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Science Advisory Board Review Panel
Attn: Dr. Thomas Armitage, Designated Federal Officer (DFO)
EPA Science Advisory Board Staff Office (1400 R)
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue NW
Washington, DC 20460

Re: Comments of Ducks Unlimited, Inc. on *Connectivity of Streams and Wetlands to Downstream Waters*: Docket ID No. EPA-HQ-OA-2013-0582

Dear Dr. Armitage:

Ducks Unlimited (DU) is a non-profit organization whose mission is to conserve, restore, and manage wetlands and associated habitats for North America's waterfowl, and for the benefits these resources provide other wildlife and the people who enjoy and value them. Our organization was founded in 1937 by farsighted sportsmen conservationists committed at the outset to grounding the organization's conservation activities in the best available science. That commitment has served DU well for over 75 years, and we have grown from a handful of people to an organization of over 1,000,000 supporters who now make up the largest wetlands and waterfowl conservation organization in the world. With our many private and public partners we have conserved over 13 million acres of habitat for waterfowl and associated wildlife in the U.S., Canada, and Mexico.

As a science-based conservation organization, every aspect of our habitat conservation work is rooted in the fundamental principles of scientific disciplines such as wetland ecology, waterfowl biology, hydrology, and landscape ecology. A number of wetland and waterfowl scientists are on staff who have decades of collective experience in research and management directly and indirectly related to wetlands and the topic of the draft report, ***Connectivity of Streams and Wetlands to Downstream Waters: A Review and Synthesis of the Science.*** It is from that perspective that we submit the following comments and examples of additional peer reviewed citations, primarily focused on wetlands and their connectivity to downstream waters, for consideration by the Scientific Advisory Board (SAB) and the SAB panel of external peer reviewers.

Our comments, perspectives, and/or additional literature citations are offered under the following headings:

- **General Comments on the EPA's Science-Based Approach**
- **Overall Clarity and Technical Accuracy of the Draft Report**
- **Two Fundamental Principles: Watersheds and Aggregation**
- **The Report's Conceptual Framework**
- **Comments on Specific Aspects of the Report and Additional Citations**
    - *Riparian and Floodplain Wetlands*
    - *Prairie Pothole Case Study and Related Connectivity*
    - *Birds as an Avenue of Connectivity*
    - *Unidirectional Wetlands and Generalization of Major Conclusions*
    - *Case-by-Case Analysis of Connectivity*

General Comments on the EPA's Science-Based Approach

Ducks Unlimited applauds the Environmental Protection Agency's (EPA) basic approach of compiling and synthesizing the science relevant to the question of the connectivity between streams, wetlands, and larger downstream waters. As indicated by the report's consideration of more than 1,000 peer reviewed publications, there is a massive, and rapidly growing, body of science that provides information regarding the types and degrees of connectivity among these water bodies. The national objective of *"restor[ing] and maintain[ing] the chemical, physical, and biological integrity of the Nation's waters"* can successfully be addressed only by using policies that are developed and implemented from a foundation built upon the best available science. From that perspective, the draft report does an excellent job of synthesizing the science that demonstrates the degree of interconnectedness among all these waters, and the influence that streams and wetland have on downstream waters. Ducks Unlimited strongly supports the EPA's "science first" approach in tackling this challenging issue.

Overall Clarity and Technical Accuracy of the Draft Report

Ducks Unlimited commends the authors on the broad scope and strength of the science brought to bear on the fundamental question of connectivity. The report is generally clear and understandable, and provides extensive documentation in support of its findings and conclusions regarding the types and degrees of connections that exist between streams and wetlands, and rivers, estuaries, and other downstream waters. In general, the report makes clear the fact that the chemical, physical and biological integrity of downstream waters are dependent upon the integrity of the upstream and upslope components of the interconnected water resources of the landscape.

Overall, we find the report's conclusions generally appropriate and accurate in light of the report's contents. In some cases, however, and in light of the cumulative weight of the science and principles involved, the authors seemed hesitant to draw generalized conclusions as broad as the weight of the science would allow. We expand upon this further below. However, in no case did we note instances in which the conclusions regarding connectivity were extended beyond those which are justified by the science compiled in the report.

