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Isolated Wetlands: Assessing Their Values & Functions

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Abstract Isolated wetlands are as valuable as non-isolated wetlands when it comes to ecological functions and values. Wetlands perform a variety of functions including flood regulation, nutrient and carbon storage, and provision of plant and animal habitat. Although the present literature supports this claim, it is also clear that much scientific works needs to be done on isolated wetlands, especially in the area of hydrology, and hydraulic connectivity and nutrient retention. Wetlands should be judged on the basis of values and functions they perform and not on the vague notion of isolation. Their loss or destruction will have significant ecological consequences on the wider biotic community.

Keywords: *isolated wetland, non-isolated wetland, hydraulic connectivity, nutrient retention*

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1. Introduction

Wetlands and associated small isolated water bodies are considered important aquatic habitats in North America [48,58,59]. However, this has not always been the case. Since European settlement, wetlands in the United States have been the subject of controversy. Wetlands were considered agricultural wastelands where mosquitoes and other disease-carrying insects bred. This perception of wetlands was further promoted by government policies which provided incentives for wetland conversion to agricultural and other land uses. During the nineteenth century, for example, 65 million acres of wetlands were transferred from federal government hands via the Swamp Lands Act to state hands on condition that they be converted to farmland [9,45]. Along with agricultural expansion came greater wetland conversion, resulting in the loss of more of the nation's wetlands. It is estimated that by 1997 total wetland acreage had fallen to 105.5 million acres down from 200 million acres at the time of European contact (Congressional Research Service 2003). Over time, increased knowledge of wetland functions coupled with tremendous wetland losses stimulated interest in protecting these critical resources. Today, federal laws encourage wetland protection or prohibit/ do not support their destruction. At present, Section 404 of the Clean Water Act (CWA) of 1972 is the only federal-level protection that covers the nation's wetlands. Jurisdictional wetlands are administered by the U. S. Army Corps of Engineers and the U. S. Environmental Protection Agency. Since implementation of Section 404 of the CWA, the issue of "isolated" wetlands has been a contentious one for developers and preservationists. An isolated wetland can be loosely defined as a wetland with no surface-water connection. Recent regulatory changes have undermined the protection afforded these wetlands under Section 404 of the CWA. While isolated wetlands have always been vulnerable, never has their future been in greater doubt.

Isolated wetlands are in fact poorly defined in the scientific literature. A recent U. S. Supreme Court decision, however, has drawn scientific attention to the issue of isolated wetlands. Consequently, a special issue of *Wetlands* was published on the topic based on the existing data (e.g; [4,31,32,53,58,59,63,70]. These studies focus on the benefits of isolated wetlands and critique the U. S. Supreme Court decision regarding isolated wetlands regulation. Since the ruling, the only national level comprehensive study has been conducted by the U. S. Fish and Wildlife Service in 2002. In this paper, I use secondary sources to provide an overview of isolated wetland definitions, values, and functions. In particular, I have identified studies that assess whether isolated wetlands are as valuable as non-isolated wetlands and whether their protection should be reinstated. Finally, I attempt to answer the following research questions. I have used the term "non-isolated" for wetlands that are connected to navigable waters or have surface water connections to other water bodies.

2. Research Questions

- What are the values and functions of isolated wetlands?
- Are they as valuable as non-isolated wetlands?
- How are wetlands protected under the law?
- What are the implications of recent wetland policy changes?

3. Data and Methodology

Using secondary sources of information I have synthesized the work of scientists over the last few

decades on the topic of isolated wetlands. More specifically, I have focused on discovering the values and functions of isolated wetlands. I have also reviewed Section 404 of the Clean Water Act to learn how both isolated and non-isolated wetlands are/were protected under this regulation. Finally, I have reviewed the recent change in regulation that excluded isolated wetlands from protection under Section 404 of the Clean Water Act.

4. Rationale of the Study

Concern over the fate of isolated wetlands in the U. S. has increased over the past years because of the U. S. Supreme Court's decision in Solid Waste Agency of North Cook County (SWANCC) v. U. S. Army Corps of Engineers. This is referred to as the SWANCC case. As a result, isolated wetlands are no more under jurisdictional wetlands. This paper attempts to gather information on isolated wetlands values and functions. It synthesizes what has been written about isolated wetlands and compares their values and functions with those of non-isolated wetlands. It also considers the impact that the Supreme Court's decision is likely to have on these potentially valuable natural resources.

