PURPOSE: The purpose of this effort was to conduct two workshops that focused on Threatened and Endangered Species (TES) and Environmental Windows (EW) research within the Dredging Operations and Environmental Research (DOER) Program in the context of the U.S. Army Corps of Engineers (USACE)-wide approach to managing these issues. The goal of the workshops was to convene a multi-disciplinary group of scientists and engineers from the U.S. Army Engineer Research and Development Center (ERDC), Environmental Laboratory (EL) and Coastal and Hydraulics laboratory (CHL), to develop ideas that will lead to accelerated progress on problems and challenges posed by TES and EW (Figures 1 and 2) within the USACE. The workshops were held to develop a new vision, solution-focused strategy, and science-based research program for addressing these challenges within the DOER program. Results of this workshop have promoted the development of the USACE Threatened and Endangered Species Team (TEST) approach that is described in Hartfield et al. (2016).

Figure 1. The clamshell dredge Chicago deepens one of the major navigation channels in New York Harbor. Kill Van Kull, New Jersey. Such operations typically are temporally confined by Environmental Windows associated with, in part, federally listed species.

Approved for public release; distribution is unlimited.
BACKGROUND AND PROBLEM: Both TES and EW have substantial impact on costs and operational flexibility of both navigation and dredging operations. The USACE Navigation program spends more than $200 million annually on compliance with Endangered Species Act (ESA) regulations (USACE 2018). However, the USACE is the only federal land management agency without a documented, comprehensive strategy for addressing TES. Furthermore, the DOER program is the only source of funding within the USACE to comprehensively address the science of navigation-related TES and EW issues. Previous and current research within DOER has focused on identifying TES that have significant impacts on the USACE dredging mission, and designing and implementing research that assists with facilitating the ability of the USACE to conduct mission activities (e.g., navigation dredging, beach nourishment, and deposition of dredged material). Within existing and limited funding resources of the DOER program, this single-species approach has provided significant advances in knowledge, but has provided mixed results in terms of easing operational restrictions on the USACE. Furthermore, DOER research activities primarily have been in response to high priority issues that have arisen, and collectively, these activities have not been sufficient to provide the science regulators with what they need to make decisions about timing, duration, and type of dredging activities (EWs) at site-specific locations. A new vision for the DOER program is needed that includes more strategic science and engineering approaches, proactively addressing TES and EW challenges that play an integral part of a broader USACE strategy.

Two, 1.5-day workshops were held back-to-back at Wilsonwood Lodge, Vicksburg, MS on 22–24 March 2011. The first workshop (TES) was conducted on the first day and the morning of the second day. After lunch on the second day, the EW workshop began and ran until the end of the
third day. Through technical presentations, case studies, round-table discussions, and short breakout sessions, workshop attendees were asked to provide input to redefine contemporary problems, identify opportunities for solving the problems, describe critical gaps to be addressed by science and engineering research, scope technical capabilities that must be developed to support the navigation program, and identify innovative approaches to deliver the solutions.

**Threatened and Endangered Species (TES) Workshop.** The first workshop focused on TES issues. The format for the workshop included a brief review of the history of the DOER TES program; three case studies of existing DOER research projects related to federally listed species (sea turtles, sturgeon, and Interior Least Tern) to stimulate ideas and round-table discussions. Short breakout sessions were formed on the following topics: (1) inland issues, especially navigation dredging in riverine areas, and (2) coastal issues, including offshore (e.g., islands) and onshore (e.g., beach nourishment) issues. However, discussions also covered other areas.

**Environmental Windows (EW) Workshop.** The second workshop focused on EW issues. An approach similar to the TES session structure was used. The workshop agenda included a review of the history of the DOER EW program; two case studies of existing DOER research projects (Maumee Bay walleye case study and the Norfolk District James River case study) to stimulate ideas and round-table discussions. Breakout sessions were used to facilitate discussion on the following topics: (1) promoting the risk paradigm as a more objective EW evaluation tool, and (2) establishing interagency partnerships to both identify critical knowledge gaps and obtain commitments for adopting new management practices as alternatives to EWs.

**DISCUSSION:** The following sections describe the outcomes and action items resulting from workshop discussions, followed by specific actionable recommendations applicable to both the TES and EW topic areas.

**Workshop outcomes.** There were several constructive outcomes generated during both workshops. During the outcomes sessions, participants provided feedback on the following two specific issues: (1) what is the USACE doing well? and (2) what are the knowledge and other gaps that are hindering USACE progress on TES and EW issues? Participant feedback for each topic is summarized separately below.

