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Perspective Essay

The iCASS Platform: Nine principles for landscape conservation design

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ABSTRACT

The Anthropocene presents society with a super wicked problem comprised of multiple contingent and conflicting issues driven by a complex array of change agents. Super wicked problems cannot be adequately addressed using siloed decision-making approaches developed by hierarchical institutions using science that is compartmentalized by discipline. Adaptive solutions will rest on human ingenuity that fosters transformation towards sustainability. To successfully achieve these objectives, conservation and natural resource practitioners need a paradigm that transcends single-institution interests and decision-making processes. We propose a platform for an emerging and evolutionary step change in sustainability planning: landscape conservation design (LCD). We use existing governance and adaptation planning principles to develop an iterative, flexible innovation systems framework—the "iCASS Platform." It consists of nine principles and five attributes—innovation, convening stakeholders, assessing current and plausible future landscape conditions, spatial design, and strategy design. The principles are organized around four cornerstones of innovation: people, purpose, process, and product. The iCASS Platform can facilitate LCD via processes that aim to create and empower social networks, foster stakeholder involvement, engender co-production and cross-pollination of knowledge, and provide multiple opportunities for deliberation, transparency, and collaborative decision-making. Our intention is to pivot from single-institution, siloed assessment and planning to stakeholder-driven, participatory design, leading to collaborative decision-making and extensive landscape conservation.

1. Introduction

The dawn of the Anthropocene—an era characterized by human-induced global ecological change and uncertainty—presents a preview of a possible future quite different from the environment that fostered the emergence and prosperity of present-day human societies. Adapting to the Anthropocene's complex array of change is a "super wicked" problem (Levin, Cashore, Bernstein, & Auld, 2012, p. 2; Waddock, 2013), comprised of multiple, contingent, and conflicting issues. Super wicked problems cannot be fully assessed using siloed decision-making approaches developed by hierarchical institutions using disciplinary science (Norris, O'Rourke, Mayer, & Halvorsen, 2016). Finding adaptive solutions for how to thrive in the Anthropocene rests on human ingenuity fostering transformability toward social, economic, and ecological sustainability. To that end, we propose a platform for an emerging and evolutionary step change in sustainability planning: landscape conservation design (LCD) (see Table 1).

Our theory of change (Fig. 1) is grounded in the belief that just as

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Table 1
Glossary of Terms.

Term	Definition
adaptive comanagement	A process by which institutional arrangements and ecological knowledge are tested and revised in a dynamic, ongoing, self-organized process of learning-by-doing (Folke et al., 2002)
adaptation pathway	An analytical approach to planning that allows for uncertainty and change by encouraging consideration of multiple possible futures and the robustness and flexibility of options across these futures (Bosomworth, Harwood, Leith, & Wallis, 2015)
double- and triple-loop learning	Double-loop learning: revisiting assumptions about cause and effects; triple-loop learning: reassessing underlying values and beliefs, potentially resulting in changes to institutional norms (Argyris, 1976; Butler et al., 2016; Pahl-Wostl, 2009)
governance	Sustaining coordination and coherence among a wide variety of stakeholders with different purposes and objectives (Pierre, 2000)
heuristic	Involving or serving as an aid to learning, discovery, or problem-solving by experimental and especially trial-and-error methods (Merriam-Webster Dictionary, http://www.merriam-webster.com/dictionary/heuristic)
iCASS Platform	A heuristic for landscape conservation design. The *iCASS Platform* is an innovation systems framework consisting of five attributes and nine principles. The *iCASS* acronym stands for: i = innovation, iC = inclusiveness: convene stakeholders, iA = interdisciplinary assessment of current and plausible future conditions, iS^1 = interactive spatial design, and iS^2 = informative strategy design
innovation systems framework	A holistic and dynamic approach to problem-solving that utilizes creative thinking to solve societal challenges (Iizuka, 2013)
landscape	A bounded area of indeterminate size that humans have an affinity for or connection to, and within which they assess appearance, quality, and function of the landscape based on social norms and interest (Termorshuizen & Opdam, 2009)
landscape conservation	Landscape conservation is the rapidly growing practice of people working together across large geographies, regardless of political boundaries, to conserve our natural and cultural heritage and ensure a sustainable future for both people and nature (Network for Landscape Conservation. (n.d.). Retrieved August 23 (2017)). It connects wild lands, working lands, and urban areas into whole, healthy landscapes [or social-ecological systems], and enhances the conservation value of all lands [and waters] through the development of strategies that promote adaptation and resilience (Center for Large Landscape Conservation, (n.d.))
landscape conservation design (LCD)	A stakeholder-driven, participatory process that: 1) integrates societal values and cross-jurisdiction, multisector interests with the best available interdisciplinary science and traditional knowledge; 2) assesses spatial and temporal patterns, vulnerabilities, risks, and opportunities for landscape elements valued by stakeholders; 3) results in a set of spatially explicit products and multi-objective adaptation strategies; and 4) which protects biodiversity, conserves ecosystem services, and promotes social-ecological systems (e.g., landscapes) that are resilient and sustainable for current and future generations.
silo	A system, process, department, etc. that operates in isolation from others (Oxford Dictionary, https://en.oxforddictionaries.com/definition/silo
social-ecological system	An integrated system of ecosystems and human society with reciprocal feedback and interdependence. The concept emphasizes the humans-in-nature perspective (Folke et al., 2010)
social learning	Where multiple agents combine different values, experiences, and knowledge to identify issues and potential solutions, analyze alternatives, debate choices, and identify priorities through inclusive and deliberative processes (Ojha et al., 2013)
stakeholder	All human agents and agencies, regardless of expertise, title, or role in the design process
transformability	The capacity to create a fundamentally new system when ecological, economic, or social (including political) conditions make the existing system untenable (Walker et al., 2004)

Earth's biomes and human civilizations evolved during the Holocene and will continue to do so in the Anthropocene, so too must the governance structures and processes societies use to guide decision-making (Armitage, Berkes, & Doubleday, 2010; Voss, Bauknecht, & Kemp, 2006). To be successful in tackling wicked problems, natural and cultural resource practitioners need a flexible, multi-stakeholder governance structure that transcends single-institution interests and siloed decision-making (Knight, Rodrigues, Strange, Tew, & Wilson, 2013; Toomey, Knight, & Barlow, 2016). To attain that vision, we briefly discuss the well-established concepts underlying landscape conservation design, then, using established adaptation principles, we develop an innovation systems framework—the iCASS Platform—and introduce its five attributes and nine principles. The purpose of this paper is to provide practitioners with a framework that can be used to guide, test, and evaluate landscape conservation design initiatives. Our intention is to ignite transformation from single-institution, siloed assessment and planning to stakeholder-driven, participatory design, leading to collaborative decision-making and extensive landscape conservation.

