National Cooperative Highway Research Program

# RESEARCH RESULTS DIGEST

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Responsible Senior Program Officer: Christopher Hedges

## Guidance for Selecting Compensatory Wetland Mitigation Options

*This digest summarizes the interim results of NCHRP Project 25-16, "Guidance for Selecting Compensatory Wetland Mitigation Options." The digest is based on a draft prepared by A.D. Marble and Company, Inc. The objectives of the project are (a) to evaluate and describe the relative effectiveness of small-scale, individual mitigation against that of consolidated mitigation—including mitigation banks—and against other compensatory mitigation options and (b) to develop recommended criteria, performance expectations, and other guidance for selecting mitigation.*

### EXECUTIVE SUMMARY

This digest summarizes the research and findings to date of NCHRP Project 25-16, "Guidance for Selecting Compensatory Wetland Mitigation Options." This digest presents state DOT managers with the best available information on wetland mitigation options and compares the success rates of individual mitigation with those of consolidated mitigation.

Phase I results show that data on the relative success of mitigation options are incomplete and highly subjective. Available data on wetland mitigation currently deal primarily with individual mitigation, not with consolidated mitigation or with a comparison of the two. The data have consistently illustrated the problems of individual mitigation, including sites not being built, problems with grading, insufficient or excessive hydrology, incorrect plant communities, and large differences in the proposed and established mitigation types. No available research has adequately investigated the success of consolidated mitigation or determined whether consolidated mitigation's pressures on mitigation banking differ from those of individual mitigation.

The data examined for this project suggest that successful individual and consolidated compensatory mitigation depends on better site selection, better coordination between designers and contractors, and more appropriate wetland vegetation selection and planting techniques. The study also suggests that inherent factors in the mitigation banking process—such as more appropriate site selection, larger sites, greater flexibility in design, and an incorporation of upland buffers—increase the likelihood of successful mitigation.

Despite the lack of information regarding its performance in relation to small-scale, individual mitigation, consolidated mitigation has become more widely accepted over the last decade. As of January 2000, this study determined that the United States has approximately 278 mitigation banks, that 12 states have DOT umbrella banks, and that many more states have in-lieu fee programs. Twenty-three states have legislation recognizing banking as a viable mitigation option (Porter 1996, Williams 2000). The Phase I findings demonstrate that most state DOTs prefer consolidated mitigation and consider the reasons for its success similar to the success reasons for individual sites (that is, appropriate hydrology, site grading, and planting techniques, as well as good coordination between designer and contractor). Yet, largely because of interagency disagreements over the banking process, only 26 state DOTs have created mitigation banks; most DOTs rely heavily on individual mitigation and, in some cases, on nonadvanced, multiproject mitigation or on the purchasing of non-DOT banking credits.

These interim results indicate a need to further understand why many states pursuing consolidated

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mitigation options have faced overwhelming obstacles, while a minority of others have developed an array of compensatory mitigation options. Phase II of this project will emphasize evaluating specific regulatory agency issues and evaluating concerns about developing and using multiple compensatory mitigation options for state DOTs. Phase II will also involve developing a decision-making tool to assist DOT wetland managers with selecting mitigation options for their states. This decision-making tool will be supported with case studies of state mitigation programs.

Finally, results of the data collected for Phase I have yielded important information for DOT wetland managers to consider in developing mitigation sites and banks. The data clearly suggest key reasons for the success and failure of mitigation sites. These reasons apply immediately nationwide.

## BACKGROUND

Compensatory wetland mitigation is mandated by federal, state, and, in some cases, local legislation to stop the nation from losing wetland habitat. It is the third step of the 404(b)(1) sequencing approach of the Clean Water Act (Memorandum of Agreement 1989), in which compensation for unavoidable and minimized impacts is provided either on-site or off-site of the impacted wetland. As a result, almost every state has performed compensatory mitigation for wetland impacts through transportation, commercial, and private projects.

With the passage of the Transportation Equity Act for the 21st Century (TEA-21), the volume of highway projects that will be evaluated and designed over the next 4 years will increase to a historical high. An increase in road projects may cause an increase in wetland mitigation needs. TEA-21 created more flexibility in using funds and placed greater emphasis on measures to improve the environment (Federal Highway Administration, 1998). The flexibility in funding enables state DOTs to address TEA-21's operating objectives of supporting broader, more long-term environmental goals and of avoiding the most environmentally fragile areas.

Although all states want wetland compensation, the types of compensatory mitigation used from state to state vary greatly. This diversity is highlighted by the mitigation option each state agency pursues, from individual mitigation to consolidated mitigation; from wetland restoration to creation, enhancement, and even preservation; and, finally, from in-kind mitigation to mitigation of an entirely different wetland class. There is a need to develop a clear understanding of the benefits and drawbacks associated with wetland mitigation options.

The purpose of this research is to inform state DOTs about the performance of consolidated and individual mitigation wetlands and about the factors that affect mitigation success. This research also provides information about states that have successfully developed consolidated mitigation sites, such as banks and in-lieu fee programs. Other states can use this information to develop their own programs and to increase their own compensatory mitigation options.

## RESEARCH METHODOLOGY

The Phase I research was undertaken to determine which states and respective DOTs and environmental agencies perform compensatory wetland mitigation, which options they pursue, and whether these options have been successful in wetland compensation. The approach involved a database, literature, and Internet search; an agency survey; and phone and personal interviews.

The initial step of Phase I entailed a detailed database, literature, and Internet search for information on mitigation banks, data sources, and contacts. This search required the review of websites, resource agencies, and private wetland organizations. Research of current wetland literature was also completed to determine the prevailing nationwide sentiment about wetland mitigation. This search revealed the location of all proposed and existing mitigation banks in the United States; such information can be used to gauge how active each state or region is in pursuing the consolidated mitigation option. Finally, the research involved the review of recent mitigation studies prepared by state DOTs, the U.S. Fish and Wildlife Service (USFWS), the U.S. Army Corps of Engineers (USACE), and private banking entities.

The second step of Phase I involved developing an agency survey. The survey was developed by A.D. Marble and Company, Inc., and reviewed by the NCHRP Project 25-16 panel. Copies of the survey were sent to all state DOTs, as well as to federal and state environmental agencies and private banking entities. The content of the survey reflected the project's objective to determine whether states pursued the consolidated mitigation option, what the overall trend has been in satisfying wetland permit requirements, and what information has aided in the compliance with mitigation permitting. The survey also helped identify good contacts for phone and personal interviews.

Of the 142 surveys distributed to all state DOTs, to federal and state resource agencies, and to private banking entities, 55 surveys were returned. Seventy-six percent of all state DOTs (that is, 38 of 50) provided survey responses. Surveys were also received from such private entities as Florida Wetlandsbank, Inc.; Mile High Wetland Bank; Critical Habitats, Inc.; Walt Disney Company; Marsh Resources; and Ecology and the Environment.

