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Effective Coordination and Cooperation Between Ecological Risk Assessments and Natural Resource Damage Assessments: A New Synthesis

Ronald G Gouguet,† David W Charters,‡ Larry F Champagne,§ Mark Davis,|| William Desvouges,# Judi L Durda,†† William H Hyatt Jr,‡‡ Rachel Jacobson,§§ Larry Kapustka,|||| and Rose M Longoria##*

†Windward Environmental LLC, 200 W. Mercer Street, Suite 401, Seattle, Washington 98119, USA
‡US Environmental Protection Agency, 2890 Woodbridge Avenue, Bldg. No. 18, Edison, New Jersey 08837, USA
§Texas Commission on Environmental Quality, Remediation Division, PO Box 13087, MC-225, Austin, Texas 78711-3087, USA
||Tulane Institute on Water Resources Law and Policy, 6329 Freret Street, New Orleans, Louisiana 70801, USA
#W.H. Desvousges and Associates, 700 Exposition Place, Suite 141, Raleigh, North Carolina 27615, USA
††Integral Consulting, 2661 Riva Road, Suite 520, Annapolis, Maryland 21401, USA
‡‡K & L Gates, One Newark Center, Tenth Floor, Newark, New Jersey 07102, USA
§§National Fish and Wildlife Foundation, 1120 Connecticut Avenue NW, Suite 900, Washington, DC 20036, USA
||||LK Consultancy, 8 Coach Gate Place SW, Calgary AB T3H 1G2, Canada
##Confederated Tribes and Bands of the Yakama Nation, Fisheries Resource Management Program, 401 Fort Road, Toppenish, Washington 98948, USA

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Special Series

EDITOR'S NOTE:

This is 1 of 4 papers reporting on the results of an SETAC technical workshop titled "The Nexus Between Ecological Risk Assessment and Natural Resource Damage Assessment Under CERCLA: Understanding and Improving the Common Scientific Underpinnings," held 18–22 August 2008 in Montana, USA, to examine approaches to ecological risk assessment and natural resource damage assessment in US contaminated site cleanup legislation known as the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

ABSTRACT

Although ecological risk assessments (ERAs) and natural resource damage assessments (NRDAs) are performed under different statutory and regulatory authorities, primarily the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as currently practiced, the activities typically overlap. ERAs performed as part of the response process (typically by the US Environmental Protection Agency [USEPA]) should be closely coordinated with the natural resource trustees' (trustees') NRDAs. Trustees should actively participate in the early stages of the remedial investigation (RI) and work with USEPA, including the potentially responsible parties (PRPs), when appropriate, to coordinate NRDA data needs with those of the RI. Close coordination can present opportunities to avoid inefficiencies, such as unnecessary resampling or duplicate data gathering, and provide the opportunity to fulfill both process requirements with a few well-designed investigations. Early identification of opportunities for practical combined assessment can save money and time as the restoration process proceeds and facilitate a cooperative resolution of the entire site's CERCLA liability. The Society of Environmental Toxicology and Chemistry (SETAC) convened an invited workshop (August 2008) to address coordination between ERA and NRDA efforts. This paper presents the findings and conclusions of the Framework Work Group, which considered technical issues common to each process, while mindful of the current legal and policy landscape, and developed recommendations for future practice.

Keywords: Ecological risk assessment Natural resource damage assessment CERCLA Coordination Assessment endpoints

INTRODUCTION

A Society of Environmental Toxicology and Chemistry (SETAC) technical workshop was convened to discuss how ecological risk assessment (ERA) and natural resource damage assessment (NRDA) data needs and assessment processes could be more closely linked (Stahl et al. 2009). The attendees of the workshop included ERA and NRDA practitioners from the public and private sector, many of whom have been on opposite sides of contentious, even litigious, NRDA cases. A subgroup was convened to examine the statutory, regulatory, and technical foundations of these processes to determine if there are underlying elements that hinder or foster the use or sharing of information across programs. Though there are certain unique requirements for each, both programs typically rely on a common suite of core environmental data, such as information on chemical residues in abiotic and biotic media, habitat characterization, biological surveys, and toxicity testing. Yet, in many instances, data collected under 1 program are not used under the other. This can lead to redundant and more costly investigation efforts and an extension of response or restoration timeframes. The

* To whom correspondence may be addressed: ronaldg@windwardenv.com

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objectives of this subgroup were to explore the potential reasons for these inefficiencies and, to the extent possible, suggest approaches that could be adopted to facilitate more efficacious information sharing. This paper is 1 of 4 that detail the deliberations and findings of the SETAC technical workshop on the nexus between ERA and NRDA.

LEGAL BACKDROP OF ERA AND NRDA

ERA and NRDA are both creations of laws that embody the principle that the environment should provide valuable public and natural resources and pose no unacceptable risks from hazardous substances. Those laws, such as the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and its state law counterparts, invest federal, state, and tribal authorities with the authority to remediate toxic contamination and restore or secure compensation for natural resource injuries. Though technically focused, at their core laws and regulations create a process for record keeping and decision making that is driven by legal standards and statutory objectives. This paper focuses on the CERCLA process for ERA and NRDA and the respective roles of the US Environmental Protection Agency (USEPA) and the natural resource trustees (trustees) under the CERCLA statute, but the concepts are also valid for similar processes under state laws.

Under CERCLA, USEPA has primary responsibility for remedy selection. In this regard, USEPA is charged with implementing remedies that eliminate unacceptable risks to human health and the environment that are posed by the release or threatened release of hazardous substances. The trustees, which include the federal government, states, and Native American tribes, have the authority under the statute to restore, replace, or acquire the equivalent of natural resources injured by the release of hazardous substances. The performance of these statutory duties includes conducting scientific evaluations designed to inform decisions. In both situations, the ultimate financial responsibility rests with those who are known under CERCLA as potentially responsible parties (PRPs).

The CERCLA remedial investigation (RI) performed by USEPA is the 1st part of a 2-phased process and is followed by a feasibility study (FS). The RI focuses on data collection for the purpose of delineating the nature and extent of contamination and includes an ecological risk assessment (ERA), which is intended to evaluate risks to the environment. The remedial investigation/feasibility study (RI/FS), as well as the remediation itself, is part of what are broadly defined under CERCLA as "response actions." Trustees, on the other hand, perform damage assessments to "determine compensation for injuries to natural resources that have not been nor are expected to be addressed by response actions" (US Department of the Interior [USDOI] 2005a, §11.10). NRDAs include data collection as part of the injury determination phase, which is followed by the determination and quantification of damages. The goal of the NRDA is to identify restoration needs and provide compensation to the public for lost services.