5. Wetland Definitions

The term "wetland" first appeared in the literature during the mid-twentieth century [50,54]. It was used to describe transitional areas between open water and uplands. Legally, wetlands are defined as "Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (Clean Water Act of 1972, Section 404). Jurisdictional wetlands should possess three basic characteristics: wetland hydrology, hydric soil, and hydrophytic vegetation. Wetlands by definition can be either non-isolated (connected to permanent surface water) or isolated (not connected to a permanent source of water). Non-isolated wetlands include marshes, swamps, bogs, and fens. Isolated wetlands typically occur in depressions, temporary ponds, seasonal bogs and fens.

The term "isolated wetland" has not been used consistently in the scientific literature; nor is it a regulatory term [58,59]. In general, the term is used to define wetlands or ponds that lack a surface outlet to downstream rivers and bays. Unlike other freshwater bodies these wetlands are often less than one acre. They form in depressions and are seasonal in nature. Their supply of water comes from precipitation, ground water discharge, or snow melt which gets trapped in shallow clay-lined depressions [27,33,67,68,63].

Isolated wetlands are sometimes referred to as "geographically isolated wetlands" which can be defined as "wetlands that are completely surrounded by upland," for the purposes of scientific studies [58,59]. However, the term "geographically isolated wetlands" is more accurate from an ecological perspective because it suggests that these wetlands are not isolated but rather hydrologically connected to other wetlands and water bodies through ground-water flows or by intermittent overflows. Clearly, no conclusions have been reached on a universal definition of isolated wetlands. Studies conducted in recent years have defined isolated wetlands differently:

- The National Research Council defines isolated wetlands as a "wetland not adjacent to another body of water" (NRC 1995).
- The U. S. Fish and Wildlife Service (2002) define them as "Wetlands with no apparent surface water connection to perennial rivers, streams, estuaries, or ocean."
- Tiner [57,58] describes them as "Wetlands that are completely surrounded by upland," for the purposes of scientific studies.

The U. S. Fish and Wildlife Service (2002) identified 19 different types of isolated wetlands. These are:

1) Prairie potholes
2) Playas
3) Rainwater basin wetlands
4) Nebraska Sandhills wetlands
5) Salt flat and salt lake wetlands
6) Wetlands of Washington's Channeled Scablands
7) Desert springs and their wetlands
8) Glaciated kettle-hole wetlands
9) Delmarva potholes
10) Coastal Plain ponds
11) Carolina Bay wetlands
12) Pocosin wetlands
13) Cypress domes
14) Sinkhole wetlands
15) Former floodplain wetlands
16) West Coast vernal pools
17) Woodland vernal pools
18) Coastal zone dune swale and deflation plain wetlands
19) Great Lakes alvar wetlands

The detailed descriptions and characteristics of these types can be found at http://library.fws.gov/Wetlands/isolated.pdf. Table 1 shows characteristics for some of them.

Table 1. Hydrologic landscape setting [69] dominant water source, and introductory references for major regional isolated wetland types. All these wetland types are considered depressional under the hydrogeomorphic classification [7,56]

Wetland Types	Hydrologic Landscape	Dominant Water Source	Reference
Carolina Bays	Flat Coastal	Precipitation and discharge from local ground water systems	[48,53]
Playa Lakes	High Plains	Surface runoff and precipitation	[3]
Vernal Pools	Arid plains and Plateaus	Precipitation	[66,70]
Prairie potholes	Hummocky Glacial	Variable dependent upon landscape position	[3,26]

6. Benefits of Wetlands

In this section I focus on wetland values and functions especially habitat functions, nutrient retention, and connectivity to other surface water bodies. My intent is to compare the values and functions of isolated wetlands with those of non-isolated wetlands. Wetlands in general are among the most productive ecosystems in the biosphere. Due to high sediment and organic matter

loading the system has high microbial and macrophyte productivity [36]. An immense variety of microbes, plants, insects, amphibians, reptiles, birds, fishes, and mammals can be found in wetland ecosystems [38]. Boylan and Maclean [6] estimate that 46% of endangered species in the United States are wetland-dependent. Wetlands also support various species of insects [28]. According to Spieles and Mitsch [56] wetland ecosystems are ecologically complex and they do not always exhibit a high degree of biodiversity relative to other freshwater ecosystems; however, they do provide habitat for a variety of communities. Wetland soils are saturated and typically have higher rates of primary production and slower rates of decomposition than deepwater systems. They serve many ecosystem functions including nutrient and sediment sequestration [5,11,22,24,25,29,38,41,46,56,57]. Like forests, wetlands are sponges that absorb runoff. During periods of flood, wetlands temporarily store water, releasing it slowly into the river channel [8]. Some common wetland functions are stated below; however, in most instances no single wetland possesses all these values.