It bears noting that this paper is unique among the many that tackle similar issues and scope: it is written by practitioners from federal/state agencies and nonprofit organizations that are enmeshed in the sociopolitical realities of conservation in the United States, and as such, provides a lens of pragmatism not necessarily present among scholarly papers. We acknowledge every country has a particular conservation context it must operate within, such as the challenges between private property rights vs the commons, economic constraints, etc. This paper, and the iCASS Platform it introduces, incorporates universal truths in adaptation planning and governance, and as such, can be applicable, not only within the United States context, but the global community at large.

2. Landscape conservation design

This paper holds that sustainability—an overall condition of low vulnerability and high resilience (Wu, 2013)—is, and will remain, the single most important concern of the global community (Kuhlman & Farrington, 2010; Waddock, 2013), and that it is best achieved using the adaptation strategy of landscape conservation. Issues surrounding the vulnerability and resilience of linked social–ecological systems are well documented in global and national assessments (IPCC, 2014; Melillo, Richmond, & Yohe, 2014), national strategic planning documents (NFWPCAP, 2012), and international agreements (United Nations, 2015). However, questions remain about how, and at what rate, societies structurally and functionally adapt their decision-making processes when faced with either fully anticipated or completely unknown management challenges.

Achieving a trajectory toward sustainability requires transformation: a shift from traditional decision-making models and a move toward novel approaches designed for the challenges of the Anthropocene (IPCC, 2014). Societies begin the process of transformation when events challenge their resilience or when their support systems begin to show vulnerabilities (Kates, Travis, & Wilbanks, 2012). Ideally, transformational processes gain momentum when stakeholders undergo iterative double- and triple-loop learning to reconsider their values and institutions, question status quo methodologies, and explore broad-scale intensive and extensive strategies (Argyris, 1976; Butler et al., 2016; Pahl-Wostl, 2009).

Sustainability science (Heinrichs, Martens, Michelsen, & Wiek, 2015) has broadened the discussion from incremental management actions focused on individual components of localized systems to holistic, transformational design processes that enhance the coupling of social and ecological systems (Berkes, Colding, & Folke, 2003; Folke et al., 2010; Walker, Holling, Carpenter, & Kinzig, 2004).

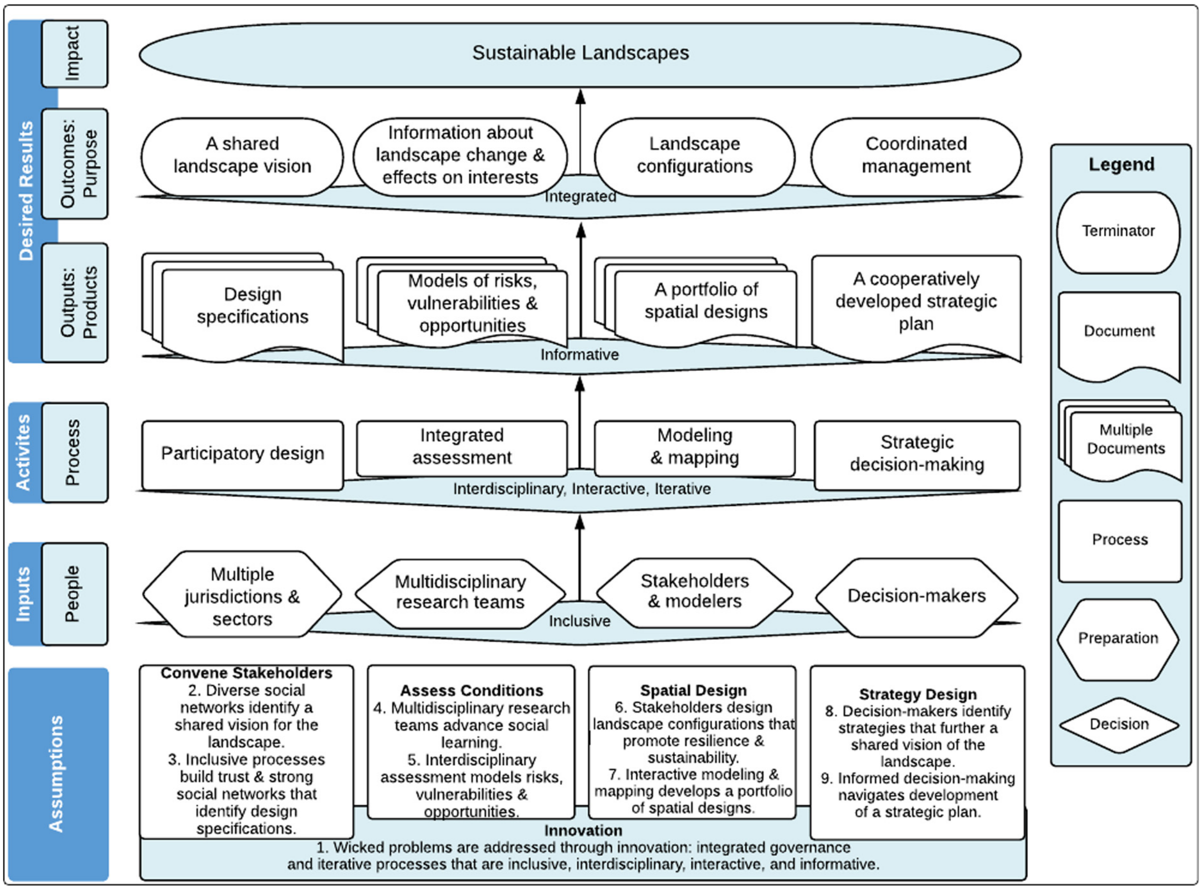

Fig. 1. Theory of change. The iCASS Platform, a set of attributes and principles for landscape conservation design, can result in effective inputs, activities, outputs, and outcomes that facilitate sustainable social-ecological systems.

Transformational approaches, such as ecosystem management (Lackey, 1998) and adaptive comanagement (Folke et al., 2002; Plummer et al., 2012), have been developed and tested over recent decades. More recently, "large-scale," "landscape," and "large landscape" approaches (with or without the term "conservation" appended) have begun to be expressed in policy (DOI, 2017) and explored in regional decision-making processes (Minnesota Prairie Plan Working Group, 2011).

