Chapter 15: Place-Based Opportunities for Nature in the US

Chapter Lead
Patricia A. Soranno, Michigan State University

Chapter Authors*
Elena M. Bennett, McGill University
Kevin C. Elliott, Michigan State University
Erle C. Ellis, University of Maryland, Baltimore County
Adrienne L. Hollis, National Wildlife Federation
Viniece Jennings, Florida A&M University
Tanya Pelach, Quinault Indian Nation
Mónica D. Ramírez-Andreotta, University of Arizona

Graphics Lead
Patricia A. Soranno, Michigan State University

Chapter Point of Contact
Courtney D. DeLoatch-Hill, University of Washington

*Authors listed in alphabetical order.

Date
February 23, 2026

Chapter Contents

Summary

Nature and people in the United States are connected. Actions that support nature can reduce risks, support local economies, and improve health and well-being (see Chs. 12–14). Many laws, investments, and stewardship efforts have improved air, water, and wildlife in many places, but nature continues to decline, and benefits and harms are not evenly shared across communities (see Chs. 5–10) (1). The overarching opportunity described here is to improve how place-based actions are carried out and the policy and governance approaches that help those efforts last, spread, and accumulate nationally. Place-based actions such as floodplain reconnection, wildlife crossing retrofits, and neighborhood green infrastructure are more reliable when affected people help shape decisions. We highlight three place-based practices that help these actions work well: coordinating across connected land and water, using decision-ready information, and building participatory partnerships with shared decision-making: (1) Partners can coordinate built projects and nature-based actions across connected land and water so that water, materials, and wildlife can move through the landscape and investments reinforce one another. (2) Partnerships can identify and use decision-ready information to help set clear goals for shared measures, document methods, and track progress (2,3). (3) Partnerships work best when affected residents help set priorities, share decision authority, and stay involved through implementation, with clear responsibilities and long-term stewardship (see Chs. 5, 11) (4,5). These practices are easier to repeat when policies, incentives, and other levers across Tribal, state, and federal levels clarify responsibilities, pay for coordination and upkeep, and track outcomes and harms by place and population, including who benefits and who bears costs. Shared information systems also help when they protect privacy and set fair rules for Indigenous data and knowledge (6–8). Repeating these practices in key parts of connected systems helps local actions add up, while tracking results in standardized ways makes it easier to learn and correct problems early and illuminate the broader national picture of how nature is faring.

Background

Over the arc of US history, many laws and policies have aimed to support thriving nature and a healthy environment for people. Examples include the Clean Water Act, Clean Air Act, Endangered Species Act, National Environmental Policy Act, and Coastal Zone Management Act. Major public investments and programs also shape land and water management, including Farm Bill conservation programs and infrastructure investments. These efforts have helped improve air and water quality in many places and support recovery of some species and entire ecosystems. Many examples of what has worked, and why, are described in this Assessment (see Ch. 4: Bright Spots). Even so, nature continues to decline in many ways across the United States, with impacts that vary by place and by who benefits and who bears costs (see Chs. 5–8). Major drivers of declines in nature, such as land conversion, pollution, invasive species, and climate-related stressors continue, and many chapters describe response options tailored to those drivers and impacts (see Chs. 9, 10, 12, 14). This chapter focuses on opportunities, meaning ways to improve how

place-based actions (local efforts) are carried out, and the regional and national enabling policy and governance supports that help those efforts persist, spread, and add up nationally.

This chapter is written for people who make, shape, fund, and live with nature decisions: community groups, individuals, Tribes, local and regional governments, state and federal agencies, businesses, nongovernmental organizations, public health and healthcare partners, educators, youth-serving organizations, and philanthropic partners. Rather than try to list every action and actor needed to address the drivers of nature loss or its thriving, this chapter focuses on the conditions that help many different actions work better, last longer, and reach more people and places.

Place-based actions are local efforts such as restoration, stewardship, protections, invasive species management, pollution controls, infrastructure improvements, and nature-based solutions. Place-based actions matter because they are where people experience nature in day-to-day life; build relationships and meaning through work, recreation, learning, and cultural practice; and where they gain benefits in well-being (see Ch. 5: Connection and Ch. 13: Health and Well-Being). These relationships between nature and people are also often linked to stewardship and collective efforts to protect valued places (see Ch. 5: Connection). Place-based work is also where tensions can arise over access, uses, safety, and trade-offs, because places carry different meanings and values for different people (see Ch. 11: Culture). For these reasons, actions work better when people affected by them help shape priorities, roles, and follow-through, including working through what to allow, where, and for whom and respecting Indigenous groups' rights and responsibilities (see Ch. 11: Culture).

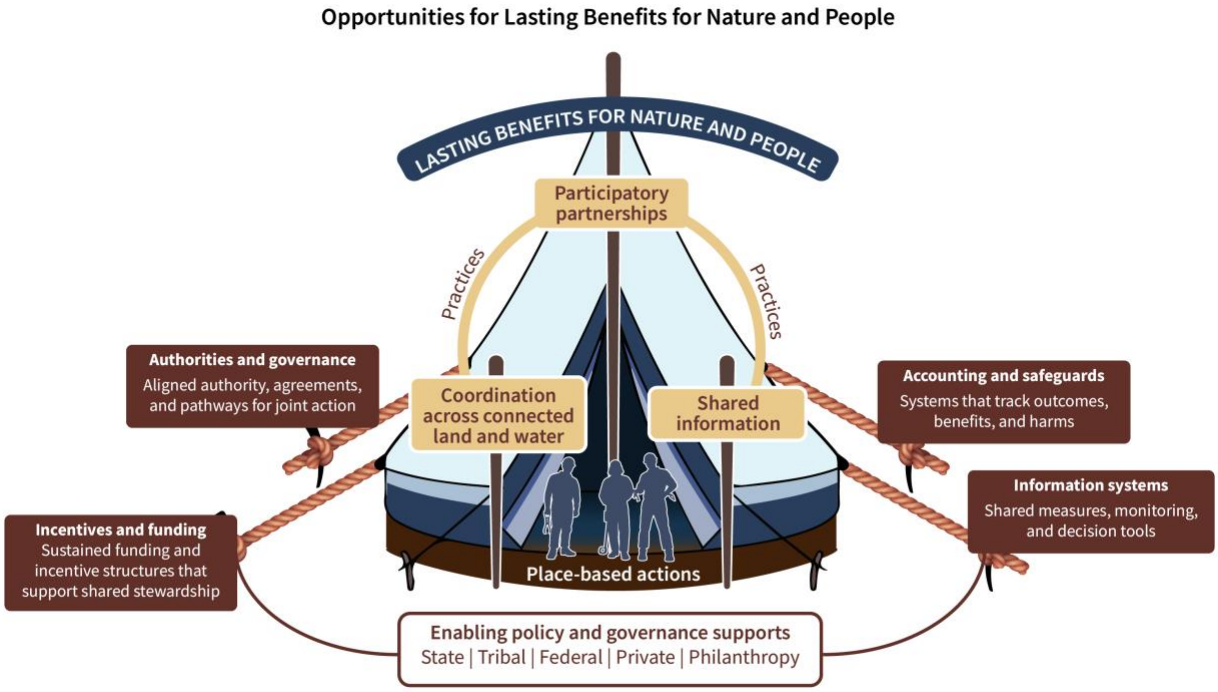
Three place-based practices support these actions: *Coordination across connected land and water* means planning and investing so actions add up across upstream and downstream places. *Decision-ready information* means information people can use now, not just store, because it is timely, comparable, and tied to clear goals. *Participatory partnerships* mean people affected by decisions help shape priorities, roles, and follow-through, including how benefits and trade-offs are handled over time. Examples of how these practices show up in real places are described across the Assessment, including in discussions of the bright spots that document what has worked and why (see Ch. 4: Bright Spots).

Nevertheless, local practice alone is not sufficient to scale results. Therefore, we also describe four policy and governance enabling factors (the "supports" in Figure 15.1) that support local-scale actions and help their success persist and spread: authorities and governance, incentives and funding, accountability and safeguards, and information systems (5,9). These enabling factors include setting minimum standards and providing coordination when needed while still leaving room for solutions that fit local contexts. They also make it easier to deliver health benefits from nature, many of which depend on coordination, sustained capacity, and shared information across sectors (see Ch. 13:

Health and Well-Being). Authorities and governance at state, regional, national and Tribal levels shape what is allowed and who has a seat at the table and whether affected communities have real authority and resources to participate, not only a chance to comment (10,11). This includes respecting the place-specific rights, responsibilities, and knowledge systems of Indigenous groups, including where access rules, stewardship authority, and culturally significant practices are central to outcomes (see Ch. 5: Connection and Ch. 11: Culture). Incentives and funding, also at these broader governance levels, shape what is affordable to do well, including who can pay for coordination, long-term upkeep, and staffing. Standards and expectations that are broadly applied for accountability and safeguards make benefits and harms visible over time and reduce the chance that burdens are shifted to others. Safeguards matter in part because benefits depend on real access: whether places are safe, welcoming, affordable, and usable and whether rules and infrastructure inadvertently exclude valued practices (see Ch. 11: Culture and Ch. 13: Health and Well-Being). Finally, information systems make it possible to compare results across places and learn over time while protecting privacy and sensitive knowledge.

