WETLAND MANAGEMENT FOR NATURE. WHAT CANADA, THE NETHERLANDS AND POLAND CAN LEARN FROM EACH OTHER

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Abstract: This paper focuses on wetland management in Canada, Poland and the Netherlands. It reviews wetland literature and examines general differences in indicators for wetland use and wetland protection in these three countries. Some key papers will be used to illustrate the main trends and differences in the literature. Next personal observations are added in an attempt to identify and explain differences and similarities in the approach to wetland conservation, management and restoration among the three countries. The differences seen between Canada and the Netherlands largely seem to be controlled by historical and geographical factors. Canada is a large nation with much undisturbed wetlands. As such it can focus on the conservation of its wetlands and experimenting with the use of wetlands as resources. Management is focused on preservation of natural processes. The Netherlands is a very small nation with an extremely human-dominated environment and almost no wild nature left. Most natural wetland ecosystems have been reclaimed and the reserves have semi-natural ecosystems. Therefore, nature preservation focuses on the restoration of wetlands, the maintenance of these restored wetlands and preservation of endangered species. Poland is the most interesting and challenging case being a country with lots of biodiversity, however much of it located outside reserves. As Poland recently joined the European Union future economic developments and its constraints for nature are uncertain. We discuss these and conclude that Poland can learn from both the Canadian and Dutch approach to wetland management. Following this managers can use a combination of approaches gained from various countries when creating wetland management plans and policy. Through international workshops such as organised in the

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WETHYDRO Centre of Excellence knowledge regarding wetlands and their management can be shared among scientists and stakeholders. This sharing of knowledge will allow nations to tackle their wetland problems and hopefully stop the worldwide degradation of wetlands.

INTRODUCTION

In stark comparison to the past, man has recently recognised the critical importance of wetlands and their associated processes. This realization came to light only after considerable research into wetland systems. Wetlands are characterized by permanent or semi permanent saturation of the soil with water, these conditions produce hydric soils, with hydrophytic vegetation and biological processes adapted to these saturated conditions (Tarnocai 1980). It is understood that wetlands provide many vital services within the environment. Wetlands are highly productive habitats for fish and game, they regulate water quality and quantity, nutrient cycling, and act as a buffer between terrestrial and aquatic systems. The protection and conservation of wetlands was initiated in order to maintain these valuable services. The Ramsar convention is one of a host of attempts to protect the wetlands of the world. The Ramsar Convention on Wetlands, signed in Ramsar, Iran, in 1971, is an "intergovernmental treaty, which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources," (Ramsar 2004). Ramsar (and subsequently our definiation of wetlands) defines wetlands as ¨areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres¨(Ramsar 2004). However, in most areas of the world wetlands have experienced catastrophic losses over the past 100 years. In some areas of the world, such as California and Iowa, 99% of the wetlands have been destroyed (Kundzewicz 2003). In order to regain at least some wetland functions there arouse a need to restore disturbed or destroyed wetlands. Further more as it became clear that many wetland processes are or can be useful to humans, the creation of wetlands with specific purposes (i.e. waste water treatment, flood mitigation) also began (Mitsch and Wilson 1996).

This study conducted a review of recent wetland literature, focusing on wetland management. Three countries, Canada, Poland and The Netherlands, will be used as case studies to help illustrate patterns in the literature. These countries located on comparable latitudes in the northern hemisphere, have similarities in their Quaternary history and therefore in geohydrological characteristics. They however, differ greatly in size, recent socio-cultural history and in their wetlands environmental state. Therefore management goals and objectives should also vary between countries. In order to meet these different goals the type of management practices undertaken within each country should differ as well. For example, in highly fragmented and disturbed wetlands, management practices might tend to focus on rehabilitation of disturbed systems. However, less disturbed areas may choose to focus on the conservation of undisturbed wetlands. One must also realize that socio-economical conditions will dramatically influence the type of

wetland management and practices employed within a country (La Peyre *et al.,* 2001). Should key differences exist between the case study nations, wetland managers can use this knowledge when choosing an effective management plan to meet their specific management objectives. As well those in a position to shape environmental policy and objectives within a nation can use this knowledge in the creation of future goals.

