REPORT OF DR. JOY ZEDLER ON
DRAFT ENVIRONMENTALIMPACT STATEMENT FOR THE
ST. JOHNS BAYOU/NEW MADRID FLOODWAY PROJECT (2013)

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I am Professor of Botany and Aldo Leopold Chair of Restoration Ecology at the University of Wisconsin-Madison. I have studied wetland and other aquatic ecosystems for over 45 years, and have more than 250 peer-reviewed publications. I have served on 4 panels of the National Research Council of the National Academy of Sciences, including a role as chair of the 2001 panel requested by the U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency to review the science and practice of wetland mitigation and to make recommendations for future practices. It issued a report called *Compensating for Wetland Losses Under the Clean Water Act.* This report was broadly embraced by the U.S. Army Corps of Engineers, which issued a memorandum to the field in 2003 highlighting key recommendations, reaffirming them, and calling the recommendations of this report either a "basic requirement for mitigation success" or a "guide for mitigation site selection." U.S. Army Corps of Engineers, Memorandum to the Field on Adaptation of NAS Guidelines (Oct. 29, 2003). My comments on the 2013 Draft Environmental Impact Statement for this project draw heavily from this work and build on early comments I have made about this project based on extensive review of this and earlier versions of the environmental impact statement.

In my comments in 2006, I concluded: "[T] he claim that this mitigation fully offsets project impacts on aquatic resources is completely inconsistent with scientific understanding of wetland functioning, wetland replacement, wetland restoration, and mitigation of other aquatic areas, as well as inconsistent with established practice under the Section 404 program.4 The claim is so outside the range of reasonable scientific understanding that it cannot be seriously advanced as science-based. It therefore should be disregarded." The final version of that Environmental Impact Statement was rejected by the federal District Court in the United States as arbitrary and capricious.

My judgment about the previous EIS also applies to the new one based on my review of large portions of the new draft EIS, including its key analyses of project impacts and mitigation. A striking feature of the new mitigation proposal is that the use of an updated and longer period of hydrologic record indicates that the project area is yet more frequently flooded than previously identified, with a large expansion of the two-year floodplain for example, and yet the proposed mitigation has roughly stayed the same or even declined from the previous mitigation found to be inadequate. The main change is that the Corps is now relying on forms of mitigation that the Corps itself previously did not claim would provide the benefits now claimed. These include the following:

- A new and unsupported claim that work on Big Oak Tree State will provide vast fish habitat even though it is clear that river fish will have little or no access to the Park during their spawning and rearing periods;
- The claim that a few hundred acres of floodplain ponds will compensate for vast losses of inundation on thousands of acres of forested and farmed wetlands based on a changed system for scoring floodplain ponds and the unexplained rejection of previous agreements with the US Fish & Wildlife Service that borrow pits and other permanent water bodies should only be used to compensate for loss of other floodplain pond habitat;
- Reliance for mitigation on thousands of acres of reforestation of batture lands, which are different from the project area while previous versions of the EIS proposed little reliance on batture lands because of this inappropriate hydrology;
- Claiming wetland mitigation credit for the Ten Mile Pond waterfowl management area, a site which has long existed and was created by state agencies and which the Corps never claimed mitigation credit for before in the several previous draft and final environmental impact statements;
- Abandonment of plans to create a multi-hundred acre shorebird management area (itself inadequate) based in large part on the theory that Ten Mile Pond will mitigate most of the habitat and in part apparently on the theory that shorebird mitigation is not necessary.

I divide these comments into the following sections: (1) summary of the core effect of the project and (2) proposed impacts on wetlands; (3) the inconsistency between proposed mitigation plans (and the analysis of those plans) and the now scientifically accepted core principles of mitigation for wetlands and other aquatic ecosystems; (4) flaws with the reliance on HEP models; (5) how the shorebird mitigation analysis highlights those flaws; and (6) how the lack of a detailed mitigation plan is also inconsistent with wetland mitigation practice and the requirements for scientific evaluation.

1. Core Effect of Project and Mitigation

The core ecological importance of the project area is based on three key but simple points. First, the Mississippi River ecosystem depends on regular and variable overflow of the river channel into an extensive and diverse floodplain, which provides direct habitat for the majority of river fish and the vast majority of waterfowl, shorebirds and other animal life and indirectly supports the river food chain. Second, more than 90% of this connected floodplain has been eliminated, which not only makes all floodplain rare but also makes calm, connected backwater capable of maintaining shallow-water areas over diverse flood conditions even more rare. Third, the project area is one of the largest remaining such habitats along the Mississippi River. According to Corps analyses, the two-year floodplain in the New Madrid and St. Johns Bayou basin now extends to roughly 45,000 acres, the five-year floodplain to 76,000 acres, and the area inundated by the river at some time more than 100,000 acres. .

At various places, the DEIS attempts to disparage the ecological value of the project site on the grounds that it is altered both hydrologically, through alteration of the Mississippi River's basic flows, and vegetatively, through clearing of most of the land for agriculture. It is true that these alterations somewhat alter and somewhat reduce the ecological functions. But virtually all aquatic ecosystems in the United States are heavily altered. The project area is as close to providing the functions of natural floodplains as can exist almost anywhere on the lower Mississippi River. It would be more accurate to say that in such a changed system, the persistence of the critical elements of floodplain functions by the project makes this site more important, not less.

2. Wetland Impacts

Of the tens of thousands of acres of regularly inundated floodplain, many are wetlands. The Corps of Engineers itself has acknowledged 14,040 acres of vegetated wetlands within the five-year floodplain. Virtually all of these acres will have their inundation areas and periods heavily diminished. That is in part because they are above the water levels at which gates will be closed at different times of the year, and in part because pumping and blockage of water will reduce the quantity of water that will remain in the floodplain after initial flooding. This assessment of 14,040 acres corresponds roughly with EPA's assessment of 14,614 acres of naturally vegetated wetlands within the five-year zone.

EPA, however, also identified acres within the basins above the 5-year flood zone. The DEIS indicates the Corps' intent to ignore impacts on these wetlands on the theory that they are little influenced by backwater flooding. It is true that the flooding from the river will not be the principal source of water for these wetlands, but further reduction in flooding is likely to alter these wetlands as well. These impacts therefore should be counted.

The even larger concern is "farmed wetlands." The DEIS announces that it will consider only 1,096 acres of farmed wetlands based on estimates provided by NRCS. However, there is no analytical basis offered to justify these delineations. This estimate of farmed wetlands conflicts with analysis by EPA as part of an interagency team. The EPA analysis is expressed in EPA document titled: St. Johns Bayou/New Madrid Floodway Wetland Assessment Probability Survey Design, and an October 21, 2011 St. Johns Bayou and New Madrid Floodway (SJ/NMF) Wetland Assessment, both of which were obtained from the EPA. This analysis found 42,985 acres of farmed wetlands within the five-year flood zone of both basins (Probability Survey Design p. 4).

The two EPA documents provide extensive explanation of the methodologies employed, which included bench surveys using aerial photographs and field analyses. These methodologies were proper. Farmed wetlands are areas that were naturally vegetated wetlands as evidenced by their wetland ("hydric") soils, which have been cleared for farming but are still flooded enough to meet hydrology criteria. The principal challenge in identifying these wetlands is determining their flood regimes. Water can come to these areas from precipitation, from local runoff and, in the case of the project area, from backwater flooding. Because there are no direct multi-year measurements that capture all these sources of water, the federal agencies that share responsibilities for wetlands have developed so-called "mapping conventions" that indicate the presence of extended flooding from various visual signatures in aerial photographs. They have also identified direct "secondary" hydrologic indicators that can be used at the field level. The EPA documents indicated that both tools were employed, including field visits by personnel from multiple agencies. The field visits also verified the presence of hydric soils. There is no reason to doubt the EPA assessment.

Even more definitively, the Corps' own hydrologic data substantiate that there are roughly 9,200 acres of farmed wetlands created by backwater flooding. I illustrate how:

- The DEIS states the accepted view that the vast majority of the project area has hydric soils (and the existing of such soils has not been in dispute for the inundated parts of the project).
- The DEIS states at several points that a farmed wetland is any farmed area that has hydric soils and is flooded for 15 consecutive days during the growing season at least once every other year. In Table 3 and 7 of the Hydraulics Appendix at C-8, the Corps also states that the growing season used to delineate wetlands for the project is March 20^{th} to November 11. The same tables also provide the flood line, not for 15-day inundation but for 14-day

> inundation in each basin in Tables 3 and 7 of the DEIS. Those flood lines are 287.1 in St. Johns and 287.7 in New Madrid. Using Tables 3.1 and 3.2 of the DEIS, these elevations can then be applied to determine the quantity of agricultural land that is flooded for 14 consecutive days in both basins, and they come to 9,207 acres. (Tables 3.1 and 3.2 provide data only for foot level elevations, not tenths of a foot. But the DEIS indicates that the Corps interpolated linearly to derive areas inundated at tenths of a foot from these data and these calculations do the same). Tables 3 and 7 also show the 14-day inundation line after the project is built, and from that it can be found that 8,280 acres of these wetlands will no longer meet wetland criteria under the proposed project.

These data that find 9,207 acres of farmed wetland are for 14 consecutive days. They are a reasonable proxy for 15-day inundation. However, calculations of the 15-consecutive-day line were undertaken by Dr. Amy Lerner, a geographer at Princeton University, using a common statistical program and based on an excel spreadsheet of the Corps' sump elevation data presented in the hydraulics appendix and provided by the Corps to the Fish & Wildlife Service. This analysis shows that the 15-day flood elevation line is virtually identical at 287.7 in the New Madrid Floodway and 287 in the St. Johns Bayou Basin. Using these flood elevations with the data provided in Tables 3.1 and 3.2 of the DEIS shows that 9,174 acres of agricultural land meet the inundation for farmed wetlands. Based on the stipulations in the DEIS that the vast majority of the project area has hydric soils, and the field analyses described in the EPA wetland documents that found hydric soils, I therefore conclude that at a minimum 9,174 acres meet the legal criteria for farmed wetland.

To emphasize, these data are the Corps' own analysis of which acres in the project area flood from Mississippi River backwater, on what dates and for how long. The same hydrologic analysis underlies virtually every aspect of the EIS, from analysis of flood damages to analyses of the various habitat impacts. It is inconsistent and unjustified for the Corps to rely on this hydrologic analysis for all other analyses of the project and to ignore their implications for wetlands. I also emphasize that this analysis does not undercut the EPA analysis, which is based on approved interagency methodologies for examining the presence of water from additional sources beyond backwater flooding

The Corps has disputed that the elimination of backwater flooding on vegetated wetlands will eliminate their wetland status, but the Corps' own hydrologic analysis shows that the project will eliminate 8,280 acres of farmed wetlands. That is significant. Generally accepted wetland mitigation policy applied by the Corps and the EPA to private parties under Section 404 calls for no net loss of wetland acres as well as functions. That is also the accepted scientific recommendation, dating to the Conservation Foundation's 1988 call for no net loss of acreage and function. However, none of the proposed mitigation will restore or create wetlands where they do not now exist.

This level of wetland impacts is large compared to other permitted projects. I am not aware of any permit issued under the Clean Water Act allowing the elimination of over 8,000 acres of wetland, and based on my experience of observing the federal wetland program, that level of impacts would not be permitted primarily for the economic benefits of agricultural drainage.

3. Functions of Farmed Wetlands and Inundated Agricultural Lands

The DEIS also states that it can ignore farmed wetlands (apart from those found by NRCS) because they do not provide wetland functions. The DEIS contains the following extraordinary statements: "An overwhelming amount of scientific literature concludes that while vegetated wetlands provide numerous ecological beneficial goods and services, wet agricultural areas provide a disservice and are largely anathema to conservation." DEIS p. 75. It supports this statement with 13 references, one of which is to a paper of mine. It also states on p. 76: "Farmland, whether considered farmed wetlands or prior converted cropland, in the project area provides an ecological disservice to nutrient removal." It further states: "Prior converted cropland was not considered wetlands because these areas have been so degraded that they no longer provide any significant wetland function." There are several basic flaws with this argument.

First, the DEIS admits that both farmed wetlands and even areas that might qualify as prior converted cropland in the project area provide important functions as habitat for fish, and water-dependent wildlife. These are wetland functions as specifically defined by the section 404(b)(1) guidelines. C.F.R 230.30 – 230.32

Second, the literature cited does not support the claims. For example, the paper of mine in *Frontiers in Ecology and Environment* 1:65-72 (2003) is about the ecological damage caused by the impacts of wetland loss, primarily drainage, to agriculture. It is about the impact of activities such as this project. It does not address the intermediate values of agricultural areas that remain inundated for extensive periods. To the extent I can tell, neither do the other articles cited.

Third and most fundamentally, the Corps is confusing the impact of fully drained wetlands for agriculture and the impact of the remaining inundation. Agricultural lands, of course, use fertilizer and are sources of nitrogen pollution to the Gulf of Mexico. The primary sources of that pollution are fully drained agricultural lands in the drainage, particularly those areas with extensive tile drainage. The question is, what is the impact of longer inundation on those lands that remain inundated for many days? That includes those areas inundated long enough to be considered farmed wetlands and those inundated not quite long enough but still extensively.