Data sharing and coordination: The legal environment

In practice, ERAs and NRDAs have often been conducted as independent exercises, with their own data collection and management procedures. Accordingly, data sharing and coordination has been more the exception than the rule, so much so that questions have arisen as to whether such sharing is actually restricted by law. It is not. Nothing in CERCLA or its implementing regulations prohibits the sharing of data between ERAs and NRDAs. There may be specific constraints on how data from 1 program may be used in another, but that should not be confused with a legal restraint on sharing.

If anything, there is a trend in federal and state policy and guidance to favor a more coordinated approach to remediating and restoring natural resources (USDOI 2007). Implicit in these authorities and guidelines is the need to share data and coordinate management among programs, including ERAs and NRDAs. Comprehensive, large-scale restoration efforts, such as those in coastal Louisiana (PL 101-640, 1990), the Everglades (PL 106-541, 2000), and the San Francisco Bay–Delta region (PL 108-361, 2004) exemplify the trend.

For example, the Texas Commission on Environmental Quality (TCEQ) is both the lead response agency and a trustee agency and is thus responsible for the cleanup and a participant in the NRDA as a cotrustee. Four other agencies (the National Oceanic and Atmospheric Administration [NOAA], the US Fish and Wildlife Service [USFWS], Texas Parks and Wildlife, and the General Land Office) share cotrusteeship with TCEQ. In-house management of these dependent and sometimes overlapping responsibilities led TCEQ to recognize the need for better and more formal coordination of these related environmental restoration activities among the agencies.

In 2001, a memorandum of understanding (MOU) executed among the 5 trustee agencies and TCEQ to coordinate the ERA and the Texas ecological services analysis (ESA) was adopted as a state regulation (Texas Commission on Environmental Quality 2001). The ESA employs tools and methods typically associated with NRDA. Tools such as the habitat equivalency analysis (HEA) (NOAA 2000), compensation scaling (NOAA 1997), and sediment quality guideline-based assessment (Gouguet 2005) are used to select ecological risk management options. In ESA, if human health risk is appropriately managed and ecological risks are shown to be expected to recover over a reasonable time, "compensatory restoration" can be used to manage the remaining ecological risk while monitored natural recovery (MNR) occurs. This quantum of restoration credit is also considered a portion of the overall compensable natural resource loss, a down payment for continuing natural resource service losses during MNR. The trustees must take care to ensure that "double recovery" (i.e., double collection of damages for the same injured resource [USDOI 2005b, §11.15(d)]) does not occur. The trustees typically ensure that the "remaining" NRDA liability is resolved through restoration-based solutions. This method is a version of the environmental benefits analysis environmental management approach (Efroymson et al. 2004).

The CERCLA process was envisioned as a continuum from remediation to restoration. The statute and its implementing regulations suggest a certain degree of coordination. For example, Section 104(b)(2) of CERCLA requires USEPA to "seek to coordinate" assessments, evaluations, and investigations with state and federal trustees when natural resources are affected (Public Health and Welfare 2003, §9604[b][2]). The language is mirrored in the National Contingency Plan (NCP; USEPA 2005b, §300.430[b][7]). Similarly, the law requires coordination among federal, state, and tribal trustees and between trustees and USEPA. For example, field samples

and data collection in the early stages of the NRDA "should be coordinated with [USEPA] to minimize duplication of sampling and data collection efforts" (USDOI 2005c, §11.22[b]). Within the NRDA process, trustees with overlapping jurisdiction are required to inform one another of potential actions, such as the development of an assessment plan, and are generally encouraged to cooperate and coordinate assessments (USDOI 2005d, §11.32[a][1] and [2]).

Significantly, the regulations state that the trustees are required to notify PRPs before the commencement of a damage assessment, and they must invite "the participation of the [PRP] in the development of the type and scope of the assessment and in the performance of the assessment" (USDOI 2005d, §11.32[a][2][iii][A]). Any meaningful coordination between the USEPA-led ERA and the trustee-led NRDA must be accompanied by some form of formal cooperative arrangement between PRPs and trustees in the damage assessment process.

Although there is substantial overlap in the data used by the 2 processes, the ERA will usually not provide certain information required for the NRDA. For example, the NRDA has a phase to quantify damages, including lost services. Typically, the quantification of service losses will not be relevant to support the selection of a remedy at a CERCLA site and is usually outside the scope of the ERA. A companion paper (Gala et al. 2009) provides a more thorough comparison of the ERA and NRDA processes and identifies clear opportunities to improve both processes through "cross-fertilization" and better coordination.

The USEPA is not authorized to recover the costs of studies or other tasks that do not support the remedial decision and that do not qualify as response actions under CERCLA. This gap in authority can be overcome by a formal agreement for cooperation among USEPA, the trustees, and the PRPs—wherein the parties agree in advance to broaden the scope of data gathering for the ERA beyond what would otherwise be relevant to remedy selection, and the PRP agrees to cover the additional costs as part of the a NRDA. Formal cooperation among USEPA, PRPs, and trustees has other advantages, such as data sharing, as discussed below.

Data sharing in an adversarial process

Data sharing is not illegal; in fact, some laws and policies encourage it (e.g., Public Health and Welfare 2003, §9604[b][2]). The language is mirrored in the NCP (USEPA 2005b, §300.430[b][7]). However, the legal nature of the ERA and NRDA processes, coupled with the respective interests of their participants, can and does affect the climate and culture for data sharing, cooperation, and coordination. Simply put, CERCLA imposes a liability scheme, making the recovery of costs for response actions and natural resource damages (NRDs) essentially adversarial. Monetary exposure, corporate image, and legal precedent are all at stake, and these dynamics affect the ways in which the participants behave. Data sharing can and does take place in this environment, but it is often not done in a spirit of cooperation among technical experts. Rather, it is often based on a strategic decision largely controlled by individuals who are often well removed from the technical realm and might be operating under a different set of motives.

If there are practical constraints on sharing and collaborating among USEPA, the trustees, and the PRPs, generally it is for the above reasons. But although these are adversarial proceedings, it does not mean that the role for sharing and collaboration is not significant. Improved cooperation and coordination will require a greater understanding and appreciation of 1) the duties and objectives of the parties involved and 2) the benefits that sharing and collaboration can provide. Consideration should be given to developing an "alternative resolution process" that encourages a more cooperative and efficient approach to reaching remedial and NRDA settlements. Improved cooperation will also facilitate the use of data sharing agreements, MOUs, and stipulations that build on shared experience but allow for the uniqueness of each case.

BARRIERS TO COORDINATION OF ERAS AND NRDAS

Even though the provisions of CERCLA and its implementing regulations require coordination between USEPA and the trustees in the conduct of ERAs and NRDAs, many institutional barriers make coordination a challenge. Chief among these barriers are distrust, timing, funding, and the need to retain rights to litigate, among others (Table 1), as discussed below.