Obviously the aim of this study was to provide an objective comparison of the case study nations approach to wetland management. The literature was reviewed and articles categorized by country and the wetland management perspective employed. However, there are several problems inherent in this approach. Three of the major issues were that researchers did not always study issues that were relevant to the environmental problems in their nation, and the categorization of the papers, into various different focuses, was quite subjective. As well most of the research came from the United States, or was trans-national thus finding conclusive differences between the nations was difficult. Further more as only english language literature was examined Canadian literature was heavily biased.

Irrespective of this subjectivity many key differences and gradients exist between the nations studied. This paper will first explore the general differences between the three nations, focusing on nine indicators and general knowledge regarding the countries. Following this the results from the literature search will be examined and key papers will be highlighted and discussed. Personal observations from the researchers, one a Canadian student studying in the Netherlands who has recently visited Poland and the other a Professor with over 20 years in wetland research in the Netherlands and Poland will also be examined. Using the knowledge gained from this review the key differences and gradients observed in the three case nations will be highlighted and conclusions will be drawn. The implications we see for the management and the future environmental state of the countries wetlands will be discussed.

INDICATORS AND GENERAL KNOWLEDGE

Table 1 highlights differences, in land use, industrial activity and socio-economic conditions between the three countries studied. The countries steadily increase in size, beginning with the relatively small Netherlands, followed by Poland, and finally finishing with Canada, each time total land mass increases by a magnitude. Correspondingly the amount of people per square kilometre of arable land increases from a low value in Canada to the relatively high value in the Netherlands. This trend is still observed even though Poland and the Netherlands have a far higher percentage of total arable land when compared to Canada, highlighting the large size differences and human disturbance between the countries. Using the percent rural population one can assess the urbanization of a country. Therefore the Netherlands has the most urbanised country, followed by Canada and finally Poland with 37% of its population being rural. Percent rural population is an important figure to consider since wetland protection and management is predominantly conducted in rural areas. The economic indicator of GDP (Gross Domestic Product) per capita shows The Netherlands and Canada to

be at a similar economic level while Poland's substantially lower value indicates its economic immaturity when compared to the developed economies of Canada and The Netherlands.

Interestingly Canada and the Netherlands have similar amounts of Ramsar sites, with the Netherlands having seven more sites. However, the total area of land protected under these Ramsar sites differs greatly with Canada protecting a value two magnitudes larger then the Netherlands. Comparitivly Poland has a low number of Ramsar sites protecting a smaller amount of area. One can also see that the amount of organic water pollution varies between the countries, with Canada and Poland having similar values while The Netherlands has a considerably lower value. CO_2 emissions, which is sometimes used as a proxy for the level of intensity of industrial practices in a country, is similar in the Netherlands and Poland, but two times higher in Canada.

Table 1. Various statistical measures relating to wetlands and land use for three case study nations.

Country	**Land Area (1000 km^2)**	**Rural Population (%)**	**People / km^2 Arable land**	**Percent Arable Land**	**Ramsar Sites**	**Total Area (ha) Protected under Ramsar**	**GDP / Capita**	**Organic water pollutant (BOD) emissions (1000 kg per day)**	**CO2 emissions, industrial (metric tons per capita)**
Year	2001[1]	2001[1]	2001[1]	2001[1]	2004[2]	2004[2]	2003[3]	2000[1]	2000[1]
Canada	9221	21	14	5.0	36	15413011	$29,800	307.3	14.2
Poland	304	37	104	45.9	8	90455	$11,100	388.2	7.8
Netherlands	34	10	184	26.7	43	816898	$28,600	124.2	8.7

1: Source: World Development Indicators Database
2: Source: Ramsar List of Wetlands of International Importance
3: Source: CIA World Fact Book

In order to determine if there was a trend in the literature we recorded the number of "hits" received from the web of science database when the keywords, shown in table 2, were entered in combination with each respective country. If this is used as a rough guide to the dominent wetland literature being conducted within each country many trends are evident. Using the basic keyword search "wetland" and "i.e. Poland" results in Canada having the highest volume of published wetland literature, followed by the Netherlands and Poland. However, when the more abstract terms such as "conservation" and "management" are searched, Canada and the Netherlands receive similar "hits" ,even though the volume of research in Canada is much higher, while Poland's "hits" are zero or one. Finally when the key words "hydrology" and "science" are used Canada again is the highest, followed by the Netherlands and Poland with increased "hits". Thus the literature search indicates that the Netherlands are more focused on abstract concepts such as

wetland management and restoration. The results also indicate that Poland and Canada's literature is focused more on the processes such as hydrolgy and the "hard" science of wetlands.

