, and even animal protectionists who find common ground with agencies. In fact, agencies should afford even the most extreme animal rightists opportunities to comment on management plans, eliminating rightists' feelings of isolation and frustration that produce desperate acts of opposition to agency efforts. Several non-traditional groups that could enter conservation coalitions with agencies are spotlighted.

Minorities and ethnic groups represent one potential source of support. In some cases, an initial interest in conservation will have to be cultivated, such as in a symposium held in Denver, Colorado, on July 13, 1991, "Environmental Issues in Ethnic Communities". The one-day conference, sponsored by over 60 civic, social action, and conservation groups, was for "all Coloradans interested in environmental issues facing the state's ethnic communities—and in how members of these communities can become involved in the critical issues" (Ethnic Communities Conf. 1991).

In Missouri's case, focus group research has suggested that urban blacks (about 10% of the state's population) have some outdoor interests and would desire to learn more, but several fears limit their involvement. The MDC will respond by ensuring that the Powder Valley Nature Center in St. Louis and Burr Oak Woods Nature Center in Kansas City provide an environment that welcomes blacks, offers outdoor experiences in secure settings, and provides opportunities for social interaction among black visitors (Wallace et al. 1991). Focus group participants said that good experiences in outdoor settings will encourage them to return, and bring their families and friends with them.

Another group of special interest to the MDC consists of the "hobby farmer"; those people residing in urban areas but who own farm or forest property in rural Missouri. Twenty-four percent of urban Missouri householders own rural property in the state (Mo. Dep. Conserv. 1990*b*). Not only in Missouri but the nation as well, there is renewed interest in country living and rural values. So appealing is the frontier image to Americans that associating products with "frontier fantasy" now ranks among the most effective marketing devices (Edmondson and Fost 1991). And so alluring is the call of the frontier that some urbanites are relocating to rural settings (Sofranko and Williams 1980, Bodnar and McManus 1990). The MDC is conducting a survey of over 2,500 urbanites owning rural land to explore how the agency might capture the interest and support of this unique group by offering products and services appealing to their fish, forest and wildlife-related interests.

Opportunities also exist for fish and wildlife agencies to cooperate in furthering the conservation efforts of allied organizations. For example, in 1990, MDC provided a sizeable grant to the St. Louis Science Center to support expansion of that facility. The money helped construct a "conservation" hall, for which the MDC receives recognition, featuring fish, forest, and wildlife exhibits. Also, MDC assisted the St. Louis Zoo in funding a major exhibit on Missouri streams, stream conservation, and native fish. Both the Science Center and Zoo receive hundreds of thousands of visitors each year, many of whom may have little familiarity with MDC, but some of whom will come away from the exhibits with at least an introduction to MDC's role.

Provide Exemplary Service and Examples—Whether in the private or public sector, there is no substitute for good service to the clientele. In coming times of fiscal competitiveness and crisis, agencies that are perceived as hustling to please customers, practicing what they are preaching, as in recycling (Hamer 1990), and seeking to serve as many diverse interests as possible, will be in the best

position to request and receive additional funding and staff (Braus 1990). Agencies with narrow bases of support, or perceived as out of touch with citizen interests and expectations, may find themselves being considered for consolidation within other governmental agencies, and even forsaken by their familiar constituencies (Reiger 1989).

Finally, agencies likely to prosper in the 21st century are those that will detail their goals and objectives for resource management in formal strategic and operational plans open to inspection by the public. Moreover, successful agencies will be those that monitor their programs and services through ongoing social research to determine if the program should remain untouched, fine-tuned, subjected to major overhaul, or scrapped.

CONCLUDING REMARKS

A society's culture includes knowledge, beliefs, arts, morals, customs, laws, and other capabilities and habits acquired by the citizenry as members of society (Tylor 1889). Thus, a wide array of social and economic topics have potential for influencing the role of wildlife in 21st century lifestyles. This paper reviewed countercultural factors that could negatively influence the place of fish and wildlife recreation in a new age, and considered agency and social actions that could buffer these countercultural events and enhance fish and wildlife recreation. Resource professionals should train themselves to be observers of cultural phenomena, anticipating social change. By helping to influence events in the 21st century, resource professionals can assure that the wildlife-related landscape is one rich in harvest-oriented and aesthetic-oriented recreation. This cultural landscape will benefit both our nation's fish and wildlife resources and citizenry.

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The Fisheries and Wildlife Agency in 2020

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Abstract: *The fisheries and wildlife agency in 2020 will differ markedly from today's agency. Public support will depend on a well-informed citizenry composed of many interest groups. The agency will emphasize urban non-consumptive programs aimed at a diverse constituency. Many routine functions will be contracted to private firms. Fisheries and wildlife agencies will join comprehensive agencies; consequently politics will concern the average professional less, but will be paramount to agency leaders. Agencies will be decentralized to allow integrated, team management. General tax revenues will supply most funds, supplemented by license and other user fees, federal excise taxes and environmental assessment fees. Consequently, formal planning and reporting will be an absolute necessity in order to maintain general support. Agencies will share governance of resource management with native Americans, other agencies, and private groups. Environmental scanning will be a standard technique for anticipating conflicts. Agency management will be more competent, often with trained managers in leadership positions. Professional staff will be diverse ethnically and disciplinarily, with greater differentiation of labor and responsibility.*

Imagine the curious reader, browsing through the library in 2020 and finding this book. He will undoubtedly turn the pages with a smile, noting the mistakes in our predictions. He'll probably copy an especially amusing passage, take it back to the office, and tack it to the bulletin board by the coffee pot.