CERCLA creates a dynamic for the lead remedial agency, the trustees, and the PRPs, which, on its face, does not lend itself to cooperation. The statute establishes a "Superfund" of appropriated funds, taxes on feedstock chemicals, and enforcement actions against PRPs to provide funding for hazardous substance-related response. The CERCLA program, in part, also depends on settlements and unilateral orders under which PRPs perform or pay for remediation and, in the case of NRD provisions, under which they perform restoration or compensate the public for documented natural resource injuries.

If no settlement is reached with the PRPs on remediation, USEPA can issue a unilateral administrative order, sue for an injunction, or fund the cleanup and sue for recovery of its response costs. If no settlement is reached with the PRPs on NRD, the government can file suit against the PRP to recover damages. Thus, the agencies and PRPs must find a way to work together cooperatively while preparing to litigate if no settlement is reached. This dynamic drives all parties to be reluctant to share information and inhibits the development of a partnering relationship that could lead to the efficient conduct of the studies.

PRPs often adopt dramatically different approaches to dealing with this perceived conflict. Some PRPs believe that they can best defend themselves against their potential liability under CERCLA by becoming actively involved with USEPA and the trustees; others believe that their best defense is to prepare for litigation and not to participate in cooperative activities with the agencies. The requirement that full consensus be achieved both by the agencies and the PRPs, particularly groups of PRPs with divergent interests, makes decision making difficult. The lack of strong leadership or lack of an established decision-making framework among the government and PRP representatives can lead to indecision or decisions that are not necessarily representative of the position of the majority of the group being dictated by the most vocal or extreme party. Extreme positions can polarize the parties, making coordination and cooperation all the more difficult. Coordination is also made more challenging by the fact that PRPs tend to be less familiar with NRDAs than with the RI/FS process, including ERAs.

Table 1. Examples of barriers to coordination and cooperation in ERA and NRDA[a]

Barrier
Need to preserve litigation options stifles cooperation/coordination
• "Litigation sensitivities" make information sharing and communication difficult
Lack of trust at the outset
• Preconceived perceptions of the "other side" and their motivations
• Experiences at other sites, "war stories," reinforce these prejudices
Limited sharing of technical data
• Adversely affects trust (e.g., they're hiding something)
• Not currently done on a regular basis
• Intellectual property issues with academic-led research efforts
• Legal constraints (e.g., preparation for litigation)
Lags in interaction: Historically NRDA is conducted afterward to remedy selection
• Late trustee involvement in the RI/ERA leads to missed opportunities for data collection to meet NRDA needs
• Funding for trustee participation in RI/ERA has to be secured
Lack of trustee management direction facilitates inefficiencies in approach
• Managers must specify goals
• Managers must supervise staff/counsel/contractors to ensure activities are directed toward achieving goals
• Allows personalities and agendas to dictate NRDA approaches and outcomes at sites, rather than process and data
Lack of current guidance for the conduct of NRDA
• Inconsistent approaches to NRDA
• Uncertainties on process and outcome can lead to PRPs to delay NRDA involvement
Requirement for complete unanimity or "consensus" on Trustee side
• "Lowest common denominator" or "most conservative estimate" driving decisions

[a] ERA = ecological risk assessment; NRDA = natural resource damage assessment; PRP = potentially responsible party; RI = remedial investigation.

The NRDA and ERA are complementary processes that should be coordinated and, when the PRPs are involved, can be performed cooperatively. If the 2 processes are not well coordinated, USEPA and the trustees might miss an opportunity to develop a common conceptual site model, with the result that no coordination of data quality objectives will occur to govern studies. To some degree, this results from the historical practice whereby USEPA typically conducted its RI/FS, including the ERA, before the trustees conducted their NRDA. Although there are exceptions in which the NRDA has preceded the ERA, CERCLA presumes that when an RI/FS is being conducted, the NRDA will follow remedy selection. The reason underlying this order is that NRDs are the residual damages to natural resources that remain after the remedy has been completed. Indeed, CERCLA prohibits the filing of an NRD claim "before selection of the remedial action if the President is diligently proceeding with a remedial investigation and feasibility study" (US Code 2003, § 9613 [g][1][B]). However, notwithstanding the statutory structure that makes NRD residual to the remedy, unless the design and conduct of the 2 studies are closely coordinated, data collection can suffer from inefficiency, including a duplication of effort or worse—data gaps that can impede the resolution of site risks and natural resource liability.

A genuine mutual intent on the part of both trustees and PRPs to cooperatively settle issues is a pivotal condition for finding ways of coordinating or cooperating in assessments. Excessive focus on potential future litigation could result in the management of the process being surrendered, by default, to attorneys in the initial stages of the NRDA. Perceptions of looming litigation can pervert the technical exchange, stifle communication, and prevent input to the problem formulation or assessment plan. Missed opportunities might later force trustees to duplicate efforts that otherwise could have been coordinated to address their information needs.

Compounding this problem is the fact that the parties sometimes do not have or allocate resources early enough in the process to begin an NRDA at the outset of the ERA. Inadequate resources might also result in less management-level involvement and less supervision of staff and contrac-