The short answer is that the flooding in these areas will provide extensive water quality treatment. Wetlands "denitrify" nitrate, the form that runs off farm fields, through microbial activities that are present in saturated soils. Even two or three days of saturated soil conditions are enough to cause soils to become anaerobic and to start to denitrify. Large wetland areas are particularly effective because of the combination of conditions that will allow both nitrification and denitrification. The project area farmed wetlands and flooded agricultural fields tend to be flooded for many days, long enough to create these conditions. They therefore serve as a filter for pollutants running of agricultural fields higher up in the landscape, for pollutants in the soils of the agricultural lands themselves, and for pollutants in Mississippi River waters that back up into the floodplain.

Because of these values, restoration of wetlands, even farmed wetlands, has been identified as an important strategy for addressing the problems of the so-called "dead zone" in the Gulf of Mexico due to nitrogen runoff in the Mississippi River watershed.

Dr. Christopher Woltemade has provided previous reports and testimony about the large water quality benefits that can be estimated from the project area cite. Nothing in the materials cited would undercut that analysis.

4. Fundamental Scientific Flaws with the Proposed Mitigation

A striking feature of the mitigation proposed for the project is that it does not involve restoring wetland or floodplain hydrology to any areas that are not already frequently flooded. I attach on the next page a table of the principal mitigation proposed for the project in the fisheries appendix, and it shows how much of the mitigation proposed is based on artificial hydrologic manipulation of existing wetland areas. They include Big Oak Tree State Park and Riley Lake, both of which will have levees built around them to artificially manage water levels. The mitigation plans for waterfowl and shorebirds also rely heavily on artificial hydrologic manipulation of relatively small impoundments that will be surrounded by levees and manipulated through pumps. That includes Ten Mile Pond. The waterfowl mitigation also includes a proposal to close the gates and maintain waters permanently or semi-permanently inundated in the lower parts of the basins in

December or January for waterfowl.

Apart from hydrologic manipulation, the mitigation is to be supplied by altering the vegetation of existing flooded lands. They include bottomland hardwood (BLH) reforestation on lands that already flood (and in fact many of which will flood less frequently as a result of the project). Weighted by mid-season fish mitigation, 58% of the mitigation is provided by roughly 3,200 acres of reforestation in lands that will be behind levees and additionally drained by the project, and the vast bulk of the remainder is provided by batture lands between the levees. These lands also already flood, and have dramatically different hydrology, temperatures, flood durations.

In effect, compared to the project areas impacted, including 75,000 acres in the five-year floodplain, the mitigation is modest in area (8,700 acres excluding Ten Mile Pond, which already exists), involves no re-inundation of areas to offset the areas no longer inundated, and focuses heavily on artificial hydrologic management and structures of these smaller areas.

Table 23. Fisheries compensatory mitigation benefits (AAHU) in the St. Johns Bayou Basin.

Mitigation	Acres	Early	Mid	Late
Impacts		-386.6	-441.3	-245.3
BLH Restoration < 285'	400	40.7	41.9	15.4
BLH Restoration < 5-year	1,816	124.2	127.9	50.1
Riparian Buffer Strips	47	5.9	5.6	1.8
Ecologically Designed Borrow Pits	387	268.4	268.4	268.4
Net Gain		52.6	2.5	90.4

Table 24. Fisheries compensatory mitigation benefits (AAHU) in the New Madrid Floodway.

Mitigation	Acres	Early	Mid	Late
Impacts		-1,729.5	-2,061.1	-1,165.8
Big Oak Tree State Park and Surrounding Area	2,800	914.0	889.5	577.3
BLH Restoration < 285'	387	61.7	70.5	0.0
BLH Restoration < 5-year	1,970	179.3	84.7	0.0
Batture Land Reforestation	3,050	692.4	692.4	310.2
Ecologically Designed Borrow Pits	60	41.6	41.6	41.6
Floodplain Lake	432	326.8	326.8	326.8
Net Gain		486.2	44.4	90.1

Borrowing from my 2006 report, I explain why this mitigation is inconsistent with science, including modern understanding of how aquatic ecosystems function and of the efficacious mitigation of impacts on wetlands and aquatic ecosystems..

a. Inconsistency with accepted understanding of the importance of natural hydrology

Aquatic and wetland ecologists agree that natural hydrologic patterns are critical to the ecological functions of rivers and wetlands. In a report on riparian areas that include floodplains, the National Research Council committee called hydrology the "master variable" in driving the ecology of riparian areas, whose key components include not just broad averages but magnitude of water, frequency, duration, timing and rate of change. National Research Council, *Riparian Areas, Functions and Strategy for Management* (2002).[1]

The focus on preserving and/or restoring natural hydrologic patterns reflects humility about the limits of our understanding of the role played by each variable for different ecological functions and hard-taught lessons about how alterations of natural hydrology have often had strong effects that were not well understood. For example, disruption of natural flow patterns, and the timing and amount of wet and dry conditions, of Florida's Everglades are believed to be the root cause of the great declines of its fish and wildlife, and the restoration of these natural patterns of flow was the principal goal of a more than $8-billion restoration plan authorized by Congress.

As early as 1852, Charles Ellet wrote in *Overflows of the Delta.* (Prepared under instructions from the War Department, Washington) that the Mississippi River was overflowing because of agriculture and levees that prevented floodwaters from moving onto their former floodplains. p. 24. The disruption of natural hydrology caused by levees is believed to be the root cause of the disappearance of more than a million acres of wetlands in coastal Louisiana and a significant contributor to increased hurricane damages. The Corps has proposed an even more expensive plan to restore natural hydrology to reverse the losses of these wetlands. And while these are two of the most high-profile examples of unintended negative consequences of

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[1] This report explicitly addresses wetland mitigation. However, the same scientific principles apply to any mitigation activity required to offset impacts on aquatic ecosystems, including floodplain habitat for fish whether or not they qualify as wetlands. The Clean Water Act Section 404(b)(1) guidelines require that impacts on fish habitat be offset in general, as well as impacts on wetlands

altering natural hydrological conditions, hundreds of papers on rivers and wetlands have demonstrated adverse ecological consequences from hydrologic alteration for countless other rivers and wetlands. Numerous other papers have demonstrated that efforts to restore wetland and river habitat without restoring natural hydrologic patterns nearly always fail to reproduce key aquatic functions.

For these reasons and more, the report of the National Research Council of the National Academy of Sciences, prepared by the committee that I chaired, strongly emphasized the importance of naturally variable hydrological conditions. One of the major guidelines it set forth for wetland mitigation was as follows: "Restore or develop naturally variable hydrological conditions. Promote naturally variable hydrology, with emphasis on enabling fluctuations in water flow and level, and duration, and frequency of change, representative of other comparable wetlands in the same landscape setting." National Research Council, *Compensating for Wetland Losses Under the Clean Water Act* p. 125 (2001). The report also stated, "Hydrology is most often cited as the primary driving force influencing wetland development, structure, functioning, and persistence. Proper placement within the landscape of compensatory wetlands to establish hydrological equivalence is necessary for wetland sustainability." Ibid p. 45. Elsewhere, the report stressed, "Hydrological variability should be incorporated into wetland mitigation design and evaluation. . . . Hydrological functionality should be based on comparisons to reference sites during the same time period." Ibid p. 45. The reference to "reference sites" is to provide a mechanism for imitating natural hydrology.

The Corps officially embraced this recommendation in its 2003 Mitigation Memo. This memo states: "Natural hydrology is the most important factor in the development of successful mitigation. Wetlands and other waters are very dynamic, and dependent on natural seasonal and yearly variations that are unlikely to be sustainable in a controlled hydrologic environment." This memo went on to refer to our recommendation to establish natural hydrology as a "basic requirement."

The Corps' claim for this project that the loss of a vast area of seasonally flooded aquatic habitat could be replaced by unnaturally extended flooding on a small area of already existing wetlands would be an extreme example of what the NRC report recommended *against*.

b. Improper reliance on engineered hydrology

Related to the biological importance of natural hydrology is the report's strong recommendation against the reliance on engineering structures even to establish natural hydrology, let alone to distort it. Our report discussed problems with the use of engineering structures to establish hydrology, and stated "natural hydrology should be allowed to become reestablished rather than finessed through active engineering devices to mimic a natural hydroperiod," i.e., a naturally variable hydrology. The Corps has accepted this recommendation as well, and writes in its memo regarding adoption of NAS recommendations, "Artificial structures and mechanisms should be used only temporarily. Complex engineering and solely artificial mechanisms to maintain water flow normally will not be acceptable in a mitigation proposal."

Because the Corps' proposed mitigation relies on these kinds of artificial engineering structures, not just for fish but also for waterfowl and shorebirds, this proposed mitigation violates its own established principles.

c. Inconsistency with importance of spatial extent and landscape position

The importance of preserving or reestablishing natural hydrologic variability is closely related to the importance reflected in landscape position. The NRC report notes that "[l]andscapes have natural patterns that maximize the value and function of individual habitats." The report also encourages the preservation of "large buffers and connectivity to other wetlands," and generally recommends locating mitigation sites in comparable landscape positions and with comparable hydrology as the impact site. NRC Report p. 124. Noting that "slight differences in topography," i.e., elevation, have major impacts on hydrology and associated plants and animals, the report also calls for providing "appropriately heterogeneous topography." Ibid p. 127. The Corps has endorsed this recommendation as well in the 2003 Mitigation Memo. For example, it writes, "attempting to place mitigation in a dissimilar ecological complex than that of the impact water is expected to result in a wetland/water unlikely to replace the functions of the wetland/water that was lost." Memo p. 6. It also emphasizes the need for varied topography Memo p. 8-9.

For this project, the Corps proposes to create small areas to be managed in uniform ways as replacement for lost functions on an extensive expanse of wetlands and floodplain habitats with varied topography, extensive contiguity and, for much of the land, open hydrologic connectivity. This proposal violates the NRC panel's recommendations as well.

The rationale for the NRC panel's recommendations applies fully to the proposed project. The project area, according to the 2002 EIS, supports a wide range of fish, bird and amphibian species. These diverse species will use different kinds of habitats affected heavily by variable flood regimes, are adapted to take advantage of natural flood variability, and will therefore benefit from different aspects of that natural hydrology. Artificial flooding, even if it were to benefit some species, will almost certainly disadvantage others. The levees and water control structures designed to achieve ponding will obviously serve to obstruct fish passage. Extensive flooding over a large number of acres for many days, as occurs today, will also do more to trigger water quality filtration functions than somewhat longer flooding over a very small number of acres. Existing flooding will create a range of microhabitats, and interactions between floodplain and stream networks, that could not be mimicked by extended ponding on a small number of acres. The NRC has recommended the importance of these variations in microhabitat explicitly on floodplains:

> "River-floodplain systems have a lateral structure that begins at the main channel and progresses through undefeated and vegetated channel borders and floodplain habitats (backwaters and seasonally flooded vegetation types). Backwaters and large-scale eddies provide refuges from the high velocities and colder winter temperatures of the main channel. Within each of the border and floodplain areas, there are distinct patches, usually determined by small differences in land elevation, that in turn determine the period of inundation (or water depth, in permanently flooded areas) and soil saturation."

National Research Council, *Restoration of Aquatic Ecosystems* p. 181 (citation omitted). The NRC emphasized the importance of this patchiness, writing that "restoration necessarily involves maintenance or recreation of the original patchiness." p. 183, and emphasizing that floodplain connectivity is critical because "[a]nother way in which the character of rivers is drastically altered is by cutting off interactions with the riparian zone and floodplains." Ibid p. 169.

There is also the real risk, and in this case a likelihood, of a range of additional unintended adverse environmental consequences, of which blockage to fish passage is only the most obvious. They include the following common adverse consequences for artificially-prolonged hydroperiods that may occur particularly in the proposed shorebird and waterfowl impoundments:

- Rapid invasion of ponded areas by invasive wetland weeds such as cattails (*Typha* spp.), which can, within a single growing season, form dense canopies that cover wet soils
- Exclusion of native fish and/or shorebird use of weed-dominated wetland impoundments even beyond the problems that artificial barriers pose to fish access
- Eutrophication and fish kills in persistent, warm water

Artificially prolonged flooding could also result in a range of biochemical impacts that are hard to anticipate. In the face of the limitations of our understanding, and the repeated demonstration that alterations to natural hydrologic variability tend to have highly adverse consequences, the accepted understanding is that mitigation and other forms of environmental restoration should focus on reestablishing natural hydrologic variability. In this matter, the Corps has proposed to do the opposite of these recommendations.

The proposed project would dramatically reduce or eliminate flooding according to a relatively natural pattern on tens of thousands of acres of wetlands and other valuable floodplain areas, and replace them in part by artificially manipulating the hydrology on a small number of acres of already existing wetlands and in part by planting trees on already flooded land. According to established understanding, the focus of mitigation should be reestablishing of relatively natural flooding on appropriate presently dry areas, typically former wetlands, to offset the impacts on the proposed wetlands. Doing so requires mitigation sites roughly comparable in size to those affected (and often more).

Proper mitigation would probably undermine the economics of the project because it would essentially involve rewetting an area equivalent to that which this project will drain. But that is the point: Under the Clean Water Act program, wetland impacts are designed to be for unavoidable impacts to wetland systems necessitated by important economic activities that therefore warrant the effort to reproduce the lost wetland areas and functions elsewhere. The fact that this project can only be economically justified if it fails to follow these mitigation principles applicable across the regulatory program to private parties and local governments should not be a justification for violating these principles and cannot warrant a finding that project impacts are mitigated.