Erlhoff and Marshall (2008) note the design discipline includes the people, processes, and products that facilitate people's intention (or purpose) to transform their environment into a more desirable one. We refer to people, purpose, process and product as cornerstones of innovation. Cope and Kalantzis (2011) describe design as "an engine of change" (p. 49), and Roozenburg and Eekels (1995) define it as "conceiving [of] an idea for [development of] an artifact or system, and expressing the idea in an embodiable form" (p. 53). Within the context of landscape conservation, design can be an adaptation pathway—a transformative decision-making approach that challenges, if not contributes to, the body of existing strategic frameworks. Our intention is to further landscape conservation through stakeholder-driven design processes, undertaken at regional scales, which identify desired landscape configurations and adaptation strategies that promote sustainability.

Therefore, we define LCD as a stakeholder-driven, participatory process that: 1) integrates societal values and cross-jurisdiction, multisector interests with the best available interdisciplinary science and traditional knowledge (*the people*); 2) assesses spatial and temporal patterns, vulnerabilities, risks, and opportunities for landscape elements valued by stakeholders (*the process*); 3) results in a set of spatially explicit products and multi-objective adaptation strategies (*the products*); and 4) which protects biodiversity, conserves ecosystem services, and promotes social-ecological systems (e.g., landscapes) that are resilient and sustainable for current and future generations (*its purpose*).

A proactive approach to landscape conservation that yields a robust, complex, interconnected network of protected, conserved, working, and developed lands can facilitate an adaptive response to emerging or unforeseen challenges and promote resilient societies within sustainable landscapes (Melillo et al., 2014; NFWPCAP, 2012). The overarching aim of LCD is to collaboratively develop innovative, coordinated strategies (*a strategic plan*) that facilitate adaptation across jurisdictions and sectors. In addition, it identifies landscape configurations (*blueprints*) that allow ecological systems to resist, recover, and adapt to changing conditions (Aplet & McKinley, 2017; Fisichelli, Schuurman, & Hoffman, 2016), typically by encouraging ecologically representative, redundant networks that work to restore or maintain ecosystem integrity, strengthen connectivity, and appropriately scale responses to disturbances (NFWPCAP, 2012).

To be successful, LCD must be a bottom-up, collaborative approach to making decisions, as opposed to a top-down, single-institution planning process (Ansell & Gash, 2008; NASEM, 2015; Wyborn & Bixler, 2013). LCD combines the concepts of social learning, and spatial and strategic planning to come to understand the nature of ecological systems as the supporting context of social-ecological systems. LCD can be a crucial aspect of landscape conservation because of its participatory approach, and because successful landscape conservation rests on stakeholder choices (Nassauer, 2012). Stakeholder participation in LCD can assure that products developed offer relevant guidance to those engaging in the stewardship and use of desired future landscapes (Nassauer, 2012). LCD characteristics and how they differ from planning characteristics are presented in Table 2.

Table 2
Landscape conservation design and equivalency with general planning characteristics organized by four cornerstones of innovation.

Cornerstones of Innovation	Planning Characteristics (The Current Approach)	Landscape Conservation Design Characteristics (The Transformed Approach)
People	Single institutions	Multiple institutions
	"Internal" coordination/facilitation	Bridging organization coordinates/facilitates
Purpose	Achieve the agent's mission, mandates, and goals	Achieve resilient and sustainable multifunctionality
	Focus is within jurisdictional boundaries	Focus is region-wide
	Agent-specific learning and decision-making	Social learning and decision-making
	Institutional success	Collective impact
Process	Institution-driven	Stakeholder-driven
	Rigid governance structure	Flexible governance structure
	Stakeholders provide input as part of the process	Stakeholders direct all aspects of the process
	Issue-driven	Value/Interest-driven
	Atomistic	Holistic
	Disciplinary-based	Interdisciplinary-based
	Science informs single-agent policies, programs, strategies	Science informs multiple stakeholders' policies, programs, strategies
	Planning for historic/current conditions	Designing for potential futures
	Siloed decision-making	Horizontal decision-making
	Iterative	Iterative
Product	Determined by agent	Determined by stakeholders
	"Draft" until "Final"	Prototypes
	"Final" until revised	"Living"
	"Sit on the shelf"	Live in "the cloud"
	Text, maps, data	Same plus models, decision-support tools, strategic plans, cooperative agreements, etc
	Directs institutional action at site-specific scale	Guides collective action at the regional-scale

3. The iCASS Platform: An innovation systems framework for LCD

A single design process for landscape conservation would stifle the innovation needed to address the challenges of wicked problems (Erlhoff & Marshall, 2008; Nassauer, 2012). As an alternative, we propose a heuristic for LCD: the iCASS Platform. It is an innovation systems framework: a holistic, yet flexible systems-based approach that encourages innovation to solve societal challenges (Iizuka, 2013). It consists of *five attributes*—innovation, convening stakeholders, assessing conditions, spatial design, and strategy design (Fig. 2)—and *nine principles* (Fig. 3). To design it, we synthesized four sources: 1) international agreements on adaptation and biodiversity conservation (IPCC, 2014; UNEP, 2000, 2011), and U.S. government adaptation policy (CEQ, 2011) (Supplemental Material, Table S1); 2) input obtained during five practitioner forums hosted between October 2014 and July 2015 in the United States (Supplemental Material); 3) governance and adaptation planning literature; and 4) over 225 years of combined professional experience in conservation research, planning, and delivery within the United States context.