The data compiled from the survey were subsequently arranged in spreadsheets, and figures were created to illustrate the overall responses. The final process was to contact all key respondents and develop a more accurate picture of wetland mitigation throughout the United States. This process was and is done by ongoing phone and personal interviews that occur when specific information needs are identified. A series of questions was drafted to standardize the interviews.

Individual states are not equally involved in the amount and type of wetland mitigation options they employ. Although states have the same "no overall net loss" goal, their staff sizes, levels of expertise, dynamics between resource agencies and DOTs, and funding will all determine the mitigation options they pursue, as well as the amount of agency resources spent on monitoring and maintenance. As such, states' experiences and responses to the survey and interview questions must be understood in the context of the states' respective mitigation activities.

## RESULTS AND FINDINGS

### Permit Requirements and Agency Input

Permit requirements may differ among states, largely because of environmental constraints and federal agency personnel, as well as because of the environmental goals (for example, creating wildlife habitat) of the state agencies. The survey conducted in this project asked respondents to indicate the most typical federal, state, and local wetland permit requirements for compensatory mitigation projects (see Figure 1). The responses indicate that the most common permit requirements are that the site be monitored, have an established wetland acreage, have an established plant survivorship (for example, at least 50-percent survival of planted woody species), and meet specific hydrology criteria. The responses also indicate that permits requiring a specific percentage of canopy coverage or a specific type of wetland vegetation planted were not typical for most states. Some responses also indicate that the removal or reduction of exotic species and the incorporation of an upland buffer are required by some state agencies.

The survey asked wetland managers which agencies, other than permit agencies, had input on site selection or design for both consolidated and individual mitigation projects (see Figure 2). Eighty percent of responses indicate that the USFWS, the U.S. Environmental Protection Agency, and the state fish-and-game entities all provide input into their DOT mitigation process. A much smaller percent of state DOTs are given guidance from natural heritage programs, the U.S. Department of Agriculture, and nonprofit organizations like the Nature Conservancy. Coastal states indicate receiving additional input from the National Marine Fisheries Service, state departments of marine resources, and local coastal districts.

### Success of Wetland Mitigation Types and Classes

#### *Wetland Types*

*Wetland type* refers to the type of mitigation developed. Examples of wetland type include creation, restoration, enhancement, and preservation.

Determining the most effective type of mitigation largely depends on each state's mitigation priority. The survey and subsequent interviews indicate that restoration mitigation is most often encouraged and results in the greatest likelihood of success. Restoration mitigation grew out of the efforts to bring back midwestern prairies (Jordan 1981), and the aim, according to the National Research Council's Water Science and Technology Board (1992), is "to emulate a natural, functioning self-regulating system that is integrated with the ecological landscape in which it occurs." For example, instead of having to create wetland characteristics out of uplands, managers can restore previous hydrological conditions or add appropriate wetland plantings to prior converted farmlands. Although wetland creation and enhancement are still used, most DOTs pursue wetland restoration projects, integrating wetland enhancement and preservation whenever possible. The argument for wetland restoration is that restoration ultimately limits the number of potential problems associated with compensatory mitigation, such as lack of appropriate hydrology. A Minnesota Department of Natural Resources study (1998) and a study of Maine's wetland mitigation program (Woodlot Alternatives, Inc. 1996) recommend that creation mitigation be used as a last resort and that a greater use of restoration for project-specific mitigation be encouraged. Specifically, these studies promote restoring previously drained wetlands rather than creating wetlands, especially when these projects will affect high-quality or scarce natural upland features.

#### *Wetland Classes*

*Wetland class* refers to a classification system that describes wetlands with respect to their location or origin, as well as the type of vegetation or substrate found in the wetland. Examples of wetland class include palustrine emergent persistent wetlands (Cowardin classification system [Cowardin et al. 1979]) and depressional wetlands (hydrogeomorphic [HGM] classification system [Brinson 1993a]).

Like type selection, class selection depends on each state's mitigation priority. Some states are encouraged by resource agencies to mitigate for only one particular class, regardless of which wetland class is impacted, in an effort to restore unique or significant wetlands. For example, Kentucky and Tennessee policies encourage compensatory mitigation of forested wetlands over other classes. Class selection also depends on site selection, topography, and diversity of wetland habitats within the state. The survey asked DOTs and resource agencies which wetland classes, using the Cowardin and HGM classification systems, were most successfully mitigated.

**Cowardin Classification System.** The survey results indicate that the emergent and open-water wetlands are often most successfully mitigated in palustrine, estuarine, and lacustrine systems. With palustrine and estuarine systems, forested wetlands were least successfully mitigated. About wetland classes, the survey data suggest that palustrine and lacustrine emergent and open-water wetlands are the easiest