This outcome shouldn't upset us. The most probable outcome is that every prediction will be wrong. If we are honest with ourselves, we will admit that thinking realistically about future change is extremely difficult. Consider that first paragraph. Although it is easy to imagine the scene depicted, almost everything in it is probably wrong. The curious reader won't be browsing in a library, because libraries will be high-density storage facilities, with access limited to trained librarians searching for requested volumes. The reader is as likely to be a she as a he. And if she does have the volume, she'll be searching through a computer file rather than flipping pages. She won't copy anything physically,

TABLE 1. *Suggestions for future needs in fisheries and wildlife management presented in the 1950s by authors in the Transactions of the North American Wildlife Conference, Journal of Wildlife Management, and Transactions of the American Fisheries Society. Research performed by Anne Seinwell, Virginia Tech.*

AUTHOR	SUGGESTIONS
Chilson (1957)	Create partnerships among governments, agencies, and private groups
Davis (1953)	Solve international population growth
Huber (1953)	Increase public participation Create research and administrative specialties in college Train all professionals in public relations
Leffler (1957)	Perform research on laws and habitat management Perform technology transfer to public Cooperate among state and federal agencies and among farmers and other landowners Integrate land and water management Increase public education
Leonard (1955)	Create good working conditions Perform directed research
Lively (1953)	Increase public education Remove politics from management
McKay (1953)	Integrate resource management
Ordway (1959)	Create worldwide resource management and legal system Provide worldwide technical assistance
Parsons (1957)	Evaluate fishery management practices
Schoenfeld (1957)	Develop favorable public opinion Educate for public administration
Shomon (1956)	Integrate resource education Collaborate among agencies, governments, and private groups
Steen (1951)	Empower private enterprise to manage resources responsibly
Sylvester (1957)	Integrate natural resource management Create resource generalists to administer management programs

TABLE 1. *continued*

AUTHOR	SUGGESTIONS
Taylor (1956)	Establish comprehensive national policy on resource management
Voigt (1952)	Integrate resource management Inventory condition, productivity, and use of resources Develop and apply comprehensive plans for land areas Increase private landowner responsibility Preserve examples of natural areas Administer resources efficiently Assure full public participation Assess projects on national level Establish national policy review board

and she probably won't have an office to return to. If she wants others to see it, she'll post it electronically to their work stations. With any luck, though, we'll still have coffee pots.

No predictions are more difficult than predictions about the fisheries and wildlife agency of the future. Agencies are currently pulled between the polarizing forces of performing their traditional roles for an appreciative clientele and of responding to the beckoning arms of the large but unproven "general public." In that context, we are dismayed that the directions suggested by commentators about 30 years ago (Table 1, page 112) are similar in most ways to the directions that we suggest here for the next 30 years—yet agencies appear to have changed relatively little.

Nevertheless, we will describe the directions in which we believe fisheries and wildlife agencies will be moving. The paper is organized around six themes that have been identified by fisheries and wildlife agency leaders as crucial to their future success (McMullin et al. 1991)—strong public support, quality agency management, a healthy political climate, adequate funding and visionary planning, constructive conflict resolution, and an effective, highly motivated staff. In almost all cases, many agencies are already moving towards a new future, having decided that traditional patterns of thinking and working must be selectively altered for success in the next century.

Directors surveyed by McMullin et al. (1991) also stressed a seventh crucial area—quality natural resources. We take as a given that the successful agency will

be technically expert about resource management, employing the most qualified people, adopting scientific management, and dedicating the mass of their staff, funds, and facilities directly for protecting and improving animal and habitat resources. We have concentrated our analysis on the structure and organization of agencies, because we believe that improved agency management is essential to quality resource management.

PUBLIC SUPPORT

Fisheries and wildlife agencies have always known that public support is essential for their success. Ross Leffler, Assistant Secretary of the Interior for Fish and Wildlife under President Eisenhower, said that "Faced with the paradox of providing more with less, there is—as never before—the need for public understanding. . .People will give the backing needed when they understand the problems and what needs to be done" (Leffler 1957: 76).

In the early years of agencies, gaining public support was less complex—keep the focused clientele of hunters, trappers, and anglers happy. Garnering public support today is the antithesis of easy, and the future promises to be more difficult. The response of the future agency is relatively clear, however—it will seek new friends by listening to a much broader and larger audience and by providing services well beyond those provided today.

Demographic changes are so often described that they need not be reported in detail but a summary of conspicuous changes is enlightening. Retirees will be more abundant than ever; most people will live in urban areas; the traditional family group will be splintered into an array of traditional, single-parent, and multiple-unit varieties; everyone will be literate and will have access to information technology in their homes (Brick 1984, Graf and Schenborn 1984). These conditions will create diverse groups with special interests and the time, money, and sophistication to make their desires known (e.g., Kokel 1991).

Keeping these people happy will require explicit and expansive attention. Therefore, a vital characteristic of the 2020-agency will be *the presence of a substantive marketing division.* This division will provide the customer-service function—responsible for listening to the customers, packaging agency programs to meet their needs, providing information to the customers, and providing new program ideas to the agency leadership (Duda 1990). Like the marketing divisions in major corporations, this division will consume a noticeable part of the agency's financial and human resources.

The populace will be the most highly educated in the history of the earth, in

TABLE 2. *Emerging trends identified by a panel of 19 representatives of forestry, fisheries, wildlife, outdoor recreation, and forests products disciplines assembled at Virginia Tech, December, 1988 (Nielsen 1988).*

Trend	Numerical Ranking
1. Increasing concern for environmental quality	100
2. Increasing diversity of recreational demand	61
3. More intensive land use	61
4. Increasing regulation of private land	56
5. Uncertain impacts of demographic changes	47
6. Increasing demand for wood products	42
7. Increasing state and local natural resource management	34
8. The coming of a world economy	32
9. Need for human population control	29
10. Increasing attention to ecologically sensitive management	29
11. Increasing commercialization of recreation	28
12. More legislative intervention in natural resource management	28
13. Increasing problems at the rural-urban interface	27
14. Increasing need for professional "people skills"	27

all aspects of human endeavor, including natural resource conservation. Project Wild and Project Learning Tree will have operated for nearly two generations, along with a plethora of programs broadcasted by the commercial media. The myth that urbanites are ecologically illiterate will disappear, as citizens demonstrate their understanding that humans are part of the natural system and that ecological thinking is the essence of continued human existence on earth. As Doug Crowe has so elegantly stated, we will have moved from the "ME" generation to the "OURS" generation (Crowe 1989), a time when the people will be eager to join together as responsible members of the community (Allen 1984, Smoller 1984).