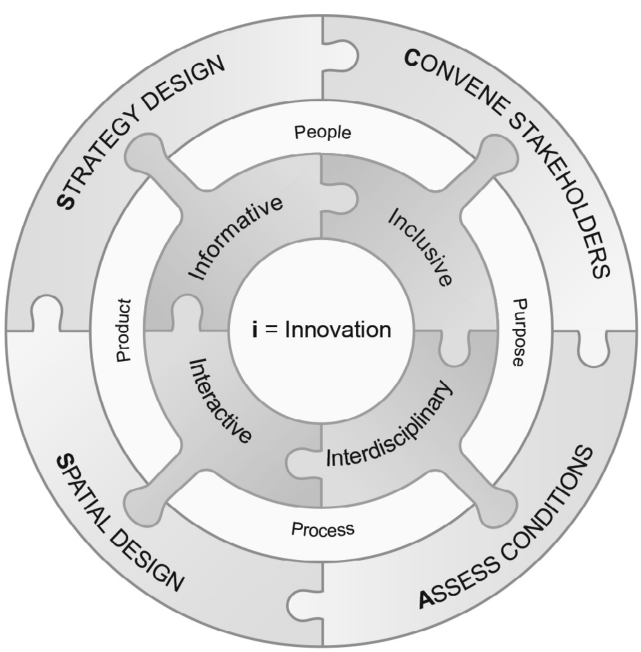

Fig. 2. The iCASS Platform is an adaptive, innovative systems framework for landscape conservation design organized around four cornerstones of innovation: people, purpose, process, and product. It includes five attributes: a) innovation, b) inclusiveness: convening stakeholders, c) interdisciplinary assessment of current and plausible future conditions, d) interactive spatial design, and e) informative strategy design.

The iCASS Platform is a synthesis of adaptation planning concepts and methodologies presented as a set of attributes and principles organized around four cornerstones of innovation: people, purpose, process, and product (Dignan, 2013). It emphasizes a design process that is inclusive, interdisciplinary, interactive, and informative. The iCASS Platform can facilitate LCD via processes that create and empower social networks, foster stakeholder involvement, engender co-production and cross-pollination of knowledge, and provide multiple opportunities for deliberation, transparency, learning, and collaborative decision-making (Iizuka, 2013; Malerba, 2002). By providing organizational guidance to stakeholders on the overall design process, while allowing space for local customization and innovation to unfold, the iCASS heuristic offers practical and flexible guidance for practitioners to follow and may contribute to the larger body of strategic decision-making approaches that exist. We provide case study examples from the authors' experience in the United States to demonstrate iCASS Platform attributes in Table 3.

Our intention is to pivot from single-institution, siloed assessment and planning to stakeholder-driven, participatory design, leading to collaborative decision-making and extensive landscape conservation. We understand that advocating a collaborative, multi-objective design approach to landscape conservation represents relatively new territory for many practitioners. While it is our assertion that the iCASS Platform provides a theoretical construct that facilitates making such a leap, only through monitoring many LCD processes, and evaluating if resilient and sustainable social–ecological landscapes are achieved as a result, can its success or failure be determined.

3.1. Attribute: i = Innovation

3.1.1. Principle #1: Wicked problems are addressed through innovation

Landscape conservation requires a design process that facilitates innovation: the exploration, development, and application of ideas that

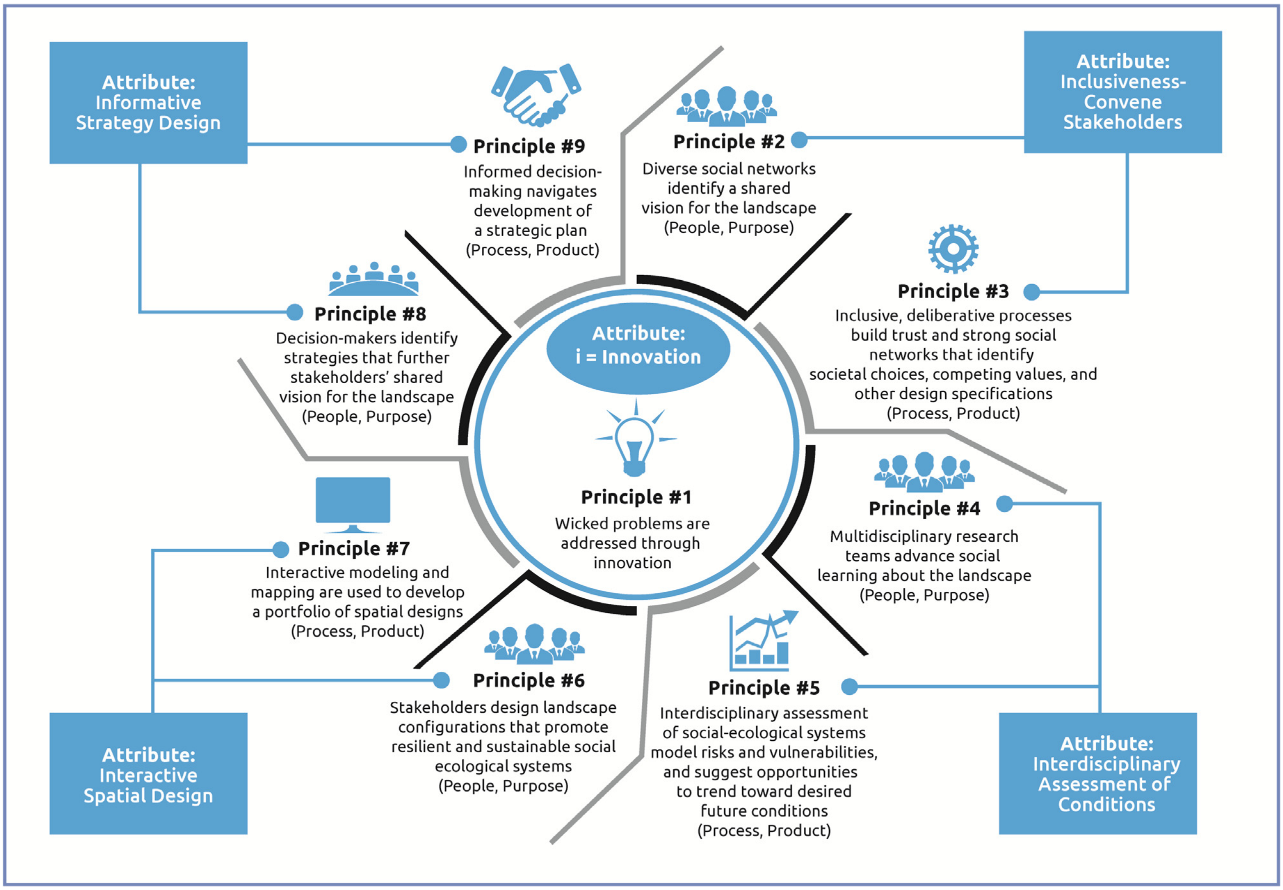

Fig. 3. The iCASS Platform consists of an adaptive set of nine principles organized around five attributes.

address wicked problems and improve human well-being (Brown, 2009). Innovation emerges when a systems framework is used to facilitate social learning among diverse agents (Iizuka, 2013) who use that knowledge to question existing norms and design new concepts, services, and products (IPCC, 2014; Malerba, 2002; Ojha, Hall, & Sulaiman, 2013). Innovation is the central attribute for iCASS, and underpins all other attributes.