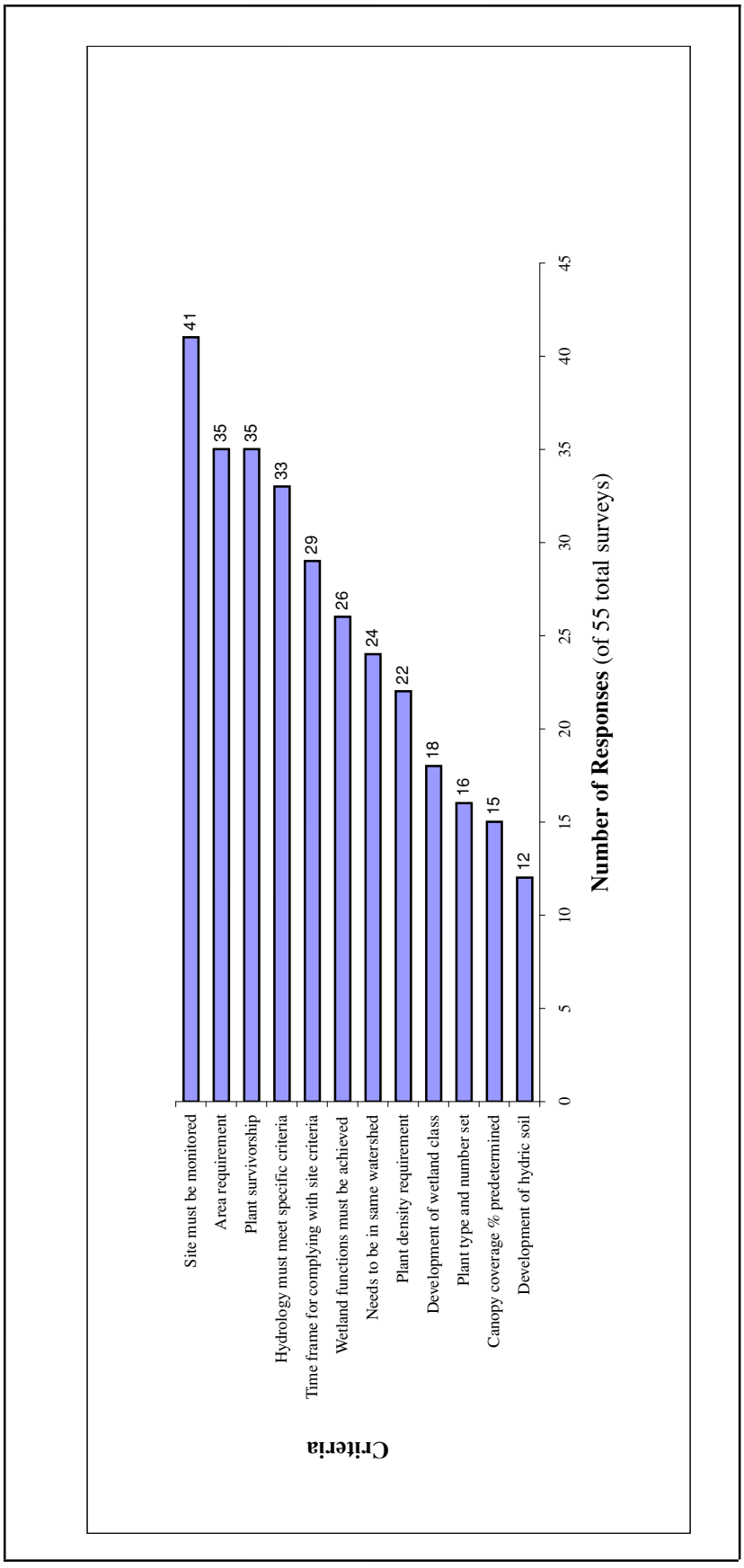



*Figure 1. Survey responses: what are typical federal, state, and local permit requirements for your mitigation site?*

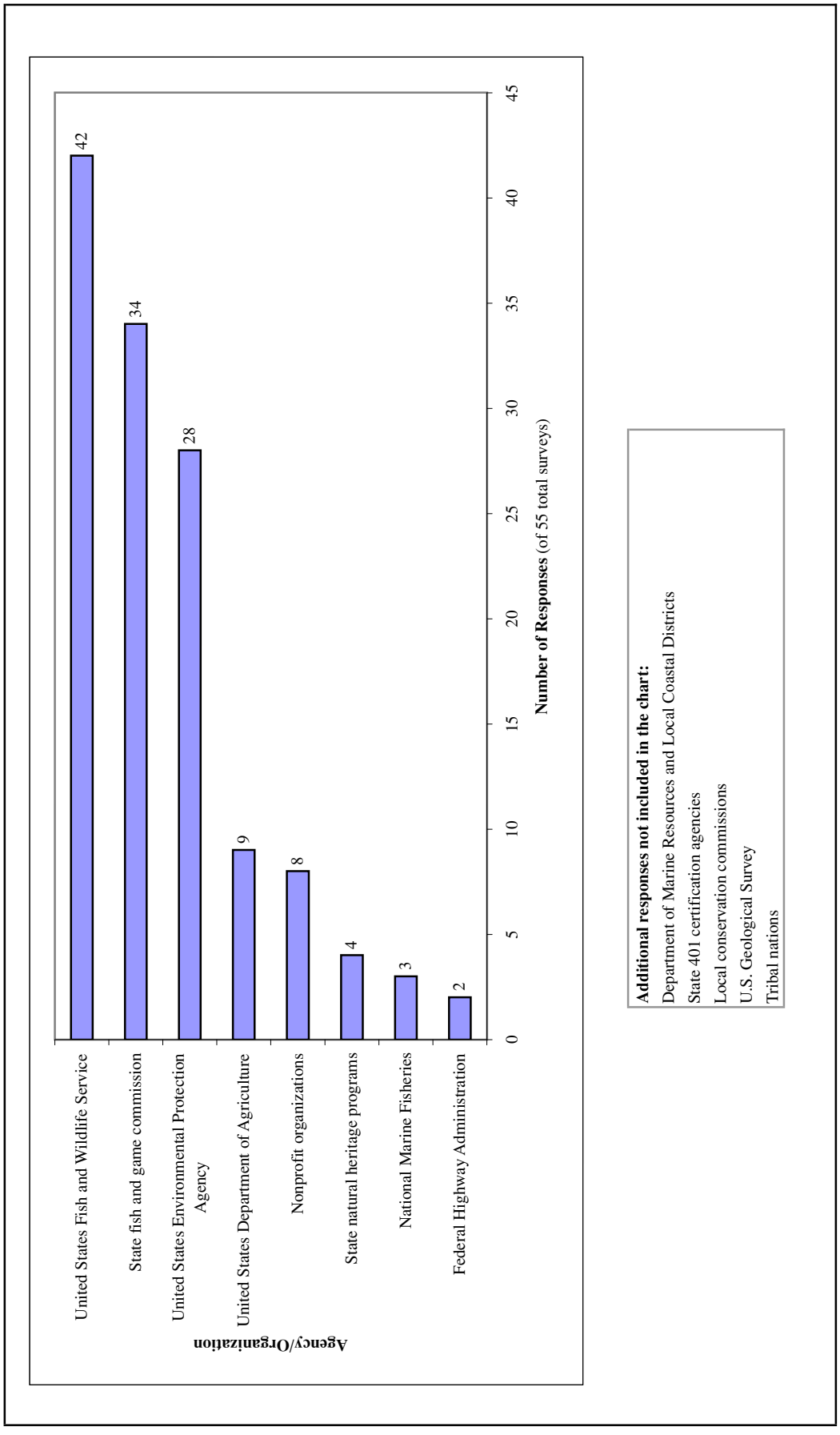



*Figure 2. Survey responses: which agencies, other than permit agencies, have input on site selection or design for mitigation projects?*

to mitigate because of the flexibility and variability in grading for emergent and open-water wetlands. Palustrine and lacustrine wetlands are commonly created in conjunction with each other because emergent vegetation tolerates a variability of inundation. If grading has created deep areas, the emergent vegetation can still adapt to the shoreline and shallower areas. In contrast, forested wetlands require considerably more precision in grading and more time to develop. Saplings may not be able to tolerate the fluctuations in hydrology tolerated by mature trees. Furthermore, forested wetlands may require 50–100 years to fully mature—a period beyond most DOT monitoring requirements, which rarely exceed 5 years. No conclusive statement can be made for marine and tidally influenced wetlands because of the scarcity of responses for these classes. This scarcity possibly results from limited opportunities for mitigation in these classes, the difficulty of constructing compensatory wetlands, or poor survey feedback.

**Hydrogeomorphic Classification System.** As the use of the HGM classification system is less prevalent, only 30 responses refer to this system. Many of these responses (13 of 30, or 43 percent) indicate that mitigation with depressional (for example, pothole) wetlands is most successful. Riverine and estuarine fringe wetlands are also indicated as being viable mitigation options, with six and four responses, respectively.