In order to keep public support, the agency will actively participate in the broad sweep of ecological education. Perhaps through its own cable channels, printed materials, and video productions, perhaps in partnership with other groups, the agency will provide *fisheries and wildlife information as part of an integrated ecological education.* The agency will have learned to emphasize through education its long-term role as ecological protector, thereby assuring the broad support of the nation's formerly silent majority.

TABLE 3. *Excerpts from North American Fisheries Leadership Workshop, May, 1991, regarding nature of public fisheries agencies in 2020 (unpublished meeting notes).*

VISION
- act as stewards and advocates of public trust for aquatic resources
- meet current and anticipated future challenges
- act proactively via monitoring of stocks
- evaluate progress with social factors and attitudes
- develop funding that reflects diversity of public interests
- receive broad public input in formalized programs
- get and provide timely feedback
- cooperate on clear missions with other agencies
- work in concert with developers at early project stage

LONG-TERM AGENDA
- manage ecosystems, not species
- develop allocation plans with broad groups of users
- use modern technology to collect and transfer data
- implement broad networking for information flow to and from constituencies
- involve stockholders in management decisions
- cooperate among agencies and other groups to assure communication
- operate with an interdisciplinary and diversified work force
- protect traditional funding
- develop general funding
- charge developers and extractive users for costs of protecting resources

The public will also be more fractionated, with different groups holding strong opinions about ecological preservation and about responsible recreation (Table 2, page 115). To preserve order, the marketing division will be forced to monitor public opinion purposely and continuously and to compel differing factions toward agreement. Mechanisms of public involvement, which have evolved in recent decades from nonexistent to a single model (the public hearing) and now to a variety of formal and informal techniques (from judicial hearings to opinion surveys), will become complex programs with many formalized strategies for particular situations. As planned now by the California Department of Fish and Game (1991), for example, public forums will allow citizens with disparate interests to focus on the "Common Ground for Wildlife." In many states, formal congresses will convene to explore areas of common concern; the Idaho Wildlife Congress and Wisconsin Conservation

Congress are contemporary models. Programs such as Maryland's Natural Design in Development (Thompson and Northrop 1991) will assemble interested parties to discuss hypothetical issues in advance of-and in place of-typical site-specific battles.

By necessity, agencies will need to know in detail the level of public interest and the range of public interests on virtually every proposed action (Table 3, page 116). Technology will come to the rescue, with interactive electronic communication possible on a routine basis (Smoller 1991). The public will be offered opportunities to comment, based on autotutorial information, and those comments will be incorporated instantaneously into databases for decision-making. Conversely, interested citizens will be provided access to the entire agency—reports, data, and plans—in a user-friendly way (Carey 1979). In essence, the agency and the citizenry will be one body rather than two, with somewhat more expertise vested in one and slightly more power vested in the other (Kinsey 1980). Fisheries and wildlife managers will have evolved to be creators of management options, disseminators of information, and facilitators of a publicly oriented decision-making process (McMullin and Nielsen 1991). *Public involvement will have reached its rightful goal as the merger of public interest and public service.*

AGENCY MANAGEMENT

Fisheries and wildlife agencies have been relatively simple bureaucracies, generally run by agency professionals who had the most vision, ambition, or personality. In general, that agency will have disappeared by 2020, replaced by a more complex, purposefully organized and managed bureaucracy.

Faced with the complexity of a broadened constituency and an expanded vision of natural resource management, the current trend towards *incorporation of fisheries and wildlife agencies into more comprehensive departments of natural resources* (DNRs) will have continued (Wildlife Management Institute 1987). Although the independent agency will still exist in some states with low-density rural populations where the majority of the population hunts and fishes, DNRs will be the rule.

Leadership in DNRs, and hence in fisheries and wildlife programs, will be more professional. That is, trained administrators will run the programs, rather than upgraded professional fisheries and wildlife biologists (e.g., Baumann 1989). Administration of the programs will improve under this leadership, provided that administrators recognize their technical limitations and use their

professional staffs to make scientifically valid resource-management decisions. This expert management will filter down to lower levels in the agency, at once discouraging the ambitions of traditional professionals and encouraging continued learning by those who are willing to add administrative and managerial expertise to their technical background. The successful agency will *invest significantly and selectively in managerial training of its staff.*

Under the continuing pressure to make government more efficient and to reduce the overall size of centralized governments, fisheries and wildlife agencies will emphasize renting expertise rather than owning it. *Many routine functions will be contracted to private firms,* so that long-term commitments to specialized staff, equipment, and facilities decline. License selling, habitat improvement, land maintenance, fish production, limited-access recreation, and similar routine programs are likely candidates for contracting to private businesses (Larkin 1988). As environmental assessments for development permits become routine, these will be contracted as well. In general, agencies will seek ways in which necessary societal functions can be performed in the private sector, with oversight reserved by the agency.

As the agencies become larger and more comprehensive, the size and complexity will demand *decentralization to smaller geographic regions* (Reiger 1984, Minnesota DNR 1989a, Behan 1990). The comprehensive agency will find greater efficiency, efficacy, and public support by investing programmatic responsibility to regional directors with complete technical staffs within their units. This decentralization is virtually demanded by the integrated approach to resource management that will be standard by 2020. This ecological approach will work only when fisheries, wildlife, forestry, water, soil, air, waste, recreation, law enforcement, education, and other specialists harmoniously function as a regional ecosystem team. The feared tendency for decentralization to produce regional fiefdoms is a necessary risk that can be reduced by managerial training and overall agency planning.

Decentralization is also an essential step in the empowering of all persons involved in natural resource management. By providing more autonomy to agency employees at local levels, decentralization gives them the motive and the means to succeed (Johannsen 1990). By investing teams of staff and community volunteers with the authority to make decisions, *decentralization develops local responsibility for the stewardship of resources* at the community level (Larabee 1991)—the essence of thinking globally and acting locally.