Table 2. Some common functions and use of wetland ecosystems

Ecosystem function	Ecosystem values
Nutrient storage	Removal of fertilizing nutrients helping farmers attain compliance with water quality targets
Accumulation of organic material for fuel or agriculture	Storage of carbon, source of peat
Filtering solids from waters	Wastewater and sewage treatment trapping sediments
Animal habitats	Fishing, wildfowl hunting and fish and shrimp hatcheries
Plant habitats	Forestry, agriculture (e.g., harvesting cranberries)
Regulation water out flow	Flood and erosion prevention
All other functions	Recreation, research, and education

Source: [47].

7. Benefits of Isolated Wetlands

Ecological and economic functional values of individual wetlands depend upon individual location, size and relationship to adjacent land and water areas. Geographically isolated wetlands are not homogeneous but have a broad range of functional responses, due to their occurrence over a wide range of climatic and geologic settings. According to Tiner [58,59], these isolated wetlands offer vital habitat for wildlife despite their “isolation.” Like other wetlands they perform many valuable functions (e.g., nutrient cycling, surface water detention, and shoreline stabilization). Isolated wetlands are oases for wildlife. They provide shelter, food, and spawning and nesting sites for birds, fish, mammals, reptiles and invertebrates (U.S. Fish and Wildlife Service 2002). Ecologically, isolated wetlands have their individual characteristics that can influence habitat functions. For example, some isolated wetlands may lack certain predators that dominate food webs and depress diversity [1,54]. Others are subjected to seasonal drying thus rarely contain fish [2,34]. For example, in Florida fish predation is diminished because these systems have an annual cycle of filling and drying out which prevents predatory fish from becoming established [1,30,39]. It has been suggested that fish presence in temporary wetlands ranges from 0 to 21% [2,55]. The temporary nature of some small isolated wetlands provides safe ground for amphibian larvae (anuran species) due to the lack of predatory fish [40,51,52,65]. These wetlands provide habitat for unique and often diverse assemblages of organisms [66]. Similarly, a long-term study of a small wetland (0.5 ha) known as Rainbow Bay documented 27 species of amphibians (anurans and caudates) [52]. Scientifically, one cannot evaluate wetland values and functions based solely on whether the wetland in question is isolated or not. Small wetlands are extremely valuable for maintaining the biodiversity of a number of plant, invertebrate, and vertebrate taxa (e.g., amphibians) [51]. The authors suggest that the abundance of wetlands is directly related to critical processes of ecological change, such as connectance and source-sink dynamics and evolutionary change, including genetic structure and local adaptation. The number of individual wetlands is extremely important because it reflects the abundance and distribution of individual wetland populations, the basic unit of community dynamics responsible for maintaining species diversity [49] and the most basic unit of population dynamics responsible for maintaining genetic diversity [21]. Spieles and Mitsch [57] stated that because of the abundance of detritus found in wetland ecosystems, the microinvertebrate communities (which are detrivores in nature) are found in abundance. Dodson and Lillie [18] suggest that small wetlands provide valuable habitat for an enormous variety of wildlife ranging from microscopic zooplankton to rare plants to waterfowl. These small isolated wetlands are important breeding sites for amphibians and function as important food resources for migrating waterfowl [60]. Studies conducted on depressional wetlands indicate that these habitats support endemic species. Depressional wetlands supply breeding ducks with the diverse habitat they need for feeding, breeding, nesting, and brood-rearing [3,27,69].