Social learning is a foundational principle in innovation systems frameworks and stakeholder efforts to address change and uncertainty. It occurs when multiple agents combine their different values, experiences, and knowledge in order to identify issues and potential solutions, analyze alternatives, debate choices, and establish priorities through inclusive, deliberative processes (Ojha et al., 2013). It is expedited by iterative processes that provide opportunities for governance bodies, consisting of design practitioners, scientists, decision-makers, local experts, and other stakeholders, to engage in hypothesis building, experimentation, adaptive management, and deliberative forms of decision-making (Fulton Suri, 2008; IPCC, 2014; Jacobson & Robertson, 2012). Social learning results in positive outcomes such as stronger relationships, fundamental changes in participant and organizational behavior, and development of innovative strategies (Berkes, 2009; Salter, Robinson, & Wiek, 2010).

LCD—similar to other research, planning, and design efforts—requires iterative processes to facilitate social learning in addressing complexity and uncertainty. It is a continuous cycle of conceptualization—an ongoing divergence and convergence of ideas (Roozenburg & Eekels, 1995). The application of prototyping is integral to the iterative design process, foundational to experimentation, and key to social learning. Prototypes can inspire stakeholder engagement, visually represent and explore new ideas, produce tangible products that improve over time, and highlight design weaknesses or flaws prior to implementation (Erlhoff & Marshall, 2008; Fulton Suri, 2008).

Facilitating innovation capable of addressing landscape change requires integrated governance: stakeholder-driven, participatory decision-making grounded in social networks, experimentation, and empowerment (Crona & Parker, 2012; Tress, Tress, Fry, & Opdam, 2005). Integrated governance is grounded in stakeholder representativeness and engagement, transparency, collaboration, and informed action (Carson, 2009; Hartz-Karp, 2007). It originates when cross-jurisdiction, multisector stakeholders progress from siloed decision-making approaches—which have traditionally promoted a polarity between conservation and resource use—to collaborative approaches to managing the flow of ecological services to society (Carcasson, 2013; Hanleybrown, Kania, & Kramer, 2012). Integrated governance can foster innovation by promoting and facilitating transdisciplinary communication, expanding stakeholder knowledge by sharing ideas and perspectives across organizational boundaries, and considering multiple perspectives in making decisions (Erlhoff & Marshall, 2008; Tress et al., 2005).

3.2. Attribute: iC = Inclusiveness: Convening Landscape Stakeholders

3.2.1. Principle #2: Diverse social networks identify a shared vision for the landscape (Innovation Cornerstones: People, Purpose)

Convening a cross-jurisdiction, multisector body of stakeholders that represents the diversity of social values and interests in the landscape is central to the successful design and development of a sustainable social–ecological landscape (CEQ, 2011; IPCC, 2014; UNEP, 2000, 2011). Inherent in this attribute is the recognition that no single institution possesses the ability to respond to the complexity of the Anthropocene alone, and that an inclusive, stakeholder-driven approach to LCD relieves individual institutions from solving the

Table 3
This non-extensive list conveys case studies from the United States that illustrate attributes of the iCASS Platform.

iCASS Platform: Attributes	Example	Summary/Purpose	References
Innovation	Carnegie Airborne Observatory	Using advanced imaging technology and data analytics to galvanize action that protects the environment over large geographic extents.	Carnegie Airborne Observatory (2018). Who we are [HTML]. https://cao.carnegiescience.edu
	Conservation InnovationCenter	Develops partnerships, processes, and products that maximize the efficiency and effectiveness of broad-scale conservation.	Chesapeake Conservancy (2018). Conservation Innovation Center [HTML]. http://chesapeakeconservancy.org/conservation-innovation-center/
	Conservation Planning Atlas	Platforms that showcase spatial information and supporting documentation that technical experts, managers, and decision-makers can interact with.	Conservation Biology Institute (n.d.). LCC Conservation Planning Atlases [HTML]. https://consbio.org/products/projects/conservation-planning-atlases
Inclusiveness: Convene Stakeholders	Landscape Conservation Cooperatives	A national network of bridging organizations that bring diverse stakeholders together to work collaboratively through conservation planning and design.	Landscape Conservation Cooperative Network. (n.d.). About LCC [HTML]. https://lccnetwork.org/about/about-lccs
	National Wind Coordinating Collaborative	Identifies, defines, and discusses through broad stakeholder involvement and collaboration wind power-wildlife interactions.	National Wind Coordinating Collaborative (2018). About NWCC [HTML]. https://www.nationalwind.org/about-nwcc
	Pajaro Compass Network	A diverse membership consisting of cross-jurisdiction, multisector interests working collaboratively to articulate collective values.	The Pajaro Compass (2016). A Network for Voluntary Conservation [PDF]. http://www.pajarocompass.org/resources/documents/pdf/pajaro-report.pdf
Interdisciplinary Assessment of Current and Plausible Future Conditions	Integrated Landscape Assessment	Collaboratively exploring the dynamics of broad-scale, multi-ownership landscapes over time by evaluating and integrating information.	Oregon State University (2018). Integrated Landscape Assessment Project [HTML]. http://inr.oregonstate.edu/ilap
	Landscape Conservation and Climate Change Scenarios for the State of Florida	A strategic instrument allowing exploration of potential future conditions which helps organizations make more informed choices in uncertain times.	Vargas, J.C., Flaxman, M., & Fradkin, B. (2014). Landscape Conservation and Climate Change Scenarios for the State of Florida: A Decision Support System for Strategic Conservation. Summary for Decision Makers. GeoAdaptive LLC, Boston, MA and Geodesign Technologies Inc., San Francisco CA. Retrieved from http://peninsularfloridalcc.org/page/climate-change-scenarios
	Ecoregional Assessments	Identifies regionally important habitats and gauges potential changes to them.	The Nature Conservancy (2017). Ecoregional Assessments [HTML]. https://www.conservationgateway.org/Files/Pages/ecoregional-assessment-to.aspx
Interactive Spatial Design	Adaptation Portfolio Spatial Decision Support System	An optimization algorithm integrated with priority mapping overlays that spatially allocates three management types of interest.	Gallo, J. A. & Aplet, G. (2016). Allocating Land to a Three Zone Climate Adaptation Strategy Using a Spatial Decision Support System. Open Science Framework. May 14. https://osf.io/h5pa8/
	Arid Lands Initiative	A facilitated planning process that developed a priority areas portfolio that meets conservation goals for connectivity.	Arid Lands Initiative (2014). Our Shared Priorities [HTML]. http://aridlandsinitiative.org/our-shared-priorities/
	Crucial Habitat Assessment Tool	Facilitates early non-regulatory planning efforts to reduce conflicts while ensuring wildlife values are better incorporated into land use planning.	Western Association of Fish and Wildlife Agencies (2018). Crucial Habitat Assessment Tool: Mapping Fish and Wildlife Across the West [HTML]. http://www.wafwachat.org/
	Minnesota Prairie Conservation Plan	Identifies a landscape configuration and recommendations for protecting, enhancing, and restoring acreage goals.	Minnesota Prairie Plan Working Group (2011)
Informative Strategy Design	Implementation of the Minnesota Prairie Conservation Plan	Identifies stakeholder management actions for prairie conservation that ensures no duplicative efforts, missed opportunities, or confusion.	Minnesota Prairie Plan Working Group (2011). Implementing the Minnesota Prairie Conservation Plan. Minnesota Prairie Plan Working Group, Minneapolis, MN. 22p. Retrieved from http://www.mda.state.mn.us/~/media/Files/news/govrelations/pollinators/dnrprairieconsplan.ashx
	National Climate Adaptation Strategy	A comprehensive, multi-partner framework to guide responsible and effective actions by natural resource managers and other decision makers.	National Fish, Wildlife and Plants Climate Adaptation Partnership (2012)
	Puget Sound Action Agenda	A diverse partnership effort, informed by qualitative and quantitative science, that identifies regional strategies and specific actions.	Puget Sound Partnership., (n.d.). Action Agenda for Puget Sound [HTML]. http://psp.wa.gov/action_agenda_center.php