**Outcome Session: What is the USACE doing well?**

Workshop participants were asked to provide feedback based on their experience on what the DOER program is doing well to address TES and EW associated issues. TES workshop participants suggested that the USACE works well with regulatory agencies and outside organizations to reduce conflicts between engineering activities and TES, and provides leadership through focused workshops (described below). Responses related to EWs were grouped into the following three main categories: (1) improved EW debate outside the USACE, (2) improved plume study data, and (3) credibility earned in certain circumstances, especially related to sea turtles.

**Threatened and Endangered Species (TES) - Positives**

- The USACE is building positive working relationships with the U.S. Fish and Wildlife Service (USFWS). Although engineering activities and resource conservation
and management often are at odds, there are several examples of how the USACE has worked closely with the USFWS to reduce conflicts. Focused efforts by ERDC researchers, USACE Districts, and the USFWS have resulted in better balance for outcomes of Biological Opinions (BiOp’s) resulting from Endangered Species Act Section 7 Consultations. Since 2005, the ERDC has funded American Bird Conservancy (ABC) to conduct investigations on both coastal and inland birds of particular interest to the USACE. One specific objective of this relationship is to improve the way the USACE addresses bird conservation issues with the USFWS. This work has substantially increased USACE credibility with the USFWS and others.

- **The ERDC is providing leadership through workshops and regional meetings in pursuit of reducing TES/mission conflicts.** The ERDC has exhibited initiative by engaging other Federal, state, and non-governmental organizations, in assembling experts to discuss conflicts between the mission and resource protection. In 1988, the USACE held a national workshop (Dickerson and Nelson 1990) that was attended by approximately 200 individuals to investigate the best means of minimizing dredging impacts to sea turtles. This workshop was a springboard for the most subsequent work on the topic. From 2005–2006, the ERDC worked with ABC to conduct a series of three regional (North Atlantic, South Atlantic, Gulf Coast), coastal-based workshops dealing with USACE coastal engineering activities and bird conservation (e.g., Guilfoyle et al. 2006). Workshop participants included a diversity of ornithologists, engineers, project planners, coastal ecologists, geomorphologists, regulators, and others. These meetings assembled representatives from many different Federal, state, and local agencies and non-government organizations. These workshops helped reduce some areas of conflict between engineering activities and bird habitat needs, including expanded USACE capabilities to contribute to various bird conservation efforts, and to make the bird conservation community aware of opportunities that exist through working with the USACE under the Ecosystem Restoration mission area.

**Environmental Windows (EW) - Positives**

- **The debate about EWs is being done in earnest.** Stakeholders and other agencies recognize the concern about EW restrictions and their effect on dredging operations. Likewise, they recognize the programs concern about the effects of dredging on TES. Progress is being made in making both EW and TES impact decisions more science-based. The DOER program began to focus on this issue a few years ago and has contributed to this success. Several manuscripts and other reports have been published documenting the effects of suspended sediments on aquatic species such as walleye, oysters, Atlantic sturgeon, and smallmouth bass that are driving EW in waterways in various parts of the country (Suedel et al. 2012a; Suedel et al. 2012b; Suedel et al. 2014; Reine et al. 2014; Suedel et al. 2015; Edge et al. 2015; Kjelland et al. 2015; Wilkens et al. 2015).

- **Plume studies are improving exposure data quality and are beginning to change perceptions.** Measuring and tracking plumes in the field during dredging operations have improved understanding of plume dynamics around operating dredges. The generation of
such exposure data is improving the science of dredge plumes as a source of exposure for resuspended sediments, and is improving perceptions of the actual risk this material poses to aquatic receptors.

- **The USACE has earned credibility in some areas, especially related to sea turtles.** The USACE Sea Turtle Data Warehouse (now Operations and Dredging Endangered Species System (ODESS) [https://dqm.usace.army.mil/odess/#/home](https://dqm.usace.army.mil/odess/#/home) is used to compile information on incidental takes of sea turtle species. Existing mitigation tools for beach applications, among other tools, have shown that sea turtle behavior varies with temperature, leading to the removal of EW in some seasons in the Gulf of Mexico. Similar progress is being made in the Atlantic region. With biological opinions in place, progress is being made on a project by project basis. Some biological opinions can be changed, and in these cases, considerations can be made to review and revise the EW. Having good communications and relationships with stakeholders in these areas can help the process of reviewing and revising the EW.

*Outcome Session: What are the major gaps in knowledge or approaches to TES and EW?*

Workshop participants provided feedback on what knowledge and other gaps exist that are impediments to more effectively addressing TES and EW issues. There were a number of gaps that were identified by participants; these were generally related to the lack of scientific data, collaborations/communications with agencies, the true cost of restrictive EWs, and prioritization of USACE assets to tackle complex EW issues.