Table 2: Number of "hits" received in a literature search of three case study nations and their wetland research. The literature search in Web of Science was conducted by searching the name of each respective country combined with the key words listed below (e.g. TS=(Canada) and (wetland) and (conservation))

Country	Wetland	Wetland & Conservation	Wetland & Restoration	Wetland & Management	Wetland & Creation	Wetland & Hydrology	Wetland Science
Canada	362	19	18	39	6	37	38
Poland	37	0	1	1	0	3	2
Netherlands	87	17	13	24	5	11	9
Total Hits	7107	640	1207	588	156	574	875

It is clear that there are many differences between the case study countries. Canada is a large nation that is relatively under populated. Because of it's size Canada has been able to protect large areas of land under Ramsar sites. Canada has many wetlands, which cover approximately 18% of Canada, giving Canada almost 25% of the world's wetlands (Environment Canada 2004). Canada does have high organic pollution emissions and CO_2 emissions thus one can assume highly intensive industrial practices. The Netherlands on the other hand, is a very small country with a high population density. Though the Netherlands has a large number of Ramsar sites the actual area they cover is small when compared to Canada. This indicates a highly fragmented mosaic of wetland conservation sites. Due to its high population density and its associated environmental problems, industries in the Netherlands have been forced to control their emissions, which seems to be successful considering the BOD and CO2 emissions. Poland is the intermediate country in size and population density. From the indicators examined it is clear that Poland is the least developed of the three countries examined. This is probably due to its political past, which tended to have less concern for environmental agreements and environmental conservation. This history may explain the low number of Ramsar sites covering very little area. As well industries influence on wetlands seems to be quite intensive in Poland as judged by high organic water pollution values. This high level of pollution is of concern since it may increase as the pace of development increases in Poland within the EU.

We can also add some personal observations not reflected in the statistical figures presented above. Canada's wetlands are mainly lakes in the eastern and central provinces and vast peatlands in the North. There are river-marginal wetlands along large rivers such as the Hudson, Red and Mackenzie and coastal wetlands both in the east and west. In the central south there are also numerous small pothole wetlands. Lakes and pothole wetlands are also frequently occurring in northern Poland, due to a comparable ice-age history as Canada. Poland also has river-marginal wetlands along rivers of different sizes, such as Biebrza, Narew, Warta, Bug and Wisla, the latter two being quite polluted. On the border with Germany the Oder is flowing to the Baltic Sea. In the Netherlands there is only one big wetland, the Waddensea, which is tidal wetland with mudflats and sandy islands in the north. Furthermore most Dutch peatlands were drained and cultivated and many

coastal wetlands and lakes were reclaimed. Since the Netherlands is the delta of two major European rivers, the Rhine and Meuse, there are also river-marginal wetlands along some stretches of these heavily trained rivers. As mentioned above most protected wetlands are small and are embedded in a matrix of agricultural and urban land.

LITERATURE REVIEW

The above comparison illustrated the numerous physical and socio-economical differences between the three countries (Table 1). As well the literature review of the last ten years was conducted using Web of Science V2.0, and appropriate key words (see Table 2). These results seemed to indicate a focus in the Netherlands on wetland management and restoration, where as Canada and Poland were focused more on wetland processes. Approximately 350 papers were reviewed and examined for their significance to wetland research and wetland management. Below are the key articles that will be used to illustrate the main trends and differences in the literature.

THE NETHERLANDS IN THE LITERATURE

The Netherlands is a low-lying country in the highly developed area of North-Western Europe. The country is comprised mainly of the ancient deltas of the Meuse and the Rhine. Much of the country has been reclaimed using a complicated system of dykes, ditches, polders and extensive water pumping. As such much of the country is or was previously wetlands, thus wetlands research is of prime importance in the Netherlands.