Two Fundamental Principles: Watersheds and Aggregation

We were pleased that the report explicitly recognized the importance and appropriateness, in the scientific context, of two inter-related principles that are key to assessing the connectivity of wetlands (and streams) and downstream waters. The first of these is the principle that *watersheds* should serve as the geographic basis for assessing the biological, physical and chemical connections among these types of waters within a landscape or region. This is recognized, and borne out by the compiled science and in numerous and diverse contexts throughout the report, and thereby underscores that this is a foundational principle for evaluating connectivity of wetlands with other waters within any given landscape or regional context. Watersheds exist at various scales, of course, and the most appropriate scale of watershed for any particular policy should be carefully considered within the context and scale of the policy under development or implementation.

The second basic principle, operating in tandem with the watershed basis for evaluating connectivity of wetlands and other waters, is that of *aggregation*. The report recognizes that in many cases connections with significant consequences for the biological, chemical and physical integrity of downstream waters exist, but are sometimes expressed in measurable terms only at the landscape level when the wetlands are considered in the aggregate. For example, the loss of one small, prairie pothole wetland may not have a demonstrably significant effect on large downstream waters such as the Mississippi or Red River.

When the aggregate impacts of the drainage and/or filling of pothole and other wetlands in the watershed is considered, however, the integrity of downstream waters can be demonstrated to be significantly impaired. One of the best examples of this principle is perhaps the Gulf of Mexico's expansive hypoxic zone, which is an impairment of a downstream water that is not the result of a single small (or even large, in this case) project or occurrence, but is rather a reflection of the cumulative impact of losing thousands of small wetlands throughout the Mississippi River watershed. While the hypoxic zone is a notable example of this principle at work at the largest scale, the report references numerous citations which either individually, or taken together, illustrate the importance of this principle at every scale. We offer in the context of our specific comments below several recent citations not currently referenced in the report, and that further illustrate the importance of the interrelated principles of aggregation on a watershed basis to appropriately assess connectivity among wetlands and other waters.

Report's Conceptual Framework

In general, we commend the authors for devising a useful conceptual framework for assessment of connectivity. While novel, the framework of "unidirectional" and "bidirectional" for wetlands has utility for describing the broad, landscape settings within which wetlands occur in relation to larger, downstream waters. The limitation of the "unidirectional" category, however, is that this broad category includes the vast majority of the nation's wetlands, and includes an extremely diverse range of wetland types. We appreciate that the report recognizes this limitation, and that the need to consider this issue at the national scale has also constrained the scope of the general conclusions drawn with respect to this one, broad, diverse suite of wetland types.

We were pleased to see the completeness of the consideration of the types of connectivity that exist between wetlands and downstream waters. For example, from a scientific perspective, it is important to recognize that downstream waters are often connected to wetlands, both unidirectional and bidirectional, via groundwater, and that these connections can result in impacts to the integrity of downstream waters as a consequence of actions taken that affect the integrity of the wetlands.

In addition, artificial connections that are occurring with increasing frequency and scope are clearly recognized in the report as an avenue of connectivity and impacts. For example, the connectivity provided by digging drainage ditches that connect geographically isolated wetlands with road ditches, which in turn serve as the functional equivalent of headwater streams and ultimately carry water (along with sediments and chemical constituents) to downstream waters has significant consequences for the larger flowing waters. These examples illustrate the importance of considering the full array of connections that exist between wetlands and other waters, and the report's conceptual framework does a good job of identifying and describing these connections.

The treatment of "connectivity and isolation" is an important inclusion in the conceptual framework. As indicated in the report, so-called "geographically isolated wetlands" are very often not hydrologically isolated from other waters, and in virtually all cases could be considered "connected" by virtue of their isolation. Although from a non-scientific perspective that relationship may not be intuitive, the ability of these types of wetlands to retain water that would otherwise flow to downstream waters and thereby increase flood flows, for example, is an important type of connectivity between these wetlands and the downstream waters. Also, when wetlands of this type are drained, flows toward downstream waters will by definition be increased. Of course, the degree to which those downstream waters and flows are affected is a function of many factors specific to the situation. Nevertheless, it is important that the relationships of "isolation" and "connectivity" be included in the conceptual framework.