Figure 15.1 provides a simple roadmap for how these pieces fit together. It shows how place-based practices achieve lasting benefits when they are supported by policy and governance enabling factors across multiple levels of decision-making, including state, Tribal, and federal governments and agencies, as well as nonprofits. The Key Messages that follow describe each place-based practice in turn and point to the often cross-cutting enabling supports that help these practices persist, spread, and deliver durable benefits. Local work is more durable when higher-level policies and governance make it easier to collaborate, provide stable capacity, and supply backbone systems for accountability and learning.

Figure 15.1. Place-Based Practices and Enabling Policy and Governance Supports That Help Actions Last and Spread



Lasting benefits depend on place-based practices and enabling supports that help actions persist and spread.

Place-based actions happen in specific places, but lasting benefits depend on both place-based practices and enabling policy and governance supports that help effective efforts start, persist, spread, and add up across places. The canopy represents lasting benefits for nature and people. The platform represents place-based actions. The poles represent three place-based practices that help actions work well: coordination across connected land and water, shared information, and participatory partnerships with shared decision-making. The outer tent ropes represent enabling policy and governance supports across levels of decision-making, including state, Tribal, and federal governments and agencies, as well as nonprofits. These supports include authorities and governance, incentives and funding, accounting and safeguards, and information systems. Figure original to The Nature Record.

Key Message 15.1: Coordinating decisions and investments across connected land and water delivers lasting benefits

Because land, water, and air connect places from headwaters to coasts, across landscapes, and downwind, choices made upstream, nearby, or upwind can affect flooding, water quality, habitat, and health in other places (very well established). Communities, governments (state, Tribal, and federal), and partners (e.g., nonprofits,

industry) get better results when they plan built projects and nature-based actions together and coordinate across boundaries so that roads, stormwater systems, shorelines, wetlands, streams, and habitat connections work as one system supported by clear roles, aligned funding, safeguards, and shared information (well established). Many small projects that restore broken connections, when repeated in enough places and targeted to key parts of a network, can add up to big region-wide benefits over time, including floodplain reconnection, barrier removal in streams, distributed green infrastructure in cities, and migration corridor actions that maintain movement across jurisdictions (well established).

State of Knowledge 15.1

Ecological connectivity describes how water, organisms, and materials move through land and water systems and how those movements shape flooding, water quality, habitat, and biodiversity across places (12,13). It includes connections across water networks (from headwaters to coasts), across land (such as migration routes and dispersal across habitat networks), and across air (such as nitrogen or sulfur depositions and wildfire smoke that affect ecosystems downwind) (14–17).

The policy and governance enabling supports for this practice include clear authorities and governance that allow coordination across boundaries, incentives and funding that make joint planning possible, accountability and safeguards that prevent shifting harms to others, and shared information systems that help partners target investments and track outcomes over time. This is where the "local practice" and the "enabling supports" meet: Local partners align projects on the ground, while broader rules, funding, and shared systems reduce the friction and fill the gaps that no single place can solve alone. Coordination is easier when planning, permitting, and funding are set up to support projects that cross boundaries, such as multi-jurisdiction watershed restoration, regional habitat networks, and transportation projects that reconnect wildlife movement routes. When incentives reward shared outcomes (like reduced flood risk, improved habitat function, or fewer wildlife–vehicle collisions) rather than isolated project outputs, agencies and partners have clearer reasons to align road, stormwater, shoreline, wetland, and stream investments across jurisdictions. Coordination is easier to sustain when partners share decisions and responsibilities over time and rules and safeguards are in place (see KM 15.3).

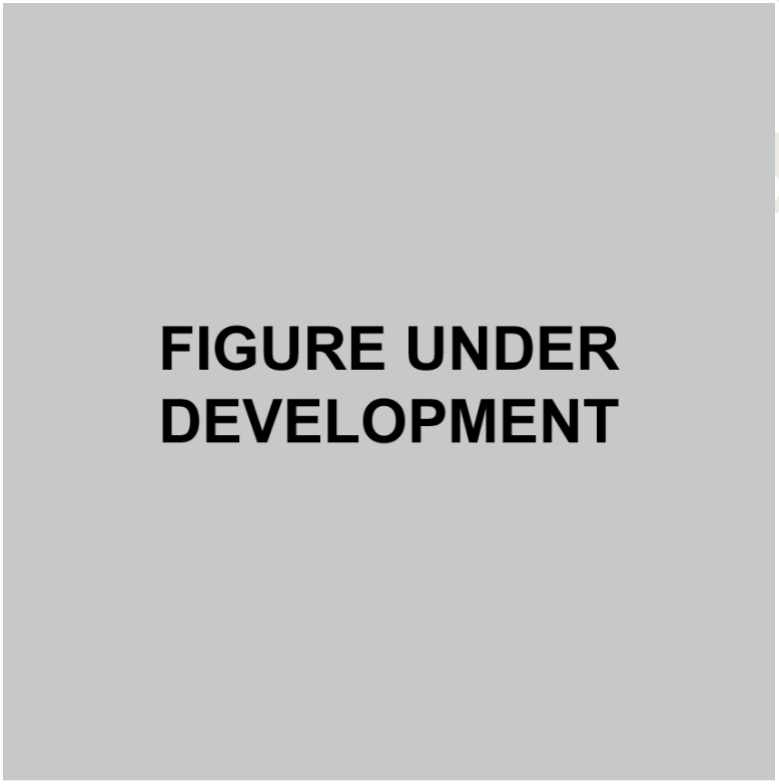
Connections Across Water, Land, and Air

Water flows downhill, carrying sediment, nutrients, contaminants, and many organisms. As a result, headwaters, wetlands, rivers, and coasts function as one connected system. Choices about land cover, drainage, and restoration upstream can change flooding, water quality, and habitat conditions downstream, including in estuaries and coastal waters (18,19) (see Ch. 14: Risk and Security). These linkages change with storms, seasons, and drought. Long-lasting benefits depend on keeping natural pathways (e.g., floodplains, wetlands, and riparian vegetation) and built pathways (e.g., culverts, stormwater networks,

and shoreline structures) working together, rather than treating them as separate projects (18,19) (see Ch. 14: Risk and Security).

These connected pathways extend across land. Habitat networks across the landscape influence whether plants and animals can move, recover, and persist as conditions change (20). Roads, fences, and development can break habitat networks and disrupt migrations and dispersal. Place-based actions that restore terrestrial connectivity include protecting key habitat linkages, restoring "stepping-stone habitats" (small, isolated patches that enable wildlife movement between larger patches), and installing wildlife crossings (overpasses, underpasses, and culvert retrofits) in the right places. Corridors can, on average, increase movement between habitat patches (21), and combining crossing structures with fencing can substantially reduce wildlife mortality (Figure 15.2) (22). Across this Assessment, examples of barrier removal, culvert upgrades, fish passages, and wildlife corridors show how targeted local projects can restore connectivity when repeated across enough places (see Ch. 4: Bright Spots).

Figure 15.2. From Policy to Practice: Coordinated Action to Reconnect Big-Game Migration Corridors in the Western US



When states and federal agencies work from the same plan, wildlife corridors can be protected and restored at scale.

*(**a**) National and regional policy align priorities across 11 western states. (**b**) A coordinated implementation pathway links movement mapping, shared priority-setting, cross-boundary*

*coordination, and targeted investments. (**c**) Reported outcomes include millions of acres of improved habitat, wildlife-friendly fencing, coordination meetings, and monitoring/research efforts. Figure original to the Nature Record.*

Air also connects places. Air pollution and nitrogen and sulfur deposition can travel far beyond their source locations and affect soils, forests, and waters when they settle back to the ground (18). Wildfire smoke can travel long distances and affect ecosystems and communities downwind, including altering stream and lake conditions through changes in chemistry and light (23). In cities, impervious surfaces and storm-drain networks can move runoff quickly into streams and coastal waters, increasing flood peaks and transporting pollutants. Urban trees and parks can provide modest air quality benefits in addition to other co-benefits (24). Coordinating investments in roads, drainage, shorelines, parks, trees, and wetlands helps reduce flood risk, improve water quality, support habitat, and avoid shifting problems downstream or into neighboring jurisdictions.

Planning and Funding Projects to Work Together

Many decisions that affect ecological connectivity are made through built projects, such as roads, culverts, stormwater systems, shoreline protection, and wastewater upgrades. Other decisions involve nature-based actions, such as restoring wetlands and floodplains, reconnecting streams, and protecting coastal habitats. Better results are often achieved when built and nature-based projects are planned and funded together so they work as one connected system (25,26). This includes coordinating across boundaries, because water, flooding, and habitat do not stop at jurisdictional lines. When coordination is missing, "good" local projects can create preventable harms elsewhere. For example, levees that reduce flood risk in one place can raise flood depths and expand flooded areas in other places along a river network (27). Along coasts, parcel-by-parcel shoreline armoring can protect one property while increasing erosion risks for nearby unarmored properties through wave deflection and other spillovers (28).