**Threatened and Endangered Species (TES) – Knowledge Gaps**

- **A better understanding is needed of the monetary and operational impacts of TES to USACE missions.** There was consensus that USACE expenditures on TES are high, but may be eventually reduced through acquisition of improved species data, better relationships and communication with resource and regulatory agencies, and focused research efforts.

- **For some taxonomic groups, especially fishes, more basic life-history information on TES is needed.** Information on population sizes, dispersal, and vital rates (e.g., survival), would provide better information for decision tools (e.g., population models), including making better (and perhaps cost-saving) management decisions.

- **New tools and technology are needed to better understand TES ecology.** Emerging technologies such as eDNA, stable isotopes, and light-level geolocators could possibly solve some unanswered questions in a more cost-effective manner.

- **Better data and solution-based science may help ease restrictions.** For example, having a clearer understanding of the endpoints for habitat restoration, or region-specific TES population goals, would provide the USACE with tangible targets. This would similarly help guide more focused research.
• Assess how the USACE responds to regulatory agencies. Although the USACE is often constrained by TES restrictions imposed by regulatory agencies, USACE personnel perhaps have much to gain by having a better understanding of state and Federal laws, how regulatory agencies operate, and by engaging them earlier in the planning process.

Environmental Windows – Knowledge Gaps

• Exposure, effects and species life history data are lacking to adequately assess dredging plume risks in many cases. While much was learned during DOER and other past USACE research programs, these historical data are often insufficient to assess resuspended sediment risk to aquatic species. The USACE is now better informed about what the actual exposures to dredging plumes are and understand that more data are needed. There is also a lack of basic life history information on species driving EW. In the absence of such data, oftentimes the broadest possible species distribution and timeframe are put in place as the default, thereby resulting in a restrictive EW.

• While hypothetical case studies exist, more case studies are needed based on actual EW situations in the field. A hypothetical case study using Pacific herring in San Francisco Bay has been used as an example for how EW can be set (Suedel et al. 2008). However, more case studies are needed using actual EWs. Actual field case studies will have the extra benefit of showing how alternative methods, tools, and techniques can be applied for setting new EW, and revising existing EW.

• Interagency communications and collaborations are often lacking when setting EWs. It was acknowledged during the workshop that engaging agencies and stakeholders in collaborative efforts to define the exposure, effects, and life history data to better inform EW may be mutually beneficial to all parties involved in setting, reviewing, and revising EWs. Current forms of engagement include communications with the national and regional dredging teams and presentation of technical information at conferences. Current engagement often lacks the collaboration needed to effectively communicate the science and other information behind the EW.

• The USACE states that the currently restrictive EWs cost a great deal of money, but have little supporting information on actual costs. There is a lack of information about the costs associated with USACE dredging operations adversely affected by EWs, especially costs related to economics and operations. There are numerous questions that should be answered with such an effort, including where EWs are costing the USACE the most, what species are costing the most, and what are the most critical EW priorities. In the past, the ERDC had published costs associated with dredging operations by dredge type and time of year, but this type of information has not been recently compiled and published.

• A means for prioritizing USACE investments for identifying EW research priorities needs to be developed. A process is needed to effectively prioritize limited USACE resources for identifying EW research priorities. One option to accomplish this is to focus resources on one, or just a few EW issues, perhaps in the same geographical area and within the purview of one USACE district (e.g., USACE Buffalo District in Great Lakes
harbors). Focusing resources in this manner would determine whether such an effort improved the EW review and revision process. If successful, the USACE would have a more compelling reason to focus EW research and development efforts in the future.

- **There is a lack of information about the broader implications of dredging operations related to natural variability and other human activities.** From an exposure standpoint, few data exist placing dredging-related plumes into proper context with other sources of suspended sediments in navigable waterways (i.e., ship, barge and other vessel traffic and storm events). Sediment budgets should also be compared in channels that have been dredged vs. those channels that have not been dredged. Not dredging channels during the restricted season leaves them more vulnerable to resuspension from storms and ships. Placing dredging operations in context with the broader sediment budget picture will aid understanding of dredging contributions to the larger suspended sediment budget. In addition, there is a general lack of information regarding optimal timing of activities (i.e., beach nourishment and noise impacts on aquatic species).

- **The USACE needs to improve communications on incidental takes of sea turtles and other species.** The USACE has generated data on sea turtles that show that the incidental take is substantially smaller than incidental takes from other applications (i.e., commercial and recreational fishermen). However, the potential risk for incidental take of sea turtles still exists during hopper dredging operations throughout sea turtle coastal habitats (Dickerson et al. 2018). Over the past 15 years, the international dredging community has incorporated sea turtle protection methods developed by the USACE into some of their hopper dredging projects when possible. The USACE needs to place this information into proper context with other sources of sea turtle mortality. Likewise, such communications should be improved for other species such as sturgeon.