5. Inappropriate Use of Habitat Models

A related flaw with the Corps' analysis is its misuse of its habitat models, which go under the general category of Habitat Evaluation Procedures or HEP. By using these models to quantitatively estimate mitigation acreage requirements for very different kinds of habitat under very different hydrologic conditions, the Corps has used these models beyond any scientifically accepted level.

HEP models attempt to evaluate habitat for animals on the basis of very few criteria. For example, the fish model used by the Corps for this project is based entirely on numbers of average daily flooded acres and the different kinds of vegetation on those acres. In and of itself, it does not factor in such obviously critical factors as extent of contiguous habitat, hydrologic variability, microhabitats, temperature, water velocity, relationships among habitat types, and conditions under extreme flooding or drought.

The models also ignore the values of habitat diversity for the broad range of species being evaluated, providing one score for all fish, one score for all waterfowl and one score for all shorebirds. Because of their simplicity, HEP models have generally come into disrepute, particularly if used for more than one target game species. The HEP models for this report are intended to cover a range of species that in reality have different needs. Thus, when the National Research Council panel evaluated analytical tools for wetland mitigation, it noted that HEP models have often been used in the past, but did not recommend their continued use. *Compensating for Wetland Losses*, ch. 7. The National Research Council panel recommended the use of assessment techniques that meet eight conditions, few of which are met by HEP models.[2]

However, even if HEP models are to be used, it is broadly understood that they can only be used under conditions that essentially compare very similar habitats in all respects other than those varied by the model. For example, the fish HEP model can be used, if at all, to compare different floodplain habitat values for acres with different vegetation that experience similar patterns of natural hydrologic variability in similar landscape contexts. It cannot be used to compare habitats with very different kinds of hydrology, such as one relatively natural and the other highly managed and artificial. The most obvious reason is that no science went into the development of the model to reflect these important differences, such as those between relatively natural hydrology over an extensive landscape and those in a small area subject to artificial flooding and with barriers to fish access. When HEP models are used in fundamentally different hydrologic or landscape settings, or with very different ranges of other important characteristics, they are no longer science-based. To illustrate the problem, imagine an accurate model used to assess the number of annual calories needed by adults of different weights and heights. Such a model would not imply that adults would be equally healthy regardless of whether they received those calories through balanced meals or through candy bars. Neither would it imply that adults would be healthy whether they eat these calories in three meals a day or in one meal in a single day. At best, the Corps is attempting to use a habitat model for fish that was developed by comparing sites with comparable

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[2] Key recommendations include that the assessment technique “includes reliable indicators of the important wetland processes (hydrology, sedimentation and primary production)”; that it “incorporates effects of position in landscape,” that it “assess all recognized functions”; that it is “sensitive to changes in performance over a dynamic range” (such as difference in conditions in both very large and very small floods). Compensation for Wetland Losses p. 136-137. None of these conditions are met by the HEP models used for this project.

hydrology and landscape to evaluate mitigation sites with completely different hydrology and landscape position.

6. Shorebird Example

The discussion of shorebirds and proposed "mitigation" illustrate the flaws with the project and the mitigation plans. A broad number of shorebird species, use the Project area for both spring and fall migration and are an important part of the Mississippi River ecosystem. These species vary in their precise needs, using areas of different water depths, consuming invertebrates such as insects and worms, and in some cases, catching small fish. Most are visual feeders that depend on open areas, which is why wet fields can attract shorebirds to forage. As water moves up and down natural floodplains, there is a constantly moving front of shallow water that makes available different areas for shorebirds, some longer legs and others with shorter legs, such that they collectively feed in a diversity of habitats, including agricultural lands and edges of marshes, as well as in the same habitat at different times, depending on water depth and other factors. The DEIS calculates that the project will eliminate 731 acres of "optimized habitat." In light of different habitat value assigned to areas of different water depth, that implies that something on the order of 1,300 acres or more of the floodplain are flooded on average at all times throughout the entire Spring migratory period at depths that permit feeding by some species of shorebirds.[3]

The first presumption behind the mitigation is that this diversity of habitats and conditions can be replaced by managing and permanently inundating roughly 1,286 acres of agricultural lands every single year for 93 days in the Spring. This claim is simply not credible. There is no reason to believe that shorebird food supplies available every single day over 93 days of flooding on the same acres would be equal to that available on what now exists over thousands of acres flooded each to the right depth for shorebirds for only a portion of those days. This analysis also assumes that the only habitat values are food supplies and that shorebirds of multiple species will use one small confined area to the full degree that use much larger, diverse and variable areas. And it ignores the fact that dense bird usage makes birds susceptible to the transmission of disease.

This analysis also ignores the likelihood that wetland inundated with shallow water for 93 consecutive days will be invaded by marsh vegetation (most predictably

[3] I deduce this from the fact that the Corps indicates that 1,286 acres of habitat flooded every day during the shorebird season would be needed as mitigation based on its likely variable depths, which implies that similar numbers of acres are already flooded on average assuming a similar distribution of depths.

cattails, which can invade and dominate ponded areas within 93 days) and that even if the mitigation site will support invertebrates, dense vegetation will not attract many shorebirds. Active management would be required at all times to prevent dense weed invasions.

Second, the mitigation project would result in a net loss of wetland area and habitat for shorebirds because the plan says that the existing waterfowl management area, Ten Mile Pond, will provide 993 (77%) of the 1286 wetland acres lost by constructing the New Madrid Floodway. That cannot comply with Clean Water Act requirements for the obvious reason that the Ten Mile Pond wetland already exists. There is also no demonstration that the Ten Mile Pond area is managed or could be managed to provide the proposed water depths across the entire size, even if they were usable by shorebirds. And the fact that the Ten Mile Pond area is also being flooded and used to provide waterfowl habitat in the winter (and therefore prior to the start of the shorebird season indicated as March 15th) means that its food supplies would already be partially depleted and management for waterfowl would compete with management for shorebirds.

Finally, the mitigation plan suggests that there is no real need to mitigate for shorebirds, arguing that shorebirds would not originally have used the project area because it would have been wooded, and on the premise that mitigation might otherwise involve converting forest to agricultural land. Both claims are misguided.

- Although shorebird use would probably have been limited in the project area when it was mostly forested, overall the lower Mississippi Valley provided extensive habitat through its network of mudflats, sandflats, shallow pools and marshes. (Some of the project site was undoubtedly also unwooded.) The cut-off and drainage of more than 90% of the floodplain has severely reduced that available habitat. Fortunately, some human modifications have simultaneously made new habitats available, and those species that could take advantage of them have continued to survive. People have altered the overwhelming majority of the remaining habitat in the United States. If alterations were a justification for ignoring conservation of altered habitats, the bulk of the remaining habitat in the United States would be quickly extinguished.

- The ignoring of project impacts on shorebird habitat is a kind of Catch-22. Under standard mitigation principles and practice, the reduction of tens of thousands of acres of relatively naturally (and therefore irregularly) flooded aquatic habitat would need to be compensated by re-flooding tens of thousands of acres elsewhere in

> ways designed to mimic natural patterns as much as possible. Compensatory mitigation of this type is nearly always required of private parties, and it is inherent in the goals of maintaining spatial extent of aquatic ecosystems. In turn, the goal of spatial extent is based on the judgment that maintaining wetland area is necessary to preserve wetland functions, particularly in light of the importance of maintaining natural hydrology.
>
> For this project, of course, re-flooding other farmland, marsh and woodlands to offset the drainage of the project area would presumably not allow the project to be cost-effective because it would cancel out the economic gains of draining farmland. But that does not change the scientific judgment of the type of mitigation truly necessary to offset the project, and it also explains why large agricultural drainage projects cannot comply with the requirements of the Clean Water Act.

Ruling out the proper mitigation, the DEIS then correctly notes that it would undermine other conservation values to convert flooded forest to flooded agricultural land. But the correct approach is to do mitigation properly by re-flooding comparable areas, which recreates the habitat needs not only of shorebirds but of the diversity of other species. The proper refusal to consider leveling existing forests provides no rationale for ignoring the basic rules of mitigation; nor does it diminish the lost habitat values to shorebirds.

Shorebirds are a major part of the Mississippi River valley ecosystem. They rely on vanishingly few remaining locations that flood in the extensive, diverse and variable ways of the project area. The loss of shorebird habitat under the project would be extensive, and the proposed mitigation is mostly non-existent.

7. Failure to Specify Particular Mitigation Sites or Other Attributes of Detailed Mitigation Plan

Virtual all assessments of wetland mitigation, as summarized in *Compensating for Wetland Losses Under the Clean Water Act*, have found that most wetland mitigation projects have shortcomings to differing degrees, in that the target wetland mitigation has not fully replaced the lost wetland area and functions. The reasons for their shortcomings include the fact that compensating for wetland losses is technically very challenging and subject to a range of difficulties for even the most promising projects. Another reason is that the degree of commitment to wetland mitigation sites tends to wane once the underlying project has gone forward. The degree and likelihood of a project achieving its stated objective depends on the characteristics of the proposed mitigation sites.

One of the questions addressed by the National Research Council panel in *Compensating for Wetland Losses* was whether mitigation projects should therefore be completed prior to authorizing project impacts. The panel rejected this requirement on practical reasons, while noting that this level of certainty is one of the potential benefits of wetland mitigation banks. But the report emphasized the critical importance of providing a detailed mitigation plan before approval of project impacts. NRC Report p. 101.

Review of a specific mitigation site and reasonably detailed restoration plans are critical to any assessment of the likelihood and degree of mitigation, as well as the likelihood and degree of compliance. These are not minor details that can be resolved later. Given the challenges facing mitigation, there can be no legitimate determination that mitigation is likely to offset project impacts without this information. The NRC panel also recognized that mitigation ratios, i.e., the area of mitigation needed, need to be adjusted to reflect the prospects for achieving compliance. NRC Report p. 150. That too cannot occur properly without detailed advance information about mitigation sites and restoration plans. Such levels of details do not support any legitimate judgment about the extent to which mitigation will truly offset project impacts, and it is inconsistent with Corps-recommended practice as represented to the NRC panel

A few examples illustrate the significance.

- The DEIS claims that fish will be able to access Big Oak Tree State Park. The Park is above the elevation level at which inundation will normally be allowed to occur, and gates will have to be closed most of the time when floodwaters could reach the Park. It is also unclear how waters can reach the Park from the river during the bulk of the late winter, spring and summer when allowing water to move through a canal toward the Park would allow that water to spill over and flood adjacent lands that are supposed to be dry. The lack of detail of the mitigation plan is probably obscuring these large technical obstacles.
- Mitigation relies heavily on batture lands, which are in fact highly unlikely to provide the kind of calm, still waters with relatively higher temperatures necessary for spawning fish. Identification of specific mitigation sites would be necessary to examine if appropriate mitigation lands could truly be found.
- The mitigation plan claims that thousands of acres in the floodplain will be simultaneously acquired at high enough elevations to support

mast-producing trees for waterfowl but at low enough elevations to provide enough flooded habitat for fish as well as waterfowl. Identification of specific mitigation sites would permit closer examination of these claims.

Detailed mitigation plans are not merely necessary to make sure that proper mitigation is carried through, but they are also necessary to demonstrate that the proposed mitigation can truly achieve the claims of fully mitigation project impacts.

For all these reasons, I do not believe it is scientifically credible for the DEIS to claim that the impacts of the proposed project on aquatic resources would be fully or even substantially mitigated.

This document represents my views to the best of my knowledge, information and belief. I make these views subject to penalties for unsworn falsifications to authorities.

____ ______ Date: 25 November 2013
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PROFESSIONAL EXPERIENCE and EDUCATION

1998- Professor of Botany; Arboretum Research Director, Univ. of Wisconsin, Madison
1980-98 Professor of Biology, San Diego State University (SDSU)
1986- Director, Pacific Estuarine Research Laboratory, SDSU
1997 Associate Director, Environmental Science Program, SDSU
1991-3 Director, Coastal and Marine Institute, SDSU
1969-80 Asst. and Assoc. Professor, SDSU
1968-69 Instructor in Botany, Univ. of Missouri, Columbia
1968 Ph.D. in Botany (Plant Ecology), Univ. of Wisconsin, Madison
1966 M.S. in Botany, Univ. of Wisconsin, Madison
1964 B.S. in Biology, Augustana College, Sioux Falls, So. Dak.

RESEARCH INTERESTS

Wetland ecology; structure and functioning of wetlands; restoration ecology (especially adaptive restoration--learning while restoring through large field experiments); interactions of native and invasive species, diversity-function relationships in restoration sites; use of native species to manage stormwater; long-term monitoring; applying scientific information to ecosystem management.