In practice, cross-boundary coordination is easier when enabling supports reduce the friction that no single place can solve alone. Authorities and governance can make it easier to use shared plans, align permitting, and clarify who can do what across boundaries. Incentives and funding can align timelines and budgets, including covering the real costs of coordination and long-term maintenance. Accountability and safeguards can make trade-offs visible over time, so benefits are not gained by shifting risks or costs to others. Information systems can support shared maps, consistent monitoring, and learning across projects and jurisdictions. Many "bright spot" efforts described elsewhere in the Assessment, such as dam removal, culvert upgrades, fish passages, and wildlife crossings, depend on this kind of coordinated planning, durable funding, and shared information to scale beyond single projects (see Ch. 4: Bright Spots).

Urban settings show parallel needs for coordination. Stormwater, transportation, parks, and redevelopment decisions are often funded and managed through different programs and timelines. Integrated planning approaches help align investments over time and

combine gray and green infrastructure (e.g., vegetation buffers around concrete irrigation channels) in ways that reduce flooding and improve water quality while also supporting access to shade and cooler neighborhoods (29–31). Coordination also improves follow-through, because the benefits of green and gray systems depend on consistent maintenance, clear roles, and transparent reporting of what is working where. In practice, coordinating these investments helps projects reinforce one another and makes it easier for communities to see how decisions were made and how benefits and risks are expected to change.

Cumulative Benefits of Many Local Projects

Many actions that restore broken connections happen at local scales, but their benefits can add up when they are repeated in enough places and targeted to the most important parts of a network. For example, floodplain reconnection can reduce flood peaks and improve habitat and water-quality functions, with larger benefits when reconnection occurs in multiple locations and is coordinated with upstream and downstream management (31–33). Similarly, removing or upgrading barriers like undersized culverts and dams can reconnect stream networks; coordinated prioritization can target locations that reconnect large portions of a network efficiently (34,35). In cities, green infrastructure can also deliver larger benefits when it is implemented broadly and maintained over time, reducing stormwater stress and improving receiving-water quality (30,36). Finally, across the western US, migration corridor mapping shows where many local actions repeated along a route (e.g., wildlife-friendly fencing, road-crossing structures, and targeted habitat protection) collectively maintain functional connectivity across jurisdictions for migratory ungulates (37,38). Together, these examples show a consistent pattern: Coordinated, repeated local projects in connected systems can produce region-wide improvements over time.

Description of Evidence Base

There is converging evidence that connected systems transmit effects across places, leading to confidence that the finding that choices made in one area or system affect other areas or systems is *very well established*. For water, long-running observations and process studies show that upstream land cover, drainage, and restoration influence downstream flooding, water quality, and habitat through river networks (see Ch. 14: Risk and Security). For land and biodiversity, large-scale synthesis work drawing on broad datasets and long-term fragmentation experiments shows that breaking connections across landscapes changes ecological conditions and persistence over time (17), and a recent synthesis summarizes strong, multi-study evidence that organism movement and connectivity are foundational to ecological function across scales (16). For air pathways, empirical studies document downwind ecosystem responses to wildfire smoke and related atmospheric transport, including measurable changes in lake conditions during smoke events (14). The evidence that coordination improves outcomes and that misalignment creates spillovers is *well established* and comes from governance scholarship that

explains why cross-boundary problems often require shared rules, roles, and accountability (5,9). It is also supported by empirical studies that quantify unintended consequences when actions are not coordinated, such as levee-driven flood-risk spillovers along river networks (model-based network analyses) (27) and shoreline armoring that shifts erosion risk to nearby properties (econometric evidence) (28). Evidence that the cumulative effects of many small actions can add up to large effects at broader scales is *well established* and draws on meta-analyses that show that corridors, on average, increase movement between habitat patches and that road mitigation reduces wildlife mortality most when crossing structures are paired with fencing (21,22). Network prioritization studies and empirical evaluations show how targeting key nodes (such as barrier removals or upgrades) reconnects large portions of stream networks efficiently (34,35). Movement ecology studies using telemetry and corridor mapping show how coordinated actions along migration routes can maintain functional connectivity across jurisdictions for migratory ungulates (37,38). Together, these evidence types support high confidence that connected-system effects are real and widespread, that coordination and enabling supports reduce spillovers and improve follow-through, and that cumulative benefits emerge when local actions are repeated at sufficient scale and in the right places.

Key Message 15.2: Decision-ready information improves the outcomes from actions for nature and people when shared standards, sustained capacity, and safeguards make it usable

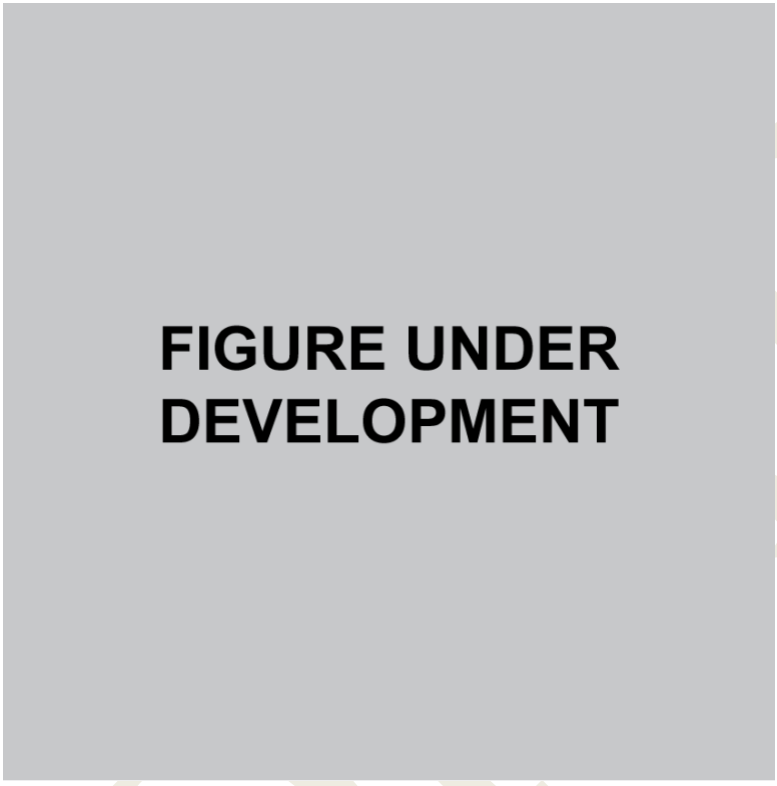
Outcomes from actions for nature and people can be tracked more effectively when monitoring is linked to decisions, uses appropriate standards, and is sustained over time (very well established). Decisions improve when data and analysis make trade-offs visible—including who benefits, who bears costs or harms, and how certain the evidence is—and when they are supported by clear reporting and privacy safeguards (well established). Peer learning, training, and technical support make it easier for people to use information, learn what works, and adjust actions (well established).

State of Knowledge 15.2

Decision-ready information is designed for a specific situation, delivered in a timely fashion, and documented so it can be checked and updated (Figure 15.3). Information is necessary, but it is rarely sufficient on its own. In equity terms, this also means setting explicit distributional goals and measuring outcomes by place and population, not only in aggregate (8,11). Information improves outcomes most when decision processes and institutions make it usable, trusted, and acted on, including shared standards and infrastructure, sustained capacity, and safeguards that protect people, sensitive knowledge, and knowledge systems (3,39–42). This Key Message highlights three practical elements of decision-ready information in environmental management: tracking outcomes with shared measures so that actions can be evaluated and adjusted over time; comparing

benefits, costs, risks, and who is affected so that trade-offs are visible and reviewable; and investing in peer learning, training, and technical support so that lessons spread across places and persist through turnover and change. These practices are easiest to sustain and spread when national policies and programs support common measures and reporting expectations, long-term monitoring and support roles, and shared systems that reduce the need for each community to rebuild methods from scratch.

Figure 15.3. From Data to Decisions: How the Chesapeake Bay Program Turns Monitoring into Action and Learning



Clear, public dashboards help partners choose actions, track results, and adjust when progress stalls.

*The Chesapeake Bay Program's Bay Barometer dashboard is an example of decision-ready information in practice. (**a**) A small set of outcomes is summarized in an easy-to-scan dashboard view (status, trend, and target timing), with links to detailed indicator pages and data sources.(**b**) A simplified "indicator card" shows the types of information that make results transparent and reviewable, including what is measured, the time period, targets, data sources, updated timing, and notes about methods or uncertainty. (**c**) A simple learning loop shows how partners use updates to continue actions when results are on course, accelerate or refine actions when results are off course, improve monitoring when results are uncertain, and then track again as conditions change. Figure original to The Nature Record.*

Tracking Outcomes

Tracking outcomes is most useful when it starts by explicitly addressing three questions: what is the decision being made, what are the outcomes that matter, and what is the smallest set of measures that can show whether the actions are helping? National synthesis guidance on ecological indicators and conservation monitoring emphasizes explicit objectives, clear baselines, and consistent methods so that results can be interpreted and compared over time (2,43). The US National Climate Assessment defines indicators as observations or data that provide insights into how a system is changing over time, and it emphasizes regular updates and clear documentation (44). Tracking should include both what was done and what changed, because measuring activity without outcomes limits learning and can create false signals of success (43,45). For example, for a floodplain project, indicators could include flood peak changes, water-quality measures, and whether nearby residents can safely access the site.