According to Leibowitz [32] isolation has a fundamental influence on the way water enters and leaves a wetland. Isolated wetlands, however, do not represent ecologically isolated habitat for many organisms such as some amphibians and reptiles which use both isolated wetlands and adjacent water bodies or forest to complete their life cycle. Thus it can be suggested that the effect of isolation may not be as significant as the term "isolated wetlands" suggests. Many of the biological features of isolated wetlands may result from environmental conditions that also occur in non-isolated wetlands. Whigham and Jordan [63] examined water-quality data for isolated wetlands in three hydrogeomorphic classes (depressions, slopes, and flats) and found that alteration of hydrologic conditions (e.g., ditching, filling) usually resulted in increased nutrient export to downstream systems. From a water-quality perspective, they concluded that so-called isolated wetlands are rarely isolated, and that the term isolation is not very useful from an

ecosystem perspective. Similarly, like non-isolated wetlands, isolated wetlands function as nutrient retention. Studies suggest that isolated wetlands have organic accumulation rates that exceed those of non isolated wetlands because of lower decomposition and export during inundation [7,13,14]. In contrast, Hopkinson [23] and Craft and Casey [14] show that nutrient inputs to isolated wetlands are low compared to open riparian and floodplain wetlands. This is due to their "closed" material cycles and oftentimes small catchment size (< 100 km^2). For this reason, nitrogen and phosphorous sequestration is low in closed wetlands compared to open wetlands [23]. Due to the low input of nutrients in closed isolated wetlands, net primary productivity tends to be lower in isolated wetlands compared to more open wetlands [23]. Similarly, Craft suggests that isolated wetlands act as nutrient sinks. It is likely that depressional wetlands are important in trapping sediments and sequestering nitrogen and phosphorpus [14]. These authors also found that there is no significant difference in sediment or organic carbon and nitrogen accumulation between depressional or closed and open wetlands. According to Philips the nutrient retention capacity of isolated wetlands is proportional to basin size; however, few studies document deposition from smaller basins [14]. Depositional patterns and site and event characteristics are not fully understood [22].

The ability of isolated wetlands to sequester nutrient may be important in maintaining high quality groundwater by capturing nitrogen and other pollutants. In spite of their importance in supporting ecosystem processes, biodiversity and water quality improvement, little is known about the role of depressional wetlands as sinks for sediments and nutrients [13]. According to van der Valk, and Pederson (2003), prairie potholes are important habitats for most groups of wetland organisms, with the important exception of fish. Potholes are not ecologically isolated habitats. Their flora, fauna, and functions (primary production, food webs, mineral cycling, water storage capacity, etc.) are largely determined by water levels, not by degree of isolation. Usually prairie potholes are hydrologically connected by ground-water flows and, during wet years, even by surface-water flows. Similarly, fens (isolated wetlands usually saturated by groundwater) are among the most floristically diverse of all wetland types, supporting a large number of rare bryophytes and vascular plant species, as well as rare animals including land snails, butterflies, skippers, and dragonflies. Several species listed under the Endangered Species Act inhabit fens and help maintain stream water quality through denitrification and phosphorus absorption [4]. Also, King and Simovich found that California's vernal pools are rich in faunal diversity and endemism. Based on the above - mentioned research isolated wetlands, like non-isolated wetlands, provide a variety of valuable functions. It appears that many of the functions performed by non-isolated wetlands are also performed by isolated wetlands [31,58,59].

8. Are Isolated Wetlands Really "Isolated"?

The issue of isolation is a recent one in wetland science. Even though isolated wetlands can be geographically isolated several studies suggest isolated wetlands have complex but direct hydrologic interaction with other wetlands and uplands (e.g., [63,67,68]). Based on these studies, it can be assumed that isolated wetlands are, in fact, not isolated hydraulically or hydrologically. The issue of "isolation" is still a controversial one and needs to be examined further. Though geographically isolated, wetlands can be biotically connected to other wetlands or other aquatic systems through the movements of plants and animals. For example, many animals including amphibians require both aquatic and terrestrial habitat at different stages of their life [52].

9. Wetland Protection in the United States

Historically, wetland losses in the U. S. have been exacerbated by government policy. Only in recent decades have policy changes resulted in a significant decrease in the rate of wetlands loss [15,16,64]. Today, wetlands are protected through a variety of programs and laws (CRS, Issue Brief IB97014 2003):

- Section 404 of the Clean Water Act
- Programs for agricultural wetlands
- Laws that protect specific sites, such as establishing units in the National Wildlife Refuge System
- Laws that protect wetlands along migratory bird flyways.