**Action Items**

Identifying actionable items for the DOER TES and EW topic area was an important charge for workshop participants. Participants identified several areas in which both topic areas could be revised to improve future outcomes. The following key topics, recommendations, and action items, are based on assimilation of significant input by workshop participants:

**Develop a comprehensive long-term strategy for addressing TES and EW within the USACE.** First and foremost, the USACE should develop an agency vision and strategy to prioritize and fund critical TES and EW research. This effort should be completed with coordination among Headquarters, District, Division, and ERDC personnel. To facilitate the development of the strategy, the ERDC should compile existing data on which species are causing the biggest impacts to the USACE mission (monetarily and operationally), while establishing a prioritized list of TES (research hypotheses for these species) and EW to direct research efforts that provide the highest return on investment. The USACE Threatened and Endangered Species Team website (https://test.el.erdc.dren.mil/index.html) and the USACE Threatened and Endangered Species Cost Database (https://tescost.el.erdc.dren.mil/Default.aspx) provide a wealth of information on TES and EW from a species-specific standpoint, and provide a good framework for this effort. Detailed action items for developing the strategy include the following:
Generate and make available a detailed table that illustrates the TES that are responsible for the top 90% of agency direct TES expenditures (i.e., budget line-item expenses).

Aside from broadly defining the nature and type of impacts by TES and EW to the USACE mission, and the number of projects impacted by TES and EW, estimate the additional costs of TES and EW on the USACE mission (e.g., opportunity costs, permitting, scheduling, project delays, constraints imposed by mitigation measures, additional labor efforts). Combine these costs with known direct costs. Previous and current DOER research has developed a system to estimate such costs by closely working with USACE Districts (https://tescost.el.erdc.dren.mil/Default.aspx).

Assemble an Expert Task Team of ERDC, District, Division, and Headquarters personnel (integrating disciplines including modelers, risk assessors, engineers, field biologists, decision analysts, regulatory personnel, etc.). The team would participate in developing the long-term strategy mentioned above, to include addressing specific TES challenges and establishing a prioritized TES list to better inform how research investments are made, and taking a critical look at which species are having the largest mission impacts to the agency. Some specific EW challenges the team could address include the following: developing, applying, and communicating science to counter unreasonable EW requirements, developing a process to review and revise EWs once established, developing and communicating ways in which EWs can be applied adaptively rather than fixed, and illustrating the often-overlooked benefits of USACE mission activities. A detailed analysis (using multi-criteria decision analyses or other appropriate techniques) could be conducted to determine how best to allocate research dollars to provide for the biggest return-on-investment.

Publish profiles for high-priority TES and emerging sensitive species that provide species-specific information on impacts, lack of necessary life-history information, research needs, etc.

Eliminate political boundaries (i.e., Districts and Divisions) when making decisions about where to invest funds for TES. Funds should be directed where needed most for monitoring, research, or adaptive management. For example, <5% of the interior least tern population resides in the Northwestern Division, yet they receive >90% of the money for tern recovery. These funds are badly needed in the Little Rock, Tulsa, and Vicksburg Districts for monitoring and habitat management where the bulk of the interior least tern population resides.

Establish national and regional task forces for the prioritized species. Develop specific research needs, including testable hypotheses, and prioritize these for funding. Regional and national groups should meet annually and biannually, respectively, and include USACE, USFWS, National Marine Fisheries Service, and other agencies as necessary.

Develop reporting criteria for annual response by Districts that includes input for TES and associated impacts (similar to above).

Develop an online tracking system for all data associated with this recommendation.
As part of the overall DOER strategy, participants also identified several other areas in which the DOER program could be revised to improve future TES and EW outcomes. The following key topics represent significant input received by participants during the workshop, with TES challenges being discussed first.

**Threatened and Endangered Species**

- **Develop a more comprehensive strategy for addressing imbalances in take between the USACE and the private sector.** Several examples illustrate this imbalance, including take restrictions for (1) Atlantic Sturgeon (USACE is taking 1–2 individuals per year while netting activities are taking thousands, and (2) sea turtles (dredging takes 20–30 individuals per year while the private fishing industry takes thousands). The ERDC should develop a white paper that provides details of take restrictions on the USACE for prioritizing TES, and a summary of annual take for these species.

- **Develop a proactive strategy for predicting unlisted species likely to impact future missions (or with high potential for future federal listing).** The Department of Defense (DoD) Partners in Flight ([https://www.denix.osd.mil/dodpif/home/](https://www.denix.osd.mil/dodpif/home/)) has already conducted such an exercise to prioritize those non-listed species with the highest likelihood of impacting the future military mission. This list provides a basis for developing monitoring efforts that will support future legal compliance and mission requirements. The Expert Task Team should work together to generate lists, by taxa, of those species associated with the Navigation Mission having the highest likelihood of being Federally listed.