As Wassen *et al.* (2002) observed, “Human activities have led to the loss of a large proportion of diversity in vegetation types in riparian wetlands in Western Europe (Van Urk 1984, Cirujano *et al.* 1996)… Recently policy has become more focused on conservation of remaining wetlands and on rehabilitation of disturbed rivers and floodplains (Van Dijk *et al.,* 1995, Jongman, 1998)”. From this it is clear that there has been massive deterioration and destruction of the wetlands of Western Europe. Interestingly the authors make special note of the loss of vegetation diversity, rather then general habitat loss or ecosystem pollution. As well the authors note that national policy previously did not focus on conservation, or the rehabilitation of floodplains. The authors concluded that the Dutch wetland system that they were studying would be positively affected by a return to a natural variable flood regime. This conclusion arouse after comparing their damaged system to a near-natural reference site in Poland. By using a Polish reference site the authors argue for the return to more natural processes within Dutch wetlands. This is opposed to the usual Dutch approach of intensive human management of wetlands. This study highlights the importance of natural systems that are not affected by humans, not only for their environmental value but also their research value.

Another paper highlighting the Dutch approach to wetlands and their management is Grootjans *et al.*’s (2002) article dealing with the restoration of brook valley

meadows in the Netherlands. The authors state that, "In the Netherlands, a restoration project is considered a success if many red list species or target species, which were common in meadows that existed half a century ago is re-establish… This idea of success can be very different in other countries (Pfadenhauer and Grootjans 1999)". Again there is a clear focus on vegetation diversity and the restoration of rare vegetation. As well the question of what a "successful restoration of wetlands" is raised. As indicated previously, the environmental objectives of nations vary, thus their notion of success should vary as well. The researchers also concluded that there exists occasions when the restoration of an area should not be attempted. Instead wetland managers should focus their attention elsewhere, on more promising restoration sites, rather then always attempting to restore former wetland sites. An example of this is agricultural fields damaged by repeated years of intensive farming, where seed banks have been depleted and extreme nutrient and soil changes have occurred. Thus in heavily damaged or disturbed areas complete restoration isn't possible and new land uses should be explored, therefore restoration is not the only answer. However, the authors found that if too much time hasn't elapsed or too heavy disturbances then active management practices such as topsoil removal or nutrient limiting can work in restoring a site.

Lamers *et al.*'s (2002) study echoes similar sentiments to Grootjans *et al.* (2002) and Wassen *et al.* (2002). Lamers *et al.*'s quotation, seen below, confirms the level of degradation in the Dutch landscape. "At present, the Netherlands have become so densely populated that it is impossible to consider the management and restoration of fens solely from an ecological viewpoint. Ecological restoration will only be possible within a tight hydrological framework, which is strongly dominated by agricultural interests and public safety". Thus wetland management in the Netherlands must heavily consider many factors beyond the ecological. Clearly the level of success to be attained when restoring such damaged systems is vastly different to that of undamaged systems not affected by humans. The authors note that when defining success in the Netherlands, "restorers do not use a "pre-human" concept for most fen types, but rather a cultural-historical concept, using the landscape of the 19th century or the beginning of the 20th century as a benchmark. The idea that not only (so-called) natural, but also semi-natural systems in the Netherlands are worth conserving, was initiated by Westhoff in 1945."

Grootjans *et al.*'s (2002) study into coastal dune slacks again comes to similar conclusions, confirming the trends identified so far. "In the Netherlands, success of a restoration project is almost always judged by whether or not a restored site provides good growing conditions for rare or endangered plant or animal species…" In the Netherlands there is even a classification developed for setting targets for - and evaluating the success of - restoration projects. This is called the "nature target types" (Bal *et al.,* 1995). This system gives for each ecosystem a number of characteristic species belonging to it. This technocratic and species-oriented notion of success of restoration efforts can be quite different from what is considered success in other parts of the world. Parikh and Gale (1998), for instance, reported on a successful creation of a dune slack in North America where rapid vegetation development followed after constructing a new wetland that

received a considerable amount of topsoil saved from a donor wetland in order to stimulate vegetation growth as soon as possible. This type of wetland restoration would be considered a failure amount to Dutch nature managers because the input of much organic matter would encourage a rapid establishment of fast growing species, which would prevent the establishment of endangered species of nutrient–poor habitats". Thus the authors themselves have identified a key difference between North American approaches and the Netherlands. Grootjans *et al.* (2002) describe Dutch nature conservancy as being well trained in "gardening with wild species in natural mosaics". The authors conclude that this approach may be valid in some instances, such as saving endangered species. However, the authors found that this gardening approach can have unintended consequences, sometimes causing major permanent changes to ecosystems. As well the authors note that public opinion places a central role in wetland policy in the Netherlands. The authors note that currently the public prefers semi-natural wetlands, yet they also explain that "Such societal desires may, however, change (Allen 1994) and the concept of "wilderness" may become more popular". Therefore, wetlands are not only "strongly dominated by agricultural interests and public safety" but also by public preferences for "wild" or semi-natural landscapes.