Under the Rivers and Harbors Act of 1899, the U. S. Army Corps of Engineers was empowered to regulate public waterways and ensure the navigable capacity of the nation's waters. The act was revised in 1968 to consider fish and wildlife values, conservation, pollution, aesthetics, ecology and other factors in the general interest of the public. With passage of the Federal Water Pollution Control Act (33 U.S.C. 1344) amendments of 1972, the Army Corps of Engineers assumed responsibility for administering the regulatory discharge of dredge and fill material into "waters of the United States." In March 1995, the Army Corps' responsibilities were further extended to include all "waters of the United States" including wetlands under Section 404. The U. S. Army Corps of Engineers and the U. S. Environmental Protection Agency (EPA) are responsible for making jurisdictional determinations of wetlands regulated under Section 404 of the Clean Water Act (CWA) and under the definition of "waters of the United States" including both isolated and non-isolated wetlands. Isolated wetlands were included in the definition of "waters of the United States," based on their use by migratory birds. Section 404 of the CWA is the only federal regulation that affords direct protection to wetlands [20]. Through the CWA wetlands are the only ecosystems to be comprehensively regulated on both public and private lands within the U. S. (National Research Council 1995) because at present only 25% of wetlands are owned by the federal government leaving an estimated 75% in the hands of private owners (U. S. Environmental Protection Agency 1993).

The five federal agencies that share primary responsibility for protecting wetlands are (www.fws.gov):

- Department of Defense, the U. S. Army Corps of Engineers
- The U. S. Environmental Protection Agency (EPA)

- Department of Interior, U. S. Fish and Wildlife Service (FWS)
- Department of Commerce, National Oceanic and Atmospheric Administration (NOAA) and
- Department of Agriculture, Natural Resources Conservation Service (NRCS) (formerly the Soil Conservation Service).

In addition, many individual states have established their own wetland regulation programs. Given that 74% of wetlands in the U. S. are on private lands, programs that offer incentives to private landowners to preserve their wetlands, such as the "Wetlands Reserve Program" are critical for protecting these resources (Council Environmental Quality 1998). The Wetlands Reserve Program (WRP) was established to slow down wetland conversion to farmland and to restore converted wetlands through the use of permanent easements purchased from willing landowners (CRS, Issue Brief IB97014). An Emergency Wetlands Reserve Program (EWRP) was established in response to Midwestern floods in 1993. As of 1996 about 400,000 acres were enrolled in these two programs. Since the establishment of Section 404 of CWA, isolated wetlands have been protected solely under the Army Corps of Engineers reguation "Migratory Bird Rule." Recent change in wetland regulation has caused regulators and scientists to question whether all wetlands should be treated the same or whether some should be given less stringent protection.

10. Isolated Wetlands Protection in the United States

Section 404 is the only federal-level protection for wetlands in the United States. Section 404 grants the Corps authority to issue permits "for the discharge of dredge or fill materials into navigable waters at specified disposal sites." The term "navigable waters" is defined under the act as "the waters of the United States including the territorial seas." The term "waters of the United States" include "waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sand flats, wetlands, prairie potholes, wet meadows, playa lakes, or natural ponds, the use degradation or destruction of which could affect interstate or foreign commerce' (33 CFR section 328.3 (a) (3)). In 1986, the Corps further clarified that Section 404 ((51 Fed. Reg. 41217) applies to intrastate waters which are or

- would be used as habitat by birds protected by Migratory Bird Treaties; or
- which are or would be used by habitat by other migratory birds which cross state lines; or
- which are or would be used as habitat for endangered species; or
- which are used to irrigate crops sold in interstate commerce

11. 2001 U. S. Supreme Court Decision and Wetland Regulation

"Clean Water Act provision (33 USCS 1344), requiring a permit from Army Corps of Engineers for a discharge of fill material into navigable waters was held not to extend to isolated, abandoned sand and gravel pit with seasonal ponds which provide migratory bird habitat."