## Factors Influencing the Success of Individual and Consolidated Mitigation

Phase I literature research revealed a lack of data comparing the success rates of individual and consolidated mitigation options. Although several studies evaluate individual mitigation efforts within states or federal agency regions (Johnson et al. 2000, U.S. Fish and Wildlife Service 1998, Gwin and Kentula 1990), they do not focus on the experiences of people in the transportation field. To address this need, the agency survey specifically targeted DOT wetland managers across the United States for their experiences with wetland mitigation options.

### *Individual Mitigation*

Support for individual mitigation is driven by the belief that lost functions and values must be mitigated close to the impact, usually within the same watershed, and that on-site mitigation is more practical. The belief is rooted in watershed-based management, which emphasizes the need to preserve the overall flood flow, nutrient removal, and storage capacity functions, as well as the wildlife habitat values within each watershed. These individual, often small compensatory wetlands (they are often 2 acres or smaller) may appear to serve little function but are actually important components of the larger natural system (Trochlell and Bernthal 1998). For example, small wetlands are critical to waterfowl, reptiles, and amphibians, thus providing for a diversity and abundance of food resources and a viable habitat. Brinson (1993b) has suggested that small streamside wetlands in the upper reaches of watersheds more effectively maintain water quality than do similarly positioned wetlands in the mid to lower reaches of rivers and streams. Maltby et al. (1995) have confirmed this trend in wetlands along small drainages in Europe.

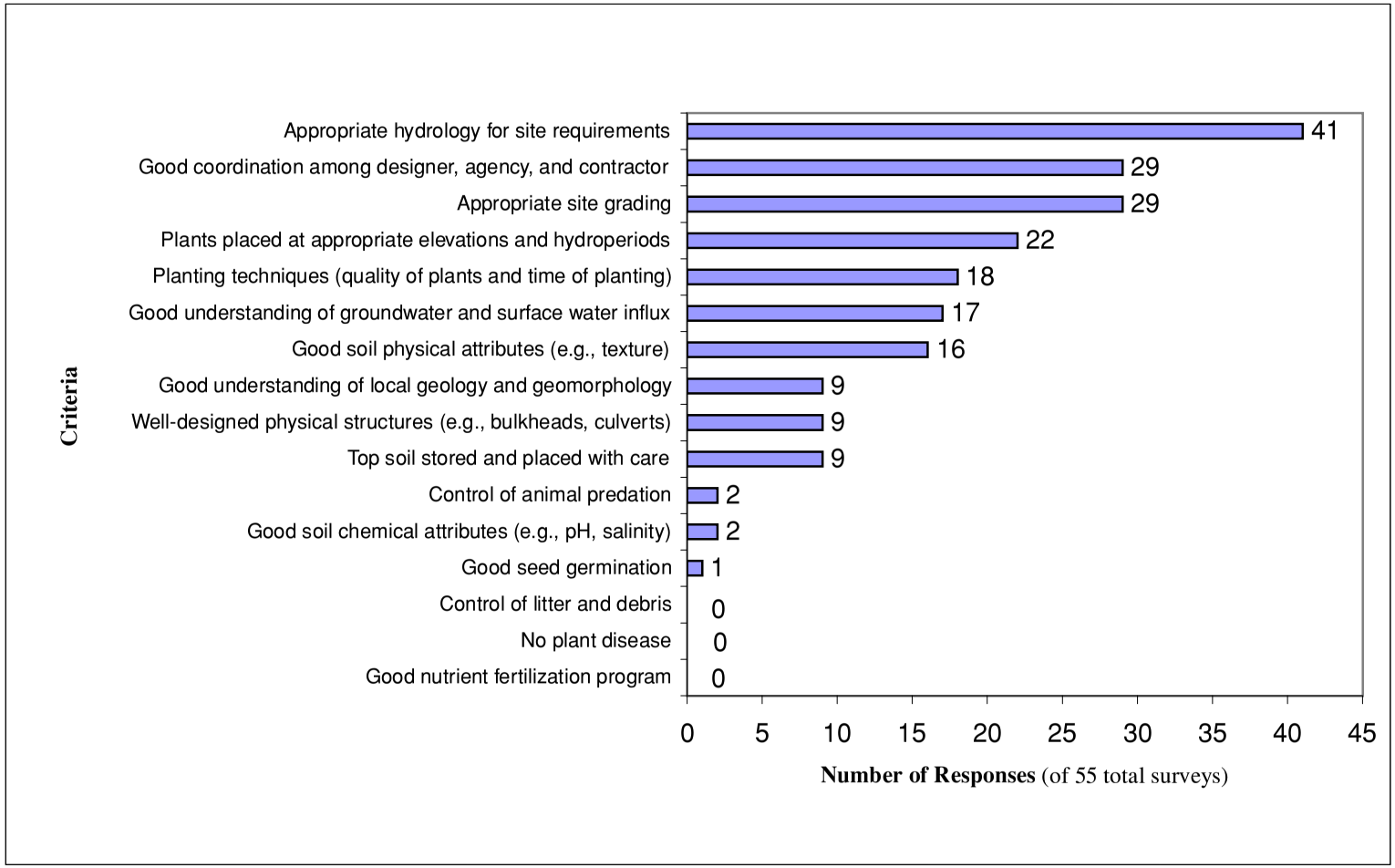
Support for individual mitigation can also be justified for practical reasons: Individual mitigation sites can be cost-effective when created adjacent to road construction, as construction equipment is already set up in the project area. Individual mitigation sites can also use areas where fill has been borrowed, spreading the cost of wetland creation between road construction needs and wetland grading. DOTs mentioned in their survey responses that the often lengthy and complicated process of developing a consensus on mitigation banking and of subsequently drafting a banking instrument makes individual mitigation a more efficient, less restrictive process.

Mitigation success is a product of many factors because of wetland community characteristics. Appropriate hydrology, vegetative communities, and soil type predominately characterize a wetland community. For these three components to exist, however, good planning, design, and site maintenance must be present. State DOTs and resource agencies indicated in their survey responses that the three most important reasons for the success of their individual mitigation sites were appropriate hydrology for the site; good coordination among designer, agency, and contractor; and appropriate site grading (see Figure 3). The respondents also indicated that using appropriate planting techniques and understanding hydroperiods and appropriate plant elevations were critical to wetland mitigation success. Controlling animal predation, having good seed germination, and using a nutrient fertilization program were not seen by many of the respondents as critical to the success of individual compensatory mitigation.

The survey also asked respondents to identify problems with establishing individual wetland mitigation sites (see Figure 4). Respondents indicated that insufficient hydrology and poor site selection are the most common problems with mitigation sites. Respondents also indicated that invasive plants and lack of necessary training or skill among contractors or designers often resulted in problems with mitigation sites. Survey options like vandalism, poor soil (that is, chemical) attributes, problems with physical structures (for example, culverts and berms), and improper planting techniques were rarely selected.