sustainability conundrum alone. The purpose of being inclusive in LCD is to convene and empower a broad coalition of stakeholders to create a shared vision of a landscape responsive to societal perceptions of vulnerability and risk. Another objective is to design and deliver measures—a collective, stakeholder response—that promote a sustainable landscape (Roozenburg & Eekels, 1995; Sayer et al., 2013).

A diversity of stakeholders in the design process increases opportunities to share knowledge, technical expertise, and other resources (Ansell & Gash, 2008); assures that relevant science will be used to guide learning and decision-making (Funtowicz & Ravetz, 1994; Pahl-Wostl, 2009); and allows for individual and institutional champions to emerge in taking a collaborative decision-making approach to sustainability (Fulton Suri, 2008). More importantly, it helps ensure design products are relevant to stakeholders (Nassauer & Opdam, 2008; Salter et al., 2010). We know that identifying and integrating knowledge across disciplines and stakeholder groups can be challenging (Raymond et al., 2010), yet it is an essential step toward achieving inclusiveness. Bringing a broad range of stakeholders together is not, however, a panacea. Stakeholders often bring competing objectives and maladaptive agendas to the table (Butler et al., 2016), but working through disparate views and values is an important step in promoting inclusiveness, social learning, and coordinated management.

3.2.2. Principle #3: Inclusive, deliberative processes build trust and strong social networks that identify societal choices, competing values, and other design specifications (Innovation Cornerstones: Process, Product)

Building effective partnerships capable of enduring the challenges of extended collaboration is difficult. Improved approaches to enhance the success of stakeholder participation and further transformation toward a desired future are needed (Hansen et al., 2013). Inclusive, decentralized decision-making processes, like LCD, are grounded in three core principles of open governance—participation, transparency, and collaboration (Pahl-Wostl, 2009). Convening an inclusive set of cross-jurisdiction, multisector stakeholders requires unique and adaptive leadership models. Bridging organizations are key to facilitating inclusive, open governance processes that build trust among diverse stakeholders (Hanleybrown et al., 2012; Jacobson & Robertson, 2012). Their role is to cultivate initial enthusiasm for the project, provide a neutral environment for stakeholders to deliberate, commence and coordinate work, and identify project champions to provide complementary leadership (Crona & Parker, 2012).

Deliberation—the purposeful process of empowering stakeholders by providing facilitated forums that strive for transparency—is necessary in horizontal, participatory decision-making (Carcasson, 2013; Ojha et al., 2013). Trust and collaboration are more likely to unfold and cultivate innovations that facilitate long-term outcomes when diverse stakeholders share views and information in open and transparent forums (Knight et al., 2013; Termorshuizen & Opdam, 2009). Disagreement and conflict may arise at points throughout the deliberative process. Forward progress in LCD may be impeded until a bridging organization or stakeholder champion steps into resolve the conflict (Hartz-Karp, 2007; Jacobson & Robertson, 2012). Nevertheless, successful collaborations overcome such challenges, and combine expertise and resources to achieve synergistic effects in adaptation (Kania & Kramer, 2011).

It is not enough to focus solely on participatory decision-making processes. Doing so can result in a stakeholder consensus for meeting their needs and interests without meeting ecosystem needs, especially over the long-term. What we strive for is a pragmatic, yet disciplined approach that produces substantive outcomes using the tenets of conservation science while empowering stakeholder social learning and negotiation (Groves & Game, 2016). To that end, facilitated forums lead stakeholders to: identify design specifications; include values, interests and targets; present perspectives on vulnerabilities and risks; articulate assumptions; and develop scenarios, prototypes, and strategies for promoting sustainable social-ecological landscapes (Iversen, Halskov, & Leong, 2012; Jacobson & Robertson, 2012). Design specifications guide compilation and co-production of scientific information—including interdisciplinary assessments of current and plausible future conditions—that supports decision-making.

3.3. Attribute: iA = Interdisciplinary Assessment of Current and Plausible Future Conditions

3.3.1. Principle #4: Multidisciplinary research teams advance social learning about the landscape (Innovation Cornerstones: People, Purpose)

Designing sustainable social-ecological systems requires fully realized narratives that express the social, economic, and ecological values held and desired by stakeholders (CEQ, 2011; IPCC, 2014; UNEP, 2000, 2011). Assessing the current, plausible, and desired future conditions of a multifunctional landscape is a complex task suited to no single discipline (Salter et al., 2010). Multidisciplinary research teams consisting of technical and non-technical stakeholders, representing relevant social, economic, and ecological disciplines, and local, traditional, and indigenous groups are fundamental to landscape conservation and the design of sustainable social-ecological systems (IPCC, 2014). Inherent in this attribute is the recognition that no single discipline can understand the uncertainties of how social-ecological systems respond to change; and that interdisciplinary assessment teams are needed to explore the transdisciplinary nature of, and issues associated with, those systems (Erlhoff & Marshall, 2008; NFWPCAP, 2012; Norris et al., 2016). Interdisciplinary assessments compile and co-produce information that provides a holistic understanding of the complex spatial and temporal aspects of, and linkages among, social-ecological elements of interest to stakeholders. In addition, such assessments facilitate social learning about how environmental change and uncertainty affects those interests (NFWPCAP, 2012; Salter et al., 2010).