Decentralization allows staffing to meet programmatic needs in proportion to

demand. Because most demand is people generated, much *more effort will be directed towards urban and suburban areas.* Although today's agencies often contemplate urban programs or agree to start programs with the expectation that local agencies will soon take over, the 2020-agency will recognize that urban programs are essential. Without aggressive attention to urban needs, the fisheries and wildlife agency will slowly atrophy, dispersed among conservation, recreation, education, law enforcement and other agencies which are eager to serve the urban clientele.

POLITICS

Politics remains a dirty word in most fisheries and wildlife circles today, as it was in 1953, when Charles Lively reflected that "...one of the most important steps to be taken, where it has not already been accomplished, is to remove the management of conservation programs from politics..." (Lively 1953: 43). This distrust for political interest in fisheries and wildlife will surely have changed by 2020. Along with their technical expertise, natural resource professionals will help form the vision for politicians and the public (Backiel 1990).

All general societal trends point to a continuing growth in the power of non-governmental groups in the management of society. They express this power through politics-directly or indirectly. The successful fisheries and wildlife agency in 2020 will have recognized the importance of both kinds of politics—big-P politics (the official domain of elected representatives) and little-p politics (the indirect influences of individuals and groups on bureaucratic decisions). Successful agencies recognize this importance now; the only significant change is that all agencies will address politics proactively in the future.

Societal attention, and hence political attention, will focus more consciously on environmental quality and natural resource conservation. Legislative acts and executive directions will thrust *natural resource agencies into a central role in society, where their decisions will influence other sectors*—business, education, social programs—so forcefully that natural resource agencies will be under close public and political scrutiny and intense political pressure. Even employees of natural resource agencies, like the 4500 members of the Association of Forest Service Employees for Environmental Ethics (Blumenthal 1991), will provide their own political pressure. Consequently, natural resource administrators and professionals will find political savvy an addition to ecological savvy as critical elements in their successful performance.

This intense interest in natural resource issues, however, will benefit agencies

enormously overall. As the entire range of interested groups gains sophisticated access to the little-p political process, the ability of single groups to affect decisions will decline. Therefore, biologists will no longer be asked to justify political decisions on technical grounds. Biologists will be able to resume their credible positions as technical staff to the political process. Furthermore, the leveling of the political playing field will require more and better technical information. If this need is presented well-that is, politically-the resources available for technical assessments will certainly increase over the meager resources available now.

The enhanced political access by all resource groups will also require agencies to serve as a credible technical resource for all those groups. *Successful agencies will eagerly serve as the technical staff for conservation groups*, thereby assuring that the best information is used and securing public support for their technical needs.

In the big-P political arena, agencies will be involved more extensively and competently with the law-making arm of government-the legislature. This activity will be centered in an effective *legislative liaison division*, staffed with persons experienced in both politics and natural resources. Rather than a one-person program, this division will involve several staff who work continuously with legislators at federal, state, and local levels before, during, and after legislative sessions, and with the complementary legislative liaisons of private resource conservation groups. Without question, the activities of legislative liaisons will cause repeated challenges regarding the proper role of agencies as lobbyists, but the costs will be more than balanced by the increased benefits of political support.

PLANNING AND FUNDING

These two issues are combined here because they are invariably linked in practice. Planning is the activity which oversees the effective and efficient use of time, money, and property. Moreover, the increased funding for future needs will only be available to agencies whose records of achievements are well documented-another outcome of planning.

Shedding the resistance that remains today, *all agencies will become uniformly aggressive planners by 2020*. As other societal trends force fisheries and wildlife agencies to be more accountable and credible for their actions, planning must be present to tell what happened and how much it cost. As the breadth of agency responsibilities increases, agency personnel and leadership will no longer be able to write "more of the same" as their program priorities. Objective and explicit analysis will be critical; thus, planning must be available to help discover

and develop agency goals, objectives, strategies, and priorities (California Department of Fish and Game 1991).

What form planning will take is anyone's guess. The level of experimentation in planning systems is so high—and so highly criticized—that any or none of the current techniques may be universal by 2020. Only a few trends are clear. First, *planning and budgeting will be linked.* Since that is the whole point of planning—to put the bucks where the bangs are—the evolution of planning must clearly lead towards linkages. Planning is criticized today because it seems to be a report-writing exercise with little benefit. The benefits will come when programs expand or contract as a result. Second, *decisions will become increasingly governed by explicit planning techniques.* Less and less will be left to the backrooms and the board tables; and even decisions there will be carefully monitored and documented.

Third, all agencies will have planning staffs. Agencies and planners today often assert that planning is everyone's job, and they shun the designated planner. While diffused planning may be a good transition strategy to get everyone's attention, the eventual size and complexity of the task requires dedicated time, space, and expertise. Planning will remain everyone's job—just like writing budgets is everyone's job—but *formal planning divisions will assume a role in agency functioning.*

The more interesting—and heart-rending—questions regard funding. This must surely be the most discussed topic among agency leaders today, and probably has been throughout time. Despite what appears to be great uncertainty on the detailed answers to this question, the fundamental trends are absolutely clear. We all know that future funding must be large, stable, and inflation-proof, but we are mystified by how to make that happen.

License revenues will continue to shrink as a proportion of the agency's budget between now and 2020 (Gilstrom 1987). Aside from the apparent downward trends in license sales, it is clear that society is unwilling to order anglers or hunters to pay the true cost of fisheries and wildlife management (Washington Wildlife Commission 1989). As the breadth of agency programs continues to increase, involving more and more people who are casual or non-consumptive users, the opportunities to make users pay directly through licenses, stamps, or special permits will have been fully subscribed and still found lacking.

By 2020, agencies will have realized that the "bake sale mentality" of tax check-offs, donations, adopting-a-lake, vanity license plates and the like is a financial loser. Although these programs may have short-term value, primarily as public relations tools, their return on investment is so small in most situations that they cannot be considered seriously as long-term funding solutions (Hamilton 1987, Arrandale 1990).