On January 9, 2001, the U. S. Supreme Court decision in Solid Waste Agency of Northern Cook County v. U. S. Army Corps of Engineers (SWANCC) limited the scope of the Clean Water Act's jurisdiction by limiting the definition of "waters of the United States." The "Migratory Bird Rule" was invalidated as the sole basis for federal regulation of non-navigable, isolated, and intrastate waters ("isolated wetlands") under the Clean Water Act. The court ruled in favor of Solid Waste of Northern Cook County, a consortium of Chicago-area towns whose permit to build a landfill was denied by the Corps of Engineers based on the Migratory Bird Rule. Now isolated wetlands are no longer considered federal jurisdictional wetlands and it's up to individual states how they regulate their isolated wetlands. The Migratory Bird Rule, by which the corps extends its jurisdiction over waters which "are or would be used as habitat by migratory birds which cross state lines" (51 Fed. Reg. 41217), is not specially supported by the language of the CWA. In addition, there is no evidence that Congress acquiesced to the Migratory Bird Rule.

12. Ecological Effect of Loss of Isolated Wetlands in the United States

The U. S. Supreme Court decision placed isolated wetlands in jeopardy. Following this decision, the Fish and Wildlife Service (2002) was the first to estimate the extent of isolated wetlands in semi-arid to sub humid regions of the country. The study found that isolated wetlands constituted a significant proportion of the wetland resource. Of the 72 sites they examined 43 sites had more than 50% of their total number of wetlands designated as isolated. The results of this analysis present one perspective on the extent of geographically isolated wetlands in the country and signify a starting point for more detailed assessments [58,59]. Also, this study provides a strong basis for establishing figures on that nation's isolated wetlands and how the recent decision will affect their future abundance. Studies reviewed for this report suggest that isolated wetlands are natural ecosystems that need to be protected. Richardson [48] documented the ecological significance of isolated wetlands. According to the author the loss of small wetlands or isolated wetlands will cause a reduction in the connectivity of existing species populations. According to Semlitsch and Bodie [51], the disappearance of small wetlands will likely cause a reduction in ecological connections among remaining species. They also concluded that small isolated wetlands are not expendable if our goal is to maintain present levels of species biodiversity. Similarly, Carolina bays (depressiononal wetlands of the southeastern United States Coastal Plain) are rich in biodiversity and provide a major breeding habitat for numerous amphibians. Most Carolina bays are not naturally connected with streams or other water bodies. These ecosystems are ecologically important for species which require an aquatic environment during part of their life cycle. If these wetlands are not protected in the future, a major source of biological diversity in the southeastern

United States will be lost [53]. Van der Valk and Pederson (2003) determined that prairie potholes serve as important waterfowl breeding areas in North America. They had legal protection under the Migratory Bird Rule even though they are generally not associated with navigable waters. The U. S. Supreme Court's decision in the SWANCC case invalidates the use of the Migratory Bird Rule, thus depriving prairie potholes from federal protection in the future.

Fens also help maintain stream water quality through denitrification and phosphorus absorption. However, fens generally develop in headwater areas and could be defined as "isolated" for jurisdictional purposes because of their distance from navigable-in-fact waters. If so defined, the critical roles that fens play in maintaining biological diversity and stream water quality will be lost [4]. While the biological functions of wetlands are often accepted by wildlife biologists and ecologists, they are often questioned by developers, planners, and engineers, especially when the wetlands in question are small, isolated, transient, and temporary. They are often viewed as obstacles to farming, road construction, and suburban development. This is especially true for isolated wetlands which do not have a direct visible connection with surface water. If our goal is to maintain present levels of species biodiversity, it can thus be suggested that small, isolated wetlands are not destroyable. The current laws are inadequate for maintaining regional wetland biodiversity in at least one group of amphibians. Other taxa that rely on small wetlands are also poorly served by the new ruling [51].

13. Post U. S. Supreme Court Decision

Exclusion of isolated wetlands from CWA regulation placed isolated wetlands in jeopardy. Jurisdictional determinations have been left to the individual field offices of the Corps and USEPA. The uncertainty over the extent of recent changes has restricted the states' ability to respond. Despite this uncertainty, some states have taken action. Wisconsin passed legislation in the months following the SWANCC decision. Several other states have attempted to make changes through legislation, regulations, and/or guidance with limited success. In half of the states in the U. S., there are no state programs in place or planned to address the reduction in federal protection. In these states, a significant change in federal regulation could mean the loss of important wetlands.