### *Consolidated Mitigation*

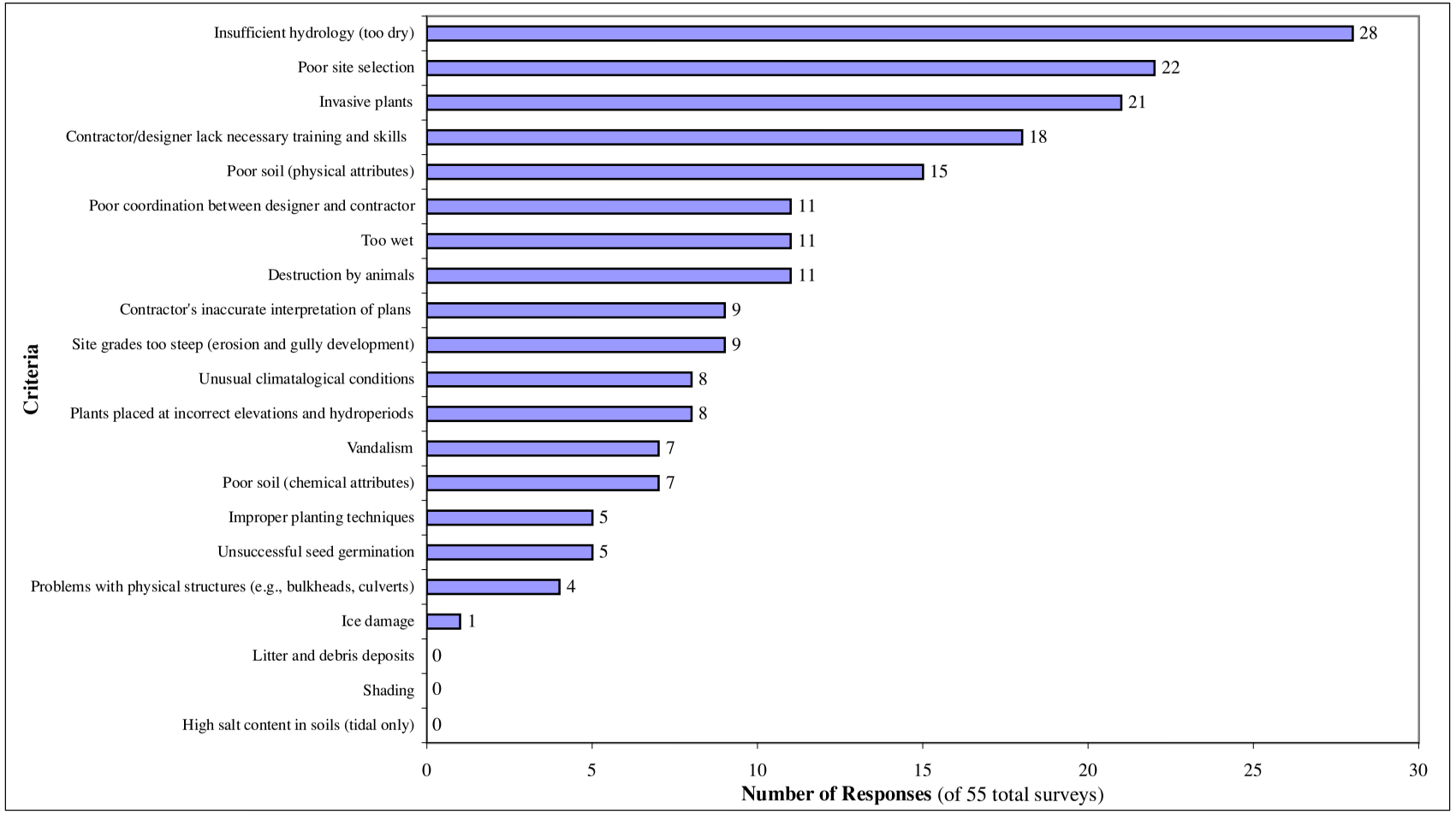
An increasing number of states have begun using consolidated wetland mitigation to streamline the mitigation process and to potentially improve mitigation wetland quality. Studies (Gwin and Kentula 1990, U.S. Fish and Wildlife Service 1998, Mockler 1998) often criticize individual mitigation sites as being inadequately designed and constructed




**Additional responses not included in the chart:**

Good site selection
Rapid colonization by volunteer native species
Stock piling of hydric soils
Qualified biologists scrutinizing plans
Compliance checks

*Figure 3. Survey responses: what are reasons for successful individual mitigation sites?*




| **Additional responses not included in the chart:** | |
|---|---|
| Inability to separate highway and wetland contracts | Lack of compliance |
| Mitigation not a priority | Woody plant survivorship |
| Inadequate weeding/maintanance of irrigation equipment | Improper plant selection |
| Lack of irrigation of plants during initial planting year | Permit negotiations too slow |

*Figure 4. Survey responses: what are problems with establishing individual mitigation sites?*

and as providing little compensation for the lost wetland function or value. The survey and subsequent interviews asked DOTs and resource managers of other agencies whether they used individual or consolidated mitigation and why the mitigation sites succeeded or failed. The results inform other agencies about the essential factors of successful mitigation.

The survey also asked respondents which reasons were most responsible for the success of or problems with their consolidated mitigation sites (for example, banks and in-lieu fee; see Figures 5 and 6). The three most common reasons for the success of these consolidated sites parallel those for the success of individual sites (that is, appropriate hydrology, good coordination, and appropriate site grading). Additionally, the respondents indicated that good site selection was important for the success of consolidated sites. Good soil attributes and planting techniques were also identified as important for the success of consolidated mitigation. Respondents remarked that incorporating natural areas, adequately funding proper maintenance and monitoring activities, and coordinating between state and federal agencies also contribute to successful consolidated mitigation.

Most responses to the question about which reasons are most often responsible for the problems with or failure of consolidated mitigation resemble answers given for individual sites. Insufficient hydrology, excessive dryness, and invasive plants were the top responses, with inappropriate planting elevations, hydroperiods, and poor coordination between designer and contractor also frequently cited. Destruction by animals or humans, excessively steep grades, and problems with physical structures were rarely cited as reasons for problems with consolidated mitigation. Wetland managers also provided several reasons for the failure of consolidated wetland sites: low-bid process, lack of compliance, lack of coordination and understanding of credit evaluation systems, and too much site disturbance.

*Keys to Mitigation Success and Failure*

Analyzing the Phase I agency survey data illustrates two important points about the success and failure of mitigation options. First, success of wetland mitigation largely depends on the communication and management between designer and contractor. If mitigation goals and site design are not properly translated by the manager to the builder, then the site, regardless of mitigation option, will likely fail. Survey responses emphasize that success and failure correlate with selecting good sites, having adequate hydrology, and using good planting techniques.