Thus the Netherlands is a highly fragmented and cultural landscape with high population densities. Due to these factors much Dutch research focuses on the restoration of wetlands with success defined as the creation of a semi-natural system. The Dutch approach is to focus on the establishment of certain rare species or "nature target types", as opposed to the establishment of natural processes. This semi-natural state can include traditional practices such as grazing, mowing or low intensive farming. However, Dutch researchers have found that this approach may not always be applicable. In heavily disturbed sites a different approach is needed since restoration is not always possible, also this "gardening" tends to favour certain species while ignoring the effects on the entire system.

CANADA IN THE LITERATURE

Canada is a large country comprised of some highly developed areas surrounded by large relatively pristine natural areas. Due to its size Canada consists of a large variety of habitats, ranging from temperate coastal areas to harsh Northern and alpine environments. Wetlands are just one of the many ecosystems that Canadian researchers study as opposed to the wetland dominated Netherlands. Much of the Canadian literature focused solely on characterizing wetland processes and flows rather then wetland management or restoration. This may indicate that Canadian researchers focus on studying natural systems therefore have less of a focus on management and restoration. However, one can still make strong conclusions regarding the management of Canadian wetlands.

Price and Waddington's (2000) study into recent advances in Canadian wetland hydrology and biogeochemistry reveals a key difference between the Netherlands and Canada. Price and Waddington state, "In less remote parts of Canada, wetlands have suffered from reclamation, exploitation, contamination and

degradation, which have seriously impaired their ecological function". Therefore, though Canada does have damaged wetlands, this is only in the "less remote" areas rather then the majority of the country. However, it is clear that many Canadian wetlands have been damaged therefore Canadian policy must also consider the reclamation of damaged sites. Further more the authors note that, "Efforts to manage wetlands in a resource context, either for wildlife, timber, peat products or water quantity and quality will become increasingly important". This highlights key differences between Canada and the Netherlands. Where as the Netherlands view wetlands as landscapes of socio-cultural importance with a focus on vegetation, Canada views them as either natural systems to be protected with a focus on wildlife or "resources" to be harnessed.

Tori *et al.*'s 2002 study, focused on the actions of Ducks Unlimited, further illustrates the Canadian approach to wetlands. Ducks unlimited is a NGO organization that attempts to protect waterfowl habitats. Over 65 years the group has restored, protected and enhanced 4.05 million hectors in North America. The group's approach is called "Integrated habitat", this is a "landscape approach to wetland restoration and management". As such the method for restoration varied with the level of degradation within a landscape. In areas where there were little disturbances the group attempted to conserve large natural areas. Ducks unlimited in association with government authorities strived to include little to no active management in these large conservation sites. However, in heavily damaged areas (i.e. Great Lakes area) the group focused instead on the restoration of wetlands to semi-natural habitats. Many of these habitats required some type of active management and almost always extensive restoration efforts. Thus this study shows how the Canadian approach has been two prong, nature conservation when possible and nature restoration when necessary. As well one can see that Canadian researchers are more interested in the fauna in a wetland, opposed to the Dutch focus on vegetation.

Houlahan and Findlay's (2004) study on the "critical" distance at which varying land uses affect wetlands highlights the Canadian perspective. The article attempts to determine at which distance a certain land use, i.e. forest or farming, affects the quality of the water and sediments in a wetland. The authors concluded "that the effects of adjacent land-use on wetland sediment and water quality can extend over comparatively large distances. As such, effective wetland conservation will not be achieved merely through the creation of narrow buffer zones between wetlands and more intensive land-uses. Rather, sustaining high wetland water quality will require maintaining a heterogeneous regional landscape containing relatively large areas of natural forest and wetlands". This article clearly focuses on and argues for the conservation of large wild areas. It is alarming that the authors conclude that Canada is not creating large enough conservation areas, since its area under Ramsar protection is one of the highest in the world. The researchers argue that if large enough areas with less border effects are not created then it will be impossible to restore natural areas since adjacent land-uses may continue to affect the wetland. The authors go on to state, "small-scale solutions alone (e.g. narrow buffers around individual wetlands) will almost certainly be ineffective".