Shared measures and standards make monitoring easier to do and easier to compare across places. When communities and agencies can draw from common measures, clear documentation about methods, and shared data formats, they spend less time inventing new indicator sets and more time using information to guide action. This is also what allows learning to spread across projects and jurisdictions, because results are comparable and can be combined to show patterns (39). Sustained staffing and funding are the make-or-break enablers: without long-term capacity for monitoring and data stewardship, tracking becomes a short-lived project deliverable rather than an ongoing part of a decision-making process (2,46). When federal agencies and partners maintain shared measures and data standards, local projects can reuse proven method across places and focus on decisions, not rebuilding protocols each time (39,40).

Comparing Benefits, Costs, and Who Is Affected

Information improves outcomes when it helps people compare options in ways that are clear, documented, and meaningful to a specific decision. Comparisons work best when they define what counts as a benefit, cost, risk, or burden; specify the time horizon; and identify who is affected. This includes where impacts fall across neighborhoods, workers, resource users, and upstream, downstream, or downwind communities, as well as how effects differ across groups that have faced disproportionate exposure to harms (3,11,47,48). Comparisons are also more useful when they show what was measured, how it was measured, and how uncertainty was handled so that claims can be checked and updated as new information becomes available (3,39).

This is where enabling supports matter. Because incentives can reward reporting successes more than reporting harms, credibility depends on clear documentation and independent review, including shared indicator definitions, required metadata, and routine checks that compare reported results to underlying data (2,45,49–51). Clear reporting standards and review processes set at state or federal levels can make comparisons more consistent across projects and places. Shared measures and decision-support tools at

regional, state, or federal levels help local projects avoid rebuilding methods from scratch and make results more comparable across jurisdictions. Safeguards are also essential because some information is sensitive or can be misused, including personal data, location-specific information that could increase risk, and Indigenous or community knowledge shared under agreed-upon conditions (39,40,52). Comparisons are more likely to be trusted and used in decisions when reporting expectations, data governance, and safeguards are clear and supported by funding, as well as by staffing for analysis and facilitation.

Learning from Others and Technical Support

Peer learning and peer networks help environmental actions spread and improve by allowing people to share practical know-how, adapt approaches to local contexts, and avoid repeating mistakes (53–56). In environmental management, this kind of learning often happens through communities of practice and other peer networks that connect practitioners across jurisdictions, agencies, and community organizations. These networks support learning that is grounded in experience, keeps pace with changing conditions, and carries forward despite staff turnover (53–55).

Hands-on technical support strengthens peer learning by helping people interpret information, apply methods consistently, and tailor actions to place-specific constraints and goals. Practical approaches include peer exchanges, mentorship and buddy programs between communities, regional learning hubs, and trusted intermediaries who translate evidence into locally relevant options and next steps (40,56,57). Training and environmental education can further strengthen this learning loop by building skills and confidence to interpret results, ask informed questions, and connect learning to action and evaluation rather than awareness alone (58,59).

These local practices spread further when enabling supports make networks durable and easy to use. Stable funding and staffing for facilitation, technical assistance, and coordination are often the difference between a one-off exchange and an ongoing learning system (40,54). Shared technology platforms and simple templates for documenting lessons learned can lower the effort required to participate and make it easier to transfer approaches across places, especially when programs explicitly value learning and improvement over time (39,55). Safeguards for sensitive knowledge and privacy, as well as shared decision-making processes, are addressed in Key Message 15.3 and are important complements to learning networks when information sharing could pose risks or create mistrust.

Description of Evidence Base

This Key Message draws on multiple evidence streams, including long-standing guidance and syntheses on ecological indicators and monitoring design, widely used decision-analysis approaches in natural resource management, and a large body of research on knowledge exchange, learning networks, and boundary-spanning support. Evidence is

strongest, and assessed to be *very well established*, for the first statement, which focuses on tracking outcomes, and shows that information is most useful when it is linked to explicit objectives, measured consistently over time, and documented in ways that support comparison and review (2,3,46). At the same time, uncertainty remains high in complex social and ecological systems where multiple drivers, time lags, and shifting baselines make it difficult to attribute observed changes to specific actions, reinforcing the need for long-term, comparable monitoring designs that track both actions and outcomes across scales (29,43,59). Evidence is also strong, and assessed as *well established*, for the importance of comparing benefits, costs or harms, and who is affected. Decision-science scholarship and environmental justice research show that trade-offs and distributional outcomes can differ across groups and places and that making these patterns visible supports legitimacy and follow-through (11,48,60). However, confidence is limited by gaps in consistent methods and indicators for tracking who benefits, who bears costs, and who has access to decision processes across different community contexts, as well as by weaknesses in comparability when metrics and documentation vary across reporting frameworks (2,3,40,45,49,50). Syntheses on knowledge exchange consistently find that peer networks and hands-on support increase the likelihood that people correctly interpret information, adapt approaches, and retain lessons through turnover and changing conditions (39,40,54,55). Even so, results vary across contexts because the effects of decision-support and learning-oriented practices depend on process design, institutional capacity, and whether participants have time, support, and authority to act on what is learned (4,40,52,54,61). As a result, this finding is assessed to be *well established*.

Key Message 15.3: Partnerships that share decision-making help actions last and benefit nature and people more

Partnerships are more likely to deliver lasting local benefits when communities, including Indigenous groups, help set priorities early and have real decision-making roles throughout planning, implementation, and follow-up (very well established). Partnerships last longer and adapt better when roles and decision authority are clear, when agreements set expectations and ways to resolve conflicts, and when funding supports coordination, facilitation, and long-term stewardship (very well established). Partnerships are more trusted and durable when safeguards protect sensitive knowledge and privacy, and when partners track who benefits, who bears costs, and how trade-offs change over time (well established).

State of Knowledge 15.3

Participatory partnerships are local practices. They happen in specific places where communities, agencies, and other partners work together to set priorities and make decisions. These partnerships are more likely to succeed and be repeated in more places when broader systems support them. State, federal, and Tribal policy and governance can enable local partnerships by creating clear pathways for shared decision-making and by aligning incentives and funding to pay for participation, coordination, and long-term

stewardship (62–66). Partnerships also tend to work better when they build on trusted conveners, co-develop processes, and invest the time it takes to build trust, even when mistrust is high at the start (67). Combining scientific information with Indigenous and Local Knowledge can yield guidance more usable for local contexts, but this depends on whether policies and rules create space for that knowledge to shape choices (41,68,69). Information systems that support these efforts are addressed in Key Message 15.2.

Participatory Partnerships and Shared Decisions

Participatory partnerships include people who live with the outcomes of an action. They help define priorities, choose actions, and decide what success means (4,52,70). In this chapter, shared decisions mean more than outreach. It means that partners have meaningful influence over which options are considered, which trade-offs are acceptable, and which choices are made, from early stages through planning, implementation, and follow-up (71–73). Across many cases, participatory approaches are more likely to improve governance outcomes when communication is sustained and when partners have real decision roles, not only opportunities to comment after options are set (65,66).

State and federal policy can make shared decision-making easier to do well and easier to repeat across places by clarifying when and how partners can share authority at key decision points and by funding participation and coordination as part of the work (5,62–64). These supports help participatory partnerships move from one-time engagement to durable, implementable decisions.

Examples of participatory partnerships include the Chumash Heritage National Marine Sanctuary (Box 15.1) and the restoration of wetlands in the Lower Ninth Ward of Louisiana (Box 15.2). Participatory Manureshed Action Networks provide another example. These networks bring together animal and crop farmers, manure haulers, and conservation professionals to test regional nutrient-management pathways that can reduce nutrient pollution while lowering costs (69).

Box 15.1. Shared Waters, Shared Wisdom: Indigenous-Led Conservation in California

The designation of the Chumash Heritage National Marine Sanctuary off California's central coast is a strong example of inclusive, community-led conservation. This 4,543-square-mile sanctuary, the 17th national marine sanctuary in the United States, is particularly groundbreaking because it was one of the first to be proposed for protection by an Indigenous community, the Northern Chumash Tribe, after a decade of advocacy.

Tribal leadership was central. Fred Collins of the Northern Chumash Tribal Council initiated the nomination in 2015; his daughter, Violet Sage Walker, continued the effort with support from the community and conservation partners. This multigenerational, community-led movement reflects decision-making grounded in lived experience, Traditional Knowledge, and a strong sense of place. The sanctuary's management promotes co-stewardship

between the Federal Government and Indigenous communities, allowing Tribal values and ancestral knowledge to guide the care of the area.

The sanctuary aims to protect diverse marine ecosystems and cultural sites from industrial threats while also supporting sustainable tourism, recreation, and fishing practices. Local universities and Tribal institutions will contribute research and public education, helping grow ocean stewardship. Inclusive processes like these can deliver multiple benefits for people and nature. Co-management will evolve over time; this openness to learning underscores that participatory governance is an ongoing, shared responsibility. The Chumash Heritage National Marine Sanctuary offers a practical example of how inclusive governance can improve follow-through and deliver multiple benefits. Transferable elements include Tribal-led vision, early engagement with agencies, clear co-stewardship roles, and a plan for ongoing learning and monitoring.