The second point relates to the expertise of the contractor in understanding wetland construction. Successful wetland mitigation often requires stricter grading plans and more precise planting techniques. Some survey respondents indicated that the most effective approach is a "design-build" process, in which experienced wetland contractors handle the mitigation project separately from the roadwork.

*Lack of Mitigation Options*

Not all states have been able to establish mitigation banks or other consolidated mitigation options, such as in-lieu fee programs. One of the intentions of the agency survey was to determine whether states have banks and, if not, why not. Seventy-six percent of respondents (that is, 42 of 55) indicated that their states have consolidated sites, with 42 percent of respondents adding that they believe consolidation provides the greatest benefits (see Table 1). An additional 15 percent believed that the benefits of mitigation options, consolidated or individual, depend on the project, while 5 percent favored individual mitigation. When asked which mitigation option provided the greatest benefits, 20 of the 55 respondents (that is, 36 percent) did not respond to the question.

When questioned why consolidated mitigation was not used in their state, survey respondents most frequently cited interagency disagreement as the biggest obstacle (see Figure 7). An additional 31 percent indicated, more specifically, that disagreement on the use of consolidated wetlands and permit issues were why their state was unable to develop mitigation banks or other forms of consolidated mitigation. Additional respondents indicated that consolidation was an impractical option or that state DOTs were unwilling to invest funds into consolidation. Interviews with 13 DOT contacts further reveal that 6 of the contacts would like to use consolidated mitigation for their projects. The remaining 7 contacts, however, believed that consolidation was unnecessary because of the scarcity of projects; because of the impracticality of restricting mitigation to designated watersheds, which are often too small; or because of the negligible number of projects within the respective watershed.

**Cost Comparison of Mitigation Options**

Cost for compensatory mitigation varies greatly and cannot be adequately compared across state lines or even within state DOT districts, as mitigation cost is a function of site availability, wetland availability, terrain type, mitigation size, individual abilities of the resource managers, design flexibility, and willingness of landowners to establish conservation easements or to sell their property outright. A Woodlot Alternatives, Inc., study (1996) compared the cost of different individual mitigation projects in Maine and in Georgia and found considerable variability. For example, the data suggest that the Georgia DOT spends much less on a per-acre basis than the Maine DOT spends. However, the disparity likely resulted from Georgia's tendency to undertake larger projects and to have more opportunities for using historically drained agricultural lands, which are used for restoration wetland projects. The study concludes that the national average cost per acre of impacted wetland (calculated as the total mitigation cost divided by the acres of wetland impact for a given project) was $68,942, while the average cost per acre of mitigation was $27,704. Because of

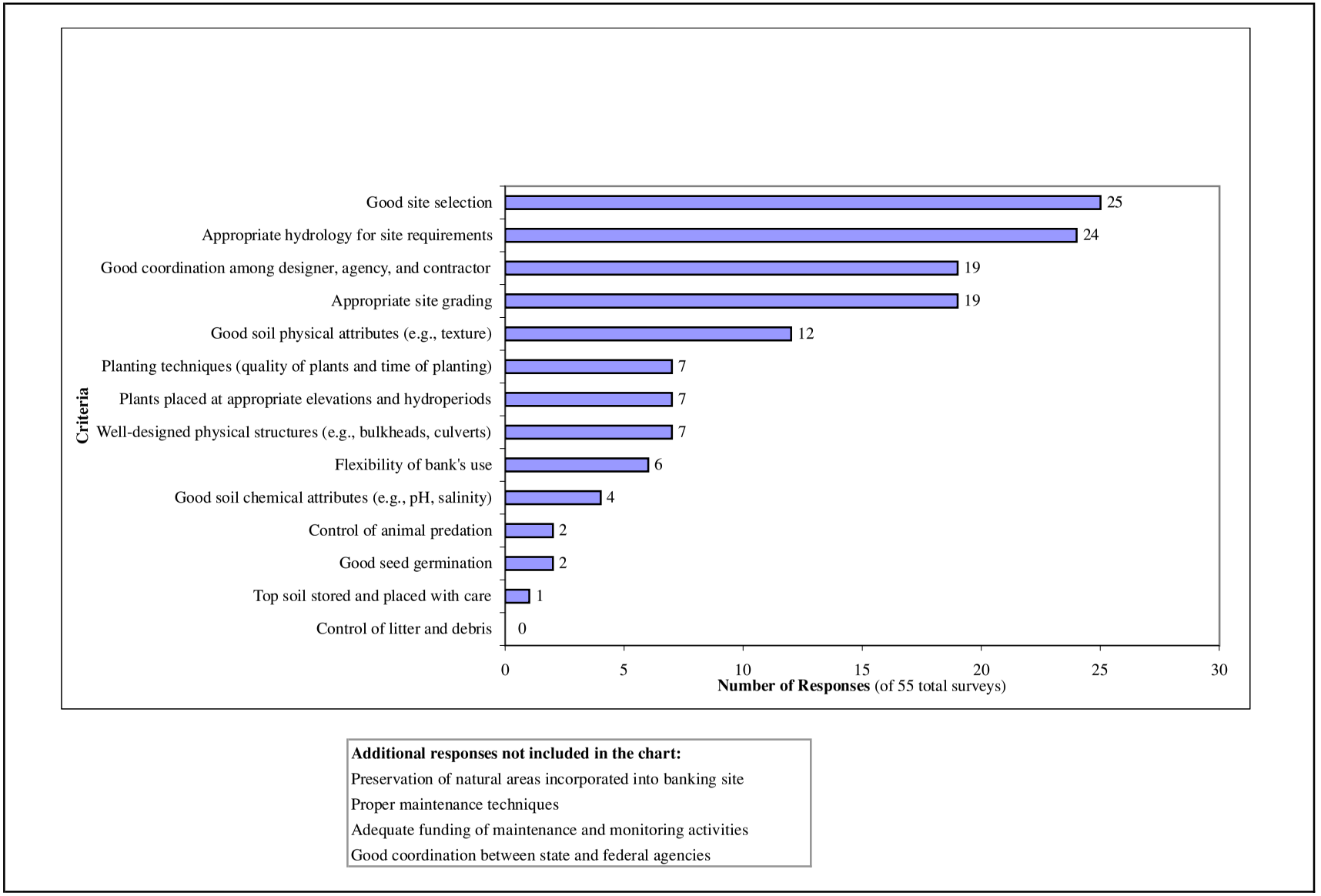
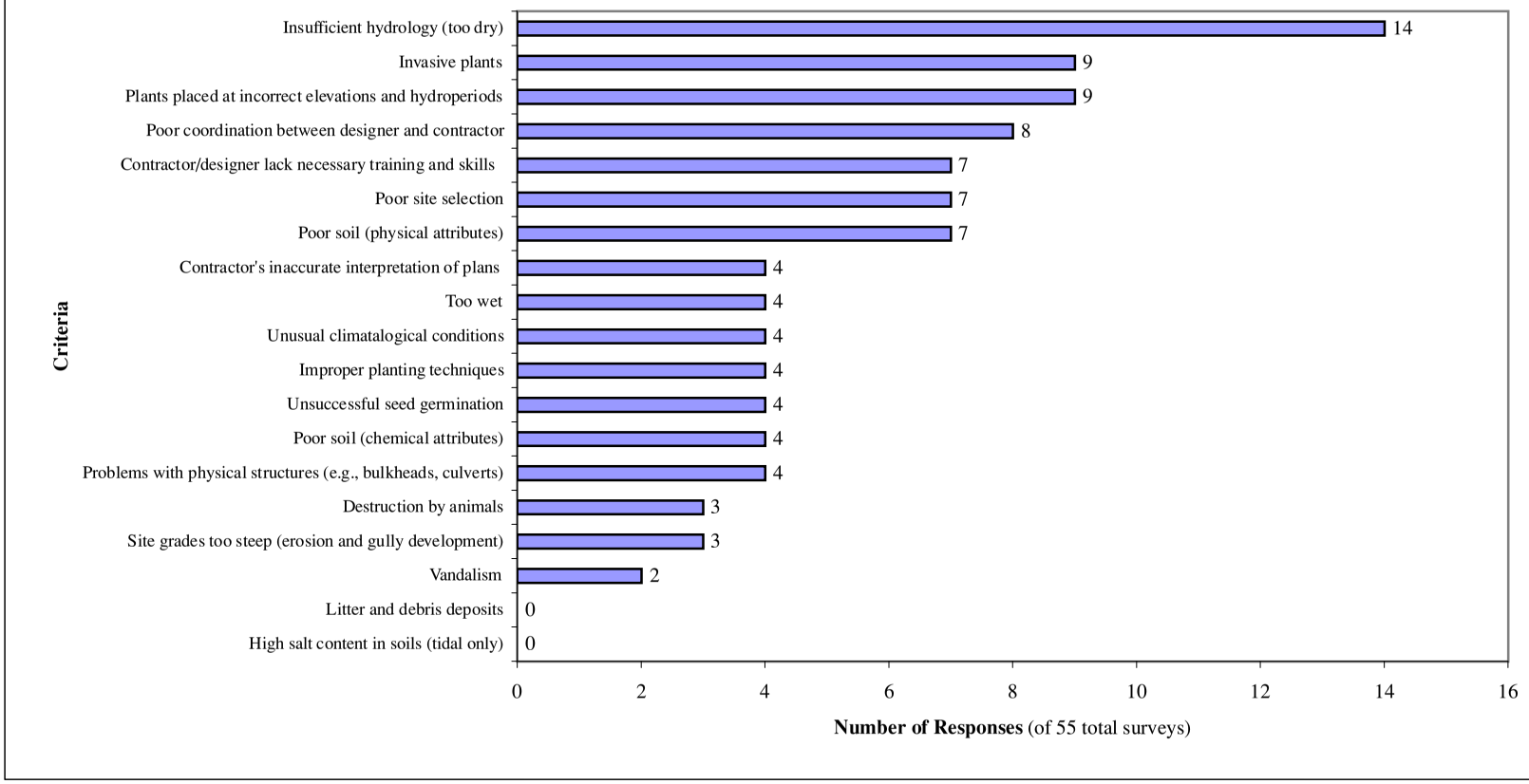