The user-pays idea will have substantially disappeared from public agencies by 2020. The true definition of user-pays is a situation in which access to a program is provided to an individual in proportion to the amount paid. Such situations are relatively rare in fisheries and wildlife (the best illustration is the daily fee fishing area). Where they do exist, private entrepreneurs will have developed competing programs which can provide better service at a lower price (Larkin 1988). Successful agencies will have identified these situations and helped private businesses take over, rather than fighting them off as competitors. By shedding the zeal to manage areas for user-pay, agencies can refocus on their fundamental mission to keep wild lands and water accessible to all users, whether they pay directly or not. Using other revenues, agencies can acquire land and easements that assure access for both present and future citizens.

The user-pays idea will be used for collecting full cost-recovery charges for environmental assessments and permitting. Rather than the agency's license buyers or the general public paying for environmental reviews, *filing fees for developers will be set high enough to recover the costs.* These fees will also exist for government agencies, which will be required to include the full cost of assessments in their project budgets. Assessment fees will generate funds sufficient to underwrite agency's environmental programs, and will allow the employment of personnel who are skilled in performing these analyses.

The ultimate funding answer for fisheries and wildlife agencies is general revenues. The successful agency in 2020 will have made the transition to a funding program in which general funds pay for the programs that benefit the general population—that is, long-term conservation of the biosphere and dispersed non-consumptive enjoyment of the outdoors.

General revenues will be delivered in a variety of ways, some already in use today. General income or sales taxes will predominate, as used now in more than half of state agencies (Wildlife Conservation Fund 1987). Lottery funds are new sources of general revenues in many states, already used for fisheries and wildlife in Arizona (Ohmart 1990) and Minnesota. Legislation that transfers general revenues into resource-specific endowments, like the "Reinvest in Minnesota" and "Reinvest in Arizona" programs, can protect funds from future political uncertainties (Brown 1988).

Despite the reluctance of some agencies to pursue general funds, most citizens and professional groups favor them as the long-term funding solution. As surveyed recently by Virgil Kopf, Virginia residents overwhelmingly endorse general revenues, sales taxes, and lottery funds for natural resource programs

TABLE 4. *Proportion of Virginia residents who agreed or strongly agreed with sources of additional resources for the Virginia Department of Game and Inland Fisheries, based on telephone surveys, Fall, 1990 (from Va. Dept. Game In. Fish. 1991a).*

Funding Source	Proportion
State sales tax on boating equipment	82.0
State sales tax on wildlife-related sporting equipment	82.0
Lottery proceeds	80.0
Horserace betting proceeds	78.2
State gasoline tax for gasoline used in boats	76.4
Conservation stamp with hunting or fishing license	73.2
Elimination of reduced license fees for special groups over 16	67.6
Tax on land development projects	65.2
Donations via utility bills	62.6
Registration fee for canoes and other small boats	61.2
Increased fishing and hunting licenses	58.5
Non-returnable bottle tax	57.0
Extra fee on first-time motor vehicle registration by new state residents	37.3
Increased motor vehicle registration for everyone	18.9

(Table 4, page 123). Furthermore, using general revenues for fisheries and wildlife represents an actual reinvestment in a state's tax-generating capability. Barber (1990), for example, demonstrated that the tax benefit in Utah from direct fisheries and wildlife expenditures exceeded $60 million in 1989, more than 30 times the approximately $2 million the agency received from general funds. As agency programs expand, the proportion of the budget supplied by general revenues will also increase, no doubt becoming the majority of the budget in most states. This process will make agencies more susceptible to the vagaries of the state budgeting process and to direct competition with the other pressing needs of society, further justification for necessary improvements in public education and political power within agencies. Successful agencies will have realized, however, that the variance around general fund revenues is more than balanced by the increased mean level of funding over traditional user-fees.

CONFLICT RESOLUTION

Consultants like to say that conflicts are not bad, but are, in fact, inevitable. Poor resolution of those conflicts, they say, is bad-but is not inevitable. As thoroughly as poor conflict resolution has characterized fisheries and wildlife

TABLE 5. *Programmatic interests of Virginia residents regarding fisheries and wildlife, as determined in telephone surveys, Fall, 1990 (from Va. Dept. Game In. Fish. 1991b). Based on a scale of 0-10, with 10 = highest importance.*

Interest	Ranking
Enforcement of environmental laws	9.28
Protection of threatened and endangered species	9.11
Education for hunting safety	9.09
Enforcement of hunting laws	9.04
Education for boating safety	8.87
Environmental assessment and emergency response	8.80
Enforcement of boating laws	8.68
Enforcement of fishing laws	8.28
Management for outdoor recreation	8.10
Management for wildlife watching	7.75
Acquisition of land for fish and wildlife	7.73
Education via workshops on resources	7.57
Technical assistance to various public and private audiences	7.42
Publication of information about resources	7.38
Provision of fishing (several aspects)	6.96-6.47
Provision of hunting (several aspects)	5.65-5.15

agencies in the recent past, good conflict resolution must characterize successful agencies in the next generation.

Many of the previously described attributes of the new agency-effective public support, enhanced political savvy, explicit planning-provide the basis for effective conflict resolution. However, they also assure that more people with incongruous interests will be involved in agency decisions and actions than ever before. The successful agency must be a skillful mediator to keep all these eggs unbroken in its basket.

The first step in conflict resolution is accurate anticipation of likely conflicts. *The successful agency will practice environmental scanning as an integral part of its strategic thinking* (Barney 1980, Schenborn 1985). Environmental scanning watches all major social institutions, monitoring trends in the nature and prevalence of attitudes and actions. Perhaps more than any other planning component, this one will require substantial patience by administrators, because the job is to look broadly—in time, space, and sector—at the possible futures in

which the agency will be functioning.