- **Explore modeling frameworks having concurrent monitoring, adaptive management and risk assessment.** The USACE should be exploring modeling approaches that inform field data and vice-versa for a synthesized, integrated, systems level suite of data, analyses, models and other tools to assist with communicating better with stakeholders. As an example, the ERDC-EL has worked closely with ABC to develop an individual-based population model for the interior least tern (ILT). This model simulates the arrival of adult ILTs to breeding areas after spring migration, the selection of nest sites given variable habitat conditions, nest and chick mortality or survival, and re-nesting after nest or chick mortality. The model is nested within an analysis structure that allows users to simulate the response of tern populations to various types of management treatments under a wide range of habitat and initial conditions. The online model allows managers and researchers to: increase their understanding of what factors limit ILT reproduction, and how these vary in response to changes in habitat conditions and the bird population, compare the expected performance of alternative management strategies for increasing ILT reproductive success, and make informed decisions about river management (e.g., dam releases) or the management of threats to ILT populations (e.g., predator control).

- **Design big picture projects that have high potential for making a difference.** The current approach to solving TES issues is focused on specific hypotheses related to individual TES. This approach has been successful for specific high-priority issues, but
limited funding and a lack of comprehensive agency vision leaves large gaps in our knowledge base. Spatially and temporally large, multi-disciplinary research efforts, rather than small piece-meal efforts that investigate individual hypotheses, should be encouraged. The military has several large research programs, such as the Strategic Environmental Research and Development Program (SERDP), the Environmental Security Technology Certification Program (ESTCP), and the Legacy Resources Management Program (LRMP), all with very large budgets and well-funded research efforts that focus on high-priority TES and other issues directly relevant to enhancing military mission capabilities. All four military service branches provide input and oversight to these programs for prioritizing allocation of research funding. These programs have delivered a multitude of solutions that have provided the DoD and regulators with better information to reduce conflicts between TES and the mission.

- **Modernize internal and external communication (improved websites and social networking).** There was consensus that the ERDC website is difficult to navigate and our customers have problems finding publications and online tools. The ERDC website should be revised to be more user-friendly and include a powerful search engine to locate publications, models, and other tools. Social networking sites (i.e., Twitter and Facebook) should be considered to provide better contemporary information on TES issues, both internal and external of the agency.

**Environmental Windows**

- **The USACE needs to develop a means of prioritizing its investments relative to EW species drivers.** A means is needed to prioritize investments in a way that will have a meaningful impact via EW review and revision. One way to accomplish this is to pool resources to focus on just one EW (i.e., walleye in western Lake Erie). Focusing resources in this manner will allow for determining whether such an effort can improve the EW review and revision process. If the result of the effort does not result in a substantively improved process, this would indicate that resources spent in such a manner would be inefficient. If successful, the USACE would have a more compelling reason to focus research and development efforts within one USACE District. A decision will have to be made as to whether a broader strategy considers focusing on one EW as being preferred, as this will determine whether this action item becomes part of the new strategy.

- **The science of EW needs to be better incorporated into the EW setting process.** One means of addressing this need is to improve communications of the results of USACE exposure and effects research on suspended sediments. Areas where good communications and relationships have been established have yielded more productive results. Therefore, such lines of communication should be expanded (i.e., to include local and regional dredging teams). It is at this level where the greatest opportunities for improving the EW process exist. For identifying a communications success story in terms of engaging regional dredging teams, the Great Lakes Dredging Team EW example should be emulated (http://greatlakesdredging.net/). For sea turtles, state dredging coordinators have been assembled on a national basis to discuss EW and related topics with some success.
A broader understanding of the effects of dredging operations is critical to relating it to the larger suspended sediment picture. The effects of dredging operations are rarely put into perspective against background conditions and other sources of suspended sediments in water bodies (i.e., vessel traffic and storm events). There may be projects where exposure and effects data can be generated via a risk assessment process to quantify background noise and natural variability in the absence of dredging operations. Another option is to identify where the suspended sediment is originating in other parts of the watershed (i.e., in riverine systems), this source may be upstream bank erosion. Such studies, if pursued, could proactively identify other suspended sediment sources. Agencies such as the National Resources Conservation Service (NRCS) and others could serve as partners to cooperatively investigate broader suspended sediment issues. Regional sediment managers may also serve a meaningful collaborative role. Maumee Bay in Lake Erie is an example EW site where multiple suspended sediment sources are possibly impacting the walleye fishery outside of dredging operations (Suedel et al. 2014). Numerous other examples also exist for oysters (Edge et al. 2015), Atlantic sturgeon (Reine et al. 2014; Wilkens et al. 2015), and other fishes (Kjelland et al. 2015).