PROFESSIONAL SOCIETIES AND EDITORIAL BOARDS

Society for Ecological Restoration International
    Editorial Board, *Restoration Ecology,* 2004-
Environmental Law Institute
    National Wetlands Newsletter Advisory Board 1998-
Society of Wetland Scientists
    International Conference Co-Chair, 2009
Ecological Society of America
    ESA Vegetation Section Chair, 1996-7
    ESA Editorial Board, *Ecological Applications,* 1992-4; reappointed 1999-2005
Estuarine Research Federation

ERF Vice President, 1987-89
ERF Program Chair, 10th Biennial International Conference, October 1989
ERF Editorial Board, *Estuaries*, 1984-89

American Ecological Engineering Society
Editorial Board, *Ecological Engineering: The Journal of Ecotechnology,* 1991-2005

Non-society journals:
Advisory Board, *National Wetlands Newsletter,* 1997-
Editorial Board, *Wetlands Ecology and Management,* 1988-2005
Editorial Board, *Ecosystems,* 1997-2000
Science Advisor, *Ecological Restoration,* 1988-2011

HONORS and AWARDS

Elected Fellow, Ecological Society of America, August 2013
Elected Fellow, Society of Wetland Scientists, May 2013
Stanford/Hopkins Marine Station: Scientific Working Group: thresholds/indicators in marine systems, 2013-
International Panel (8 mbrs) to advise South Korea's National Institute of Ecology, Oct. 2012-
Wisconsin Natural Areas Preservation Council, UW System Representative, 1999-2013
Wisconsin Chapter of The Nature Conservancy, Board of Trustees, 2004-
Environmental Defense Fund, Board of Trustees, 1998-2007; National Advisory Council, 2007-
Distinguished Seminar Speaker, Jones Ecological Reserve, Georgia, Feb. 2010
Paul Errington Distinguished Lecture, Iowa State U., March 2006.
Career Achievement Award, Augustana College: 2004
D. J. Dyksterhuis Distinguished Lecture, Texas A & M U., April 2003.
William A. Niering Outstanding Educator Award (first recipient): Estuarine Research Federation, International Biennial Conference, Tampa, Fla., November 2001
Southern California Wetlands Recovery Project: First Award for Achievements in Regional Wetland Conservation, October 2000
The Nature Conservancy National Governing Board, 1995-2004
Prepared the Society of Wetland Scientists' Position Paper on Defining "Wetland" 1999.
National Wetlands Award (Environmental Law Inst. & Environmental Protection Agency) for Science Research, demonstrating "an extraordinary commitment to the conservation and restoration of the nation's wetlands," May 1997
SDSU Biology Department Teacher-Scholar Award, May 1997
SDSU Alumni Association Award for Outstanding Faculty Contributions to the University, 1997
National Oceanic and Atmospheric Administration, Sanctuaries and Reserves Division, Special Award for outstanding contributions to the understanding of estuarine ecology and for contributions to the Tijuana River National Estuarine Research Reserve, March 1997
Society for Ecological Restoration, Theodore M. Sperry Award, 1995
National Research Council

Committee on the St. Lawrence Seaway: Options to Eliminate Introduction of Nonindigenous Species into the Great Lakes, Phase II. 2006-08.
Committee on Wetland Characterization, 1993-94
Water Science and Technology Board, 1991-94
Committee on Restoration of Aquatic Ecosystems, 1990-92
Planning Committee for the Second National Forum on Biodiversity, 1996-98
Committee on Wetland Mitigation (chair), 1999-2001

Chancellor's Distinguished Lecturer, University of California, Irvine, April 1992
Phi Beta Kappa Lecturer, SDSU, Fall 1992
Roger Revelle Perpetual Award, Oceans Foundation, 1991
Fellow, San Diego Natural History Museum, 1989
SDSU Meritorious Performance and Professional Promise Awards, 1985, 1988

ADVISORY PANELS/COMMITTEES

Lead Scientist advising the EPA Science Review Board to endorse the EPA Report on Wetland Connectivity.2013.

Science Advisory Group, Nature Reserve of Orange County (NROC), California 2013

Advisory Panel, Stanford U./Hopkins Marine Station Analysis of Thresholds for Marine Ecosystem Disruption, 2013-

Advisory Panel, South Korea National Institute of Ecology, Seocheon, 2013-

Science Review Panel for San Francisco Bay Responses to Climate Change Effects, 2012-

Science Advisory Council for Ormond Beach Restoration, The Nature Conservancy and CA State Coastal Conservancy, 2011-

Invasive *Spartina* Removal in San Francisco Bay, CA State Coastal Conservancy, 2011-

Science Advisory Council for Ballona Wetlands, Santa Monica Bay Restoration Commission, 2010-

International Crane Foundation Advisory Board, 2010-

National Ecological Observatory Network (NEON) Science Technology and Education Advisory Committee, 2008-2010

Wisconsin Department of Natural Resources, Natural Area Preservation Council, 1998-2013

State of Washington Salmon Restoration Validation Monitoring Panel, 2000-2004

UW University Ridge Research Steering Committee, 1999-2003

National Wetlands Awards Selection Committee, US EPA and Environmental Law Inst., 1997-1998

Pro Esteros, Board of Directors, 1990-91; Advisory Board 1995-8

National Parks Research Program Reviewer, Invasives in Everglades National Park, 1996-1997

Wetland Advisory Board, City of San Diego, 1992-1996

California Coastal Commission, Technical Review Committee for Developing State-Wide Standards for Mitigation Performance, 1994-2005

American Society of Civil Engineers Task Committee on Physical Processes in Tidal Wetland Restoration, 1996-98

National Wetlands Awards (Environmental Law Inst. & Environmental Protection Agency) Honorable Mention, 1994; Review panel member, 1995

U.S. Environmental Protection Agency Science Advisory Board Consultant, 1995-8
President Clinton's Forum on Science and Technology, Invitee, March 1994
Technical Panel, Environmental Protection Agency Global Change Program, 1993-5
National Water Research Institute, Research Advisory Board, 1992-3
Wetland Advisory Board, City of San Diego (Mayoral Appointee), 1992-6
California Sea Grant College, Coastal Resources Research Coordinator, 1992-6
Ecological Society of America ad hoc Committee on Wetlands Delineation, 1991
City of San Diego, Famosa Slough Guidance Committee, 1991
National Wetland Technical Council (13 members nationwide), charter member
Review Panel, US Dept. of Agriculture Competitive Grants Program for Water Quality, 1991
Scientific Advisory Committee, NOAA Estuarine Habitat Research Program, 1990-3
Tijuana River National Estuarine Research Reserve, Research and Education Committee Chair, 1982-93; Restoration Committee, 1995-8
Public Affairs Committee, Ecological Society of America (ESA), 1988-91
SDSU representative to the California Sea Grant Committee, 1986-90
Los Peñasquitos Lagoon Foundation, Technical Advisory Committee, 1985-97
Congressman Jim Bates Environment Subcommittee, 1985-6

LEAFLETS (30 well-illustrated materials that interpret research for a broad audience) at http://uwarboretum.org (click on leaflets on the publications menu)

PUBLICATIONS (not including abstracts and project reports)

Zedler, Joy B. In press. Patterns in nature and their causes. Paper Trail Essay for the Bulletin of the Ecological Society of America. (Invited).

Healy, M. G., I. Rojas-Viada, and J. B. Zedler. In revision. Adaptive control of *Phalaris arundinacea* in Curtis Prairie.

Doherty, J. M., J. F. Miller, S. Prellwitz, A. M. Thompson, S. Loheide, and J. B. Zedler. In review. Bundles and tradeoffs among six wetland services were associated with hydrologic regime.

Doherty, J. M., and J. B. Zedler. In press. Dominant graminoids support restoration of productivity but not diversity in urban wetlands. *Ecological Engineering, Special issue* on restoration.

Morzaria-Luna, H. N., and J. B. Zedler. On line Sept. 2013. Competitive interactions between two salt marsh halophytes across stress gradients. *Wetlands.*

Zedler, J.B. In press. Achievable restoration targets for urban wetlands. *Urban Coasts*, Online journal of the Center for Santa Monica Bay Studies, Los Angeles.

Galatowitsch, S. M. and J. B. Zedler. In press. Chapter 9. Wetland Restoration. *In:* D. Batzer and R. Sharitz (Eds.) *Ecology and Freshwwater and Estuarine Wetlands,* 2^{nd} edition. Elsevier, Inc., San Diego.

Lawrence, B. A., and Zedler, J. B. 2013. Tussock structural composition and carbon storage in *Carex stricta* sedge meadows. *Wetlands*. Online.

Zedler, J. B., and R. A. Lindig-Cisneros. 2013. Restoration of biodiversity, overview. In S. A. Levin, ed. *Encyclopedia of Biodiversity* 2nd Edition, Vol. 6:453-460. Academic Press. Waltham, Massachusetts.

Lawrence, B., T. Fahey, and J. B. Zedler. 2013. Root dynamics of *Carex stricta*-dominated tussock meadows. *Plant and Soil* 364:325-339. DOI: 10.1007/s11104-012-1360-y

Zedler, J. B. 2012. Chapter 1. Introduction: diverse perspectives on tidal marshes. Pp. 1-17 In A. Palaima, ed., *Ecology, Conservation, and Restoration of Tidal Marshes: The San Francisco Estuary.* University of California Press, Berkeley.

Zedler, J. B., J. M. Doherty and N. A. Miller. 2012. Shifting restoration policy to address landscape change, novel ecosystems, and monitoring. *Ecology and Society* 17 (4): 36. [online] URL: /www.ecologyandsociety.org/vol17/iss4/art36/, also at special feature URL: www.ecologyandsociety.org/issues/view.php/feature/82.

Johnston, C. A., and J. B. Zedler. 2012. Identifying preferential associates to initiate restoration plantings. *Restoration Ecology* 20:764-772.

Olson, E., S. Ventura, and J. B. Zedler. 2012. Merging geospatial and field data to predict the distribution and abundance of an exotic macrophyte in a large Wisconsin reservoir. *Aquatic Botany 96: 31-41.*

Doherty' J. M., C. Callaway, and J. B. Zedler. 2011. Diversity-function relationships changed in a long-term restoration experiment. *Ecological Applications* 21: 2143-2155.

Lawrence, B. A., and J. B. Zedler. 2011. Formation of tussocks in sedges: effects of hydroperiod and nutrients. *Ecological Applications* 21: 1745-1759.

Zedler, J. B. 2011. Restoring a dynamic ecosystem to sustain biodiversity. *Ecological Restoration* 29:152-160.

Zedler, J. B. 2011. Wetlands. Pp. 698-704 in D. Simberloff and M. Remanek, eds. Encyclopedia of Introduced Invasive Species. UC Press. Berkeley, CA.

Jelinski, N. A., C. J. Kucharik and J. B. Zedler. 2011. A test of diversity-productivity models in natural, degraded, and restored wet prairies. *Restoration Ecology* 19:186:293).

Zedler, J. B. 2010. How frequent storms affect wetland vegetation: A preview of climate change impacts. *Frontiers in Ecology and the Environment* 8:540-547.

Zedler, J B. 2010. Wetlands as harbingers of climate change. *National Wetlands Newsletter* 32: 13-17.

Healy, M.G., and J. B. Zedler. 2010. Setbacks in replacing *Phalaris arundinacea* monotypes with sedge meadow vegetation. *Restoration Ecology* 18: 155-164.

Allen, A. E., F. J. Santana-Michel, C. Ortiz Arrona and J. B. Zedler. 2010. Integrating ecological and ethnobotanical priorities into riparian restoration. *Ecological Restoration* 28: 377-388.

Prasser, N., and J. B. Zedler. 2010. Salt tolerance of invasive *Phalaris arundinacea* exceeds that of native *Carex stricta* (Wisconsin). *Ecological Restoration* 28:238-240.

Johnston, C. A., M. Tulbure, and J. B. Zedler. 2010. Latitudinal gradient of floristic condition among Great Lakes Coastal Wetlands. *Journal of Great Lakes Research* 36: 772–779.

Hall, S. J., and J. B. Zedler. 2010. Constraints on sedge meadow self-restoration in urban wetlands. *Restoration Ecology* 5:671-680.

Zedler, J. B. 2009. Feedbacks that might sustain natural, invaded and restored states in herbaceous wetlands. Pages 236-258 in R. Hobbs and K. N. Suding, eds., *New models for ecosystem dynamics and restoration,* Island Press, Washington, D.C.

Larkin, D., J. West, and J. B. Zedler. 2009. Created pools and food availability for fishes in a restored salt marsh. *Ecological Engineering* 35:65-74.

Gardner, R. C., J. Zedler, A. Redmond, R. E. Turner, C. A. Johnston, V. A. Alvarez, C. A. Simenstad, K. L. Prestegaard, and W. J. Mitsch. 2009. Compensating for wetland losses under the Clean Water Act (Redux): Evaluating the Federal Compensatory Mitigation Regulation. National Wetland Newsletter 31(2):1, 3-8 (short, reformatted version of the following).

Gardner, R. C., J. Zedler, A. Redmond, R. E. Turner, C. A. Johnston, V. A. Alvarez, C. A. Simenstad, K. L. Prestegaard, and W. J. Mitsch. 2009. Compensating for wetland losses under the Clean Water Act (Redux): Evaluating the Federal Compensatory Mitigation Regulation. *Stetson Law Review* 38:213-249.

Johnston, C. A., Joy B. Zedler, M. G. Tulbure, C. B. Frieswyk DeJong, B. L. Bedford, L. Vaccaro. 2009. A unifying approach for evaluating the condition of wetland plant communities and identifying related stressors. *Ecological Applications* 19:1739-1957.

Callaway, J. C., and J. B. Zedler. 2009. Salt marsh conservation along the leading edge of the continent. Pp. 285-307 in B. Silliman, E. Grosholz and M. Bertness, eds. *Human impacts on Salt Marshes*. University of California Press, Berkeley, CA.

Zedler, J. B. and J. M. West. 2008. Declining diversity in natural and restored salt marshes: A 30-year study of Tijuana Estuary. *Restoration Ecology* 16:249-262.