While we were pleased to see the breadth and comprehensiveness of the avenues of connectivity structured within the conceptual framework, we were disappointed with the depth of the treatment of the section related to the connectivity provided by "biota" (see page 3-47). In contrast to the other types of connectivity discussed, this discussion included less than a single page. The extent and breadth of perspectives offered in this treatment of biological connectivity seems relatively minimal in the context of the remainder of this section. We offer additional perspective in our specific comments below, and encourage that the final draft include an expanded treatment of the "biota" portion of the conceptual framework.

Comments on Specific Aspects of the Report and Additional Citations

Riparian and Floodplain Wetlands: The section of riparian and floodplain wetlands, i.e., those occurring in a bidirectional landscape context, is generally strong and comprehensive. In light of the evidence provided by the compilation of the relevant science of this section, we found the overarching conclusion that "wetlands and open-waters in landscape settings that have bidirectional hydrologic exchanges with streams or rivers, (e.g., rivers and open-waters in riparian areas and floodplains), are physically, chemically, and biologically connected with rivers…,” to be both accurate and appropriate.

That being said, we would encourage the SAB’s panel of external reviewers to consider providing additional emphasis to palustrine forested wetlands, i.e., bottomland hardwood forests. Although not exclusive to the bidirectional context, most of these wetlands likely exist within this setting. We believe that this additional focus and attention is warranted by several factors. First, the U.S. Fish and Wildlife Service’s most recent wetland status and trends report (covering the 2004-2009 time period; Dahl 2011) indicated that 50% of the remaining wetlands in the lower 48 states were palustrine forested wetlands. This fact in itself warrants that additional attention be focused in the report on this wetland type. However, Dahl (2011) also pointed out that the nation was losing over 140,000 acres of these wetlands annually during these years, a far greater rate of loss than for any other wetland type.

We recognize that the issue of connectivity as it relates to these wetlands would largely be captured within the discussion and conclusions within the riparian and floodplain section of the report. However, many readers of this report (given the extent to which it will be used by non-scientists in the formulation of policy recommendations) will not immediately think of this wetland type when reading the section on floodplain wetlands, even though they are in fact a dominant component of the wetlands within that landscape setting. This is most likely related to the often infrequent flood duration and frequency of forested wetlands. Our sense in reading this section of the report is that most non-scientists will likely think of more aquatic environments such as oxbow lakes when considering “floodplain wetlands.” This common perception will be fostered by the inclusion of the case study on “oxbow lakes.”

Given (1) the prominence of palustrine forested wetlands among wetlands in the U.S., and particularly those occurring in the bidirectional setting, (2) their current exceptional rate of loss, and (3) common misunderstandings of their status as a wetland type, we would encourage that this wetland type specifically be given greater prominence in the final report. To that end, we would also suggest that a case study on “bottomland hardwood wetlands” be developed and added to the report.

Furthermore, there is an extensive literature with respect to bottomland hardwood floodplain wetland function and connectivity, and we would encourage that the final report ensure a more comprehensive review of this body of work. In particular, a special issue of the Wetlands journal (Volume 16, Issue 3, 1996), much of which was dedicated to a suite of in-depth studies led by the Corps of Engineers of the Cache River in Arkansas, would be an excellent starting point. This special issue included a series of papers on a variety of individual subjects relating to connectivity, including denitrification, phosphorus removal, sediment retention, fish communities and floodplain ecology, and groundwater flow, among others. One citation not included in the current report, for example, is Gonthier’s (1996) paper on ground-water-flow conditions within a bottomland hardwood wetland,” but other related papers in that issue seem also to not have been addressed. The report’s conclusions and utility with respect to this important class of wetlands could be further strengthened by providing more explicit prominence can comprehensive treatment.