More case studies should be developed highlighting real-world examples and applications of decision analytical approaches. Case studies should especially be pursued using decision analytical approaches combining risk assessment, decision analysis, and mental models where aspects of space and time relevant to EWs are incorporated. Such approaches would consider EW as a decision problem, yet no studies to date have applied a structured decision process to systematically evaluate EWs. They would also blend physical and social sciences to include decision makers, decision analytical frameworks with risk analysis, modeling, monitoring, cost, and stakeholder opinions. The study published by Suedel et al. (2008) provides an example of how such an approach can be applied to setting EW using Pacific herring as a hypothetical example. This approach should be applied in real world EW settings.

The USACE should develop a strategy and objectives for reviewing and revising EWs. The USACE currently has no objective defined for EWs, nor have metrics been developed to measure success. An effective strategy can help address, for example, annual temperature variability occurring at different times of the year within a given waterway. This is a primary reason why EWs are set so restrictively, to account for annual variation, even in cases where it may not be necessary on an annual basis. Logistically, dredging schedules may not be positioned to react to seasonal changes. Developing a strategy may be able to include an early warning system that would be feasible to implement adaptively. Both internal and external USACE objectives should be developed.

The USACE should identify ways to compensate for the lack of incentive agencies have for reducing and removing EW restrictions. Maintaining the status quo is often the result when EWs are reviewed, often because agencies lack the incentive to revise them. The USACE often shuns controversy in such situations due to cultural constraints, so in some cases, decisions contrary to protectiveness recommendations are not made despite the existence of good science. One way to improve the process is to implement a top down approach to formalize EW settings by involving top scientists and policy
makers from multiple agencies (e.g., USGS, USFWS) responsible for setting EWs. The approach would provide participating agencies incentives to cooperate (i.e., there will be greater data/information exchange when collaborating) and to develop a common strategy to formalize the process that could be used for multiple projects and species.

- **The USACE should develop close relationships with non-regulatory third parties to aid collaboration and reduce conflict.** The ERDC worked with the ABC, a non-regulatory party, to conduct a series of regional workshops dealing with USACE coastal engineering activities and TES bird conservation. The workshops helped reduce some areas of conflict between engineering activities and bird habitat needs, including expanded USACE capabilities to contribute to various bird conservation efforts, and to make the bird conservation community aware of opportunities that exist through working with the USACE under its Ecosystem Restoration mission area. The ABC, while an advocate for bird conservation, has been critical of USACE activities, but has concurrently provided alternatives to engineering design that work both for conservation, and the mission. The ABC recognizes the value the USACE can bring to conserving the environment, which makes for a productive relationship. The ABC model should be replicated to tackle EW issues, this type of relationship also has been successful in addressing pallid sturgeon and sea turtle issues. Partnering with recognized non-regulatory parties could give the USACE additional credibility and build/improve agency relationships.

**RECOMMENDATIONS:** Based on the results of the two workshops, the following items were recommended by participants for developing a solution-focused strategy and science-based research program for addressing challenges to TES and EW. Some of the recommendations are actionable under the DOER program, while others should be explored and evaluated in terms of cost and implementation as part of a broader USACE vision and strategy.

- **Contribute to an agency vision and strategy.** The USACE should develop a broad strategy for prioritizing and funding critical TES and EW research. This should be a coordinated effort among Headquarters, District, Division, and ERDC personnel to articulate a corporate strategy. To facilitate the development of the strategy, the ERDC should compile existing data on which species are causing the biggest monetary and operational impacts to the USACE mission, and establishing a prioritized list of TES and EW to direct research efforts that provide the highest return on investment. Many subsequent action items would be articulated and implemented under this new strategy.

- **Prioritize USACE TES and EW investments.** The USACE should use the Expert Task Team to develop a process of prioritizing its investments in a way that will have a meaningful impact on the review and revision of both TES and EW. This can be accomplished for EW by pooling resources to focus on just one EW, such as walleye in western Lake Erie. Focusing resources in this manner determine whether such an effort can improve the EW review and revision process.

- **Determine the real costs of TES and EW.** The USACE maintains that the current restrictions by regulatory agencies related to both TES and EWs are costly, but supporting information is lacking. Information should be generated to determine where TES and EWs are costing the USACE the most, what species are costing the most, and
determine the most critical TES and EW priorities. This information should be developed quickly and communicated effectively with stakeholders.