For more information on the Chumash Heritage National Marine Sanctuary, see https://chumashsanctuary.org/.

Figure 15.4. Humqaq (Point Conception) and Kelp Forest

*(**a**) Humqaq (Point Conception), California, a site of great cultural significance to Chumash Peoples, along the coast of Chumash Heritage National Marine Sanctuary. Spellings of the Indigenous place name vary across Chumashan languages and writing systems. Photo: Robert Schwemmer/NOAA. (**b**) Giant kelp (*Macrocystis pyrifera*) at Cojo Anchorage near Humqaq, in Chumash Heritage National Marine Sanctuary. For Chumash Peoples, kelp forest waters are important fishing grounds and areas that connect people and place. Photo: Robert Schwemmer/NOAA.*

[END BOX 15.1 HERE]

Written Agreements and Long-Term Support

Written agreements and shared-authority frameworks give partners a replicable way to share responsibility and document who decides what, how conflicts are handled, and how

decisions can be revisited as conditions change (Boxes 15.1 and 15.2). For partnerships with Indigenous governments, agreements should recognize Tribal sovereignty, specify decision authority and consent processes, and delineate how knowledge and data will be used, protected, and credited (6). When agreements are written clearly, they can be adapted and reused across contexts, helping successful approaches spread (74–76).

The US Forest Service's Shared Stewardship strategy is one example. It describes a national approach in which the Forest Service and states identify shared priority landscapes, agree on outcome-focused goals, and coordinate actions across ownership boundaries (74). States, Tribes, and federal agencies can support this kind of work by creating structures that make coordination routine, such as joint committees, dedicated partnership staff roles, and shared planning processes (75–77). Early assessments suggest that these institutions can increase capacity for larger projects that cross jurisdictional boundaries over time (76,77). Many cross-boundary efforts use polycentric governance, in which multiple, connected decision-making groups at different scales operate under shared goals and rules. This structure can improve coordination while still allowing actions to fit local conditions, and it can support learning and adjustment over time (5,78–80).

Sustaining these partnerships over many years also requires steady funding, experienced people, and institutions built to last. Pairing project dollars with multiyear support for staffing, maintenance, and coordination can help protect benefits that build slowly and strengthen them as conditions change (see Ch. 12: Economy and Ch. 14: Risk and Security). State and federal agencies and other funders can enable sustained partnerships by investing in the organizations that do the ongoing work, including training, small grants, technical assistance, and the networks that connect local stewards with agencies and funders (81,82). Funders can also simplify applications and reporting and pay for core operating capacity alongside project dollars, including basic administrative needs such as financial management and reporting (81,82). In cities, these supports can help stewardship groups maintain parks, street trees, community gardens, and shorelines while also building the social ties and shared capacity that make follow-through more likely (81,83). Stable funding and staffing help partnerships endure across project cycles and leadership changes.

Box 15.2. Reclaiming the Lower Ninth Ward and Accompanying Land: A Community-Driven Case Study in Wetlands Restoration

The Sankofa Community Development Corporation (CDC), founded in 2008 by Rashida Ferdinand with support of Lower Ninth Ward residents, is restoring approximately 40 acres of wetlands in New Orleans, Louisiana. After the tragic consequences of Hurricane Katrina, local leaders pursued restoration to reduce flood risk, improve water storage, and create community benefits in a neighborhood that experienced severe flooding and long-term disinvestment.

Through a Cooperative Endeavor Agreement with the City of New Orleans, Sankofa gained rights to the site and has worked to transform it from an area of blight and illegal dumping

to a vast ecological wonder with Louisiana native wildlife, flora, and fauna returning to the area. In addition to 40 acres of restored wetland ecosystem, more than 100 bird species have returned to the area, which also serves as a living laboratory for green infrastructure. The area also boasts the capacity to store 8 million gallons of stormwater and contains 10,000 square feet of urban vegetable and pollinator gardens, with more planned.

Community participation is central to this restoration effort. Historically marginalized residents are actively engaged in planning and executing the restoration work, shifting away from the traditional dynamic where external experts dictated local projects. Through educational workshops and hands-on involvement, organizations like Sankofa CDC empower residents, highlighting their rights and crucial role in shaping a resilient and sustainable future. Restoration activities offer more than ecological benefits: They foster emotional healing, alleviate fears of environmental threats, and rekindle a deep community connection to the land.

Sankofa works with city, state, and federal partners on site design, permitting, and infrastructure coordination, as well as with nonprofits and training programs to support environmental education and workforce development. Keeping coordination simple and roles clear has helped the project move from planning to implementation and maintenance. Sankofa is also working in cooperation with the EPA, the Deep South Center for Environmental Justice, and LA Green Corps to bring environmental justice resources to the project in the form of education, advocacy, and workforce development. In addition, Sankofa has received approval from Norfolk Southern Railroad to develop the area, with plans to remain off the railroad's right-of-way and create a barrier between public access and the railroad.

Community participation is central to this effort. Residents help shape priorities, review plans, and guide how the site will be used and maintained. Workshops and hands-on activities build local capacity to participate in decisions and support long-term stewardship. Project partners also emphasize practical safeguards, such as local hiring, community benefits commitments, and attention to displacement risk, so that restoration benefits accrue to existing residents over time (84,85). By bringing together local residents, nonprofit organizations, academic institutions, and government agencies, this restoration project embodies a collaborative model for addressing climate crises, restoring ecosystems, and ensuring that local voices inform decision-making. In the words of Rashida Ferdinand, founder and CEO of Sankofa, "We believe in uplifting healthy environments for everyone and that real change happens when we practice equity and justice for all, through respect, resource investments, and mission-aligned partnerships" (86).

For more information on the Sankofa Community Development Corporation, see https://sankofanola.org/.

[END BOX 15.2 HERE]

Accountability and Safeguards

Partnerships are more trusted and durable when safeguards protect sensitive knowledge and privacy and when partners can see how benefits and burdens are shared over time (41,42,85,87–90). For example, rights- and benefit-sharing arrangements are practical rules, written or customary, that specify who has access, who has decision authority, and how benefits and burdens are shared. Clear rules support accountability because they make it easier to explain decisions, reduce conflict, and follow through when conditions change. When communities help collect and interpret exposure and impact information through participatory research, the resulting evidence is often more usable and more likely to influence decisions, especially when agencies recognize the data and provide clear rules and safeguards for how it is used (88,90,91).

For partnerships that involve Indigenous communities, safeguards must recognize Tribal sovereignty and the right of Tribes to set the terms for consent, use, and stewardship of Indigenous Knowledge and data (6,92). Indigenous data sovereignty work emphasizes that governance is not only about whether information is shared but also about who controls it, how it is interpreted, how it is credited, and how it benefits the people and places it comes from (6,92). Efforts to create shared standards for data collection and reporting are most effective when they allow diverse approaches in order to respect Indigenous or local knowledge systems (41,42). These safeguards are especially important when knowledge is sensitive, when benefits and burdens are uneven, or when historical harms have created high mistrust (see Chs. 2, 9, 11).

State and federal governments can strengthen accountability and safeguards by setting clear expectations in programs, permits, grants, and reporting systems (91). Examples include requiring benefit- and burden-tracking as part of project reporting (including who benefits, who bears costs, and how trade-offs change over time); requiring privacy and data governance plans that specify permissions, protections, credit, and consent processes; funding independent facilitation and community participation so that safeguards are workable in practice, not only on paper; and establishing accessible processes for resolving concerns and documenting how input shaped decisions (6,62). When Indigenous Knowledge or Tribal data are involved, agencies can adopt policies and review processes that align with CARE principles (collective benefit, authority to control, responsibility, and ethics) and then use FAIR principles (findable, accessible, interoperable, and reusable) only where sharing is appropriate and consented to (6,7). Using these standards early helps set clear expectations before data are collected or shared (6,7).

Description of Evidence Base

The finding that partnerships are more likely to deliver lasting local benefits when communities help set priorities early and have real decision-making roles is *very well established* because it is supported by multiple syntheses and reviews across many cases and sectors, including participation and co-production research that repeatedly links

sustained engagement and meaningful influence to improved governance outcomes and follow-through (52,65,66,71,72). These syntheses are reinforced by widely used participation and public engagement frameworks that distinguish outreach from shared authority and clarify how process design affects outcomes (62,73). The finding that partnerships last longer and adapt better when roles and decision authority are clear is also assessed as *very well established* because it is supported by collaborative governance scholarship and social–ecological systems research that converges on the importance of clear roles, agreed procedures, conflict resolution, and sustained capacity for joint action (5,63,64,80), together with applied evaluations and program evidence on cross-boundary stewardship and long-term support models (74–77,81–83). The finding that partnerships are more trusted and durable when safeguards are in place is assessed as *well established* because it is supported by research in community-engaged environmental health and environmental justice showing that community-involved tracking of exposures and impacts can produce more usable evidence and increase influence on decisions, especially when institutions recognize the data and set clear rules for its use (85,87–91). There is also rapidly developing scholarship and standards for Indigenous data sovereignty and governance that specify consent, authority, and protections when Indigenous Knowledge or Tribal data are involved (6,7,62,92).