Prairie Pothole Case Study and Related Connectivity: In light of the central importance of the Prairie Pothole Region (PPR) to maintaining continental levels of a number of species of waterfowl, this case study is of particular interest and importance to Ducks Unlimited. It is also one of the regions and wetland types with which DU scientists are most familiar. In addition, given the very high densities of wetlands in some portions of this landscape, prairies potholes would seem to offer one of the clearest opportunities for demonstrating the variety and degree of linkages that exist between geographically isolated wetlands and downstream waters.

We agree in principle with the section's final conclusion that, "given evidence in the current literature, however, when proper climatic or topographic conditions occur, or biotic communities are present that promote potential or observed connections, measurable influence on the physical, chemical, and biological condition and function of downstream waters is highly likely." In light of the highly dynamic nature of the PPR, climatically, hydrologically, and biologically, the conditional statements contained within the conclusion are typically fulfilled at some point over the span of decades over which this dynamism occurs. It is also self-evident and intuitive, in viewing satellite images of large portions of the PPR in which prairie potholes are a key component of the landscape, that these wetlands as a class and in the aggregate exert a significant influence on downstream waters. As described in the report, some of the most important of these impacts would be a consequence of the geographic isolation of many of them.

This case study can be strengthened by including some of the more recent literature regarding the role of isolated prairie pothole wetlands in watershed hydrology in the PPR, for example, relative to new theories, and related evidence, dealing with dynamic contributing area and the role of distributed storage, i.e., isolated wetlands and wetland drainage (Huang et al. 20111; Shaw et al. 2012; Shaw et al. 2013). Although alluded to throughout the case study, the geographic isolation is one of their most important characteristics, and directly results in their ability to serve as water sinks and chemical (nutrient and other pollutant) traps and thereby positively influence the integrity of downstream waters. This feature should be emphasized to adequately represent the value and connectivity of geographically isolated prairie wetlands, as highlighted by Mitsch and Day (2006), Wang et al. (2010), Yang et al. (2010), and Schottler et al (2013).

An example of further evidence of this type of connectivity, and the degree of impact on large, important downstream waters, is described in a series of publications related to Lake Winnipeg and portions of its watershed. Lake Winnipeg, is located in Manitoba, Canada, and includes a watershed that spans nearly 1 million km^2, covering parts of Alberta, Saskatchewan, Manitoba and Ontario in Canada, and portions of Montana, North Dakota, South Dakota, and Minnesota in the U.S. The watershed drains 90% of the agricultural land in Canada, with the vast majority encompassed within the Prairie Pothole Region where in excess of 450,000 ha of wetlands have been lost over the last 40-60 years. Specifically, in the Red River basin which delivers the majority of the nutrients to Lake Winnipeg, over 50% of the wetlands have been eliminated in the U.S. portion f the watershed (Schindler et al. 2012), with as much as 90% loss or more in portion of the Red River watershed in Canada (Hanuta 2001). Over this same time frame, the runoff:precipitation ratio has increased dramatically (Ehsanzadeh et al. 2011), likely due to the synergistic interaction of increased drainage (i.e., increased hydrologic connectivity) and precipitation. Increases in flooding and water yield have been directly linked to increased phosphorus export in the Lake Winnipeg watershed (Environment Canada and Manitoba Water

Stewardship, State of the Lake Report 2011) and demonstrate the ability for isolated wetlands, in the aggregate and at the level of the watershed, to affect the integrity of one of the world's largest lakes. We encourage the review and incorporation of the science described in the literature cited above and related literature, to strengthen the report's synthesis of prairie pothole related information and the related conclusions.

Birds as an Avenue of Connectivity: Although the report synthesizes much information regarding connectivity of wetlands and streams with downstream waters, we were disappointed by the sparse consideration of birds (and larger, relatively mobile vertebrates other than fish) as an avenue of biological connectivity. The report includes only about 18 mentions of birds, and the most frequent mention was that birds can serve as a vector or mechanism of transport of seeds, vegetative material, and invertebrates between waters.