Frieswyk, C. B., C. Johnston, and J. B. Zedler. 2008. Identifying and characterizing dominant plants as an indicator of community condition. *Journal of Great Lakes Research* 33(Special Issue 3):125-135.

Adam, P., M. D. Bertness, A. J. Davy, and J. B. Zedler. 2008. Saltmarsh. Pp. 157-171 in N. Polunin, ed. *Aquatic Ecosystems*. Cambridge University Press. Cambridge, U.K.

Johnston, C.A., B. Bedford, M. Bourdaghs, T. Brown, C. B. Frieswyk, M. Tulbure, L. Vaccaro, and J. B. Zedler. 2008. Plant species indicators of physical environment in Great Lakes coastal wetlands. *Journal of Great Lakes Research* 33 (Special Issue 3):106-124.

Johnston, C.A., D. Ghioca, M. Tulbure, SB. L. Bedford, M. Bourdaghs, C. B. Frieswyk, L. Vacaro, and J. B. Zedler. 2008. Partitioning vegetation response to anthropogenic stress to develop multi-taxa indicators of wetland condition. *Ecological Applications* 18:983-1001.

Varty, A., and J. B. Zedler. 2008. How waterlogged microsites help an annual plant persist among salt marsh perennials. *Estuaries and Coasts* 31:300-312.

Stiles, C. A., B. Bemis, and J. B. Zedler. 2008. Evaluating edaphic conditions favoring reed canary grass invasion in a restored native prairie. *Ecological Restoration* 26:61-70.

Zedler, J. B., and K. Potter. 2008. Southern Wisconsin's Herbaceous Wetlands: Their Recent History and Precarious Future. Pages 193-210 in *The vanishing present*. D. Waller and T. Rooney, eds. University of Chicago Press.

Larkin, D. J., S. P. Madon, J. M. West and J. B. Zedler. 2008. Topographic heterogeneity influences fish use of an experimentally-restored tidal marsh. *Ecological Applications* 18:483-496.
Zedler, J. B., C. L. Bonin, D. J. Larkin, and A. Varty. 2008. Salt marshes. Pages 3132-3141 in Sven Erik Jorgensen & Brian D. Fath, 2008. *Encyclopedia of Ecology*, 1st Edition, Elsevier B.V., Oxford.
Boers, A. M., and J. B. Zedler. 2008. Stabilized water levels and *Typha* invasiveness. *Wetlands* 28: 676-685**.**
Wagner, K., S. K. Gallagher, M. Hayes, B. A. Lawrence, and J. B. Zedler. 2008. Wetland restoration in the new millennium: Do research efforts match opportunities? *Restoration Ecology*16: 367-372*.*
Hall, S. J., R. A. Lindig-Cisneros and J. B. Zedler. 2008. Does harvesting sustain plant diversity in Central Mexican wetlands? *Wetlands* 28:776-792.
Peterson, C. H., K. W. Able, C. F. DeJong, M. F. Piehler, C. A. Simenstad, and J. B. Zedler. 2008. Practical proxies for tidal marsh ecosystem services: Application to injury and restoration. *Advances In Marine Biology* 54:221-266.
Committee on the St. Lawrence Seaway: Options to Eliminate Introduction of Nonindigenous Species into the Great Lakes, Phase 2; National Research Council. 2008. *Great Lakes Shipping, Trade, and Aquatic Invasive Species*. Transportation Research Board, Washington, D.C. (Member of this NRC Committee).
Bonin, C. L., and J. B. Zedler. 2008. Plant traits and plasticity help explain abundance ranks in a California salt marsh. *Estuaries and Coasts* 31:682-693*.*
Boers, A., R. Veltman, and J. B. Zedler. 2007. *Typha x glauca* dominance and extended hydroperiod constrain restoration of wetland diversity*. Ecological Engineering* 29:232-244.
Morzaria-Luna, H., and J. B. Zedler. 2007. Does seed availability limit plant establishment during salt marsh restoration? *Estuaries* 30:12-25.
Frieswyk, C. B., and J. B. Zedler. 2007. Vegetation change in Great Lakes coastal wetlands: Deviation from the historical cycle. *Journal of Great Lakes Research* 33:366-380.
Kercher, S. M., A. Herr-Turoff, and J B. Zedler. 2007. Understanding invasion as a process: The case of *Phalaris arundinacea* in wet prairies. *Biological Invasions* 9:657-665.
Zedler, J. B. 2007. Success: An unclear, subjective descriptor of restoration outcomes. *Ecological Restoration* 25:162-168.
Wilcox, J. C., M. T. Healy and J. B. Zedler. 2007. Restoring native vegetation to an urban wet meadow dominated by reed canarygrass (*Phalaris arundinacea* L.) in Wisconsin, USA. *Natural Areas Journal* 27:354-365.
Sullivan, G., J. Callaway and J. B. Zedler. 2007. Plant assemblage composition explains and predicts how biodiversity affects salt marsh functioning. *Ecological Monographs* 77:569-590.
Herr-Turoff, A. and J. B. Zedler. 2007. Does morphological plasticity of the *Phalaris arundinacea* canopy increase invasiveness? *Plant Ecology* 193:265-277.
O'Brien, E., and J. B. Zedler. 2006. Accelerating the restoration of vegetation in a southern California salt marsh. *Wetlands Ecology and Management* 14:269-286.

Larkin, D. J., G. Vivian-Smith, and J. B. Zedler. 2006. Topographic heterogeneity theory and ecological restoration. Pp. 144-164 In: Falk, D., M. Palmer, and J. B. Zedler, eds. *Foundations of Restoration Ecology*. Island Press, Washington, D.C.

Falk, D., M. Palmer, and J. B. Zedler, eds. 2006. *Foundations of Restoration Ecology*. Island Press. Washington, D.C.

Palmer, M. A., D. A. Falk, and J. B. Zedler. 2006. Ecological theory and restoration ecology. Pp 1-10 In: Falk, D., M. Palmer, and J. B. Zedler, eds. *Foundations of Restoration Ecology*. Island Press, Washington D.C.

Falk, D. A., M. A. Palmer, and J. B. Zedler. 2006. Integrating restoration ecology and ecological theory: A synthesis. Pp. 341-345 In: Falk, D., M. Palmer, and J. B. Zedler, eds. *Foundations of Restoration Ecology*. Island Press. Washington D.C.

Peach, M. A. and J. B. Zedler. 2006. How tussocks structure sedge meadow vegetation. *Wetlands* 26: 322-335.

Boers, A., C. Frieswyk, J. Verhoeven and J. Zedler. 2006. Chapter 10: Contrasting approaches to the restoration of diverse vegetation in herbaceous wetlands. Pp. 225-246 in R. Bobbink, B. Beltman, J J.T.A. Verhoeven, and D.F. Whigham, eds. *Wetlands as a natural resource*, Vol. 2. *Wetlands: Functioning, Biodiversity Conservation and Restoration*. Springer Verlag.

Zedler, J. 2006. Wetland restoration. Pp. 348-406 in D. P. Batzer and R. R. Sharitz, eds. *Ecology of Freshwater and Estuarine Wetlands*. Elsevier, Inc., San Diego.

Frieswyk, C. B., and J. B. Zedler. 2006. Do seed banks confer resilience to coastal wetlands invaded by *Typha* x *glauca*? *Canadian Journal of Botany* 84:1882-1893.

Callaway, J. C., K. W. Wallace and J. B. Zedler. 2006. Reply to comment on our paper Evolution of tidal creek networks in a high sedimentation environment: a 5-year experiment at Tijuana Estuary, California. *Estuaries and Coasts 29*:1268-1269.

Zedler, J. B. 2005. Restoring wetland plant diversity: A comparison of existing and adaptive approaches. *Wetlands Ecology and Management* 13:5-14.

Fellows, M. and J. B. Zedler. 2005. Effects of the non-native grass, *Parapholis incurva* (Poaceae), on the rare and endangered hemiparasite, *Cordylanthus maritimus* subsp. *maritimus* (Scrophulariaceae). Madroño 52:91-98.

Zedler, J. B. 2005. Restoration ecology: Principles from field tests of theory. *San Francisco Estuary and Watershed Science.* On line at: http://repositories.cdlib.org/jmie/sfews/vol3/iss2/art4

Zedler, J. B. 2005. How compatible are biodiversity and ecosystem-service restoration goals? *National Wetlands Newsletter* 27(6):1,11-13,19.

Herr-Turoff, A., and J. B. Zedler. 2005. Does wet prairie vegetation retain more nitrogen with or without *Phalaris* invasion. *Plant and Soil* 277:19-34.

Lindig-Cisneros, R. y J. B. Zedler. La restauración de humedales. 2005. Pp. 201-213 In: Sánchez, Ó., E. Peters, R. Márquez-Huitzil, E. Vega, G. Portales, M. Valdés y D. Azuara, eds. *Temas Sobre Restauración ecológica. Instituto Nacional de Ecología-Semarnat*. U.S. Fish and Wildlife Service, Unidos para la Conservación. México, D. F.

Wallace, K.J., J.C. Callaway, and J.B. Zedler. 2005. Evolution of tidal creek networks in a high sedimentation environment: A 5-year experiment at Tijuana Estuary, California. *Estuaries* 28:795-811.

Zedler, J. B., and S. Kercher. 2005. Wetland resources: Status, ecosystem services, degradation, and restorability. *Annual Review of Environment and Resources* 30:39-74. Annual Reviews, Palo Alto, CA.

Kercher, S. M., and J. B. Zedler. 2004. Multiple disturbances accelerate invasion of reed canary grass *(Phalaris arundinacea* L.) in a mesocosm study. *Oecologia* 138:455-464.

Zedler, J. B. 2004. Compensatory mitigation for damages to wetlands: Can net losses be reduced? *Transactions of the Wisconsin Academy of Arts, Letters and Sciences* 90:103-117.

Callaway, J. C. and J. B. Zedler. 2004. Restoration of urban salt marshes: Lessons from southern California. *Urban Ecosystems* 7:107-124.

Morzaria-Luna, H., J. C. Callaway, G. Sullivan and J. B. Zedler. 2004. Relationship between topographic heterogeneity and vegetation patterns in a Californian salt-marsh. *Journal of Vegetation Science*.15:523-530.

Kercher, S. M., Q. Carpenter, and J. B. Zedler. 2004. Interrelationships of hydrologic disturbances, reed canary grass *(Phalaris arundinacea* L.), and native plants in Wisconsin wet meadows. *Natural Areas Journal* 24:316-325.

Zedler, J. B., and S. Kercher. 2004. Causes and consequences of invasive plants in wetlands: Opportunities, opportunists, and outcomes *Critical Reviews in Plant Sciences* 23:431-452.

Kercher, S. M., and J. B. Zedler. 2004. Flood tolerance in wetland angiosperms: a comparison of invasive and noninvasive species. *Aquatic Botany* 80:89-102.

Zedler, J. B. 2004. Compensating for wetland losses in the United States. In M. M. Rehfisch, C. F. Feare, N. V. Jones, and C. Spray, eds. *Climate Change and Coastal Birds*. *Ibis* 146 (Suppl. 1): S92-S100.

Zedler, J. B., and J. C. Callaway. 2003. Adaptive restoration: A strategic approach for integrating research into restoration projects. Pp. 167-174 in D. J. Rapport, W. L. Lasley, D. E. Rolston, N. O. Nielsen, C. O. Qualset, and A. B. Damania, eds. Managing for Healthy Ecosystems. Lewis Publishers, Boca Raton, Florida.

Zedler, J. B. 2003. Wetlands at your service: Reducing impacts of agriculture at the watershed scale. *Frontiers in Ecology and Environment* 1:65-72.

Ward, K. M., J. C. Callaway, and J. B. Zedler. 2003. Episodic colonization of an intertidal mudflat by a native cordgrass *(Spartina foliosa)* at Tijuana Estuary. *Estuaries* 26:116-130.

Lindig-Cisneros, R., J. Desmond, K. Boyer, and J. B. Zedler. 2003. Wetland restoration thresholds: Can a degradation transition be reversed with increased effort? *Ecological Applications* 13:193-205.

Miller, R. C., and J. B. Zedler. 2003. Responses of native and invasive wetland plants to hydroperiod and water depth. *Plant Ecology* 167:57-69.

Zedler, J. B., H. N. Morzaria-Luna, and K. Ward. 2003. The challenge of restoring vegetation on tidal, hypersaline substrates. *Plant and Soil* 253:259-273.

Maurer, D. A., R. Lindig-Cisneros, K. J. Werner, S. Kercher, R. Miller, and J. B. Zedler. 2003. The replacement of wetland vegetation by *Phalaris arundinacea* (reed canary grass). *Ecological Restoration* 21:116-119.

West, J., Williams, G., Madon, S. P., and Zedler, J. B. 2003. Integrating spatial and temporal variability into the analysis of fish food web linkages in Tijuana Estuary. *Environmental Biology of Fishes* 67:297-309.

Meyer, J. L., L. A. Kaplan, D. Newbold, D. L. Strayer, C. J. Woltemade, J. B. Zedler, R. Beilfuss, Q. Carpenter, R. Semlitsch, M. C. Watzin, and P. H. Zedler. 2003. Where rivers are born: The scientific imperative for defending small streams and wetlands. White paper. The Sierra Club, Washington, D. C.