3.3.2. Principle #5: Interdisciplinary assessment of social-ecological systems, model risks and vulnerabilities, and suggest opportunities to trend toward desired future conditions (Innovation Cornerstones: Process, Product)

Developing interdisciplinary assessments to provide a holistic, systems-based perspective of stakeholder interests requires stakeholder engagement. Social, economic, and ecological conditions vary by region, and stakeholders are one of the most relevant sources of qualitative and quantitative information about those three elements (CEQ, 2011; IPCC, 2014; UNEP, 2000, 2011). Computer models have proven valuable for systematizing and assembling quantitative information from various disciplines to better understand problems; however, they are less useful for assessing qualitative changes in societies and institutions, which can dramatically affect how individuals and groups interact with their landscape. These qualitative, normative aspects of decision-making have inspired movement toward participatory interdisciplinary assessments (Salter et al., 2010; UNEP, 2011).

Bridging organizations can coordinate the development of participatory interdisciplinary assessments that seek to understand transdisciplinary challenges posed by complex societal interactions with a landscape. Design methodologies (Brown, 2009; Erlhoff & Marshall, 2008; Roozenburg & Eekels, 1995) can be used to identify research questions from values and issues defined by stakeholders. Assessment teams should: seek out and use existing quantitative data and qualitative information and knowledge relevant to stakeholder values and perceived risks; integrate local, traditional, and indigenous knowledge into all assessment aspects; use innovative technologies to model spatial and temporal patterns, vulnerabilities, and risks (IPCC, 2014); and develop social, economic and ecological endpoints as system state indicators to understand the current condition of the landscape as well as for a range of plausible future scenarios (Allen & Hoekstra, 2015; Groves & Game, 2016; IPCC, 2014; Tress et al., 2005).

Each scenario should be a coherent, internally consistent, plausible future condition (IPCC, 2014; Melillo et al., 2014); and as a set of scenarios, they should collectively offer a divergent range of relevant possible futures (National Park Service, 2013; Rowland, Cross, & Hartmann, 2014). Useful scenarios allow decision-makers to craft experimental responses to multiple futures, comprehend the implications of specific uncertainties, and identify opportunities (National Park Service, 2013; Rowland et al., 2014). Interdisciplinary approaches within this framework are needed to integrate information on historical, present-day, and possible future system states, including climate, land use, demographics, and other social-ecological drivers. Stakeholders can offer additional insights into the vulnerability, sensitivity, and adaptive capacity of valued social-ecological elements under different potential future system states. Participatory, interdisciplinary assessments can yield analysis of: key information sources, ecological context, priority element rankings, data and knowledge uncertainty, vulnerable landscape elements, and potential climate refugia (Hansen et al., 2013). The scientific information co-generated from interdisciplinary assessments directly informs spatial design.

3.4. Attribute: iS[1] = Interactive Spatial Design

3.4.1. Principle #6: Stakeholders design landscape configurations that promote resilient and sustainable social-ecological systems (Innovation Cornerstones: People, Purpose)

Spatial design uses the compiled and co-produced data, information, and knowledge from the assessment to identify locations best suited for the range of desired land uses (Groves & Game, 2016). Technical and non-technical stakeholders and decision-makers who reflect the diversity of social values and interests on the landscape, and that have a thorough understanding of its vulnerabilities, risks, and potential opportunities, are essential when spatially designing configurations that promote sustainable social-ecological systems (CEQ, 2011; IPCC, 2014; UNEP, 2000, 2011). Inherent in this attribute is a recognition that no single institution possesses the ability to model and map priority locations to retain the diversity of societal values and stakeholder interests, and that an interactive, participatory approach is more effective in visually representing desired future landscape conditions that are supported by stakeholders. The purpose of an interactive spatial design process is to produce landscape configurations that protect biodiversity and the delivery of ecosystem services, maintain and enhance ecosystem integrity, and promote sustainable social-ecological systems (Groves & Game, 2016; IPCC, 2014; NFWPCAP, 2012).

A beneficial aspect of stakeholder engagement in spatial design is development of a deeper trust that the models used to identify priorities integrate their interests with other information and knowledge, which furthers social learning and collective agreement on resource allocation and landscape objectives (Melillo et al., 2014). Interactive spatial design helps stakeholders organize and evaluate the costs and benefits of various options, communicate the uncertainty associated with various trade-offs, and identify priorities (Melillo et al., 2014; Moilanen, Wilson, & Possingham, 2009). As they participate in spatial design, stakeholders learn that meeting one objective often makes it difficult or impossible to achieve others, requiring further negotiation. Overall, the co-development of a spatial design helps organize landscape elements while maintaining and improving stakeholder buy-in (De Groot, Alkemade, Braat, Hein, & Willemen, 2009; Melillo et al., 2014).

3.4.2. Principle #7: Interactive modeling and mapping are used to develop a portfolio of spatial designs (Innovation Cornerstones: Process, Product)

Bridging organizations can coordinate development of a spatial design portfolio that promotes sustainable social-ecological systems. Use of decision support tools and applications, in conjunction with charrettes attended by stakeholders, facilitates development of complex spatial designs and visual communication of priority land-use decisions (De Groot et al., 2009; Moilanen et al., 2009). Two primary approaches to spatial modeling include: optimization models, which provide spatial analytical solution sets that strive for the biggest “bang for the buck” for one or a few objectives; and priority mapping overlay models, which assign a relative value of importance for a priority objective (e.g., biodiversity) or combination of objectives (e.g., social and ecological resilience) for every landscape analysis unit (Knight et al., 2013). For the latter approach, a large number of sub-objectives may be combined in a tree-based hierarchy. Both approaches have their benefits, and an integrated model using both may be desirable (Jankowski, Fraley, & Pebesma, 2014).