We fully understand the constraints that will be imposed by the policy context within which this scientific information about connectivity will be used, but we maintain that almost entirely ignoring birds as avenues of connectivity, in and of themselves, represents a mistaken and overly constricted view of connectivity. We strongly encourage the panel to re-consider the perspective that birds can serve as independent avenues of connectivity within the existing policy constraints, and to include in the final report additional treatment of birds. We describe below, and provide citations, with respect to one perspective that illustrates clearly how birds can be viewed as providing biological connectivity.

We recognize and accept that *migrating* birds, i.e., birds in the process of their seasonal migration, cannot be used, within existing policy, as surrogate evidence of connectivity between wetlands and downstream waters. Migrating birds often move thousands of miles, sometimes in the course of a few days, and often stop in many wetlands as well as downstream waters for short periods of times. While birds, such as waterfowl, may use and be dependent upon a range of wetlands and other waters over the course of their annual life cycle and extensive migratory range, we accept that this type and level of connectivity is currently precluded from being used within the existing national policy framework.

In the context of establishing a science-based, biological basis for connectivity, however, a *migrating* bird and a *migratory* bird are two different entities. We understand that, for example, a redhead duck migrating from its breeding habitat in North Dakota and stopping for a short time at a wetland in central Iowa on its way to its wintering ground on the Texas Gulf coast cannot in and of itself be used to demonstrate, within the existing policy framework, connectivity between the Iowa wetland and other waters. However, when a *migratory* bird (a formal, legal designation of a large category of birds based upon their inclusion in 4 bilateral treaties between the U.S. and Canada, Mexico, Japan, and Russia, and formally included in the protections of the Migratory Bird Treaty Act, as differing from *resident* or non-migratory species) like the redhead can be shown to be dependent upon *both* navigable waters and physically non-proximate waters *within* a season and within a relatively local or regional context, use by migratory birds should indeed contribute to the establishment of connectivity between wetlands and downstream waters. In such cases, if the wetlands were to be drained, the biological integrity of the downstream water would be impaired because the species could no longer exist in the region. In instances such as this, the bird species provides a very real avenue of connectivity which affects the integrity of the larger, downstream water.

Wintering redheads and lesser scaup provide excellent examples of this perspective on biological connectivity provided by birds. Approximately 80% of the entire North American population of redheads winters in estuaries of the Gulf of Mexico, most in the Laguna Madre of Texas and Tamaulipas, Mexico (Adair et al. 1996; Ballard et al. 2010). They forage almost exclusively on shoalgrass in the hypersaline lagoon, essentially a part of the Gulf of Mexico (Ballard et al. 2010). Large numbers of lesser scaup also winter in the Gulf Coast region, and generally forage on invertebrates in the saline and brackish marshes and offshore habitats of Texas and Louisiana (McMahan 1970). Large concentrations of diving ducks in the region, including these two species, also make daily use of inland, coastal freshwater ponds in order to flush out the salt loads ingested while feeding in the saline habitats (Adair et al. 1996; Ballard et al. 2010). While both studies found that redheads and scaup tended to make greater use of wetlands that were in closer proximity to the coast when they were available, they flew much farther inland during dry years to acquire freshwater because they require the fresh water to survive. Adair et al. (1996) found that redheads used geographically isolated wetlands up to 13 miles inland, and scaup used wetlands up to 33 miles from the coastal navigable waters. Thus, these researchers and others (e.g., Woodin 1994) concluded that these migratory bird species are dependent upon *both* the downstream water (i.e., the Laguna Madre and Gulf of Mexico *and* the inland, geographically isolated freshwater wetlands. If the inland freshwater wetland habitats were adversely impacted by drainage, for example, the entire region would be far less able to support redhead, scaup and other diving duck populations, and the biological integrity of the downstream water of the Laguna Madre would therefore be affected. This clearly constitutes an example of within-season, day-to-day connectivity between these waters provided by birds and in a way that affects the biological integrity of both categories of waters.