Callaway, J. C., G. Sullivan, and J. B. Zedler. 2003. Species-rich plantings increase biomass and nitrogen accumulation in a wetland restoration experiment. *Ecological Applications* 13:1626-1639.

Kercher, S. M., C. B. Frieswyk, and J. B. Zedler. 2003. Effects of sampling teams and estimation methods on the assessment of plant cover. *Journal of Vegetation Science* 14:899-906.

Bonilla-Warford, C., and J. B. Zedler. 2002. Potential for using native plant species in stormwater wetlands. *Environmental Management* 29:385-393.

Keer, G., and J. B. Zedler. 2002. Salt marsh canopy architecture differs with the number and composition of species. *Ecological Applications* 12:456-473.

Maurer, D. A., and J. B. Zedler. 2002. Differential invasion of a wetland grass explained by tests of nutrients and light availability on establishment and vegetative growth. *Oecologia* 131:279-288.

Lindig-Cisneros, R. and J. B. Zedler. 2002. *Phalaris arundinacea* L. seedling establishment: Effects of canopy complexity in fen, mesocosm and restoration experiments. *Canadian Journal of Botany* 80:617-624.

Madon, S. P., J. West, and J. B. Zedler. 2002. Responses of fish to topographic heterogeneity in an experimental marsh (California). *Ecological Restoration* 20:56-58.

Zedler, J. B., and Paul Adam. 2002. Saltmarshes Pp. 238-266 in M. Perrow and A. Davy, ed. *Handbook of Restoration Ecology*, Cambridge: Cambridge University Press. Cambridge, UK.

Lindig-Cisneros, R. and J. B. Zedler. 2002. Relationships between canopy complexity and germination microsites for *Phalaris arundinacea* L. *Oecologia* 133:159-167.

Desmond, J., D. Deutschman, and J. B. Zedler. 2002. Spatial and temporal variation in estuarine fish and invertebrate assemblages: Analysis of an 11-year dataset. *Estuaries* 25:552-569.

Woo, I., and J. B. Zedler. 2002. Can nutrients alone shift a sedge meadow towards the invasive *Typha* x *glauca? Wetlands* 22:509-521.

Werner, K. J. and J. B. Zedler. 2002. How sedge meadow soils, microtopography, and vegetation respond to sedimentation. *Wetlands* 22:451-466.

Lindig-Cisneros, R. and J. B. Zedler. 2002. Halophyte recruitment in a salt marsh restoration site. *Estuaries* 25: 1174-1183.

Zedler, J. B., editor. 2001. *Handbook for Restoring Tidal Wetlands*. Marine Science Series, CRC Press LLC, Boca Raton. Florida.

Zedler, J. B., R. Lindig-Cisneros, C. Bonilla-Warford, and I. Woo. 2001. Restoration of biodiversity: An overview. Pp. 203-212 in S. Levin, editor. *Encyclopedia of Biodiversity, Vol. 5..* Academic Press, San Diego.

Noe, G. B., and J. B. Zedler. 2001. Spatio-temporal variation of salt marsh seedling establishment in relation to the abiotic and biotic environment. *Journal of Vegetation Science* 12:61-74.

Noe, G. B., and J. B. Zedler. 2001. Variable precipitation limits the germination of upper intertidal marsh plants in southern California. *Estuaries* 24:30-40.

Madon, S. P., G. D. Williams, J. M. West, and J. B. Zedler. 2001. The importance of marsh access to growth of the California killifish, *Fundulus parvipinnis*, evaluated through bioenergetics modeling. *Ecological Modelling* 136: 149-165.

Williams, G. D., J. M. West, and J. B. Zedler. 2001. Shifts in fish and invertebrate assemblages of two southern California estuaries during the 1997-98 El Niño. Bulletin of the Southern California Academy of Sciences 100(3): 212-237.

Goodwin, P., A. J. Mehta, and J. B. Zedler. 2001. Tidal wetland restoration: An introduction. *Journal of Coastal Research* Special Issue 27:1-6.

Zedler, J. B., and J. C. Callaway. 2001. Tidal wetland functioning. In P. Goodwin and A. J. Mehta, eds. Tidal Wetlands; Physical and Ecological processes. *Journal of Coastal Research* Special Issue 27:38-64.

Zedler, J. B., and R. Lindig-Cisneros. 2001. Functional equivalency of restored and natural salt marshes. Pp. 565-582 in M. Weinstein and D. Kreeger, eds. *Concepts and Controversies in Tidal Marsh Ecology*. Kluwer Academic Publishers, Dordrecht, The Netherlands.

Zedler, J. B., and L. Shabman. 2001. Compensatory mitigation needs improvement, panel says. *National Wetlands Newsletter* 23(4):1, 12-14. [Also reprinted in *Ecological Restoration,* November 2001.]

McCarty, J. P., and J. B. Zedler. 2001. Ecological restoration and its potential to reduce the negative impacts of global change. Pp. 532-539 in H. A. Mooney and J. Canadell, eds. Encyclopedia of Global Environmental Change, Vol. 2: The Earth System: Biological and Ecological Dimensions of Global Environmental Change. John Wiley and Sons Ltd., London.

Lindig-Cisneros, R. A., and J. B. Zedler. 2001. Effect of light on *Phalaris arundinacea* L. germination. *Plant Ecology* 155:75-78.

Turner, R. E., A. Redmond, and J. B. Zedler. 2001. Count it by acre or function—Mitigation adds up to net loss of wetlands. *National Wetlands Newsletter* 23(6):5-6,14-16.

Zedler, J. B., J. C. Callaway, and G. Sullivan. 2001. Declining biodiversity: Why species matter and how their functions might be restored. *BioScience* 51:1005-1017.

Committee on Wetland Mitigation; National Research Council. 2001. *Compensating for Wetland Loss under the Clean Water Act*. National Academy Press, Washington, D.C. (Coauthor of this book and chair of the panel that produced it).

James, M. L., and J. B. Zedler. 2000. Dynamics of wetland and upland subshrubs at the salt marsh-coastal sage scrub ecotone. *American Midland Naturalist* 82:81-99.

Zedler, J. B. 2000. Restoration of biodiversity to coastal and inland wetlands. Pp. 311-330 in B. Gopal, editor. *Biodiversity in Wetlands: Assessment, Function and Conservation.* Backhuys Publishers, Leiden, The Netherlands.

Zedler, J. B., and J. C. Callaway. 2000. Evaluating the progress of engineered tidal wetlands. *Ecological Engineering* 15:211-225.

Desmond, J. S., G. D. Williams, and. B. Zedler 2000. Improving the design of fish habitat mitigation projects in southern California. Pages 245-251. *In* J. E. Keeley, M. Baer-Keeley, and C.J. Fotheringham, eds. 2nd Interface Between Ecology and Land Development in California. US Geological Survey Open File Report 00-62. Sacramento, California.

Streever, W., and J. B. Zedler. 2000. To plant or not to plant? BioScience 50:188-189.

Zedler, J. B. 2000. Progress in wetland restoration ecology. *Trends in Ecology and Evolution* 15:402-407 (invited review article).

Trnka, S., and J. B. Zedler. 2000. Site conditions, not parental phenotype, determine the height of *Spartina foliosa. Estuaries* 23:572-582..

Lindig-Cisneros, R. and J. B. Zedler. 2000. Restoring urban habitats: A comparative approach. *Ecological Restoration* 18:184-192.

West, J. M., and J. B. Zedler. 2000. Marsh-creek connectivity: Fish use of a tidal salt marsh in southern California. *Estuaries* 23: 699-710.

Noe, G. B., and J. B. Zedler. 2000. Differential effects of four abiotic factors on the germination of salt marsh annuals. *American Journal of Botany* 87:1679-1692.

Boyer, K. E., J. C. Callaway, and J. B. Zedler. 2000. Evaluating the progress of restored cordgrass *(Spartina foliosa)* marshes: Belowground biomass and tissue N. *Estuaries* 23:711-721.

Fong, P., and J. B. Zedler. 2000. Sources, sinks, and fluxes of nutrients (N+P) in a small highly modified urban estuary in southern California. *Urban Ecosystems* 4:125-144.

Desmond, J., J. B. Zedler, and G. D. Williams. 2000. Fish use of tidal creek habitats in two southern California salt marshes. *Ecological Engineering*. 14:233-252

Sullivan, G., and J. B. Zedler. 1999. Functional redundancy among tidal marsh halophytes: a test. *Oikos* 84: 246-260.

Zedler, J. B., J. C. Callaway, J. Desmond, G. Vivian-Smith, G. Williams, G. Sullivan, A. Brewster, and B. Bradshaw. 1999. Californian salt marsh vegetation: An improved model of spatial pattern. *Ecosystems* 2:19-35.

Boyer, K. E., and J. B. Zedler. 1999. Nitrogen addition could shift species composition in a restored California salt marsh. *Restoration Ecology* 7:74-85.

Zedler, J. B., and J. C. Callaway. 1999. Tracking wetland restoration: Do mitigation sites follow desired trajectories? *Restoration Ecology* 7:69-73.

Zedler, J. B. 1999. The ecological restoration spectrum. Pp. 301-318 in W. Streever, ed. An International Perspective on Wetland Rehabilitation. Kluwer Academic Press, Dordrecht, The Netherlands.

Zedler, J. B., K. E. Boyer, G. D. Williams, and J. C. Callaway. 1999. Creating intertidal habitat for endangered species in southern California: Achievements and challenges. Pp. 739-747 in A. J. McComb and J. A. Davis, eds. *Wetlands for the Future*. Proceedings of INTECOL's V International Wetlands Conference, Gleneagles Press, Adelaide.

Williams, G. D., and J. B. Zedler. 1999. Fish assemblage composition in constructed and natural tidal marshes of San Diego Bay: Relative influence of channel morphology and restoration history. *Estuaries* 22:702-716.

Zedler, J. B. 1999. The continuing challenge of restoration. Pages 116-126 in C. Meine and R. l. Knight, eds. The essential Aldo Leopold. University of Wisconsin Press, Madison.

Zedler, J. B., J. S. Desmond, S. Phinn, B. Nyden, G. Sullivan, G. D. Williams, J. C. Callaway, K. E. Boyer, A. Powell. 1998. New tools for assessing coastal habitats. Pp. 1016-1027 in O. T. Magoon, H. Converse, B. Baird, and M. Miller-Henson, eds. *California and the World Ocean '97*. American Society of Civil Engineers, Reston, Virginia.

Zedler, J. B. 1998. Replacing endangered species habitat: The acid test of wetland ecology. Pp. 364-379 (Chapter 15) in P. L. Fiedler and P. M. Kareiva, eds. *Conservation biology for the coming age.* Chapman and Hall, New York.

Zedler, Joy B., and Naomi Rea. 1998. Introduction to the ecology and management of wetland plant invasions. *Wetlands Ecology and Management* 5:161-163.

Callaway, J. C., and J. B. Zedler. 1998. Interactions between a salt marsh native perennial *(Salicornia virginica)* and an exotic annual *(Polypogon monspeliensis)* under varied salinity and hydroperiod. *Wetlands Ecology and Management* 5:179-194.

Boyer, K. E., and J. B. Zedler. 1998. Effects of nitrogen additions on the vertical structure of a constructed cordgrass marsh. *Ecological Applications* 8:692-705.

Zedler, J. B. 1998. Southern California Coastal Marshes. Pp. 37-38 in S. Sanzione and A. McElroy, eds. Ecological impacts and evaluation criteria for the use of structures in marsh management. U.S. Environmental Protection Agency Sciences Advisory Board. EPA-SAB-EPEC-98-003.

Zedler, J. B., M. Fellows, and S. Trnka. 1998. Wastelands to wetlands: Links between habitat protection and ecosystem science. Pp. 69-112 in P. Groffman and M. Pace, eds. *Successes, limitations and frontiers in ecosystem science*. Springer-Verlag, New York.

Williams, G. D., J. S. Desmond, and J. B. Zedler. 1998. Extension of two nonindigenous fishes, *Acanthogobius flavimanus* and *Poecilia latipinna*, into San Diego Bay marsh habitats. California Fish and Game 84(1):1-17.

Zedler, J. B., and M. K. Leach. 1998. Managing urban wetlands for multiple use, including research**.** *Urban Ecosystems* 2:189-204**.**

Zedler, J. B. 1997. Conservation activism: A proper role for academics? In S. T. A. Pickett, R. S. Ostfeld, M. Shachak, and G. E. Likens, eds. *The ecological basis of conservation*. P. 345-350. Chapman and Hall. NY.

Zedler, J. B., and J. C. Callaway. 1997. Restoration Ecology: Combining the teaching of ecological principles with team experiments and native plant restoration on the SDSU campus. *Bull. Ecol. Soc. Amer.* 78:67-69**.**

Parsons, L., and J. B. Zedler. 1997. Factors affecting reestablishment of an endangered annual plant at a California salt marsh. *Ecological Applications* 7:253-267.

Zedler, J. B., G. D. Williams, and J. Desmond. 1997. Wetland mitigation: Can fishes distinguish between natural and constructed wetlands? *Fisheries* 22:26-28.

Haltiner, J., J.B. Zedler, K.E. Boyer, G.D. Williams, and J.C. Callaway. 1997. Influence of physical processes on the design, functioning and evolution of restored tidal wetlands in California. *Wetlands Ecology and Management* 4:73-91*.*

Kwak, T. J., and J. B. Zedler. 1997. Food web analysis of southern California coastal wetlands using multiple stable isotopes. *Oecologia* 110: 262-277*.*

Kuhn, N., and J. B. Zedler. 1997. Differential effects of salinity and soil saturation on native and exotic plants of a coastal salt marsh. *Estuaries* 20:391-403.