*Figure 5. Survey responses: what are reasons for successful consolidated mitigation sites?*




| Additional responses not included in the chart: | |
|---|---|
| Agencies can't agree on function/values/credit calculations | Conversion of one wetland type to another (emergent to forest) |
| Too much site disturbance | Agencies' goals superceding professionals' advice |
| Lack of understanding by all parties as to use of bank | Weeding activities that may affect desired understory species |
| Lack of compliance | Low bid process (poor performers can't be eliminated without major problem) |

*Figure 6. Survey responses: what are problems with establishing consolidated mitigation sites?*

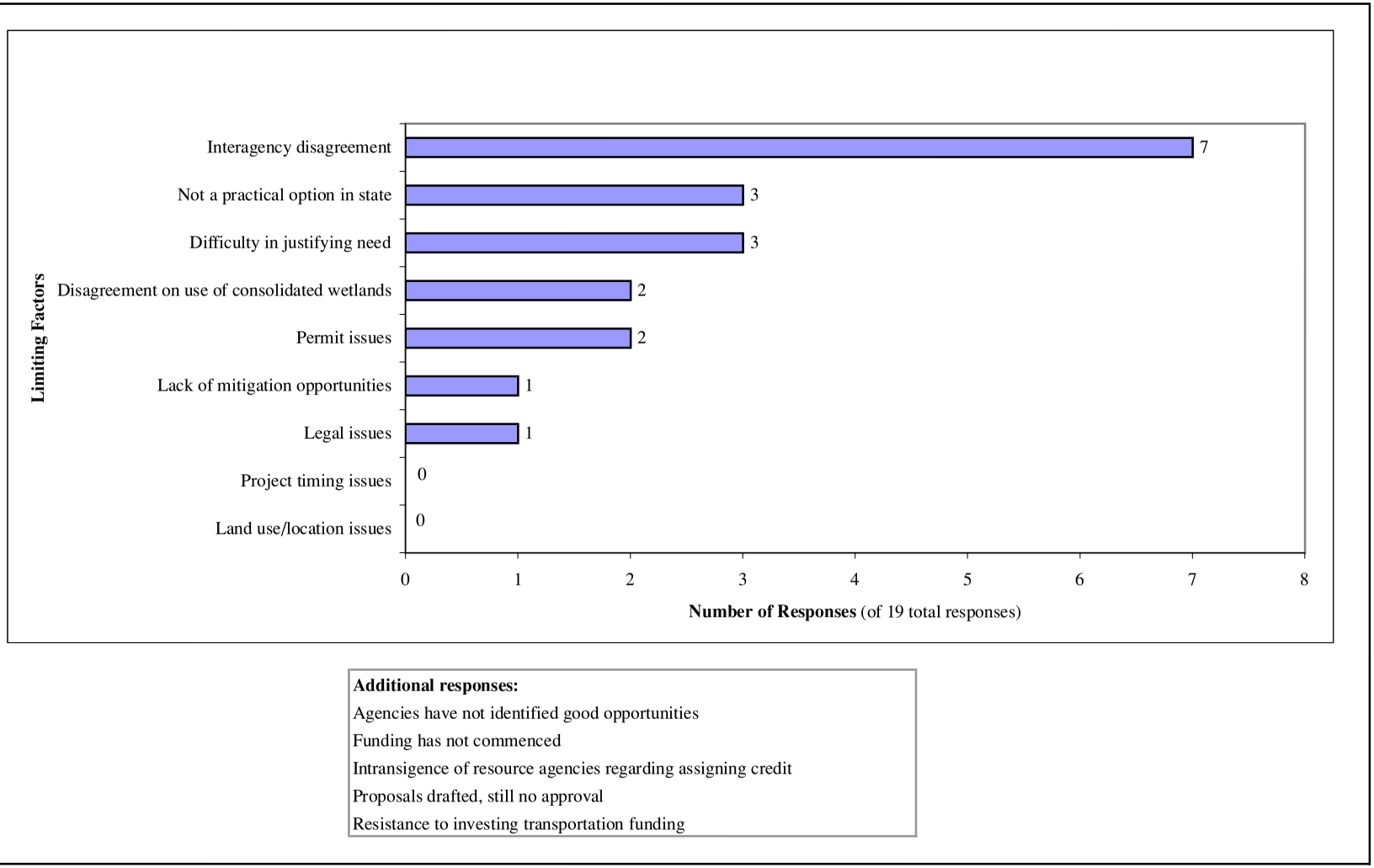



*Figure 7. Survey responses: why is consolidated mitigation not used in your state?*