Environmental scanning, along with direct assessments of public interests, will have revealed a different agenda for the fisheries and wildlife agency. Traditional fisheries and wildlife programs will decline as a proportion of the agency's workplan, replaced by programs emphasizing environmental, ecological, and education functions (Table 5, page 124). The agency in 2020 will have anticipated these interests and reoriented its programs to emphasize environmental protection and non-consumptive recreation. Central to that reorientation is a commitment to assign personnel to monitor field conditions and perform the needed field management.

Successful agencies will also avoid conflicts when possible by sharing responsibility with their potential antagonists. The term "partnership" is prevalent today, primarily as a way to enhance funding and workforce levels, but partnership will become standard in the future as the basis for land and water stewardship (Minnesota DNR 1989b). Like the future envisioned by the U.S. Fish and Wildlife Service (1991), partnerships will be the basis for accomplishing goals that address the critical issues of integrated resource management and protection.

Recognizing that authority is an important element of responsibility, *state agencies will cede some of their authority to other groups as a way to encourage holistic thinking and to eliminate us-versus-them conflicts.* Co-management of fisheries and wildlife management with native American tribes is already well established, but it will be the standard by 2020. Similar co-management will be in place with local agencies for the management of water supply lakes, local parklands, and natural reserves. As a window on the future, the Idaho Fish and Game Department and the U.S. Forest Service are currently testing co-management on selected national forest units.

PERSONNEL FACTORS

Ultimately, the natural resource of agencies is the capacity of the professional workforce in fisheries and wildlife. As Jim Remington, former Executive Director of the Virginia Department of Game and Inland Fisheries, once said, the program administrator is also a habitat manager-of the habitat for professionals. *The successful agency in 2020 will be a positive and purposeful manager of the professional habitat.*

The agency in 2020 will be a diversified workplace. Today's agency employs mostly carbon copies of the fisheries or wildlife biologist—strong background in science, preferably with a research degree. *Tomorrow's agency will have recognized the importance of other skills in agency function.* They will be hiring persons

trained as professional biologists, but supplemented with professional communicators, educators, engineers, researchers, environmental analysts, and managers (Edwards 1981).

The role of the administrator is especially important—and different from today. The future decentralized agency will have regional units operated by local autonomous teams. For such teams to be effective, they will require expert leadership-the kind provided by persons trained to manage people and to understand the broad aspects of resource conservation. This person will also be likely to advance to higher levels, based on her or his understanding of the issues presented in this volume (Soden et al. 1988).

This change in the professional demographics will require a substantial change in professional compensation. The successful agency will have discovered how to keep its best researchers doing research, its best biologists doing biology, and its best people-managers managing people. *Different career paths will be necessary for these different professions,* without the typical arrangement that advancement is tied to administration or staff supervision (Minnesota DNR 1989b).

Continuing education will have become a major element of each person's workplan by 2020. Recognizing that their personnel are their capital, agencies will budget long-term maintenance of that capital as a high priority. Moreover, the complexity of working as a responsible member of an integrated resource management team will require continued training in technical and managerial skills. All workers will spend at least 10% of their time on a weekly, monthly, and yearly basis in continuing education of all types. The consequence will be better job performance, better ability of the agency to cope with individual turnover, and increased loyalty to the agency.

Finally, the agency of 2020 will have embraced a diverse workforce throughout its operations. No longer functioning as one of the last holdouts of the white-male workplace (Duke 1991), the agency must reflect societal demographics. A skilled workforce will obviously also depend on changes in universities so they develop a diverse student body. This is especially true as agencies attempt to address urban and non-consumptive wildlife management. Building on the need for fisheries and wildlife personnel to work at strange times in strange places, the successful agency will effectively utilize workers who wish to work part time, at home, on compressed schedules, and in other non-uniform ways. *The successful agency will house its staff in a flexible and individualized work habitat.*

GETTING TO 2020

The changes in agency structure and function outlined here are quite similar to changes anticipated in other times and places. The Wildlife Management Institute (1987) has described the basic characteristics of the idealized agency (Table 6, page 128) in terms that were agreeable in the 1950s and no doubt will be agreeable in 2020. The ultimate realization is that our vision for agencies is not a destination, but a journey. And, as with any journey, the job is to get started and keep rolling. The agency which starts and maintains a successful journey towards the future will share several characteristics.

First, the successful future agency must know its mission. In times of great uncertainty, a shared vision of the essential purpose of the agency is necessary to maintain direction and motivation. The successful agency will focus its vision on maintaining the long-term ecological health of the earth. This is the fundamental mission that will unite the fisheries and wildlife agency with every citizen-young or old, urban or rural, domestic or foreign. As part of this mission, the successful agency will focus on providing quality outdoor recreation to its citizenry.

Second, the successful future agency will embrace change. Change is the only constant in organizational life. Given that agencies are public service organizations subject to the desires of the public and the politicians who represent them, a willingness to adapt to new approaches, strategies, and arrangements is essential. Not only must the agency be willing to accept change, it must master change.

Third, in response to the first two needs, the successful agency must think and act holistically, embracing the concepts and practices of integrated resource management. This will require an emphasis on linkages rather than isolation, on partnerships rather than dominance, and on shared vision rather than single purpose. Just as diverse biological communities are more stable and resilient, diverse management communities are more likely to survive and produce well in an uncertain world.

Fourth, the successful agency must plan for the future. Although comprehensive planning is still viewed with skepticism by many resource professionals, it is the only way to keep the journey going in the right direction. The benefits of planning for effective management are only beginning to be realized. Like natural resource management, planning is a visionary process designed to promote long-term health in an agency.

Fifth, the successful agency must invest in its people through continuing education. Continuing education has two benefits. First, it provides the new information and skills needed to address future problems effectively and

TABLE 6. *Characteristics of effective state agencies, as listed by the Wildlife Management Institute (1987).*

1. Clearly stated organizational objectives written in a policy manual
2. Dedicated and general funds
3. Sufficient professionally trained personnel
4. Continuing education for new and veteran personnel
5. Long and short-range resource management plans, prepared with public involvement
6. Support for problem-oriented and basic research
7. Knowledge of status and distribution of animal populations
8. Biological management units (presumably owned or controlled by agency)
9. Habitat and restoration programs (presumably on agency owned or controlled lands)
10. Cooperative programs with private landowners and other agencies
11. Public information and education programs
12. Consistent efforts to maintain public understanding and support.

efficiently. Second and more importantly, continuing education creates the mindset that change will always occur and that the proper approach is to learn how to guide and profit from those changes.