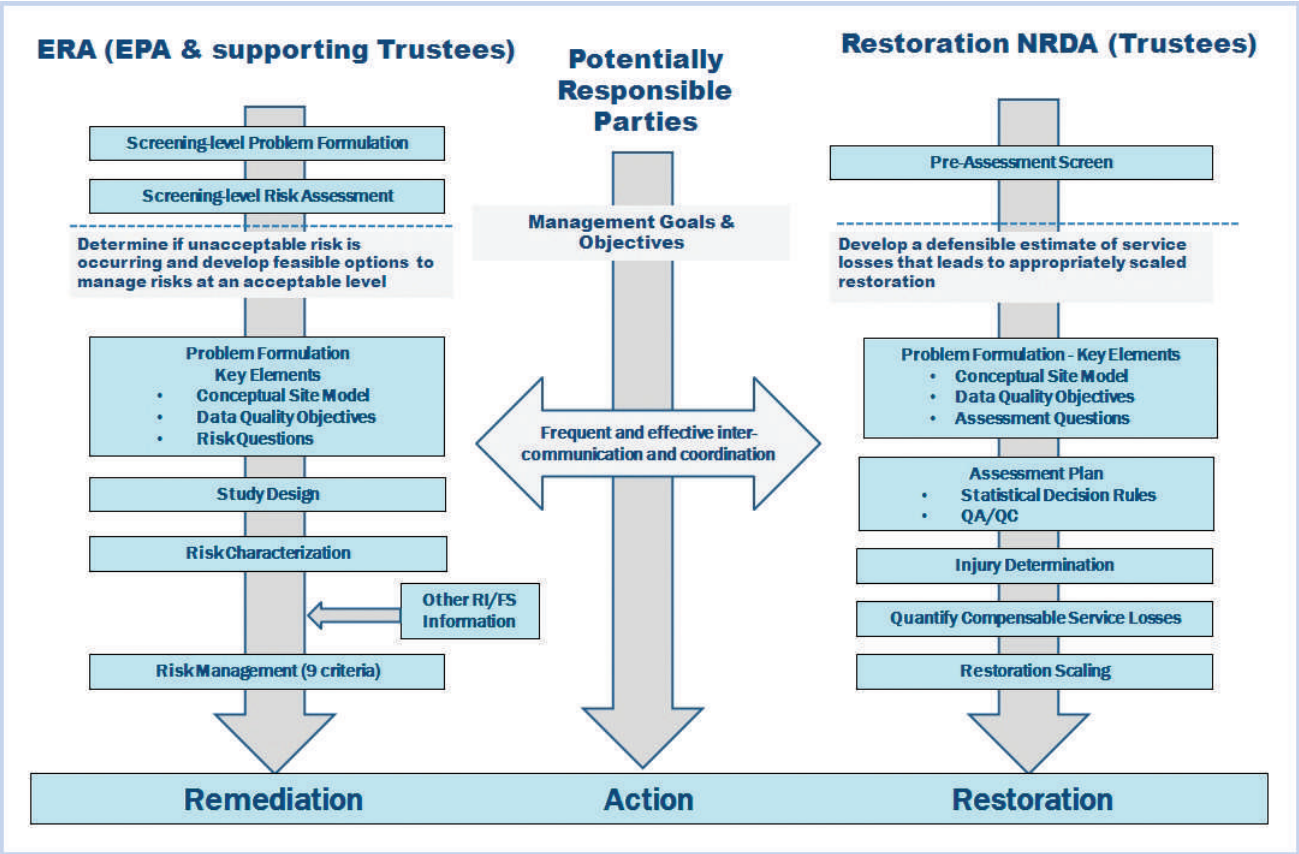

Figure 1. Perceived analogies and similarities of requirements between the ecological risk assessment (ERA) and natural resource damage assessment (NRDA) processes.

tors. In addition, a lack of close management supervision might enable inexperienced or uninformed staff members or contractors to assert undue influence that could be inconsistent with the goals of the PRPs or trustees.

Another obstacle to cooperation and coordination is the lack of explicit guidance that is consistently followed by all parties for the conduct of NRDAs as a combined effort with RI/ERAs. Although a variety of NRDA guidance documents exists (http://restoration.doi.gov/homepage.html or http://www.darrp.noaa.gov/library/1_d.html), the procedures described in many of these documents are out of date and largely ignored by the trustees or NRDA practitioners. The CERCLA/USDOI NRDA regulations that outline the details of assessment are optional for trustees, thereby allowing flexibility. Willing PRPs can take advantage of this flexibility by engaging in early coordination and cooperation of the ERA/RI and NRDA. Trustees typically encourage and welcome the approach. In fact, the DOI's Natural resource damage assessment and restoration (NRDAR) Federal Advisory Committee recommended that DOI adopt procedures that promoted coordination between response and NRDAR activities (USDOI 2007).

However, the lack of relevant, current guidance for coordinating RIs/ERAs and NRDAs creates uncertainties regarding process and potential outcome that cause PRPs to delay involvement in the NRDA until a much later phase or until a trustee files suit. For example, the absence of clear guidance can lead to highly variable approaches to damage assessments across sites, which in turn, can lead to outcomes that are dictated not just by the specific characteristics of the site and by the process and data but by the training, personalities, and preferred approaches of the individual trustees and PRP practitioners involved. This variability creates additional uncertainty that can be a disincentive for early PRP engagement in the NRDA. Explicit guidance could also suggest mechanisms by which the trustees could reach consensus on damage assessment outcomes, if the trustees work would otherwise result in divergent conclusions.

Data gathering and sharing can also present potential barriers to success. The trustees and PRPs might not be operating under the same quality assurance standards, even if, as is seldom the case, they share common data quality objectives. The possibility of litigation often leads the parties to be reluctant to share data and other information before formal pretrial discovery takes place, potentially creating significant inefficiencies.

All of these potential barriers need to be overcome before ERAs and NRDAs can be more effectively coordinated.

BENEFITS OF COORDINATION BETWEEN ERAS AND NRDAS

The entire CERCLA process (RI/FS and NRDA) should be coordinated. Statutory and regulatory requirements explicitly promote that coordination can be found in CERCLA §104(b)(2), NCP § 300.305 (USEPA 2005a), and so on. Although coordination between the lead federal response agency and the trustee should be a given, the extent to which the NRDA truly is coordinated with the RI/FS depends on the willingness of the PRPs to agree to cooperate. Figure 1 presents an idealized flow of the ERA and NRDA processes and shows how key steps line up with their counterparts in the other process and denotes the frequent and effective communication and coordination that must to occur between

Table 2. Examples of incentives for coordination and cooperation in ecological risk assessment (ERA) and natural resource damage assessment (NRDA)

Incentive	Group	
	PRP	Trustee
Access to NRDA information	•	•
Early involvement in NRDA process	•	—
Input into decision-making NRDA process	•	—
Ability to influence NRDA work conducted	•	—
Cost control		
• Reduced oversight/indirect costs	•	•
• Reduced opportunity costs for staff resources	•	•
• More options for contracting	•	•
• Not paying for shadow assessment	•	—
• Minimize need to conduct a full damage assessment for litigation	•	•
• Reduced legal costs	•	•
Building Trust		
• Earlier achievement of objectives, simultaneous on-site remediation/restoration	•	•
• Greater availability of restoration options (reduce lost opportunities)	•	•
• Accelerate achievement of restoration goals	•	•
Access to external funding	—	•
Leverage other funding sources (internal and external)	•	•
Good will	•	•
Common public outreach	•	•

the processes to be most successful. The Lavaca Bay, Texas, USA, National Priorities List (NPL) site may have come closest to this ideal (LBNRT 1999) (see *Case Studies* below).

Notwithstanding the barriers that could thwart direct cooperation on ERAs and NRDAs between USEPA and the trustees (Table 1), many substantive benefits can result from cooperation with the PRPs (Table 2). However, it could be difficult to forge formal agreements. Too many compromises necessary to bring all players into agreement can make such agreements unworkable in practice. In other words, an "all or nothing" approach to coordination is often not a successful strategy; rather, as discussed below, incremental steps are more likely to lead to success.

An approach that has been demonstrated to be successful is a process whereby trust is built through a series of small discrete steps (e.g., production of the assessment plan) implemented through a series of short-term agreements under which the financial and technical commitments of the parties are limited. Including PRPs in the early stages of the development of the assessment plan and sharing information, especially nonsensitive data, can demonstrate a commitment to build trust, which in turn can lead to increased cooperation.

The commitment to coordinate through the sharing of information can also translate into significant cost savings on the part of both the PRPs and trustees. For instance, a reduction in some of the redundant oversight tasks can free staff to work on other priorities and increase flexibility, including the consideration of innovative options for contracting for the work to be done. The PRPs can also benefit from an elimination of the need to engage in a shadow NRDA. Both groups have the potential to realize additional cost savings through reduced legal costs and a reduction in the need to conduct a full damage assessment for litigation.