- **Develop an Expert Task Team.** The USACE should develop an Expert Task Team with different disciplines; it should consist of members inside and outside the DOER program to integrate modeling, risk assessment, engineering, field biology, regulations, and decision analysis disciplines. The Team would be tasked with participating in developing the long-term vision and strategy, and addressing specific TES challenges. This would include establishing a prioritized TES list to better inform how research investments are made, and taking a critical look at which species are having the largest mission impacts to the USACE. The Team would also address specific EW challenges, including developing, applying and communicating science to EWs, developing a process to review and revise EWs, developing and communicating ways in which EWs can be applied adaptively, and illustrating the overlooked benefits of USACE mission activities.

- **Develop objectives for addressing TES and EW issues.** The USACE should develop internal and external objectives for improving TES and EW performance. The USACE currently has no objective defined for EWs, nor have metrics been developed to measure their success. An effective strategy can help address parameter variability occurring within waterways, a primary reason why EWs are set so restrictively. Both internal and external USACE objectives should be developed, with the Expert Task Team being a participant in their development.

- **Continue current successes.** The USACE should continue its efforts to build relationships, (e.g., with USFWS, NOAA-National Marine Fisheries Service), while providing leadership through regional and national meetings to help reduce TES and EW conflicts. Credibility is hard earned and efforts to earn additional credibility are recommended. Recent research generating exposure and effects data for EW species drivers, and population modeling such as that completed for the interior least tern, should be expanded.

- **Document case studies.** The concept of developing a process for reviewing and revising EW will be more quickly accepted if EW projects are documented. Real-world case studies using decision analytical approaches combining risk assessment, decision analysis, and mental models where aspects of space and time are incorporated, are especially needed for addressing EW issues. Such approaches would consider EW as a decision problem, a concept yet to be applied for evaluating EWs.

- **Generate more scientific data and communicate more effectively to stakeholders.** More biological, life history, exposure, and effects data should be generated to help reduce the uncertainty surrounding TES and EW. The results of USACE research must then be effectively communicated, especially with a suite of online tools. Established lines of communication should be expanded to include local and regional dredging teams. Communications have been successful when engaging the Great Lakes Dredging Team and this example should be emulated. For sea turtles, state dredging coordinators have been assembled on a national basis to effectively tackle EW related issues.
• **Develop a better understanding of the broader implications of dredging operations.**

Dredging-related plumes and incidental takes of TES should be placed into proper context with other impacts to navigation and the species utilizing these water bodies. Studies should be undertaken to place dredging operations in proper context with the larger sediment budget picture (e.g., background conditions, storm events, and ship traffic) which will aid understanding of dredging contributions to the overall suspended sediment budget. The USACE also needs to place incidental take information from dredging operations and place these into proper context with other sources of mortality for sea turtles and other TES.

• **Develop and implement a multidisciplinary approach for addressing TES and EW.**

An approach should be developed that is multidisciplinary, integrating field data, modeling, risk assessment, adaptive management, and effective communication where data from each discipline informs the other. Modeling data should be enabled to inform field data and vice versa to create a synthesized, systems level suite of data and analyses that can be effectively communicated to TES and EW stakeholders. Such an approach, now being developed for the Interior Least Tern, should be applied to other projects and TES.

This technical note should be used as a basis for furthering the USACE programmatic TES and EW strategies and identifying new research that will accelerate the delivery of solutions to the navigation mission. By considering the above recommendations, the USACE can build on current successes to develop cost effective dredging project management approaches and identify a broad strategy using science and engineering research that is broadly applicable to solve TES and EW problems. The recommendations also should enhance ERDC capabilities in these areas and better position the laboratory to solve such problems.

**POINTS OF CONTACT:** For additional information, contact Dr. Burton Suedel (601-634-4578, Burton.Suedel@usace.army.mil) or Dr. Richard Fischer (502-454-4658, Richard.A.Fischer@usace.army.mil). This technical note should be cited as follows:


**REFERENCES**


## APPENDIX A: DOER TES AND EW WORKSHOP PARTICIPANTS

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
<th>TES Workshop</th>
<th>EW Workshop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matthew Bates</td>
<td>ERDC EL</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Jacob Berkowitz</td>
<td>ERDC EL</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Sandy Brasfield</td>
<td>ERDC EL</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Todd Bridges</td>
<td>ERDC EL</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Eric Britzke</td>
<td>ERDC EL</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Courtney Chambers**</td>
<td>ERDC EL</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Doug Clarke</td>
<td>ERDC EL</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Dena Dickerson</td>
<td>ERDC EL</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Rich Fischer</td>
<td>ERDC EL</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Tom Fredette</td>
<td>ERDC EL</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Joe Gailani</td>
<td>ERDC CHL</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Kurt Gust</td>
<td>ERDC EL</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Jan Hoover</td>
<td>ERDC EL</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Jack Killgore</td>
<td>ERDC EL</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Tahirih Lackey</td>
<td>ERDC CHL</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Rick Lance</td>
<td>ERDC EL</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Igor Linkov</td>
<td>ERDC EL</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Julie Marcy*</td>
<td>ERDC EL</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Candice Piercy</td>
<td>ERDC EL</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Burton Suedel</td>
<td>ERDC EL</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Todd Swannack</td>
<td>ERDC EL</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Rob Thomas</td>
<td>ERDC CHL</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Tim Welp</td>
<td>ERDC CHL</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Tim Wilder</td>
<td>ERDC EL</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Joe Wilson</td>
<td>CECW-OD</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

*Served as facilitator for both workshops.