Fundamental to the transformation of agencies, however, is the recognition that the anticipated changes must occur together. Any of the suggested changes will seem naive or impractical when viewed or tried alone. But when assembled as a package, the changes are mutually supportive. The agency that uses marketing strategies to determine the needs of the citizenry, involves the public in decisions and partnerships, and provides their desired programs will earn and keep their support. That support will buttress the political activism of the agency, reinforcing the impression that the agency is doing the right things for the right reasons. With public and political support, the agency will compete

well for general funds and sales taxes, assuring the necessary funding for environmental, ecological, and general recreational programs. With a professionally diverse and continually learning workforce, the agency will have the expertise to perform this broad array of programs effectively and efficiently. Planning staffs will be able to report the goals and accomplishments of the agency, setting the stage for the next round of public and political support, enlarged budgets, and satisfying performance.

As we look forward to the fisheries and wildlife agency in 2020, we are thoroughly optimistic that the transformations envisioned will produce better agencies and better resource management. Although many trends in society may seem to threaten fisheries and wildlife, the critical trends are all in our favor. People everywhere—not just hunters and anglers—want a world that is greener, cleaner, and more fun than today's world. There is much work to be done, and much support for its doing.

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Gaia: Is There a Place for Fish and Wildlife?

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Abstract: *The Gaia hypothesis, proposed by James Lovelock in 1979, suggests that Earth maintains conditions suitable for life as we know it by feedback mechanisms. The theory will be reviewed, including scientific, religious and philosophical implications. Humankind, through an ever increasing population, together with greater and greater technological development imposes greater stress on the Earth's potential to maintain conditions for life. Gaia, the Greek word for Mother Earth, has religious and cultural implications dating back many centuries. More recent scientific theory, dating back only two decades, suggests that this is a testable hypothesis. Lovelock has defined Gaia "as a complex entity involving the Earth's biosphere, atmosphere, oceans, and soil; the totality constituting a feedback or cybernetic system which seeks an optimal physical and chemical environment for life on this planet. –The Gaia hypothesis implies that the stable state of our planet includes man as a part of, or partner in, a very democratic entity." It seems unlikely that human actions will obliterate all life on Earth, but there is potential for affecting the physical and aesthetic qualities of human life. Decisions made by humankind will influence the stable state of our planet and will affect not only humans but the fish and wildlife that share our common environment. Fish and wildlife should be maintained as a physical and aesthetic resource for future generations.*

INTRODUCTION

Many Native American tribes and aboriginals believe that humans emerged from a hole in the earth, the Sipapu. Their well-being, art, and religion were tied to the land that they guarded and revered. If Gaia, Mother Earth, did give birth to humankind, we don't know the form of the birth canal; but in an evolutionary sense, Mother Earth did give birth to humankind, although the birthing process was very long.

Once established, humankind has had an increasingly greater impact on its mother. Pollutants and xenobiotics swirl in the atmosphere and settle in the most remote places and become part of all living organisms. Some think that pollutants cause the ozone hole in the polar areas. Insertions of certain gases, mostly carbon dioxide and methane, into the atmosphere may lead to global warming. Subsequent changes in climate, weather patterns, and melting of ice

caps could alter our earth to make it more or less habitable by humans. Gaia, or Mother Earth, may respond in some unknown way to be healed, change, or evolve to mother other kinds of living organisms more or less evolved than we are.

Because fish and wildlife share our common environment, their welfare is linked inextricably with ours. It behooves us to better understand and manage fish and wildlife so that we might all enjoy continued existence on a benevolent Gaia.

LOVELOCK AND GAIA

In 1979, James E. Lovelock, a British citizen, published *Gaia–A New Look at Life on Earth.* Lovelock is a well-educated man with degrees in chemistry and medicine. He taught engineering and physiology at such well known American universities as Harvard, Yale, and Baylor. He was hired by NASA to develop space probes and during this time, after his invention of the electron capture gas chromatograph, he first developed the concept of Gaia. With his electron capture gas chromatograph, he was the first to detect increased chlorofluorocarbons in the atmosphere of the earth. Lovelock was joined by Lynn Margulis, a microbiologist known as the Wizard of Ooze, in the development of the Gaia theory. They defined Gaia "as a complex entity involving the Earth's biosphere, atmosphere, oceans, and soil; the totality constituting a feedback or cybernetic system which seeks an optimal physical and chemical environment for life on this planet. (p 11)–The Gaia hypothesis implies that the stable state of our planet includes man as a part of, or partner in, a very democratic entity." (p 145) (Lovelock 1979). Lovelock was commissioned to assist with the development of a probe to Mars to determine if life existed. He chose to examine Earth and found that aliens would probably recognize that life existed on Earth because of the fluorocarbons in the atmosphere, gases that are not of natural origin. Other factors that became key parameters in the Gaia hypothesis were the constant salinity of the oceans over millions of years and the almost constant composition of our atmosphere, particularly the two major gases, nitrogen and oxygen. The sea, because it is two-thirds of the earth's surface, must be important in the homeostatic processes, but the mechanisms are largely unknown. Lovelock feels the mechanisms are biotic rather than physical. If Gaia does indeed exist, he suggests that there are associations of species which cooperate to perform essential regulatory functions. Although fish and wildlife species are relatively minor components of the total biotic environment, we might selfishly speculate that some of them are important. Margulis, who cooperated with Lovelock, is a microbiologist. She suggests that because life on

Earth began with microbes that continue to dominate the biosphere, the Gaia theory must be based on the net effect of this ancient, ubiquitous life force in the regulation of the local and ultimately the global environment (Joseph 1990). Gaia was born with the first primordial bacteria about 4 or so billion years ago. Carbon dioxide regulation is an important component of the Gaia theory. Organisms also contribute gases to the atmosphere; ruminants (many wildlife species) produce 25-50 megatons of methane, or 5 percent of the balance in the Earth's atmosphere, each year. Termites might produce even more. It is suggested that the position of Earth in the cosmic array should result in much hotter temperatures, 240-340 C, or 600 F. Perhaps life on Earth ameliorates these temperatures. Greater complexity of life on Earth requires more energy, perhaps this is one way of utilizing the excess energy from the sun. It has been suggested that Gaia might have critical "organs" such as the tropical forests or the large areas of coastal shelves that produce much of the biological activity in the biosphere. Joseph (1990) suggested that Gaia is not in competition with Darwin, but may be a testable hypothesis.