Callaway, J.C., J.B. Zedler, and D.L. Ross. 1997. Using tidal salt marsh mesocosms to aid wetland restoration. *Restoration Ecology* 5:135-146*.*

Fong, P., J. Desmond, and J.B. Zedler. 1997. The effect of a horn snail on *Ulva expansa:* consumer or facilitator of growth? *Journal of Phycolog*y 33:353-359.

Zedler, J. B. 1997. Adaptive management of coastal ecosystems designed to support endangered species. *Ecology Law Quarterly* 24:735-743*.*

Zedler, J. B. 1996. Ecological issues in wetland mitigation: An introduction to the forum. *Ecological Applications* 6:33-37*.*

Zedler, J. B. 1996. Coastal mitigation in southern California: The need for a regional restoration strategy. *Ecological Applications* 6:84-9*3.*

Boyer, K. E. and J. B. Zedler. 1996. Damage to cordgrass by scale insects in a constructed salt marsh: effects of nitrogen additions. *Estuarie*s 19:1-12.

Zedler, J. B. 1996. Ecological function and sustainability in created wetlands. P. 331-342 in D. Falk, C. Millar, and P. Olwell, eds. *Restoring diversity: Strategies for reintroduction of endangered plants*. Island Press.

Scatolini, S. R., and J. B. Zedler. 1996. Epibenthic invertebrates of natural and constructed marshes of San Diego Bay. *Wetlands* 16:24-37*.*

Zedler, J. B., principal author. 1996. *Tidal wetland restoration: A scientific perspective and southern California focus*. California Sea Grant College System, University of California, La Jolla, California Report No. T-038. 129 p.

Phinn, S. R., D. A. Stow, and J. B. Zedler. 1996. Monitoring wetland habitat restoration in southern California using airborne digital multispectral video data. *Restoration Ecolog*y 4:412-422.

Fong, P., K. Boyer, J. Desmond, and J. B. Zedler. 1996. Salinity stress, N competition, and facilitation: What controls seasonal succession of two opportunistic green macroalgae? *J. Experimental Marine Biology and Ecology* 206:203-221.

Zedler, J. B., P. Nelson, and P. Adam. 1995. Plant community organization in New South Wales saltmarshes: species mosaics and potential causes. *Wetland*s (Australia) 14:1-18.

Zedler, J. B. 1995. Reinventing wetland science. *National Wetlands Newsletter* 17(4):1, 17-20

Zedler, J. B., and B. Nyden. 1995. Innovative management of California wetlands. *Forum for Applied Research and Public Policy* 10:93-97.

Committee on Characterization of Wetlands; National Research Council. 1995. *Wetlands: Characteristics and Boundarie*s. National Academy Press, Washington, D.C. (Coauthor of this 306-page book).

Phinn, S. R., D. A. Stow, and J. B. Zedler. 1995. Monitoring wetland habitat restoration using airborne digital multi-spectral video data in southern California. Third Thematic Conference on Remote Sensing for Coastal and Marine Environments, Seattle, WA. Vol. I:322-333.

Fong, P., T. C. Foin, and J. B. Zedler. 1994. A simulation model of lagoon algae based on nitrogen competition and internal storage. *Ecological Monographs* 64:225-247.

Zedler, J. B. 1994. Coastal wetlands: Multiple management problems in southern California. Pp. 107-123 in *Environmental Science in the Coastal Zone: Issues for Further Research*. Proceedings of a June 1992 retreat held by the Commission on Geosciences, Environment and Resources, National Research Council. National Academy Press, Washington, DC.

Zedler, Joy B. 1994. Restoring a nation's wetlands: why, where, and how? Pp. 417-418 in G. K. Meffe and C. R. Carroll. *Principles of Conservation Biology*. Sinauer Associates, Inc. Sunderland, Massachusetts.

Gibson, K. D., J. B. Zedler, and R. Langis. 1994. Limited response of cordgrass *(Spartina foliosa)* to soil amendments in constructed salt marshes. *Ecological Applications* 4:757-767.

Zedler, J. B., M. Busnardo, T. Sinicrope, R. Langis, R. Gersberg, and S. Baczkowski. 1994. Pulsed-discharge wastewater wetlands: the potential for solving multiple problems by varying hydroperiod. Pp. 363-368 in W. Mitsch, ed., *Global wetlands: Old world and new*. Elsevier, Amsterdam.

Zedler, J. B. 1994. Salt marsh restoration: lessons from California. Pp. 75-95 in J. Cairns, ed. *Rehabilitating damaged ecosystems*, 2nd ed. CRC Press, Boca Raton, Fla. (Invited revision of 1988 chapter).

Gersberg, R. M., D. Dodge, L. Parsons, and J. B. Zedler. 1994. Microbial water quality of the Tijuana Estuary. *Border Health* July/August/September 1994:16-27.

Zedler, Joy B. 1993. Restoring biodiversity to coastal salt marshes. Pp. 253-258 in J. E. Keeley, ed. *Interface between ecology and land development in California.* Southern California Academy of Sciences 1992 Symposium Proceedings. Southern California Academy of Sciences, Los Angeles, California.

Zedler, J. B. 1993. Canopy architecture of natural and planted cordgrass marshes: Selecting habitat evaluation criteria. *Ecological Applications* 3:123-138.

Fong, P., J. B. Zedler, and R. M. Donohoe. 1993. Nitrogen vs. phosphorus limitation of algal biomass in shallow coastal lagoons. Limnol. Oceanogr. 38:906-923.

Zedler, J. B. 1993. Lessons on preventing overexploitation? *Ecological Applications* 3:577-579.

Zedler, J. B., and A. Powell. 1993. Problems in managing coastal wetlands: Complexities, compromises, and concerns. *Oceanus* 36(2):19-28.

Fong, P., R. M. Donohoe, and J. B. Zedler. 1993. Competition with macroalgae and benthic cyanobacterial mats limits phytoplankton abundance in experimental microcosms. *Mar. Ecol. Prog. Ser*. 100:97-102.

Fong, P., and J. B. Zedler. 1993. Temperature and light effects on the seasonal succession of algal communities in shallow coastal lagoons. *J. Exp. Mar. Biol. & Ecol*. 171:259-272.

Fong, P., R. M. Donohoe, and J. B. Zedler. 1993. Nutrient concentration in tissue of the macroalga *Enteromorpha* as a function of nutrient history: an experimental evaluation using field microcosms. *Mar. Ecol. Prog. Ser*. 106:273-281.

Committee on Restoration of Aquatic Ecosystems: Science, Technology, and Public Policy; National Research Council. 1992. *Restoration of Aquatic Ecosystems: Science, Technology, and Public Policy.* National Academy Press, Washington, D.C. (Coauthor of this 550-page book).

Zedler, Joy B., Christopher S. Nordby, and Barbara E. Kus. 1992. *The ecology of Tijuana Estuary: A National Estuarine Research Reserv*e. NOAA Office of Coastal Resource Management, Sanctuaries and Reserves Division, Washington, D.C.

Zedler, J. B. 1992. Invasive exotic plants: Threats to coastal biodiversity. Pp. 49-62 in Proceedings, Southern California Academy of Sciences "Marine Environment of Southern California" Symposium, University of Southern California, May 1991. USC Sea Grant, Los Angeles.

Busnardo, M. J., R. M. Gersberg, R. Langis, T. L. Sinicrope, and J. B. Zedler. 1992. Nitrogen and phosphorus removal by wetland mesocosms subjected to different hydroperiods. *Ecological Engineering* 1:287-307.

Sinicrope, T. L., R. Langis, R. M. Gersberg, M. J. Busnardo, and J. B. Zedler. 1992. Metal removal by wetland mesocosms subjected to different hydroperiods. *Ecological Engineerin*g 1:309-322.

Zedler, Joy B. 1992. Restoring cordgrass marshes in southern California. Chapter 1, pp. 7-51. In G. W. Thayer, ed. *Restoring the Nation's Marine Environment.* Maryland Sea Grant College, College Park, Maryland.

Bedford, B. L. M. Brinson, R. Sharitz, A. van der Valk, J. Zedler. 1992. Evaluation of proposed revisions to the 1989 "Federal Manual for Identifying and Delineating Jurisdictional Wetlands." *Bull. Ecol. Soc. Ame*r. 73:14-23.

Langis, R., M. Zalejko, and J. B. Zedler. 1991. Nitrogen assessments in a constructed and a natural salt marsh of San Diego Bay, California. *Ecological Applications* 1:40-51.

Nordby, C. S., and J. B. Zedler. 1991. Responses of fishes and benthos to hydrologic disturbances in Tijuana Estuary and Los Peñasquitos Lagoon, California. *Estuarie*s 14:80-93.

Zedler, J. B. 1991. The challenge of protecting endangered species habitat along the southern California coast. *Coastal Managemen*t 19:35-53.

Zedler, J. B., and R. Langis. 1991. Comparisons of constructed and natural salt marshes of San Diego Bay. *Restoration & Management Note*s 9(1):21-25.

Zedler, J. B. 1991. Catastrophic events and interannual variability. Pp 195-201 IN P. L. Abbott and W. J. Elliott, eds. *Environmental Perils*. San Diego Association of Geologists. San Diego.

Zedler, J., E. Paling, and A. McComb. 1990. Differential salinity responses help explain the replacement of native *Juncus kraussii* by *Typha orientali*s in Western Australian salt marshes. *Australian J. of Ecolog*y 15:57-72.

Fink, B. H., and J. B. Zedler. 1990. Stress tolerance studies of dune perennials. *Madroñ*o 37:200-213.

Pacific Estuarine Research Laboratory (PERL). 1990. *A manual for assessing restored and natural coastal wetlands with examples from southern California.* California Sea Grant Report No. T-CSGCP-021. La Jolla, California. (Principal author with sections by René Langis.) 105pp.

Loucks, O., D. Buffington, J. Reisa, and J. Zedler. 1990. ESA research agenda for the 1990's. Ecological Society of America, *Applied Ecology Section Newslette*r 18:1-3.

Fink, B. H., and J. B. Zedler. 1989. Endangered plant recovery: Experimental approaches with *Cordylanthu*s *maritimu*s ssp. *maritimu*s. Pp. 460-468 in H. G. Hughes and T. M. Bonnicksen, eds. Proceedings, First Annual Meeting of the Society of Ecological Restoration and Management. Madison, Wisconsin.

Zedler, J. B., R. Langis, J. Cantilli, M. Zalejko, and S. Rutherford. 1989. Assessing the successful functioning of constructed salt marshes. Pp. 311-318 in H. G. Hughes and T. M. Bonnicksen, eds. Proceedings, First Annual Meeting of the Society of Ecological Restoration and Management. Madison, Wisconsin.

Zedler, J. 1989. Salt marsh communities. *ZooNoo*z. Zoological Society of San Diego.62:9-13.

Zedler, J. B., and M. W. Weller. 1989. Overview and future directions. Pp. 465-473 in J. Kusler and M. Kentula, eds. *Wetland Creation and Restoration: the status of the science.* Vol. I, Regional Reviews. EPA/600/3-89/038a, Environmental Research Laboratory, Corvallis, Oregon.

Josselyn, M., J. Zedler, and T. Griswold. 1989. Wetland mitigation along the Pacific Coast of the United States. Pp. 1-35 in J. Kusler and M. Kentula, eds. *Wetland Creation and Restoration: the status of the science*. Vol. I, Regional Reviews. EPA/600/3-89/038a, Environmental Research Laboratory, Corvallis, Oregon.

Onuf, C. P., and J. B. Zedler. 1988. Pattern and process in arid-region salt marshes--southern California. Pp. 570-581 in D. Hook, W. McKee, Jr., H. Smith, J. Gregory, V. Burrell, Jr., M. DeVoe, R. Sojka, S. Gilbert, R. Banks, L. Stolzy, C. Brooks, T. Matthews, and T. Shear, eds. *Ecology and management of wetlands, Volume 1: Ecology of Wetlands*. Croom Helm, London, U.K.

Fong, P., C. S. Nordby, J. Covin, J. Tiszler, and J. B. Zedler. 1988. *Goleta Slough Ecological Reserve Management Plan*. Calif. Dept. of Fish and Game, Nongame Heritage Program, Sacramento, Calif.

Zedler, J. B. 1988. Salt marsh restoration: lessons from California. Pp. 123-138 in J. Cairns, ed. *Rehabilitating damaged ecosystem*s. CRC Press, Boca Raton, Fla.

Zedler, J. B. 1988. Restoring diversity in salt marshes: Can we do it? Pp. 317-325 in E. O. Wilson, ed. Biodiversity. National Academy Press, Washington, D.C.

Zedler, J. B. 1988. Why it's so difficult to replace lost wetland functions. Pp. 121-123 in J. Zelazny and J. S. Feierabend, eds. *Increasing our Wetland Resources.* Conference Proceedings, National Wildlife Federation Corporate Conservation Council, Oct. 4-7, 1987, Washington, D. C.

Covin, J. D., and J. B. Zedler. 1988. Nitrogen effects on *Spartina folios*a and *Salicornia virginic*a in the salt marsh at Tijuana Estuary, California. *Wetland*s 8:51-65.