A spatial design portfolio contains model-based maps showing the potential locations of specific land-use or management activities, considering future scenarios (Moilanen et al., 2009). Design models attempt to maximize the size of core areas while minimizing perimeter and reducing edge effects. Other identified areas can include buffer zones and transition areas, and important habitat connectivity areas that maintain landscape permeability and facilitate gene flow (Moilanen et al., 2009; NFWPCAP, 2012; Schmitz et al., 2015). The portfolio can communicate spatial and temporal uncertainty by visually depicting variability and sensitivity of the modeling results (Jankowski et al., 2014) under various scenarios. Land-use prioritizations co-generated from spatial design directly inform strategy design.

3.5. Attribute: iS[2] = Informative Strategy Design

3.5.1. Principle #8: Decision-makers identify strategies that further stakeholders’ shared vision for the landscape (Innovation Cornerstone: People, Purpose)

Strategy design builds upon the portfolio of products developed in spatial design to address the knowledge-action gap that occurs in many broad-scale, conservation planning efforts (Groves & Game, 2016; Wyborn & Bixler, 2013). Decision-makers—supported by scientists and planners—are critically important to successful development of coordinated adaptation strategies that promote sustainable social-ecological systems (IPCC, 2014; Melillo et al., 2014; Watson, Rao, Ai-Li, & Yan, 2012; Wyborn, 2015). Inherent in this attribute is a recognition that siloed decision-making models focused within institutional boundaries are unable to sufficiently respond to the complexity and rate of change in social-ecological systems. Horizontal decision-making models facilitate the development of information relevant across institutional boundaries and can inform collective action and have collective impact (Watson et al., 2012; Wyborn & Bixler, 2013). The purpose of informed strategy design is to translate science products into mutually reinforcing strategies that identify stakeholder roles in fulfilling a shared vision for the landscape. A strategy can promote a cross-jurisdiction, multisector approach to governance (Wyborn & Bixler, 2013) that coordinates on-the-ground delivery, monitoring, evaluation, and an adaptive approach to design revision. Integrated governance encourages management across social and ecological boundaries, and anticipates conditions that support viable and productive communities within social-ecological systems (NFWPCAP, 2012). Strategy design maximizes synergies, and minimizes trade-offs and confusion resulting from siloed decision-making and implementation.

3.5.2. Principle #9: Informed decision-making navigates development of a strategic plan (Innovation Cornerstones: Process, Product)

Bridging organizations bring stakeholders together around the assessment products and spatial prioritizations developed throughout the LCD process. In strategy design, stakeholders use that body of work to develop a common understanding of synergistic implementation approaches through the identification of high-level adaptation strategies. These strategies are then articulated as a collaboratively developed strategic plan that guides stakeholder activities within a multifunctional landscape (Melillo et al., 2014; Wyborn, 2015).

The Collective Impact framework (Barberg, 2015; Hanleybrown et al., 2012; Kania & Kramer, 2011) sets an alignment goal where each stakeholder articulates their contribution to ensuring the sustainability of their supporting social-ecological system. As Naiman (2013) notes, when restoring large river systems, success depends “on a diverse group of stakeholders working together, not by requiring all participants do the same thing, but by encouraging each participant to undertake specific activities at which it excels in a way that supports and is coordinated with the actions of others” (p. 406). No single agent can deliver all the tools needed to implement a strategy. Strategy design identifies the full range of potential cross-jurisdiction, multisector tools that complement individual stakeholder efforts and make the collective whole more effective. This articulation of mutually reinforcing activities (Barberg, 2015; Kania & Kramer, 2011) lies at the core of strategy design.

Fostering agreements between stakeholders that have, at times, conflicting missions, mandates, and goals is difficult. Knowledge of and skill in conflict resolution, facilitation and negotiation techniques, and a diversity of tools such as Structured Decision Making, “robust decision-making,” and trade-off analysis can help stakeholders get past roadblocks (Melillo et al., 2014). Best practices in co-governance suggest focusing first on low hanging fruit—easy wins—to gain momentum

(Ansell & Gash, 2008). Early success builds trust and stakeholders are more likely to attempt larger challenges (Berkes, 2009). Over time, continual action evolves into what Lauber, Stedman, Decker, Knuth, and Simon (2011) term the "partnership utilization" phase, where the stakeholders' implementation efforts mature.

4. Conclusion

Adapting to the Anthropocene's complex array of change agents is a "super wicked" problem that cannot be fully assessed using siloed decision-making approaches developed by hierarchical institutions using disciplinary science. Developing solutions that increase sustainability rests, in part, on the ability of natural and cultural resource practitioners to transform how they make decisions about land conservation and utilization.

LCD is a pathway to transforming sustainability planning. As a stakeholder-driven, participatory process, it identifies landscape configurations and adaptation strategies that promote sustainable social-ecological systems. We propose an innovation systems framework for LCD: the iCASS Platform—a flexible governance structure that transcends single-institution interests and siloed decision-making processes. The iCASS Platform is a set of attributes and principles organized around four cornerstones of innovation: people, purpose, process, and product. It emphasizes a design methodology that is inclusive, interdisciplinary, interactive, and informative. The iCASS Platform can facilitate LCD and expedite landscape conservation via processes that create and empower social networks, engender co-production and cross-pollination of data, information and knowledge, and provide multiple opportunities for deliberation, transparency, learning, and collaborative decision-making.

Although this paper focuses solely on the design component of the adaptive learning cycle (generally expressed as: *plan → design→implement → monitor→evaluate → revise → repeat*) (Williams, Szaro, & Shapiro, 2009), we acknowledge the importance of testing the iCASS Platform (i.e., implementing, monitoring, and evaluating results) to determine its effectiveness furthering LCD. We argue that bridging organizations play a fundamental role in coordinating and facilitating LCD. We also contend that they are the appropriate entities to evaluate iCASS's effectiveness as a participatory design methodology—one that integrates societal values and cross-jurisdiction, multisector interests with the best available interdisciplinary science and traditional knowledge. Using iCASS to guide the assessment of spatial and temporal patterns, vulnerabilities, risks and opportunities for landscape elements valued by stakeholders can produce a set of spatially-explicit products and strategies that can achieve resilient and sustainable social-ecological systems for current and future generations.

Disclaimer

The findings and conclusions in this article are those of the authors and do not necessarily represent the views of the U.S. Fish and Wildlife Service or any other agent. Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.landurbplan.2018.04.008.

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