Environmental Justice and Equity Highlights

This chapter treats fairness and meaningful involvement as part of what "success" looks like for nature decisions, not as an add-on. Long histories of unequal protection and disproportionate exposure to environmental harms mean that some communities start with higher risks and fewer options; as such, equity often requires repair and protection, not only inclusion (10). In practice, that means asking early and explicitly who benefits, who might face trade-offs, who has access to options, and who is included in decisions, and then using those answers to shape project design, funding, and follow-through (1). Because equity goals are easiest to lose at implementation, fair outcomes depend not only on good intentions and good information but also on enabling supports, including clear governance, sustained funding, safeguards, and shared information systems that make progress visible and course correction possible.

Connected Systems, Shared Benefits

Because land and water are linked from headwaters to coasts, actions that reduce risk or restore habitats in one place can shift burdens or create new barriers in another. Coordination across connected systems is therefore also a fairness issue: It helps prevent the downstream movement of flooding or pollution, and it makes it easier to target investments where needs are high and options are limited (see Chs. 6, 7, 12, 14). Planning built and nature-based projects together can also improve who can access benefits (such as clean water, cooler neighborhoods, and flood protection), especially when long-term operations and maintenance are funded rather than assumed. This equity "throughline" is strengthened when higher-level authorities and funding programs support cross-boundary

coordination and require attention not only to where burdens may be shifted but also to where benefits are claimed.

Decision-Ready Information with Guardrails

Tracking progress supports fair outcomes when results are reported in ways that show both totals and distributions, by place and population, while also protecting privacy and sensitive information. Shared measures, clear metadata, and verification reduce incentives for selective reporting, make it easier to compare outcomes across projects and support course correction when benefits are not reaching intended groups (see Ch. 12: Economy and Ch. 14: Risk and Security) (45,49). Data governance is part of these guardrails; the CARE Principles clarify expectations for permission, collective benefit, and authority to control for Indigenous data and knowledge, and they complement FAIR practices that improve findability and reuse for many types of data (6,93). These guardrails help keep information usable while respecting rights and reducing risk of harm from misuse, and they work best when supported by federal or state information systems and reporting expectations so that each community does not have to invent standards and protections from scratch.

Shared Decision-Making That Lasts

Partnerships extend benefits when communities and Indigenous Peoples are involved early and throughout, when roles and decision authority are clear, and when agreements specify how concerns will be addressed and how benefits and trade-offs will be handled over time (see Ch. 2: Equity and Ch. 9: Drivers). Practical tools exist to support benefit-sharing and follow-through, including community benefits agreements in development and infrastructure contexts, but they work best when communities have time, staffing, and technical support to participate as true partners rather than unpaid reviewers (84,94). Equity safeguards can also be concrete and practical, for example, local hiring, community benefit commitments, and attention to displacement risk so that benefits accrue to existing residents over time (84,94). These outcomes are more likely when enabling supports, including funding for participation and facilitation and clear accountability expectations, make shared decision-making feasible in practice, not only promised in principle.

References

1. Bullard RD, Johnson GS. Environmentalism and Public Policy: Environmental Justice: Grassroots Activism and Its Impact on Public Policy Decision Making. J Soc Issues. 2000 Jan;56(3):555–78. https://doi.org/10.1111/0022-4537.00184

2. National Research Council. Ecological Indicators for the Nation [Internet]. Washington, D.C.: National Academies Press; 2000 [2025 Dec 22]. https://doi.org/10.17226/9720

3. Gregory R, Failing L, Harstone M, Long G, McDaniels TL, Ohlson D. Structured decision making: a practical guide to environmental management choices. Chichester, West Sussex Hoboken, N.J: Wiley-Blackwell; 2012. 1 p. https://doi.org/10.1002/9781444398557

4. Meadow AM, Ferguson DB, Guido Z, Horangic A, Owen G, Wall T. Moving toward the Deliberate Coproduction of Climate Science Knowledge. Weather Clim Soc. 2015 Apr;7(2):179–91. https://doi.org/10.1175/WCAS-D-14-00050.1

5. Ostrom E. A General Framework for Analyzing Sustainability of Social-Ecological Systems. Science. 2009 Jul 24;325(5939):419–22. https://doi.org/10.1126/science.1172133

6. Carroll SR, Garba I, Figueroa-Rodríguez OL, Holbrook J, Lovett R, Materechera S, et al. The CARE Principles for Indigenous Data Governance. Data Sci J. 2020 Nov 4;19(1):43. https://doi.org/10.5334/dsj-2020-043

7. Wilkinson MD, Dumontier M, Aalbersberg IjJ, Appleton G, Axton M, Baak A, et al. The FAIR Guiding Principles for scientific data management and stewardship. Sci Data. 2016 Mar 15;3(1):160018. https://doi.org/10.1038/sdata.2016.18

8. Sadd JL, Pastor M, Morello-Frosch R, Scoggins J, Jesdale B. Playing It Safe: Assessing Cumulative Impact and Social Vulnerability through an Environmental Justice Screening Method in the South Coast Air Basin, California. Int J Environ Res Public Health. 2011 May 5;8(5):1441–59. https://doi.org/10.3390/ijerph8051441

9. Mansbridge J. The role of the state in governing the commons. Environ Sci Policy. 2014 Feb 1;36:8–10. https://doi.org/10.1016/j.envsci.2013.07.006

10. Bullard RD. Dumping In Dixie: Race, Class, And Environmental Quality, Third Edition [Internet]. Routledge, Taylor & Francis Group; 2000 [2026 Jan 25]. https://www.routledge.com/Dumping-In-Dixie-Race-Class-And-Environmental-Quality-Third-Edition/Bullard/p/book/9780813367927

11. Schlosberg D. Defining Environmental Justice: Theories, Movements, and Nature [Internet]. Oxford University Press; 2007 [2026 Jan 25]. https://doi.org/10.1093/acprof:oso/9780199286294.001.0001

12. Pringle C. What is hydrologic connectivity and why is it ecologically important? Hydrol Process. 2003 Sep;17(13):2685–9. https://doi.org/10.1002/hyp.5145

13. Freeman MC, Pringle CM, Jackson CR. Hydrologic Connectivity and the Contribution of Stream Headwaters to Ecological Integrity at Regional Scales[1]. JAWRA J Am Water Resour Assoc. 2007 Feb;43(1):5–14. https://doi.org/10.1111/j.1752-1688.2007.00002.x

14. Scordo F, Chandra S, Suenaga E, Kelson SJ, Culpepper J, Scaff L, et al. Smoke from regional wildfires alters lake ecology. Sci Rep. 2021 May 25;11(1):10922. https://doi.org/10.1038/s41598-021-89926-6

15. Seidler RG, Green DS, Beckmann JP. Highways, crossing structures and risk: Behaviors of Greater Yellowstone pronghorn elucidate efficacy of road mitigation. Glob Ecol Conserv. 2018 Jul;15:e00416. https://doi.org/10.1016/j.gecco.2018.e00416

16. Brodie JF, Gonzalez A, Mohd-Azlan J, Nelson CR, Tabor G, Vasudev D, et al. A well-connected Earth: The science and conservation of organismal movement. Science. 2025 Apr 25;388(6745):eadn2225. https://doi.org/10.1126/science.adn2225

17. Haddad NM, Brudvig LA, Clobert J, Davies KF, Gonzalez A, Holt RD, et al. Habitat fragmentation and its lasting impact on Earth's ecosystems. Sci Adv. 2015 Mar 6;1(2):e1500052. https://doi.org/10.1126/sciadv.1500052

18. US EPA. Connectivity of Streams and Wetlands To Downstream Waters: A Review and Synthesis of the Scientific Evidence. Washington D.C.: U.S. Environmental Protection Agency; 2015. Report No.: EPA/600/R-14/475F.