Zedler, J. B., R. Langis, J. Cantilli, M. Zalejko, K. Swift, and S. Rutherford. 1988. Assessing the functions of mitigation marshes in southern California. Pp. 323-330 in J. Kusler, S. Daly, and G. Brooks, eds. Urban Wetlands: Proceedings of the National Wetland Symposium, Oakland, California. Assoc. of Wetland Managers, Berne, New York.

Fong, P, R. Rudnicki, and J. B. Zedler. 1987. Algal community response to nitrogen and phosphorus loadings in experimental mesocosms: recommendations for southern California lagoons. San Diego Association of Governments, San Diego. 102pp.

Beare, P. A., and J. B. Zedler. 1987 Cattail invasion and persistence in a coastal salt marsh: the role of salinity. *Estuarie*s 10:165-170.

Brenchley-Jackson, J. L., T. C. Foin, and J. B. Zedler. 1987. Modeling the effect of salinity and inundation on *Spartin*a and *Salicorni*a in southern California. Proc., Wetland and Riparian Ecosystems of the American West. In Eighth Ann. Meeting of the Soc. of Wetland Scientists. Pp. 261-266.

Fong, P., R. Rudnicki, and J. B. Zedler. 1987. Phytoplankton response to nutrient loadings: a community versus component approach. Proc., Wetland and Riparian Ecosystems of the American West. In Eighth Ann. Meeting of the Soc. of Wetland Scientists. Pp. 61-64.

Rudnicki, R., P. Fong, and J. B. Zedler. 1987. Macroalgal response to nutrient loadings of varying N:P ratios. Proc., Wetland and Riparian Ecosystems of the American West. In Eighth Ann. Meeting of the Soc. of Wetland Scientists. Pp. 65-67.

Zedler, J. B., E. Paling, and A. McComb. 1987. Salinity-controlled invasions of *Typh*a in Mediterranean-type wetlands of Australia and California. Proc., Wetland and Riparian Ecosystems of the American West. In Eighth Ann. Meeting of the Soc. of Wetland Scientists. Pp. 299-303.

Griswold, T. J., C. Nordby, and J. B. Zedler. 1987. Simulated salt marshes: methods for reducing experimental error. Proc., Wetland and Riparian Ecosystems of the American West In Eighth Ann. Meeting of the Soc. of Wetland Scientists. Pp. 315-317.

Wood, L. F., and J. B. Zedler. 1987. Dune vegetation at Tijuana Estuary: interactions between the exotic annual, *Cakile maritim*a, and the native perennial, *Abronia maritim*a. Proc., Wetland and Riparian Ecosystems of the American West. In Eighth Ann. Meeting of the Soc. of Wetland Scientists. Pp. 322-323.

Fink, B. H., and J. B. Zedler. 1987. Revegetation of southern California coastal dunes as dictated by stress tolerance studies. In Proc., Wetland and Riparian Ecosystems of the American West. Eighth Ann. Meeting of the Soc. of Wetland Scientists. Pp. 324-326.

Zedler, J. B., and C. S. Nordby. 1986. The ecology of Tijuana Estuary: an estuarine profile. U.S. Fish Wildl. Serv. Biol. Rep. 85 (7.5). 104pp.

Zedler, J. B. 1986. Catastrophic flooding and distributional patterns of Pacific cordgrass *(Spartina folios*a Trin.). *Bull. So. Calif. Acad. Sc*i. 85:74-86.

Zedler, J. B., and P. A. Beare. 1986. Temporal variability of salt marsh vegetation: the role of low-salinity gaps and environmental stress. Pp. 295-306 in D. Wolfe, ed. *Estuarine Variabilit*y. Academic Press.

Zedler, J. B., J. Covin, C. Nordby, P. Williams, and J. Boland. 1986. Catastrophic events reveal the dynamic nature of salt marsh vegetation. *Estuarie*s 9:75-80.

Zedler, J. B. 1986. Mitigation problems on the southern California coast: an ecologist's view. *WaterfrontAg*e 3:32-36.

Zedler, J. B. 1986. Salt marsh restoration: trials and errors or ecotechnology. Pp. 11-16 in R. Strickland, ed. Wetland functions, rehabilitation and creation in the Pacific Northwest: the state of our understanding. Washington State Dept. of Ecology, Olympia, Washington.

Cox, G. W., and J. B. Zedler. 1986. The influence of mima mounds on vegetation patterns in the Tijuana Estuary salt marsh, San Diego County, Calif. *Bull. So. Calif. Acad. Sci.* 85:158-172.

Zedler, J. B. 1985. Wastewater input to coastal wetlands: management concerns. Pp. 127-132 in P. Godfrey, E. Kaynor, and S. Pelczarski, eds. *Ecological Considerations in Wetlands Treatment of Municipal Wastewaters.* Van Nostrand Reinhold Co., New York.

Zedler, J. B. 1985. Salt marsh restoration in southern California. *Restoration and Management Note*s 3:35-36.

Zedler, J. B., T. Huffman, and M. Josselyn, eds. 1985. Pacific Regional Wetland Functions. Workshop Proceedings. The Environmental Institute, Publication No. 90-3. University of Massachusetts, Amherst. 162 pp**.**

Zedler, J. B. 1984. *Salt marsh restoration: a guidebook for southern California.* California Sea Grant College Program. Report No. 7-CSGCP-009. 46pp.

Zedler, J. B., and C. P. Onuf. 1984. Biological and physical filtering in arid-region estuaries: seasonality, extreme events, and effects of watershed modification. Pp. 415-432 in V. S. Kennedy, ed. *The Estuary as a Filter.* Academic Press, New York.

Zedler, J. B., and W. P. Magdych. 1984. Sedimentation and estuarine productivity: research priorities for management. Pp. 113-128 in Proceedings of the National Estuarine Research Symposium, March 1984, B. J. Copeland et al., eds. Univ. of North Carolina Sea Grant Program.

Zedler, J. B., and P. A. Beare. 1984. Mediterranean-type estuaries: resilience to extreme flood events. Pp. 175-176 in Proceedings of the Fourth International Conference on Mediterranean Ecosystems, August 1984, Univ. of Western Australia, Perth.

Zedler, J. B., and G. W. Cox. 1984. Characterizing wetland boundaries: a Pacific coast example. *Wetland*s 4:43-55.

Zedler, J. B., R. Koenigs, and W. Magdych. 1984. Freshwater release and southern California coastal wetlands; Report 1, Streamflow for the San Diego and Tijuana Rivers; Report 2, Review of salinity effects and predictions of estuarine responses to lowered salinity; Report 3, Management plan for the beneficial use of treated wastewater in the Tijuana River and San Diego River estuaries. San Diego Assoc. of Governments, San Diego.

Zedler, J. B., M. Josselyn, and C. P. Onuf. 1983. Restoration techniques, research, and monitoring: vegetation. Pp. 63-72 in Proceedings of the Workshop on Wetland Restoration and Enhancement in California, Feb. 18-20, 1982, Calif. State Univ., Hayward. California Sea Grant College Program, La Jolla, Calif. Report No. T-CSGCP-007.

Metz, E., and J. B. Zedler. 1983. Who says science can't influence decision making? Proceedings, *Coastal Zone '83*, Vol. I:584-600. Am. Soc. Civil Engr., New York.

Metz, E., and J. B. Zedler. 1983. Using science for decision making: the Chula Vista Bayfront Local Coastal Program. Salt marsh restoration: the experimental approach. Proceedings, *Coastal Zone '8*3, Vol. III:2578-2586. Am. Soc. Civil Engr., New York.

Zedler, J. B. 1983. Freshwater impacts in normally hypersaline marshes. *Estuarie*s 6:346-355.

Zedler, J. B. 1982. Salt marsh vegetation: examples from the Tijuana Estuary. California Sea Grant College Program, La Jolla, Calif. E-CSGCP-003. 37 pp. (Also translated into Spanish by D. Soto).
Zedler, J. B. 1982. Salt marsh algal mat composition: spatial and temporal comparisons. *Bull. Southern California Acad. Sc*i. 81:41-50.
Zedler, J. B. 1982. *The ecology of southern California coastal salt marshes: a community profile.* U.S. Fish and Wildlife Service, Biological Services Program, Washington, D. C. FWS/OBS-31/54. 110 pp.
Zedler, J. B. 1981. The San Diego River marsh before/after the 1980 flood. *Environment Southwes*t 495:20-22.
Zedler, J. B. 1980. Algal mat productivity: comparisons in a salt marsh. *Estuarie*s 3:122-131.
Zedler, J. B., T. P. Winfield, and P. Williams. 1980. Salt marsh productivity with natural and altered tidal circulation. *Oecologi*a (Berl.) 44:236-240.
Emerson, S., and J. B. Zedler. 1978. Recolonization of intertidal algae: an experimental study. *Marine Biology* 44:315-324.
Zedler, J. B., T. P. Winfield, and D. Mauriello. 1978. Primary productivity in a southern California estuary. Proceedings*, Coastal Zone '78,* Vol. II:649-662. Am. Soc. Civil Engr., New York.
Zedler, J. B. 1977. Salt marsh community structure in the Tijuana Estuary, Calif. *Estuarine and Coastal Marine Scienc*e 5:39-53.
Hurlbert, S. H., J. B. Zedler, and D. A. Fairbanks. 1972. Ecosystem structure-alteration by mosquitofish *(Gambusia affinis*) predation. *Scienc*e 175:639-641.
Zedler, J. B., and O. L. Loucks. 1969. Differential burning response of *Poa pratensi*s fields and *Andropogon scopariu*s prairies in central Wisconsin. *Amer. Midl. Nat.* 81:341-352.
Zedler, J. B., and P. H. Zedler. 1969. Association of species and their relationships to microtopography within old fields. *Ecolog*y 50:432-442.
Zedler, J. B. 1968. Vegetational response to microtopography on a central Wisconsin drained marsh. Ph.D. Thesis, Univ. of Wisconsin, Madison. 90 pp.
Zedler J. B. 1966. Buena Vista Marsh in historical perspective. M.S. Thesis, Univ. of Wisconsin, Madison. 75 pp.

Recent reports

Zedler, Joy B. 2012. Innovationa to improve stormwater treatment. Environmental Protection Agency – Great Lakes Restoration Initiative. Final Report. EPA Region V, Chicago.
Zedler, Joy B. , and Paul H. Zedler. 2012. Learning while sustaining biodiversity at the Arboretum and beyond; with Appendices by Isabel Rojas Viada. Final report, UW-Madison Morgridge for Service Learning.
Zedler, J. B., V. Temperton, D. Lamb, R. J. Hobbs, E. S. Higgs, J. A. Harris, Y. D. Choi, and E. B. Allen. 2012. Novel approaches for the novel present and future. Proceedings, 4th International Symposium of the National Institute of Ecology, South Korea: "Importance of Ecological Restoration Studies in the Changing Environment", October 16 -17, 2012, Seocheon, South Korea.

Zedler, J. B., Editor. 2012. Eco-Cultural Restoration of the Ho-Nee-Um Pond Landscape at the UW-Madison Arboretum. Botany 670 Class Report. Archived at the Arboretum.

Zedler, J. B. and the Botany 670 Class. 2010. An Adaptive Restoration Plan for Spring Green's "Prairie View." Town Board, Spring Green, WI.

Zedler, J. B., J. M. Doherty, and the Botany 670 Class. 2009. An Adaptive Approach to Restoring Culturally-Important Plants at Grand Portage National Monument. Grand Portage National Monument, Minnesota. 76 pages.

Zedler, J. B. 2008. Testing a Comprehensive Strategy for Replacing Monotypic Reed Canary Grass with a Diversity of Native Wetland Plants. Wisconsin Department of Natural Resources, Wetland Program. Madison, WI. 70 pages.

Zedler, J. B., Editor. 2008. Restoration of the Arboretum's Eastern Wetlands. Results of Practicum by 8 graduate students, UW-Madison Water Resources Management Program. Madison, WI. 134 p. Available online at http://uwarboretum.org/research.

Ferren, W. R., Jr., J. C. Callaway, J. B. Zedler, and Ballona Wetland Restoration Science Advisory Committee. 2007. Ballona Wetland Restoration Project: Habitat descriptions and candidate ecosystem functions for restoration alternatives at Ballona Wetland.

Zedler, J. B. 2007. The need for continual, adaptive restoration at Tijuana Estuary. Invited by R. Thom, for Proceedings, Estuarine Research Federation.

Recent book reviews

Zedler, J. B. 2010. Small is Bountiful: A review of *Tidal Freshwater Wetlands by* A. Barendregt, D. Whigham, and A. Baldwin for *Landscape Ecology* 25:815–817.

Zedler, J. B. 2010. Review of "Sustaining the World's Wetlands: Setting Policy and Resolving Conflicts." *Quarterly Review of Biology* 496:10.

Zedler, J. B., D. A. Falk, and D. J. Larkin. 2007. Upstart views of restoration icons – a review of the ESA 2006 Symposium in Memphis, TN. *Ecological Society of America Bulletin* 88:104-112*.*

Frieswyk, C. B., M. T. Healy, and J. B. Zedler. 2006. Review of *The World's Largest Wetlands*, a book by L. Fraser and P. Keddy. For *Quarterly Review of Biology* 81:196.

Zedler, P. H. and J. B. Zedler. 2005. Reality check. A review of *Correction Lines* by Curt Meine. *Conservation Biology* 19:1675-1676.