In a properly coordinated approach, the parties become more comfortable with the process by virtue of having early involvement in the structuring of the assessments. PRPs benefit by having the opportunity to express their concerns to the trustees, provide input to the NRDA, and offer suggestions and critiques of the proposed assessment. Collegial exchanges serve to foster a climate of trust and set the stage for further cooperation as the assessment progresses.

Perhaps the most important benefit that results from successful coordination is that the ultimate goals and objectives of both groups can be realized more quickly, efficiently, and thoroughly. Rather than the participants assuming a confrontational stance in which ideas from the other side tend to be challenged reactively, the coordinated approach creates a climate in which alternative ideas can be analyzed more objectively and constructively. Furthermore, the simultaneous engagement of remediation and restoration actions minimizes or eliminates situations whereby remediation actions conflict with restoration actions. The elimination of such conflicts also creates additional opportunities that could be considered for restoration. The cooperative approach can also reduce the overall time required to complete the restoration activities.

Finally, the coordinated approach can provide the trustees with access to funding to enable participation in the process. Both groups in a cooperative approach are more likely to be able to leverage internal and external sources of funding and in-kind contributions.

Central to the success of a cooperative approach, the PRPs and trustees need to be cognizant of the views of other interested parties. Early in the process, clear communication regarding the reasons for pursuing a coordinated, cooperative approach should be shared openly so that the public does not perceive that the parties are colluding to reach a preordained result or to let industry off the hook. The coordinated, cooperative approach affords opportunities for engaging public stakeholders in community outreach programs, which is essential for success.

PROPOSED PROCESS FOR DEVELOPING EFFECTIVE COOPERATIVE AND COORDINATED ERAS AND NRDAS

The requirement for USEPA to notify and coordinate with the trustee agencies regarding the release of hazardous substances, coupled with the fact that ERAs and NRDAs have common elements (e.g., conceptual site models, collecting and assessing environmental data, managing contaminated sites, estimating the need for restoration), might serve as a logical impetus for the coordination of these distinct processes. The key to successful coordination is rooted in 1st having a clear understanding of the goals and objectives of the 2 processes and then working within the established procedures for the conduct of each evaluation to identify opportunities to strengthen cooperation and coordination efforts.

Goals and objectives of ERA and NRDA

The goal of the ERA is to determine whether unacceptable risk exists and to develop feasible options to reduce risks to acceptable levels. The goal of the NRDA is to develop a defensible estimate of resource and service losses that leads to appropriately scaled restoration. In concert, these processes restore natural resources affected by oil or hazardous substance releases. A companion paper (Munns et al. 2009) encourages the consideration of an ecological services (habitat-level) endpoint for ERAs, which would enable greater coordination of ERAs and NRDAs in the area of assessment endpoints and response measures.

The PRPs have several goals associated with NRDA. Some have the goal to restore natural resources, either as part of the PRP company's policy of sustainability, or green initiatives, or simply to be good corporate citizen. The PRP also has a fiduciary responsibility to its shareholders. As part of this fiduciary responsibility, it is the PRP's duty to resolve its liability but not to overcompensate. These goals are not necessarily inconsistent with the trustees' goal (and statutory mandate) of obtaining a sufficient recovery to compensate the public for the injured natural resources.

However, to increase the likelihood of a successful, coordinated, cooperative ERA and NRDA, the USEPA (and the states and tribes), the trustees, and the PRPs must all work together in a productive manner. This can be accomplished by having the participants adopt a "check your affiliation at the door" approach in order to focus on the science, but this is often easier said than done given the adversarial underpinnings of the CERCLA process and the litigious attitudes that often result from fear of liability. At a minimum, participants should discuss, agree upon, and adhere to a set of rules of general conduct from the onset. Open communication and mutual respect might seem simple, but these could be among the 1st practices to breakdown if the process turns confrontational. Having all stakeholders share their goals and objectives and identify what they perceive to be problems at the outset will greatly improve the chances of a successful cooperative approach.

USEPA/trustee coordination

One important vehicle for realizing USEPA/trustee coordination in the ERA process is the Biological Technical Assistance Group (BTAG). The BTAG is a group of technical experts who advise and assist the risk manager with ecological studies developed as part of the RI/FS and removal action phases at a Superfund site (USEPA 1991). Through the BTAG, trustees provide technical input to USEPA that not only improves the ERA (and other ecological evaluations) but also furthers the trustees' overarching role as the guardians of trust resources. Cooperation in the BTAG includes the timely exchange of information between USEPA and the trustees to ensure that the selected remedy is technically adequate to protect natural resources. In addition, selected remedial alternatives that adequately protect and restore natural resources can potentially reduce the likelihood of expensive and time-consuming NRDA activities, which could delay negotiated settlements. As has been noted, an ERA conducted as part of the RI/FS process is not the same as an NRDA; however, a properly designed ERA can play a significant role in resolving questions and issues that would otherwise require lengthy NRDA-related proceedings and delay or even prevent a comprehensive settlement with PRPs (USEPA 1991).

Coordination of the ERA process

One of the key elements of the ERA process is the scientific–management decision point (SMDP), the formal decision by the risk assessment team (composed of the risk manager, the trustees, and the PRPs). The SMDPs occur at strategic milestones during the ERA process to review and approve the products generated thus far and, if necessary, redirect the effort. At the SMDP, information should be widely shared, and any decisions that are made should strive to reflect the concerns of all stakeholders. The risk manager and risk assessors, with the advice of the remaining BTAG members, decide whether the risk assessment is proceeding in a proper and acceptable direction or recommend changes. The SMDPs thus establish communication milestones at which information should be widely shared, and any decisions made should address the concerns of all stakeholders.

Similarly, assessment endpoints (i.e., environmental values that are to be protected; USEPA 1997) must be developed for the ERA. The development of assessment endpoints is a significant milestone that affects risk characterization and subsequent risk management decisions. Assessment endpoints that are selected in coordination with the trustees' requirements can provide an opportunity for the trustees and PRPs to gather information they might need in the NRDA and in the development of the ERA.

Suggestions that can facilitate coordination

Although they are distinct evaluation processes, ERAs and NRDAs are essentially parallel efforts that follow a common assessment path consisting of 1) a screening-level assessment

to identify the potential for harm or injury, 2) conceptualizations that define the link between a contaminant and an outcome (i.e., risk or injury), 3) development and execution of studies to assess outcome, 4) assessment, 5) outcome determination/decisions, and 6) action (i.e., remediation or restoration). The key elements of ERA and NRDA (Figure 1) and points in the processes at which opportunities for coordination exist are discussed in more detail below.