19. Leibowitz SG, Wigington PJ, Schofield KA, Alexander LC, Vanderhoof MK, Golden HE. Connectivity of Streams and Wetlands to Downstream Waters: An Integrated Systems Framework. JAWRA J Am Water Resour Assoc. 2018 Apr;54(2):298–322. https://doi.org/10.1111/1752-1688.12631

20. Hilty J, Worboys GL, Keeley A, Woodley S, Lausche BJ, Locke H, et al. Guidelines for conserving connectivity through ecological networks and corridors [Internet]. Groves C, editor. IUCN, International Union for Conservation of Nature; 2020 [2025 Dec 22]. https://doi.org/10.2305/IUCN.CH.2020.PAG.30.en

21. Gilbert-Norton L, Wilson R, Stevens JR, Beard KH. A meta-analytic review of corridor effectiveness. Conserv Biol J Soc Conserv Biol. 2010 Jun;24(3):660–8. https://doi.org/10.1111/j.1523-1739.2010.01450.x

22. Rytwinski T, Soanes K, Jaeger JAG, Fahrig L, Findlay CS, Houlahan J, et al. How Effective Is Road Mitigation at Reducing Road-Kill? A Meta-Analysis. Xu J, editor. PLOS ONE. 2016 Nov 21;11(11):e0166941. https://doi.org/10.1371/journal.pone.0166941

23. Driscoll CT, Lawrence GB, Bulger AJ, Butler TJ, Cronan CS, Eagar C, et al. Acidic Deposition in the Northeastern United States: Sources and Inputs, Ecosystem Effects, and Management Strategies: The effects of acidic deposition in the northeastern United States include the acidification of soil and water, which stresses terrestrial and aquatic biota. BioScience. 2001 Mar 1;51(3):180–98. https://doi.org/10.1641/0006-3568(2001)051%255B0180:ADITNU%255D2.0.CO;2

24. Fernandez NM, Jamison HT, Gold Z. Rapid response of stream dissolved phosphorus concentrations to wildfire smoke. Commun Earth Environ. 2024 Oct 4;5(1):562. https://doi.org/10.1038/s43247-024-01732-w

25. Bridges, Todd S., Burks-Copes, Kelly A., Bates, Matthew E., Collier, Zachary A., Fischenich, J. Craig, Piercy, Candice D., et al. Use of Natural and Nature-Based Features (NNBF) for coastal resilience [Internet]. U.S. Army Engineer Research and Development Center, Environmental Laboratory, Coastal and Hydraulics Laboratory; 2015 [2025 Dec 22]. Report No.: SR-15-1. https://usace.contentdm.oclc.org/digital/collection/p266001coll1/id/3442/

26. Sutton-Grier AE, Wowk K, Bamford H. Future of our coasts: The potential for natural and hybrid infrastructure to enhance the resilience of our coastal communities, economies and ecosystems. Environ Sci Policy. 2015 Aug;51:137–48. https://doi.org/10.1016/j.envsci.2015.04.006

27. Ansari AH, Mejia A, Cibin R. Flood teleconnections from levees undermine disaster resilience. Npj Nat Hazards. 2024 Feb 28;1(1):2. https://doi.org/10.1038/s44304-024-00002-1

28. Dundas SL, Lewis DJ. Estimating Option Values and Spillover Damages for Coastal Protection. J Assoc Environ Resour Econ. 2020 Jun 8;7(3):519–54.

29. US EPA O. Integrated Municipal Stormwater and Wastewater Planning Approach Framework [Internet]. 2012 Jun [2025 Dec 22]. https://www.epa.gov/npdes/integrated-municipal-stormwater-and-wastewater-planning-approach-framework

30. US EPA O. Types of Green Infrastructure [Internet]. 2022 [2025 Dec 22]. https://www.epa.gov/green-infrastructure/types-green-infrastructure

31. Crimmins AR, Avery CW, Easterling DR, Kunkel KE, Stewart BC, Maycock TK. Fifth National Climate Assessment: Report-in-Brief [Internet]. U.S. Global Change Research Program; 2023 [2025 Dec 22]. https://doi.org/10.7930/NCA5.2023.RiB

32. Opperman JJ, Galloway GE, Fargione J, Mount JF, Richter BD, Secchi S. Sustainable Floodplains Through Large-Scale Reconnection to Rivers. Science. 2009 Dec 11;326(5959):1487–8. https://doi.org/10.1126/science.1178256

33. Opperman JJ, Luster R, McKenney BA, Roberts M, Meadows AW. Ecologically Functional Floodplains: Connectivity, Flow Regime, and Scale[1]. JAWRA J Am Water Resour Assoc. 2010 Apr;46(2):211–26. https://doi.org/10.1111/j.1752-1688.2010.00426.x

34. Wohl E, Cenderelli DA, Dwire KA, Ryan-Burkett SE, Young MK, Fausch KD. Large in-stream wood studies: a call for common metrics. Earth Surf Process Landf. 2010 Apr;35(5):618–25. https://doi.org/10.1002/esp.1966

35. McKay SK, Cooper AR, Diebel MW, Elkins D, Oldford G, Roghair C, et al. Informing Watershed Connectivity Barrier Prioritization Decisions: A Synthesis. River Res Appl. 2017 Jul;33(6):847–62. https://doi.org/10.1002/rra.3021

36. Narayan S, Beck MW, Reguero BG, Losada IJ, Van Wesenbeeck B, Pontee N, et al. The Effectiveness, Costs and Coastal Protection Benefits of Natural and Nature-Based Defences. Chapman M (Gee) G, editor. PLOS ONE. 2016 May 2;11(5):e0154735. https://doi.org/10.1371/journal.pone.0154735

37. Sawyer H, Kauffman MJ, Nielson RM, Horne JS. Identifying and prioritizing ungulate migration routes for landscape-level conservation. Ecol Appl. 2009 Dec;19(8):2016–25. https://doi.org/10.1890/08-2034.1

38. Merkle JA, Lowrey B, Wallace CF, Hall LE, Wilde L, Kauffman MJ, et al. Conserving habitat for migratory ungulates: How wide is a migration corridor? J Appl Ecol. 2023 Sep;60(9):1763–70. https://doi.org/10.1111/1365-2664.14473

39. Cash DW, Clark WC, Alcock F, Dickson NM, Eckley N, Guston DH, et al. Knowledge systems for sustainable development. Proc Natl Acad Sci. 2003 Jul 8;100(14):8086–91. https://doi.org/10.1073/pnas.1231332100

40. Dilling L, Lemos MC. Creating usable science: Opportunities and constraints for climate knowledge use and their implications for science policy. Glob Environ Change. 2011 May;21(2):680–9. https://doi.org/10.1016/j.gloenvcha.2010.11.006

41. Elliott S, Sterner B. How Open Science organizations generate epistemic oppression. Eur J Philos Sci. 2025 Aug 5;15(3):47. https://doi.org/10.1007/s13194-025-00674-0

42. Leonelli S. Open Science and Epistemic Diversity: Friends or Foes? Philos Sci. 2022 Dec;89(5):991–1001. https://doi.org/10.1017/psa.2022.45

43. Nichols J, Williams B. Monitoring for conservation. Trends Ecol Evol. 2006 Dec;21(12):668–73. https://doi.org/10.1016/j.tree.2006.08.007

44. Stevens LE, Kolian M, Arndt D, Blunden J, Johnson EW, Liu AY, et al. Appendix A4 : Indicators. Fifth National Climate Assessment [Internet]. U.S. Global Change Research Program; 2023 [2025 Dec 22]. https://doi.org/10.7930/NCA5.2023.A4

45. Allen CR, Gunderson LH. Pathology and failure in the design and implementation of adaptive management. J Environ Manage. 2011 May;92(5):1379–84. https://doi.org/10.1016/j.jenvman.2010.10.063

46. Lindenmayer DB, Likens GE. The science and application of ecological monitoring. Biol Conserv. 2010 Jun 1;143(6):1317–28. https://doi.org/10.1016/j.biocon.2010.02.013

47. Keeney RL. Value-Focused Thinking: A Path to Creative Decisionmaking [Internet]. Harvard University Press; 2009 [2026 Jan 25]. https://www.hup.harvard.edu/books/9780674039407

48. Walker G. Environmental Justice: Concepts, Evidence and Politics. London: Routledge; 2012. 272 p. https://doi.org/10.4324/9780203610671

49. Delmas MA, Burbano VC. The Drivers of Greenwashing. Calif Manage Rev. 2011 Oct;54(1):64–87. https://doi.org/10.1525/cmr.2011.54.1.64

50. Lyon TP, Montgomery AW. The Means and End of Greenwash. Organ Environ. 2015 Jun;28(2):223–49. https://doi.org/10.1177/1086026615575332

51. Montgomery AW, Lyon TP, Barg J. No End in Sight? A Greenwash Review and Research Agenda. Organ Environ. 2024 Jun;37(2):221–56. https://doi.org/10.1177/10860266231168905

52. Norström AV, Cvitanovic C, Löf MF, West S, Wyborn C, Balvanera P, et al. Principles for knowledge co-production in sustainability research. Nat Sustain. 2020 Jan 20;3(3):182–90. https://doi.org/10.1038/s41893-019-0448-2

53. Wenger E. Communities of practice: Learning, meaning, and identity. New York, NY, US: Cambridge University Press; 1998. xv, 318 p. (Communities of practice: Learning, meaning, and identity). https://doi.org/10.1017/CBO9780511803932

54. Reed MS, Stringer LC, Fazey I, Evely AC, Kruijsen JHJ. Five principles for the practice of knowledge exchange in environmental management. J Environ Manage. 2014 Dec;146:337–45. https://doi.org/10.1016/j.jenvman.2014.07.021

55. Fazey I, Evely AC, Reed MS, Stringer LC, Kruijsen J, White PCL, et al. Knowledge exchange: a review and research agenda for environmental management. Environ Conserv. 2013 Mar;40(1):19–36. https://doi.org/10.1017/S037689291200029X

56. Cvitanovic C, Hobday AJ, Van Kerkhoff L, Marshall NA. Overcoming barriers to knowledge exchange for adaptive resource management; the perspectives of

Australian marine scientists. Mar Policy. 2015 Feb 1;52:38–44. https://doi.org/10.1016/j.marpol.2014.10.026