Other avian species that spend significant time on downstream, saltwater habitats are similarly dependent upon the presence of regional freshwater wetlands for purposes of osmoregulation (Woodin 1994). We emphasize that these examples all apply to *within*-season, local/regional habitat use, and do *not* include the period of long-distance migration. Some examples of such species include: California gulls using hypersaline Mono Lake and freshwater wetlands in southern California (Mahoney and Jehl 1985); several waterfowl species requiring or using both saline lakes and freshwater wetlands in North Dakota (Windingstad et al. 1987; Swanson et al. 1984); grey teal in Queensland (Lavery 1972); and, white ibises using estuarine rookeries and requiring freshwater wetland-derived prey such as crayfishes for osmoregulatory purposes (Bildstein et al. 1990).

Thus, we believe that, as shown clearly by the examples of the redheads and lesser scaup on the Gulf Coast, the within-season dependence on *both* downstream waters and wetlands, including geographically isolated wetlands, can constitute an important avenue of biological connectivity between these waters. In these cases, without the wetlands, the species would not occupy the region as a whole and the biological integrity of the downstream waters would be impacted. Within-season use of both categories of waters by examples of other bird species demonstrates similar dependency and similar connections. This interdependence on both downstream waters and wetlands should be given the same consideration for establishing a biological connection as would the dependence upon wetlands and riverine habitats by an amphibian species, for example. Although the scale is different, they are scientifically and biologically analogous, and there is nothing within the basis for the existing policy framework that would justify disallowing the use of this kind of situation involving birds (e.g., redheads) as a basis for establishing connectivity.

Unidirectional Wetlands and Generalization of Major Conclusions: We found the literature compiled with respect to the "effects of unidirectional wetlands on rivers and other downstream waters" to be relatively comprehensive. However, as noted above with respect to the example of birds, some considerations regarding the types of connectivity, and thereby the effects of these wetlands on downstream waters, has been overlooked and should be strengthened in the final report.

We were also pleased to see the extensive treatment of geographically isolated wetlands. The perception of many non-scientists, similar to the situation described above in the example of palustrine forested wetlands, is that geographically isolated wetlands are "isolated" in every sense and therefore are presumed to lack functional and meaningful connections with other waters, including downstream waters. It is important that the report does a good job of compiling and synthesizing the scientific evidence that documents and helps make clear that geographically isolated wetlands generally are connected with and/or do have an impact, in cases by virtue of their geographic isolation, on downstream waters. The amassed evidence is compelling and justify the general statements such as, "based on what is known about how water flows across the landscape (see Chapter 3), hydrologists and ecologists would generally agree that all unidirectional wetlands are interconnected to some degree with each other and with stream networks" (page 5-37), and "a literature review study concluded that depressional wetlands lacking a surface outlet (see Figure 3-18B, C, and D) overwhelming reduced or attenuated flooding…" (page 5-26). Other similar statements, supported with the cited literature, are made throughout the section and indicate the effects that unidirectional and geographically isolated wetlands generally have on downstream waters as a result of their linkages.

We note the report's similarly frequent mention of the geographic and temporal variability regarding the types and degrees of connectivity associated with unidirectional wetlands. We agree that the studies support such a recognition, which is unsurprising in light of the extremely wide diversity of specific wetland types and landscape settings that exists across the U.S. for the broad class of unidirectional wetlands created by the conceptual framework of the report's analysis.

While accepting that the nature and degree of connectivity between unidirectional wetlands and downstream waters is highly variable across the U.S., given the compelling nature of the preponderance of the scientific evidence, we question the hesitancy of the report's authors to generalize these conclusions more broadly across the class. The Major Conclusions section of the report for this class (pages 6-1 and 6-2) states that "the type and degree of connectivity varies geographically within a watershed and across time," and this is certainly an accurate statement with which we agree. It also fairly states that this makes it "difficult to generalize about their effects on downstream waters." However, the bulk of the compiled evidence seems to us to indicate that while it is fair to conclude that the nature and magnitude of those effects may be difficult to generalize, it is also fair to conclude that there *are*, in general, effects on downstream waters. The synthesis of the cited literature also seems to indicate to us that, particularly when viewed at the aggregate and within the appropriate watershed context, these effects are generally and collectively significant. In addition, it is important to note that the general trend of the rapidly accumulating science of connectivity seems to be in the direction of most often finding some degree of connectivity when funds are secured to conduct the individual studies.