The ERA process under CERCLA

The ERA is an interdisciplinary process that draws upon environmental toxicology, ecology, and environmental chemistry, as well as other areas of science and mathematics. In 1999, the USEPA Risk Assessment Forum published *Guidelines for Ecological Risk Assessment* (USEPA 1998). The USEPA defines ERA as measuring the likelihood that adverse ecological effects might occur or are occurring as a result of exposure to 1 or more stressors. The guidelines incorporate 3 phases: problem formulation, analysis, and risk characterization. In the 1st phase, problem formulation, risk assessors evaluate goals and select assessment endpoints, prepare a conceptual model, and develop the plan to analyze the data that are available or are to be collected. During the analysis phase, assessors collect data and then evaluate the exposure to stressors to ascertain the relationship between stressor levels and ecological effects. In the 3rd phase, risk characterization, assessors estimate and describe risk.

The Superfund program implemented the above guidelines with program-specific guidance (USEPA 1997). The Superfund guidance was one of the 1st documents produced after the guidelines, is specific to the CERCLA process, and fulfills the objectives of the Office of Solid Waste and Emergency Response Directive 9285.7-17 that the ERA 1) identify and characterize current and potential threats to the environment from a hazardous substance release, 2) evaluate the ecological effects of alternative remediation strategies, and 3) establish cleanup levels in the selected remedy that will protect natural resources at risk.

The Superfund guidance provides an 8-step process for the conduct of an ERA that is intended to not only be responsive to programmatic directives but also focus the risk assessment. The 8 steps are:

1. Screening-level problem formulation and ecological effects evaluation
2. Screening-level preliminary exposure estimate and risk calculation
3. Baseline risk assessment problem formulation
4. Study design and data quality objectives
5. Field verification of sampling design
6. Site investigation and analysis of exposure and effects
7. Risk characterization
8. Risk management

The general NRDA process

Although the comprehensive "optional" NRDA regulations (USDOI 43 CFR 11) contain several procedural steps and requirements for the performance of a damage assessment, the damage assessment process basically consists of 5 major steps:

1. Preparation of the preassessment screen
2. Development of the assessment plan
3. Determining injury
4. Quantifying service losses
5. Evaluating and scaling restoration alternatives

Toward better coordination of NRDA and ERA

As with the risk assessment process used in performing an ERA, the damage assessment process is often viewed as linear. Nothing, however, prevents some of the steps from being conducted in parallel. For example, if there is information of a per se injury, such as a fish consumption advisory that limits fishing, the quantification of human use service losses that could result from the advisory could proceed while other analyses are being performed to determine injury. Similarly, some assessment teams have found it highly effective to begin identifying potential restoration opportunities early in the process. This helps maintain the focus of the assessment on the ultimate endpoint—the restoration. Moreover, an early focus on restoration might help identify restoration opportunities that are at considerable risk of being lost because of development. The identification of a desirable restoration project for which timing is critical might provide an additional incentive to keep the assessment process moving toward restoration and, in some cases, could lead to the purchase of protective options to prevent a particularly attractive restoration opportunity from being lost.

The parallels and the underlying similarity of data requirements in ERA and NRDA have led to effective coordination in some instances that the following paragraphs detail.

The trustees must prepare a preassessment screen to determine whether there is sufficient reason to conclude that a damage assessment should be conducted. This determination is made with the use of readily available information about the hazardous substance release and the potential for sufficient injury and service loss to have occurred to merit the performance of a damage assessment. This step provides an obvious opportunity for the sharing of information with the ERA process proceeding as part of the RI. Specifically, data from the ERA screening-level exposure and risk calculation steps would be very useful in this stage of the NRDA. Similarly, if a preassessment screen had been completed before the ERA preliminary screening as part of the RI, the data exchange could occur in the opposite direction.

The trustees develop an assessment plan to describe the activities that will be conducted during the remainder of the assessment process, with particular emphasis on the injury determination and service loss quantification. A review of various completed assessment plans reveals that a wide range of plans exist. Some have been quite large, such as the multivolume plan developed by the trustees for the Exxon Valdez spill. Others are more pro forma documents that describe the steps that will be completed but offer few details as to the specific activities to be conducted. In addition, in some cooperative assessments, a formal plan might not even be developed. Instead, technical memos are prepared to guide the assessment of injury and the quantification of services.

The preparation of the assessment plan offers another opportunity for coordination, with the ERA being conducted as part of the RI. For example, a conceptual site model that is prepared as part of the problem formulation step in the ERA process would be very informative and useful in planning the assessment activities. This model describes the pathways for exposure and identifies relevant receptors (natural resources). Other problem formulation steps consider how the contam-

ination is likely to affect the relevant resources within the specific ecosystem.

The assessment plan provides an opportunity for the trustees to describe the site's key resources of concern that will be addressed in the assessment process and should identify and specify explicit injury assessment endpoints (analogous to risk assessment endpoints in ERA). Once these key resources have been identified, there is an opportunity to develop coordinated measurement endpoints that address common assessment information needs (Munns et al. 2009). The assessment plan also presents an opportunity for trustees to describe how injuries will be linked to the natural resource services that will be quantified in the assessment. For example, the trustees could describe which injuries will be evaluated, the methods that will be used to evaluate those injuries, and the data that will be collected to address these needs, including "up-front" decision rules that describe how the results will be interpreted. The assessment plan is the place where the methods that will be used to quantify service losses are described. The more specific the information in the assessment plan, the easier it will be for the trustees to demonstrate why the data are needed and how they will be used to quantify service losses. An integral part of this process is the description of the quality control and quality assurance steps that will be taken to ensure the integrity of the assessment data.

To the extent that data have already been collected as part of the RI/ERA process, the assessment plan could include a description of how the data, assuming it meets the quality requirements of the NRDA, will be used. For example, if suitable sediment chemistry data exist, the assessment plan could describe where those were obtained, the extent and numbers of new samples to be collected, how the information could be used to determine whether sediments have been injured, and whether service losses have resulted from those sediment injuries. The description of how service losses will be quantified is an especially important part of the assessment plan because it will help provide the linkage between injury and the amount of restoration that might be required.

Finally, if human use services are being quantified as part of the assessment process, then the assessment plan should include a description of the services that will be addressed, the methods that will be used to quantify those services, and the data requirements for each of the proposed methods. Another opportunity for sharing data between the RI risk assessment and NRDA processes would arise with human use services. Specifically, data from the human health risk assessment conducted as part of the RI could be useful in quantifying the amount of angling that occurs in the assessment area. In situations in which it is necessary to collect site-specific data on the amount of fish consumed, it might be possible to coordinate that data collection with the data collection for recreational fishing. For example, in Lavaca Bay (see *Case Studies* below), 1 dataset was used in both the human health and the recreational fishing assessment. This led to considerable cost savings while still providing a robust dataset for use in each assessment.