57. Guston DH. Boundary Organizations in Environmental Policy and Science: An Introduction. Sci Technol Hum Values. 2001 Oct 1;26(4):399–408. https://doi.org/10.1177/016224390102600401

58. Heimlich JE, Ardoin NM. Understanding behavior to understand behavior change: a literature review. Environ Educ Res. 2008 Jun 1;14(3):215–37. https://doi.org/10.1080/13504620802148881

59. Ardoin NM, Bowers AW, Gaillard E. Environmental education outcomes for conservation: A systematic review. Biol Conserv. 2020 Jan;241:108224. https://doi.org/10.1016/j.biocon.2019.108224

60. Wolch JR, Byrne J, Newell JP. Urban green space, public health, and environmental justice: The challenge of making cities 'just green enough.' Landsc Urban Plan. 2014 May 1;125:234–44. https://doi.org/10.1016/j.landurbplan.2014.01.017

61. Reguero BG, Storlazzi CD, Gibbs AE, Shope JB, Cole AD, Cumming KA, et al. The value of US coral reefs for flood risk reduction. Nat Sustain. 2021 Apr 15;4(8):688–98. https://doi.org/10.1038/s41893-021-00706-6

62. National Research Council. Public Participation in Environmental Assessment and Decision Making [Internet]. Washington, D.C.: National Academies Press; 2008 [2026 Jan 25]. https://doi.org/10.17226/12434

63. Ansell C, Gash A. Collaborative Governance in Theory and Practice. J Public Adm Res Theory. 2008 Oct 1;18(4):543–71. https://doi.org/10.1093/jopart/mum032

64. Emerson K, Nabatchi T, Balogh S. An Integrative Framework for Collaborative Governance. J Public Adm Res Theory. 2012 Jan 1;22(1):1–29. https://doi.org/10.1093/jopart/mur011

65. Jager NW, Newig J, Challies E, Kochskämper E. Pathways to Implementation: Evidence on How Participation in Environmental Governance Impacts on Environmental Outcomes. J Public Adm Res Theory. 2020 Jun 23;30(3):383–99. https://doi.org/10.1093/jopart/muz034

66. Newig J, Jager NW, Challies E, Kochskämper E. Does stakeholder participation improve environmental governance? Evidence from a meta-analysis of 305 case studies. Glob Environ Change. 2023 Sep 1;82:102705. https://doi.org/10.1016/j.gloenvcha.2023.102705

67. Karcher DB, Cvitanovic C, van Putten IE, Colvin RM, Armitage D, Aswani S, et al. Lessons from bright-spots for advancing knowledge exchange at the interface of marine science and policy. J Environ Manage. 2022;314:114994.

68. Tengö M, Brondizio ES, Elmqvist T, Malmer P, Spierenburg M. Connecting Diverse Knowledge Systems for Enhanced Ecosystem Governance: The Multiple Evidence Base Approach. AMBIO. 2014 Sep 1;43(5):579–91. https://doi.org/10.1007/s13280-014-0501-3

69. Meredith GR, Spiegal S, Kleinman PJA, Harmel D. The social networks of manureshed management. J Environ Qual. 2022 Jul;51(4):566–79. https://doi.org/10.1002/jeq2.20334

70. Israel BA, Schulz AJ, Parker EA, Becker AB. REVIEW OF COMMUNITY-BASED RESEARCH: Assessing Partnership Approaches to Improve Public Health. Annu Rev Public Health. 1998 May 1;19(Volume 19, 1998):173–202. https://doi.org/10.1146/annurev.publhealth.19.1.173

71. Beierle TC, Cayford J. Democracy in practice: public participation in environmental decisions [Internet]. Washington, D.C: Resources for the Future; 2002 [2026 Jan 25]. 1 p. https://doi.org/10.4324/9781936331017

72. Reed MS. Stakeholder participation for environmental management: A literature review. Biol Conserv. 2008 Oct;141(10):2417–31. https://doi.org/10.1016/j.biocon.2008.07.014

73. Fung A. Varieties of Participation in Complex Governance. Public Adm Rev. 2006;66(s1):66–75. https://doi.org/10.1111/j.1540-6210.2006.00667.x

74. Schümann H, Knierim A, Bellingrath-Kimura SD, Kernecker M. Working with or against multifunctional landscapes? A case study of land users' local knowledge of grassland–forest transition zones in northeastern Germany. Ecol Soc [Internet]. 2022;27(1). https://doi.org/10.5751/ES-12970-270138

75. US Department of Agriculture. Toward Shared Stewardship Across Landscapes: An Outcome-Based Investment Strategy. USDA; 2018. Report No.: FS-118.

76. Kooistra C, Schultz C, Abrams J, Huber-Stearns H. Institutionalizing the United States Forest Service's Shared Stewardship Strategy in the Western United States. J For. 2022 Sep 1;120(5):588–603. https://doi.org/10.1093/jofore/fvac010

77. Aldworth T, Schultz C. Institutions That Influence Cross-Boundary Forest Management: Four Cases of Shared Stewardship in Practice. J For. 2023 Sep 1;121(5–6):432–42. https://doi.org/10.1093/jofore/fvad030

78. Fischer AP, Klooster A, Cirhigiri L. Cross-boundary cooperation for landscape management: Collective action and social exchange among individual private forest

landowners. Landsc Urban Plan. 2019 Aug 1;188:151–62. https://doi.org/10.1016/j.landurbplan.2018.02.004

79. Kelly EC, Charnley S, Pixley JT. Polycentric systems for wildfire governance in the Western United States. Land Use Policy. 2019 Dec 1;89:104214. https://doi.org/10.1016/j.landusepol.2019.104214

80. Ostrom E. Polycentric systems for coping with collective action and global environmental change. Glob Environ Change. 2010 Oct;20(4):550–7. https://doi.org/10.1016/j.gloenvcha.2010.07.004

81. Connolly JJ, Svendsen ES, Fisher DR, Campbell LK. Organizing urban ecosystem services through environmental stewardship governance in New York City. Landsc Urban Plan. 2013 Jan;109(1):76–84. https://doi.org/10.1016/j.landurbplan.2012.07.001

82. Landau LF, Campbell LK, Svendsen ES, Johnson ML. Building Adaptive Capacity Through Civic Environmental Stewardship: Responding to COVID-19 Alongside Compounding and Concurrent Crises. Front Sustain Cities. 2021 Nov 11;3:705178. https://doi.org/10.3389/frsc.2021.705178

83. Campbell LK, Svendsen ES. Urban ecological stewardship: understanding the structure, function and network of community-based urban land management. Cities Environ. 2008;1(1):1–31. https://doi.org/10.15365/cate.1142008

84. Salkin P, Lavine A. Negotiating for Social Justice and the Promise of Community Benefits Agreements: Case Studies of Current and Developing Agreements [Internet]. Rochester, NY: Social Science Research Network; 2008 [2025 Nov 6]. https://papers.ssrn.com/abstract=1117681

85. Wolf-Powers L. Community Benefits Agreements and Local Government: A Review of Recent Evidence. J Am Plann Assoc. 2010 Mar 22;76(2):141–59. https://doi.org/10.1080/01944360903490923

86. Ferdinand R. Sankofa. [2026 Jan 28]. About Us | Sankofa Community Development Corporation. https://sankofanola.org/about-us/

87. Wallerstein N, Duran B, Oetzel JG, Minkler M, editors. Community-based participatory research for health: advancing social and health equity. Third edition. San Francisco, CA: Jossey-Bass, A Wiley Brand; 2018. 439 p.

88. Kaufman A, Williams R, Barzyk T, Greenberg M, O'Shea M, Sheridan P, et al. A Citizen Science and Government Collaboration: Developing Tools to Facilitate Community Air Monitoring. Environ Justice. 2017 Apr;10(2):51–61. https://doi.org/10.1089/env.2016.0044

89. Stewart IT, Bacon CM, Burke WD. The uneven distribution of environmental burdens and benefits in Silicon Valley's backyard. Appl Geogr. 2014 Dec 1;55:266–77. https://doi.org/10.1016/j.apgeog.2014.09.016

90. O'Fallon LR, Dearry A. Community-based participatory research as a tool to advance environmental health sciences. Environ Health Perspect. 2002 Apr;110 Suppl 2(Suppl 2):155–9. https://doi.org/10.1289/ehp.02110s2155

91. Ottinger G. Buckets of Resistance: Standards and the Effectiveness of Citizen Science. Sci Technol Hum Values. 2010 Mar 1;35(2):244–70. https://doi.org/10.1177/0162243909337121

92. Kukutai T, Taylor J. Indigenous Data Sovereignty [Internet]. Australian Natuional University Press; 2016. http://doi.org/10.22459/CAEPR38.11.2016

93. Sumaila UR. A Cautionary Note on Individual Transferable Quotas. Ecol Soc. 2010;15(3):art36. https://doi.org/10.5751/ES-03391-150336

94. Chaffin BC, Gosnell H, Cosens BA. A decade of adaptive governance scholarship: synthesis and future directions. Ecol Soc [Internet]. 2014 [2025 Dec 17];19(3). https://www.jstor.org/stable/26269646