As indicated by Price and Waddington (2000) there tends to be a strong focus in Canada on the construction of artificial wetlands for resource exploitation. Kalin's (2001) article on the various conditions necessary for effective treatment of acid mine drainage in wetlands helps to illustrate this point. Kalin notes that if the necessary conditions, such as hydrology and geochemical processes, exist then "nature's restoration and cleaning processes will lead to sustainable, low-maintenance post mining landscapes". Therefore Kalin concludes that natural processes must be created at damaged sites. It is then hoped that these natural processes can replace active human management. Again we see the Canadian approach of striving to implement natural processes and the harnessing of wetland functions as well there is little focus on vegetation.

Environment Canada, the federal body responsible for the environment in Canada states, "It is recognized that some wetlands should be protected and managed in their natural state; some actively managed to allow sustained, appropriate use of wetland renewable resources; and some developed for their non-renewable resource values." (Environment Canada 2004). This mixed approach to wetlands, including pristine natural areas and resource exploitation, in Canada may be due to many factors. Though Canada is large and has many undisturbed wetlands, it has many areas that are highly developed with high human densities. "For example, in southern Ontario, 68% of the original wetlands have been converted from their natural state to support alternative uses such as agriculture and housing. Similarly, only about 25% of the original wetlands of the "pothole" region of southwestern Manitoba remain in existence. In the North, however, most of the wetlands are intact" (Environment Canada 2004). Therefore Canada focuses on the conservation of natural systems requiring little to no human management, while also restoring its damaged wetlands with extensive human intervention which may include resource exploitation.

POLAND IN THE LITERATURE

Poland is a medium sized country comprised of areas that are rapidly developing surrounded by large semi-natural rural areas. Due to these conditions and its political past much of Poland's wetlands have been either affected by industrial use or farming. However especially in the North – Eastern area of Poland there remains extensive near natural wetland systems.

An early Polish study is Palczynski's (1984) characterization of the various plant communities of the Biebrza valley. The author states, "Among the central-east European fens, peatlands of the Biebrza valley are the only large area preserved in its natural state". This article highlights the Polish focus on key plant species and the classification of vegetation communities. As well the article helps to illustrate the mixed level of degradation of wetlands in Poland, with some areas being highly disturbed but others such as Biebrza are in near natural states. Further more the article serves to underline the critical importance of natural areas in Poland, as Biebrza is "the only large area preserved in its natural state". This is in agreement with Wassen *et al.* (2002), who argued that the rarity of the near natural wetlands

of the Biebrza is of critical importance both ecologically and possibly more importantly as a reference site for research.

Chimielewski *et al.*'s (1997) study into the Polesie Lubelski region of Poland illustrates the urgency at which Poland's wetland and associated areas need to be protected. The study found a disappearance of approximately 30% of the wetlands in the area. The authors also note that more studies of this type are needed in order to understand the complex relationships that occur between aquatic, wetland and terrestrial systems. They note that these results are "of great importance where the practical preservation of nature and the utilization of the water ecosystems are concerned", and it "indicates the complexity of the issue". As with other Polish studies the researchers assessed the biological condition of wetlands using vegetation rather then fauna. Therefore it is clear that the remaining natural wetlands of Poland are of critical importance. It is also clear that Poland would benefit from the rehabilitation of its damaged wetlands. As well the authors call for more research into Polish wetland systems indicates the current Polish focus on wetland science opposed to wetland management.

There was little english literature in Web of Science expressing Polish positions on wetland management. This is probably due to language barriers as only papers published in English were examined. Our literature review method was therefore biased in favour of countries where English literature in peer-reviewed publications has been the dominant language of scientific communication. Much research is and has been conducted in Poland, as this monolog indicates, however these learnings are not yet being exported systematically out of the country. This highlights the importance of workshops such Wethydro and international co-operation for publication in peer-reviewed literature. As well due to the past political situation in Poland, environmental research is only now beginning to blossom and gain research attention and funding. As such the literature review indicated that much of the Polish research was focused on the hard science of wetlands such as hydrology assessment and plant community characterization opposed to wetland management. However it is clear that Polish wetland management tends to focus on fauna in a landscape of varying degrees of degradation. Since Polish wetland policy and wetland management research are currently maturing it is difficult to indicate its dominant perspective. For further reading we advise to browse through the journals Polish Ecological Studies and the Journal of Water and Land Development both published by the Polish Academy of Sciences. Also some wetland scientists have a good record of international publications, a.o. Henryk Okruszko, Tomasz Brandyk, Waldemar Mioduszewski, Leslaw Wolejko.