**Served as recorder for both workshops.
APPENDIX B: WORKSHOP AGENDAS

Dredging Operations and Environmental Research (DOER)

Threatened and Endangered Species (TES) Workshop

AGENDA

Day 1, March 22, 2011
8:30 – 9:00 Coffee and refreshments
9:00 – 9:15 Introductions, Background, and Scope of Workshop  Fischer/Marcy
9:15 – 9:30 Brief review of the history of the DOER TES program; Current DOER TES work units Clarke
9:30 – 10:00 Case Study: Interior Least Tern: Problem Description, Background, Modeling Approach  Fischer
10:00 – 10:20 Case Study: Sea Turtles  Dickerson
10:20 – 10:40 Case Study: Sturgeon and Dredging  Hoover
10:40 – 11:00 BREAK
11:00 – 12:15 Round-table discussion of existing issues, problems and approaches.
   • What is working? What needs fixing?
   • Identification of knowledge gaps, needed tools, models, etc.
12:15 – 1:00 LUNCH (Catered by Goldie’s)
1:00 – 2:30 Break-out Groups
   a. Inland Issues (Navigation Dredging in Riverine Areas)
   b. Coastal issues (offshore [e.g., islands] and onshore [e.g., beach nourishment]).

Determine:
   • New ERDC capabilities and tools/3 game changing innovations
   • Community- and systems-based approaches

2:30 – 2:45 BREAK
2:45 – 4:00 Breakout Group Reporting and Discussion  Group Leaders
4:00 Adjourn

Day 2, March 23, 2011
9:00 – 9:15 Recap of Day 1  Fischer
9:15 – 12:00 Developing a new vision and Mission Statement for the DOER TES Program, with science-based and solution-focused strategies
12:00 – 1:00 LUNCH (Catered by Goldie’s)
1:00 Adjourn (Environmental Windows Workshop Begins)
Dredging Operations and Environmental Research (DOER)
Environmental Windows (EW) Workshop
AGENDA

Day 1, March 23, 2011
12:00 – 1:00 LUNCH (Catered by Goldie’s)
1:00 – 1:15 Introductions, Background, and Workshop Scope Marcy/Suedel
1:15 – 1:30 Brief review of the history of the DOER EW program; Current DOER EW work unit overview Clarke
1:30 – 2:00 Maumee Bay Walleye Case Study Suedel
2:00 – 2:30 Norfolk District James River Case Study Clarke
2:30 – 2:45 BREAK
2:45 – 3:15 New Method for Setting EWs Linkov
3:15 – 5:00 Round-table discussion of existing issues and problems:
   • What is working? What needs fixing?
   • Identify knowledge gaps
   • Identify needed tools, models, etc.
   • Identify new ERDC capabilities/top 3 game-changing innovations
5:00 Adjourn/Dinner offsite (optional, self-pay; TBD)

Day 2, March 24, 2011
8:30 – 9:00 Coffee and refreshments
9:00 – 9:15 Brief Recap of Day 1 Suedel
9:15 – 10:30 Break-out Groups
   1. Promoting the risk paradigm as a more objective EW evaluation tool
   2. Promoting the establishment of interagency partnerships
10:30 – 10:45 BREAK
10:45 – 12:00 Breakout Group Reporting Group Leaders
12:00 – 1:00 LUNCH (Catered by Goldie’s)
1:00 – 3:30 Round-table discussion: (includes short break)
   • Redefine the EW problem and identify opportunities for solving it
   • Describe critical gaps to be addressed by DOER research
   • Scope technical capabilities that must be developed
   • Identify innovative approaches to more effectively deliver solutions
3:30 – 4:00 Next Steps Suedel
4:00 Adjourn
APPENDIX C: Participants of the Threatened and Endangered Species Workshop held on 22–23 March 2011 at Wilsonwood Lodge, Vicksburg, MS.
APPENDIX D: Participants of the Environmental Windows Workshop held on 23–24 March 2011 at Wilsonwood Lodge, Vicksburg, MS.

NOTE: The contents of this technical note are not to be used for advertising, publication, or promotional purposes. Citation of trade names does not constitute an official endorsement or approval of the use of such products.