The trustees must determine whether trust resources have been injured (injury determination) as a result of exposure to the hazardous substance or substances that are being addressed in the damage assessment. Injury is an adverse effect or behavioral abnormality that results from the exposure to a hazardous substance. Some injuries might be relatively straightforward. For example, violations of drinking water standards would constitute an injury to either the groundwater or surface water that was being used as a source for a community's water supply. Similarly, violations of surface water quality standards constitute an injury to surface water. Other injuries might require more sophisticated tests to determine whether an injury has resulted from exposure. For example, because sediment criteria exist for only a subset of chemicals, site-specific sediment toxicity tests might be needed to determine whether injury to the benthos is probable.

The injury determination step is an obvious example of where data from the ERA conducted as part of the RI process would be highly useful. As mentioned above, sediment chemistry data from the ERA process could be used to address injuries to sediment resources. Fish, bird, and other resource data could be used to determine whether those trust resources have been injured. ERA food web models might be particularly useful in helping to elucidate the exposure and injury potential to these upper trophic–level resources.

The trustees measure the magnitude of the service losses that have resulted from the injuries determined in the previous step. Services provide the key linkage to any economic valuation that is performed because services are the basis on which people value natural resources. Services also provide the metric that can be used in the quantification. For example, if HEA (see discussion below) is being used to quantify habitat losses, the quantification of service flows from the affected habitat is a critical ingredient in the formulation.

The interface between the ERA performed as part of the RI and the quantification stage of an NRDA is evolving. As some ERAs move to the use of services as measurement endpoints (Munns et al. 2009), the potential for integrating the ERA data in the service quantification phase of the NRDA increases substantially, inasmuch as both processes are much more likely to have similar metrics. Nevertheless, data gathered for the ERA as part of the RI could be useful even if they do not fully address services. For instance, in the DuPont Newport, Delaware, USA, NPL case (see *Case Studies* below), the trustees and DuPont were able to use the site's RI data to create spatial habitat/contaminant data models and to consider the effects of remedial actions and credit restoration that occurred onsite as part of the remedial actions.

A crucial step in service quantification unique to NRDA is the establishment of the baseline level of services. In USDOI regulations (43 CFR 11), baseline is defined as the level of services that would have existed but for the release of the hazardous substance. In the quantification phase, the task is to estimate the difference between the level of resource services that are found in the injured state and the level that would have existed if the release had never occurred (i.e., the baseline).

Determination of baseline is a crucial component of every damage assessment because it allows the isolation of the service losses caused by the release of hazardous substances, as opposed to degradation caused by factors that could reduce the production of services. Only service losses attributable to the hazardous substance injuries are compensable. For example, if habitat services in a riparian zone are degraded by cattle grazing, the riparian baseline value is reduced. Likewise, constructions of highways, urbanization, and stream channelization are other factors that might limit the level of services provided in a river system that have to be accounted for in the assessment process and separated from

the losses attributable to hazardous substance releases. The development of information on past land use practices, development of reference sites, and development of "background" in the ERA/RI could prove useful in determining a baseline.

The trustees evaluate and scale restoration alternatives to provide sufficient services to compensate for losses. In the past few years, HEA and its cousin, the resource equivalency analysis (REA) have been used for quantifying resource injuries and scaling restoration projects to the injuries that have been documented. The HEA is a specialized form of resource equivalency analysis that provides a common currency (called discounted service acre-years [dSAYs]) with which to compare the value of potential restoration projects as a credit against documented resource injuries (NOAA 2000). The primary utility of the HEA/REA models is the ability to scale restoration alternatives to lost resources and resource services quantified by the models in the "debit" step. Other models are typically employed when significant lost human use services are associated with site injuries. The trustees advanced the application of these modeling tools by explicitly accounting for differing habitat values for different conditions of habitat quality among the acres under consideration. The HEA/REA models are probably the most frequently used tools for ecological services scaling in NRDA. These tools can also be used to evaluate differential benefits and consequences of various response actions (Boers 2007).

CASE STUDIES

Although not common, there are several examples of Superfund sites in which the coordination of ERAs and NRDAs facilitated the achievement of objectives in a cost- and time-efficient manner. Three cases that highlight aspects of the type of and degree of coordination discussed in this paper are presented. In these examples, coordination occurred to varying degrees, sometimes to the advantage of the response process and sometimes to the benefit of the NRDA. In each case, coordination and the use of data for multiple purposes saved time and expense and led to the resolution of the site's hazardous substance issues.

Anaconda and Silver Bow Creek, Montana, USA

The Anaconda and Silver Bow operable units of the Clark Fork Superfund site, Montana, illustrate a situation in which the NRDA was completed before the ERA began. Considerable historical information about the upland, riparian, and aquatic resources had been collected during several studies before the initiation of the NRDA. In 1990, the State of Montana initiated site characterization studies for NRDA (see a comparative timeline of events at http://www.foxriverwatch.com/nrda/montana.html, accessed 8 November 2008). The case proceeded through trial and ultimately reached settlement (see a summary of the settlement agreements at http://www.doj.mt.gov/lands/naturalresource/lawsuithistory.asp, accessed 8 November 2008).

After the injury report had been filed, USEPA embarked on the ERA for the site. The data generated under the NRDA was reanalyzed for the ERA. Importantly, no new data collections were undertaken for the ERA. Similarly, the damage assessment was used to inform the selection of remedial actions.

Although the 2 processes were conducted by different parties at different times, the utility of data from the NRDA was fully compatible with the needs of the ERA. Although many stages of the processes were contentious and were influenced strongly by actual or potential litigation, in the end, the plans for remedy and restoration were coordinated and achieved a mutually satisfactory resolution.

DuPont/Christina River, Newport, Delaware

The DuPont/Christina River site in Delaware was placed on the Superfund NPL in 1990. During the planning of the remedial action for the site, DuPont, after discussions with the trustees, suggested to USEPA that it would be willing to implement addition improvements, above and beyond those required by USEPA, in the North and South Marsh Area operable units. DuPont performed the remediation and restoration construction, as designed cooperatively with the trustees and USEPA. Thus, they were able to integrate, at no additional cost, the response and restoration construction in those operable units. When the NRDA settlement was developed, the trustees used data generated by DuPont's consultant (Ecological Concerns, St. Michaels, Maryland, USA, with the Evaluation for Planned Wetlands methodology) to develop credit-side estimates of marsh service flow improvements from those habitat parcels. When these improvements were accounted for in the assessment, the restoration actions offset interim lost services in the affected assessment areas.

Lavaca Bay, Texas

This Lavaca Bay, Texas, site was begun by the trustees as an NRDA, but USEPA placed the site on the NPL in March 1994. Ultimately, this site could be the best example of early trustee involvement and coordinated response and restoration planning.