OBSERVATIONS AND CONCLUSIONS

As a Canadian student studying in the Netherlands who has visited a nature reserve in Poland, this author has noted some interesting trends. Most strikingly, were the differing notions of what constituted nature and conservation. In Canada "nature" is usually considered to be areas that are almost completely wild and relatively pristine. These systems have little to no interaction with humans, and in protected areas efforts are made to ensure this remains so. Human activities in

nature reserves are strictly controlled and there is almost no traditional practices. In contrast nature reserves in the Netherlands and Poland usually have many interactions with humans. As such, active management practices are needed to maintain the system in the desired state. As well Poland and the Netherlands tend to focus far more on vegetation and the establishment of specific vegetation communities. In Canada the focus tends to be on the restoration of natural processes that hopefully will create suitable habitats for fauna. As well the Canadian approach in disturbed areas has been the creation of wetlands as a resource rather then attempting to restore damaged wetland sites to semi-natural states as in Poland and the Netherlands.

As a Dutch Professor in wetland eco-hydrology with experience in Poland and knowledge of Canadian wetlands as well the second author has some observations too. In Canada and Poland nature is abundant. In Canada this nature is mainly in large impressive reserves whereas agricultural areas have little real nature remaining. In Poland there is also some impressive large scale natural areas, mostly in national parks but there is also numerous smaller scale, not spectacular, natural or semi-natural ecosystems in the rural area. Furthermore agriculture is not as intensive as in Western Europe or Canada. Fertilization gifts, the use of pesticides and drainage are less and everywhere there are small niches where species can survive. This results in a rich biodiversity, notably in reserves, but also abundant elsewhere. Thus, it will come as no surprise that many species that became extinct or endangered in the Netherlands are still common in Poland, for example white stork, crane, otter, beaver, ruf, black-tailed godwit, marsh harrier and many plant species of the Dutch Red List. This gives Poland as a new member state of the European Union a particular position: a rich biodiversity in non-protected areas where economic development may be a threat for survival of these species. The EU Habitat Directive and Bird Directive for instance prescribe that the habitat of a large number of species may not be destroyed by urban, industrial and infrastructure development. These directives thus will frustrate developments and changes in land use for the benefit of species, which are endangered in Western Europe but quite common in Poland. On the other hand, we expect that agricultural EU-subsidies will be used for increasing fertilization and drainage, inevitably leading to unintended drainage and eutrophication of wetlands in agricultural areas and species loss. Gielczewski (2003) explored the consequences of the expected changes in land use after Poland joining the EU for water quality and aquatic biodiversity in the Narew catchment. He concluded that there would be a severe eutrophication of surface water and subsequent loss of species compared to the present situation.

It is clear that there are key differences between the 3 countries studied. This was seen both in the comparison of indicators and general knowledge and the literature review. Table 3 illustrates the basic gradients seen in the literature.

Table 3: General trends and observations extracted from a review of three case study countries.

Country	Fragmentation / Degradation	Indicators	Focus	Definition of Success
Canada	Low	Fauna	1. Conservation of natural wetlands 2. Utilize of wetlands as resources	Establishment of natural processes, or effective resource utilization
Poland	Medium	Flora	1. Study of wetland science 2. Restoration of wetlands	Establishment of previous socio-cultural state
Netherlands	High	Flora	1. Restoration of wetlands 2. Maintenance of restored wetlands	Establishment of previous socio-cultural state

The differences seen between Canada had the Netherlands largely seem to be controlled by historical and geographical factors. Canada is a large nation with much undisturbed wetlands. As such it can focus on the conservation of its wetlands and or experimenting with the use of wetlands as resources. The Netherlands on the other hand, is a very small nation with an extremely human-dominated environment and almost no wild nature left. Most natural wetland ecosystems have been reclaimed and the reserves have semi-natural ecosystems. These are part of the Dutch cultural landscape in which other functions prevail i.e. agriculture, housing, recreation. As such nature preservation must focus all its attention on the restoration of wetlands, and the maintenance of these restored wetlands. Also since the level of degradation is lower in Canada, its researchers may focus on the requirements of local fauna, while the Netherlands focuses on vegetation especially rare species.