14. Wisconsin Case Study

Before the ruling Wisconsin's wetlands were administered by the Wisconsin Department of Natural Resources (WDNR) and local governments. The state of Wisconsin has a wide variety of isolated wetlands including prairie potholes, wet meadows, fens, and bogs. The SWANCC decision placed these wetlands at risk. Following the court decision, Wisconsin passed a new state law, 2001 WI Act 6 (details of the Act can be accessed via WDNR web site). The new legislation was drafted to protect "nonfederal wetlands" or isolated wetlands; wetlands no longer under CWA jurisdiction. According to this act isolated wetlands or other water bodies which do not fall under Corps' jurisdiction are regulated by the state. On May 7, 2001 Governor Scott McCallum signed 2001 Wisconsin Act 6 into law. Hence, Wisconsin was the first state to pass legislation after the SWANCC decision. Under this law, WDNR is authorized to regulate non-federal wetlands. The law states that "No person may discharge dredge or fill materials…unless the discharge is authorized by water quality certification issued by the department…or unless they qualify for an exemption." (WDNR website http://folio.legis.state.wi.us/).

15. Science and Policy Dilemma

"Federal Wetlands Policy should be based upon the best science available" (www. water. usgs. gov.). Using hydrologic or biotic criteria as a basis to categorize wetlands as isolated or non-isolated cannot be scientific because the degree of isolation is difficult to assess [58,59]. Geographically isolated wetlands are wetlands that are not linked in any ecologically meaningful way to waters and wetlands of the U. S. According to Tiner [58,59] one of the basic questions about "isolated wetlands" is "How abundant they are and what percent of the nation's wetlands do they represent?" According to Likens et al. isolated wetlands comprise no more than 20% of the wetland area of the contiguous United States. Leibowitz and Vining [31] found that 28% of the wetlands within an area of Central North Dakota had temporary surface water connection during high water in 1996. However, there is no statistical estimate of isolated wetlands relative to other wetlands. The point is that there is a need to document the number and variety of organisms that spend most of their lives in the "waters of the United States" but also require wetlands. Hence, wetland science would benefit from the development of a comprehensive view of isolation as a formative process across different regional wetland types [32].

The SWANCC decision has created a need to compile and make available scientific information for post-SWANCC policy development. Comprehensive data-designating the number, total area, and functional classification of isolated wetlands would lay the foundation for monitoring impacts to isolated wetlands. Studies are needed to examine and quantify how isolated wetlands, wetland complexes, and other potentially impacted waters contribute hydrologically, chemically, and biologically to "waters of the United States." The U. S. Supreme Court decision was based on the fact that "isolated wetlands" was not clearly defined in the existing CWA statue. Thus, studies are needed to show that pending laws are inadequate for maintaining the biodiversity of isolated wetland flora and fauna and isolated wetland ecosystems as a whole. If policy is to be sustained at SWANNC levels in the U. S., this will likely result in a continued loss of isolated wetlands. From a landscape perspective, wetlands regulation needs to be changed to provide greater protection for wetlands that are not covered under federal or state regulation, that do not harbor endangered species, and are generally called dry end, isolated wetlands [64]. However, it is difficult to argue for further protection of these kinds of wetlands without a more sound ecological understanding. Programs

should be initiated to promote more scientific studies, foster education, and training that will result in more informed policy making.

16. Conclusion

In this paper, I have shown that isolated wetlands are as valuable as non-isolated wetlands when it comes to ecological functions and values. Wetlands perform a variety of functions including flood regulation, nutrient and carbon storage, and provision of plant and animal habitat. Although the present literature supports this claim, it is also clear that much scientific works needs to be done on isolated wetlands, especially in the area of hydrology, and hydraulic connectivity and nutrient retention. Wetlands should be judged on the basis of values and functions they perform and not on the vague notion of isolation. The SWANCC decision will likely result in the conversion of small isolated wetlands to other uses. Their loss or destruction will have significant ecological consequences on the wider biotic community.

17. Recommendation

While the general assumption is that larger wetlands can provide these benefits more efficiently and effectively than small and scattered wetlands, scientific research has shown that wetlands provide the most benefits when there are a variety of wetland types, sizes, and depths (including small, isolated wetlands) near each other. In conclusion, I recommend:

- More thorough research on nutrient retention and hydraulic connectivity of isolated wetlands with other aquatic ecosystems.
- Study of wetland abundance.
- Establishment of a clear definition of isolated wetlands in the Section 404 of the Clean Water Act.

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