The trustees, USEPA, and the PRP started to edge away from an adversarial process and toward working together to resolve the site's problems. Fairly quickly, all of the parties came to 2 conclusions: 1) the science required for the RI was similar to what was required for the damage assessment and 2) the damage assessment should be conducted in parallel with the cleanup, not as a 2nd step after the remedial process.

Alcoa agreed to a reasonable worst-case scenario—wherein more conservative, environmentally protective estimates of resource injuries and losses are used—rather than spending additional time and money on injury assessment studies. With the use of information developed for the ERA, reasonable worst-case estimates were developed for injury categories, including birds, benthos, fish, terrestrial biota, groundwater, surface water, and lost human use (i.e., fishing closures). From these estimates, the parties then identified acres of habitat to restore and other restoration projects that would address the injuries. Each of the injury categories was documented in technical memoranda that all parties reviewed and that served as a roadmap for future restoration efforts. Oyster reef, salt marsh, and coastal prairie were constructed as the most appropriate habitats to be restored. Fishing piers and boat ramps were constructed to address the public's lost fishing opportunities.

CONCLUSIONS AND RECOMMENDATIONS

ERAs performed as part of CERCLA RIs should be closely coordinated with NRDAs performed by the trustees. Close coordination minimizes the risk of inefficiencies, such as duplicate data gathering, and facilitates the participation of PRPs in a cooperative process to accomplish both studies. Figure 1 depicts the similarities between the 2 processes and suggests coordination opportunities. Agreement on overlap-

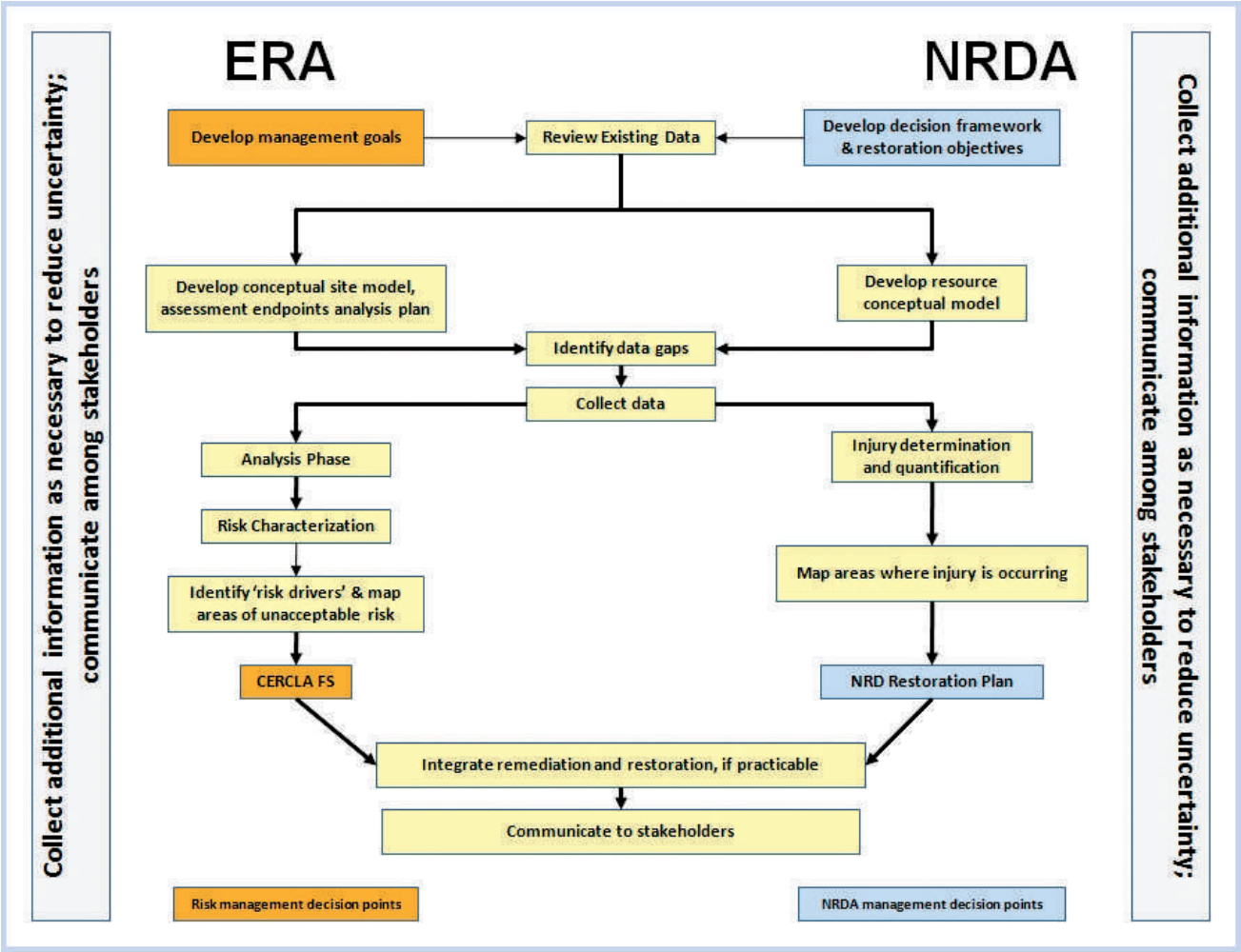

Figure 2. Idealized approach to coordinated ecological risk assessment (ERA) and natural resource damage assessment (NRDA).

ping fundamental components of both studies, such as site conceptual models, data quality objectives, and sampling and analysis plans can promote efficiency. No legal or policy barriers prevent this integration from occurring; to the contrary, existing law and policy specifically encourage coordination.

Trustees should be encouraged to become involved in the early stages of the RI and to work with USEPA to coordinate NRDA data needs with those of the RI. MOUs have proven to be a useful tool for structuring such a coordinated approach, and USEPA and the trustees should be encouraged to enter into such agreements as early as possible in the process. A closely coordinated effort on the part of USEPA and the trustees should also include the participation of PRPs in funding and conducting the studies, where appropriate. Such coordination can help the parties identify opportunities for combined assessment. Figure 2 presents an idealized coordinated process that could promote efficiency, combine data collection efforts, and lead to a more timely resolution of potential NRD liability issues.

Specific recommendations for enhancing coordination

The USEPA and the trustees should consider entering into MOUs at the outset of either an RI or an NRDA, whichever comes first. Normally the RI would be expected to precede the beginning of the NRDA, so the trustee agencies need to be alerted to the progress of the RI, and USEPA and the trustees should agree upon a working relationship as early in the process as possible.

Outdated guidance documents developed by the federal trustee agencies should be updated to reflect current practice and policy. The recently promulgated proposed CERCLA NRDA regulations should present an excellent opportunity to update trustee and USEPA guidance to conform to current practice and policy.

Practitioners should look for opportunities to formalize the process, which could include the incorporation of NRDA elements—such as injury determination—whenever possible into an Administrative Order on Consent that sets the terms for performance of the RI.

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