Poland on the other hand is an interesting case; the country has just emerged from the fog of its communist past. Environmental concerns are beginning to be addressed, and finally the resources are starting to be in place to tackle these issues (now including EU funding). As such, Poland has the most to gain from this analysis and from the experiences of Canada and the Netherlands. This study has highlighted the importance of both the Dutch and the Canadian approach. The Dutch approach is focused on restoration and effective mixed land use, where as the Canadian approach is conservation and resource utilization. The literature review has shown the critical importance that Poland must place on the protection of its last remaining natural areas. As its low Ramsar values indicate much can still be protected, as seen in the fact that the smaller more densely populated Netherlands has managed to protect a larger area. Since it is one of the remaining European countries with natural areas and a rich biodiversity in the rural area every effort must be made to increase the natural areas under protection. These areas are not only important ecologically; they are of utmost importance as non-anthropogenicly influenced reference systems (Wassen *et al.,* 2002a). Reference systems are relatively undisturbed areas where (near-) natural processes can be studied in the absence of significant human intervention. A comparison of reference areas with disturbed areas to be restored may be useful in conservation and restoration for a variety of reasons. A comparison may help to discover the relationship between key natural processes and ecosystem functioning; to estimate

the degree of degradation of areas to be restored; to set targets for nature conservation; to define environmental conditions necessary for (re) establishment of target species and communities and to design restoration measures in restoration projects (Wassen *et al*., 2002b). In order to preserve large areas with reference ecosystems, Poland would be advised to examine the Canadian wetland conservation of focusing on safeguarding key-processes for wetland functioning. Colliery to this Poland should also strive to learn how to restore their damaged wetlands, in order to increase the amount of wetlands under protection and in order to utilize the functions of wetlands. Since it is not always possible to restore a wetland to a completely natural state, Poland must also employ other wetland management practices then conservation. The Dutch approach of mixed land use, traditional management practices and semi-natural endpoints can serve as a guide for this. Using this approach The Netherlands has been able to create, protect and reap the benefits of relatively large amounts of wetlands. The importance of the Dutch approach is clear when one considers its success in the face of huge barriers such as high population density and extensive degradation and fragmentation. As well Poland would benefit from Canadian explorations into the exploitation of wetlands for resources. These artificially created wetlands can mitigate many of the negative effects of industry and if natural processes are created these wetlands involve little active management. Many other studies have also found that cross border knowledge sharing is of utmost importance (Smart and Canters 1991 La Peyre *et al*., 2001). Through international conventions such as Ramsar, and multi-nation workshops such as Wethydro knowledge regarding wetlands and their management can be shared. This sharing of knowledge will allow nations to tackle their wetland problems and hopefully stop the worldwide degradation of wetlands.

By utilizing these key learnings and by explicitly defining what success is wetland managers will be better equipped to make decisions. Though we have described general trends over the three countries, there exists much regional variability within each country. This regional variability means that depending on their local situation Canadian managers would be wise to examine lessons learned in Poland and the Netherlands and likewise for wetland managers in Poland and the Netherlands. Managers must realize that they need not and should not always attempt to have natural systems. In many cases even the best effort will produce failure in systems with high anthropogenic influence. As such semi-natural landscapes and traditional management practices should be included in management plans. These semi-natural wetlands are of vital importance to many flora and fauna, and are often highly valued by the public. However, as the literature has shown natural systems, which are often rare, are of immense value. Due to this rarity, the focus of wetland managers first and foremost must be the protection of natural wetlands. Following this managers can use a combination of approaches gained from various countries when creating wetland management plans and policy.

ACKNOWLEDGEMENTS

The lead author would like to thank the University of Calgary Environmental Science Program, especially Dr. Dixon, for the opportunity to enrich my studies in the Netherlands. As well I would like to thank the University of Utrecht Environmental Science Department, especially Professor Wassen. I was not only accepted and accommodated but also provided with countless valuable experiences.

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