**TABLE 1 Survey responses: Which mitigation option provides the greatest benefits?**

| Responses | # of Responses | Percentage of Total |
|---|---|---|
| Consolidated | 23 | 42 |
| Individual | 3 | 5 |
| Depends on the Project | 8 | 15 |
| Not Enough Experience to Compare | 1 | 2 |
| No Response Given | 20 | 36 |
| Total | 55 | 100 |

the high variability in cost accounting, however, more data must be analyzed to better understand the costs of individual and consolidated mitigation.

### Decision-Making Models

To provide guidance for compensatory mitigation options, research centered on determining whether state DOTs or other agencies relied on decision-making models to guide mitigation decisions. For example, if a wetland impact is of a particular class or size, the agency may pursue consolidated mitigation. Conversely, if the impact is larger than an established size criterion, individual mitigation may be pursued. However, the initial database and literature research, along with the survey and interviews, revealed that no such guidelines are established for DOTs. Rather, compensatory mitigation options were determined on a project-by-project basis, through regional specifications, before the agency receives a permit to take wetlands. In other words, selecting the type of compensatory mitigation is based largely on the availability of good sites, on regional wetland needs (for example, bottomland forested wetlands), on the availability of banking credits (private or DOT-related), and on the guidance of the USFWS and state fish-and-game agencies.

## SUMMARY OF PHASE I RESEARCH AND PHASE II OBJECTIVES

The original intent of this project, as stated in the research plan, is twofold: to evaluate the effectiveness of various wetland mitigation options relative to each other (this objective constitutes Phase I) and to develop a systematic decision-making process that enables state DOTs and related regulatory and research agencies to select mitigation options that are most suitable for specific projects and circumstances (this objective constitutes Phase II).

Phase I of this research has been completed and is reported in this digest. Generally, no data definitively indicate better wetland values for certain mitigation options. Data do relate, however, the perception that wetland mitigation banking not only offers higher functional replacement value, but also is a more efficient tool with more reliable outcomes.

Twenty-six state DOTs have consolidated wetland mitigation, in the form of banking, as an option. The principal reasons for DOTs not to have the option of consolidated mitigation include

- The lack of a state-enabling program or of legislation allowing wetland banks or other consolidated options (or, alternatively, the presence of state guidance or regulations specifically disallowing consolidated banking as an option). States such as Florida, Minnesota, and Wisconsin have been successful largely because of state legislation recognizing banking as an option.
- Regulatory agency concerns about consolidated wetland mitigation development, specifically those of the USACE. The USACE does not accept consolidated mitigation in some of its districts. Each of the 38 individual corps districts may determine which mitigation options to exercise in its respective district, and some have chosen not to consider certain mitigation options.
- The perception that the watershed-based requirement for banks does not afford enough flexibility for planned highway projects. In many cases, the watersheds are too small or the projects slated for a particular watershed are too few to warrant a bank.

Generally, some states lack consolidated mitigation as an option because of regulatory obstacles, poor physiographic fit, or simple lack of need.

Phase II research will primarily focus on developing guidelines for state DOTs that illustrate the selection process for wetland mitigation options at the program and project levels. The guidelines will (a) identify available options and potential barriers associated with each critical decision point in the process and (b) advise how to make choices using the best available data from literature searches, surveys, interviews, and case studies. Phase II research will also focus on technical, administrative, and regulatory issues that affect the development and use of multiple mitigation options for DOTs.

## GLOSSARY

**Consolidated mitigation:** creation, enhancement, restoration, or preservation of wetlands, for multiple impacts and multiple projects, within a project area or within an impacted watershed and applied to one mitigation site. Consolidated mitigation is most likely large scale. Examples include wetland banks; fee-based wetland mitigation; and nonadvanced, project-specific or multiproject consolidation.

**Creation:** to alter upland environments or shallow aquatic environments to produce wetlands (Institute of Water Resources [IWR] Report 94-WMB-6, 1994).

**Enhancement:** to alter an existing wetland to add, or increase, particular wetland values and functions to levels not present under previous natural conditions, or to slow the natural impairment of existing values and functions (IWR Report 94-WMB-6, 1994).

**Individual mitigation:** creation, enhancement, restoration, or preservation of wetlands for impacts associated with one project. Mitigation is for a specified amount of wetland impact associated with the project, most likely a small-scale mitigation in close proximity to or adjacent to the impacted wetland.

**In-kind:** mitigation for the same wetland classification and function as the impacted wetland, such as compensating for a forested wetland impact with a forested wetland mitigation site.

**Out-of-kind:** mitigation of an impacted wetland with a dissimilar wetland type or function, or both (for example, mitigation of an emergent wetland with a forested wetland).

**Preservation:** to provide legal protection to natural wetlands that would otherwise be lost to lawful activities (IWR Report 94-WMB-6, 1994).

**Restoration:** to return wetland values and functions to a former wetland or degraded wetland where human or natural activities have diminished or destroyed such values and functions (IWR Report 94-WMB-6, 1994).

**Successful mitigation:** mitigation that satisfies all local, state, and federal permit conditions for the project. (Note: the definition for "successful mitigation" was selected to limit the amount of subjectivity in determining the overall success of the numerous mitigation sites within the United States. Although it is understood that the ultimate goal of wetland mitigation is to achieve "no net loss" of wetland values and functions, this project focuses primarily on determining success through satisfying permit conditions.)

**DOT umbrella bank:** an agreement between a state DOT and the regulatory agencies on the roles and responsibilities of the parties for establishing and operating banks that the DOT sets up. This umbrella bank agreement covers one or several banks in the state.

**Wetland functions:** the physical, chemical, and biological processes that can be attributed to a wetland ecosystem. This phrase generally refers to wetland habitat, water quality, and hydrology.

**Wetland value:** wetland processes or attributes that are valuable or beneficial to society. The phrase also refers to the goods and services that address human needs and that result from the functions performed by wetlands.

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