GAIA AS RELIGION

Gaia, an Earth Goddess of Ancient Greece, dates back to 3000 B.C.. Cro-Magnon man adored the goddess of earth, and images appear on cave and canyon walls from Spain to Siberia. The Roman earth goddess was known as Terra; the Egyptians called her Isis; the Chinese, Kwan Yin; Hindus revered Lakshmi, Uma, and Prithivi; Africans, Yemanja; Jews, Sheckinah; and the Navajos called her Changing Woman (Joseph 1990). Many peoples have a creation story that includes some earth deity. Japanese mythology suggests that earth is the child of a divine couple (Blake Michaels per. commun.). Hebrews, Christians and Muslims have opted for a God that is external to the world he created. Joseph (1990) has suggested that God may be relegated to the relative obscurity of setting off a cosmic explosion 15 billion years ago and then letting matter and energy take its course of Darwinian evolution to the complex world of today. Some religious beliefs suggest that all life comes from the womb of Earth Mother into which all beings are received at the end of life. Many churches and sects of the new Goddess of Earth, or Gaia, have developed. These include Feraferia, Church of all Works, Mandrakara, Bear Tribe, Venusian Church, Pagan Way, Church of the Eternal Source, Reformed Druids, Holy Order of Mother Earth, and Wicca (Joseph 1990). It has been suggested that Gaia was the first possessor of the oracles at Delphi, and at Athens.

VIEWS OF GAIA–MICROCOSM TO BIOSPHERES

Ecological studies have developed that investigate microcosms; some even consider the activities within a cell wall as a microcosm. We have studied small ecosystems in the laboratory, in nature, and mathematical expressions and models have been developed to further investigate and explain their workings. Others have examined home ranges, communities, ecosystems, life zones and biospheres. A study of the whole earth, Gaia, is but the next step in trying to better understand our planet. We have sophisticated instruments in space that can measure and identify areas down to meters and even centimeters. Satellites can now position any location on Earth within a few feet. We have the instrumentation to determine human impacts on the earth, and more is being done to record global changes in the atmosphere and oceans and on land. Humans have had, and will continue to have, an increasing impact on Gaia. There will be an estimated 5.4 billion people on Earth by the middle of this year, a doubling in less than four decades. It is estimated that the population will double to 10.2 billion by 2050, 25 years earlier than previously predicted. Most of this growth, nearly 95 percent, will occur in developing countries, all demanding a greater share of the resources. At the moment, it doesn't seem that many of these nations are responding in any effective way to control population growth.

HUMAN IMPACTS ON GAIA

There are many local examples of the degradation of the environment including dump sites, deforestation, terrestrial and aquatic pollution, smog, erosion, groundwater depletion and pollution, and urban blight. More serious, in terms of global impacts, are those effects measurable from space. These are mainly associated with the atmosphere and include increased carbon dioxide, alteration in the ozone pattern, and evidence of manufactured gases, such as the fluorocarbons. There have been recent reports of herbicides in rainwater, an expected result following the finding of insecticides in rain more than 25 years ago. Direct effects of these changes on flora and fauna have been found, but impacts on the total global environment are not yet certain.

FISH AND WILDLIFE–2020

Gaia is benevolent. This is partially related to the stability of global systems such as the salinity of the oceans and the mixture of atmospheric gases. The stability of local ecosystems is debatable; many obviously change as a result of human interference. Some of these changes might be subtle such as impacts of acid rain; others, such as removal of the tropical forest, are drastic and long

lasting. Chief Seattle, of the Duwamish Tribe, spoke to the new territorial governor near Seattle in 1854 and said; "Yonder sky that has wept tears of compassion upon our fathers for centuries untold, and which to us looks eternal, may change. Today is fair, tomorrow it may be overcast with clouds" (Smith 1887). As we examine the Gaia hypothesis, which, according to Lovelock, is testable, perhaps we can determine whether, as Chief Seattle said, it will be overcast with clouds. Perhaps these changes will bring an alteration in the way humans exist. Humans may no longer exist, but it seems that in the cybernetic system proposed by Lovelock, there will always be species—perhaps of fish and wildlife—that will be necessary to the function of these systems. Nearly 30 years ago, I saw a sign in a curio shop on the edge of Chinatown in San Francisco. It said: "If the human episode, now mostly self-bludgeoning, denies itself exposure to pure nature, it will die of rot, and Baby pure nature won't care". It seems appropriate to end on a perhaps more optimistic note written by Lovelock: "It may be that the destiny of mankind is to become tamed, so that the fierce, destructive, and greedy forces of tribalism and nationalism are fused into a compulsive urge to belong to the commonwealth of all creatures which constitutes Gaia" (p 148 Lovelock 1979).

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2020 VISION

In the year 2020, the world will be very different from what it is today. Will the fish and wildlife management professions adapt to these changes or become extinct?

This symposium provides fish and wildlife management professionals throughout the country an insightful look at the changes they can expect in the next 30 years and what they can do today to prepare.

The policies we implement, the programs we develop, and the students we produce, today and in the next thirty years, will have profound impacts on wildlife and the habitats on which they depend in the year 2020. How good is our vision?

The time to plan for the future is now, so let us begin!

The Wildlife Society
North Central Section