We suggest that the major conclusions be re-stated to strengthen and better convey the appropriately generalized conclusion that unidirectional wetlands most often are connected with and/or have impacts on downstream waters, while recognizing that there is indeed a high degree of geographic and temporal variability in the nature and degree of those connections and impacts.

Case-by-Case Analysis of Connectivity: The Major Conclusions for unidirectional wetlands also makes the statement (page 6-2) that, "evaluations of individual wetlands or groups of wetlands could be possible through case-by-case analysis." We are concerned that this statement will foster misunderstandings and misperceptions, and we strongly encourage the final report to comment further on this issue, and to provide additional clarity.

Although it is technically and scientifically accurate to state that such case-by-cases analyses of individual wetlands "could be possible," it is seriously misleading (particularly to non-scientific readers of the report) to create the misperception that such an approach to assessing connectivity of individual or small groups of unidirectional wetlands is a practical approach to science-based policy. While the massive amount of science synthesized in this report generally demonstrates connectivity of wetlands and streams with downstream waters, it also indicates some other issues that impact the ability to pursue case-by-case analysis.

The report repeatedly notes the temporal variation that exists with respect to the nature and extent of connectivity. For example, in the context of unidirectional wetlands, it states that, "wetlands that lack surface connectivity in a particular season or year can be connected, nevertheless, in wetter seasons or years," and that they may "reduce flows during dry periods." The inherent degree of temporal variability in connectivity alluded to in these examples, sometimes on the scale of an extended period of years, means that an accurate scientific assessment of connectivity of an individual wetland would require years of study. The sometimes very slow rate of flow of groundwater connectivity (which, while sometimes slow in materializing, can significantly affect downstream waters) would similarly require long-term studies to document connectivity on a case-by-case basis. Although technically and scientifically possible, this approach would be cost-prohibitive and unrealistic to consider as a practical avenue of assessing connectivity. Indeed, in light of the preponderance of the evidence accumulated and synthesized in the report, the question of whether such a case-by-case analysis was also unnecessary seems to be a reasonable one.

Other, seemingly unrelated considerations also need to be considered when evaluating the extent to which the weight of the evidence could and should be generalized, versus the alternative of case-by-case analysis. For example, we suspect that the location of scientific studies tends to be generally correlated with the location of universities and other research institutions. This somewhat random factor influences the extent to which there is information for various regions and wetland types, and therefore the extent to which case-by-case analysis would be possible and reasonable to conduct across the U.S as questions of connectivity arise.

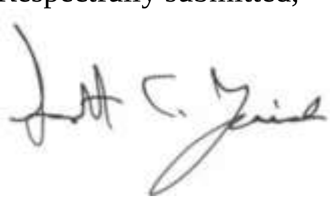
A similar situation relates to the issue of the connectivity provided by birds. Our prime example related to redheads and scaup on the Gulf Coast. There are many other species of diving ducks and other birds that exhibit similar patterns of habitat use and potential connectivity, but redheads and scaup are the only ones that have been studied to establish this degree of connectivity in the region. In the absence of complete knowledge of all such unstudied species, the question of the degree to which the generalization of the science is reasonable is an appropriate one to ask within the context of developing policy as opposed to the context of making statements with scientific certainty.

Such pragmatic considerations should be weighed in assessing the extent of generalization that is appropriate and warranted based on the scientific evidence. The limits of the ability of scientific analyses to practically assess connectivity should be addressed within the report so that there are no misunderstandings about what that could or would mean in practice.

Closing Comments

Overall, the EPA is to be commended for its approach of addressing the science-based issues first, and for its work to compile and synthesize the massive, and growing, amount of literature relevant to the issue of connectivity between wetlands and streams and downstream waters. We believe that the findings are generally accurate and appropriate. However, we encourage the panel and SAB to consider our recommendations for expanding upon and strengthening the report's information and conclusions in light of the science it currently contains, and the additional citations and perspectives the Ducks Unlimited has offered.

Respectfully submitted,



Scott C. Yaich, Ph.D.
National Director of Conservation Planning and Policy

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