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Minimum Standards for Conservation Design at Landscape-Scales (Landscape Conservation Design)

Recommendations
From the Landscape Conservation Design Minimum Standards Working Group
to the U.S. Fish and Wildlife Service – Office of Science Applications

April 2014

"The challenge of conserving fish and wildlife populations vastly exceeds the resources we can reasonably expect to have in the future. The future of conservation hinges on a landscape approach, and our success in this area will rise and fall with how well we integrate our efforts with our Federal, State and NGO partners."

– USFWS Strategic Habitat Conservation Handbook (February 2008)

"In the spirit of Strategic Habitat Conservation, and with the intent of fulfilling its conservation design element, Landscape Conservation Design stands as a partnership-driven method to assess current and anticipated future conditions, offers a spatially-explicit depiction of a desired future condition, and provides management prescriptions for achieving those conditions. Landscape Conservation Design is both a process and a product."

– NWRS Planning Implementation Team Final Report (June 2013)

Landscape Conservation Design *is a process [to design] and a product [a design] that achieves partners' missions, mandates, and goals while ensuring sustainability of ecosystem services for current and future generations of Americans. It is an integrated, collaborative, and holistic process that is grounded in the interdisciplinary science of landscape ecology, the mission-oriented science of conservation biology, and the art of design. The process results in a science-based, technologically-advanced, spatially-explicit product that identifies targets of interest to partners, articulates measurable objectives for those targets; assesses current and projected landscape patterns and processes; and identifies a desired future condition, conservation/development trade-offs, and implementation strategies. When delivered in a coordinated fashion, strategies derived from landscape conservation design processes can meet both societal values and needs while maintaining ecological integrity and biodiversity.*

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Executive Summary

A voluntary, ad hoc group – the Landscape Conservation Design Minimum Standards Working Group (Appendix A) – engaged in a six week effort to develop the following recommended "minimum standards" for consideration by the U.S. Fish and Wildlife Service – Office of Science Applications (Headquarters).

Landscape Conservation Design Minimum Standards

Phase 1: Kick-Off

Goal: To facilitate partners' understanding, agreement, and support for implementation of landscape conservation design processes and products.

MS 1.1 Document an agreement between partners to engage in collaborative design processes leading to the development of a design product that addresses their specific needs.

Phase 2: Pre-Assessment

Goal: To facilitate partners' agreement on the technical aspects of the landscape conservation design's assessment of current and projected landscape conditions prior to its development.

MS 2.1 Assemble a multidisciplinary technical team.

MS 2.2 Identify and describe the Landscape Conservation Design's:

a) Geographic planning unit

b) Targets (e.g., FWS surrogate species), attributes, and measureable objectives (e.g. population objectives)

c) Direct threats and limiting factors

d) Assumptions

e) Data availability/needs and sharing agreements/contracts.

MS 2.3 Agree on the principles, methods, and criteria to be used in development of the assessment of current and projected landscape conditions.

Phase 3: Assessment

Goal: To obtain an understanding of the relationship between targets and the direct threats that cause or contribute to limiting factors.

MS 3.1 Apply models to delineate, analyze, and assess the current state of the ecosystem.

MS 3.2 Apply projective scenarios to delineate, analyze, and assess threats and their relationship to targets' limiting factors under various spatial and temporal scenarios.

MS 3.3 Identify assumptions made in development and use of models.

Landscape Conservation Design Minimum Standards (continued)

Phase 4: Post-Assessment

Goal: To facilitate partners' understanding and obtain agreement on the assessment's results and build support for continuation of the landscape conservation design process.

MS 4.1 Create scenarios of future landscape condition.

MS 4.2 Evaluate effectiveness/impact of assumptions made.

MS 4.3 Identify data limitations and gaps to direct research and improve development of future assessments.

Phase 5: Pre-Design

Goal: To facilitate partners' agreement on the technical aspects of the landscape conservation design product prior to its development.

MS 5.1 Agree on a collaboratively-defined desired future condition.

MS 5.2 Assess and articulate the conservation deficit: the difference between the current/projected condition and the desired future condition.

MS 5.3 Agree on design principles, methods and evaluation criteria for identifying priority areas.

Phase 6: Design

Goal: To develop a landscape conservation design product that addresses the conservation deficit and achieves the desired future condition.

MS 6.1 Identify, evaluate, and select a portfolio of prioritized areas.

MS 6.2 Identify, evaluate, and select a suite of implementation strategies.

MS 6.3 Develop a preliminary implementation agreement.

MS 6.4 Compile information and products generated during the design process; document the results for peer review.

Phase 7: Post-Design

Goal: To ensure the landscape conservation design product is appropriately finalized, implemented, evaluated, and revised.

MS 7.1 Conduct peer review and revise as appropriate.

MS 7.2 Finalize the landscape conservation design including implementation agreement.

MS 7.3 Revise the landscape conservation design based on new information (including results derived from research and monitoring).

Introduction

"Working with others to conserve, protect, and enhance fish, wildlife, plants, and their habitats for the continuing benefit of the American people."

– U.S. Fish and Wildlife Service, Mission Statement

The overarching aim of the U.S. Fish and Wildlife Service is success of its mission at landscape-scales. In 2006, the Service – in response to the unprecedented scale and complexity of challenges facing fish and wildlife trust resources (e.g., climate change, habitat loss and fragmentation, etc.) – endorsed *Strategic Habitat Conservation* as its adaptive management framework to guide mission success at landscape-scales. The purpose of Strategic Habitat Conservation is to leverage the Service's conservation capacity with that of states and the conservation community to plan, design, coordinate, and deliver management actions (including monitoring and research) performed at site-specific locations so the community's combined effect may achieve outcomes larger than those the Service could achieve alone (USFWS 2009).

Strategic Habitat Conservation consists of five elements: **biological planning**[1], **conservation design**, conservation delivery, decision-based monitoring, and assumption-driven research. It is centered on the identification of measurable objectives for specific conservation targets (e.g., surrogate species), the application of models and landscape ecology/conservation biology principles, and coordinated implementation of management, monitoring, and research strategies across the landscape. Biological planning and conservation design sub-elements (see *USFWS and USGS 2006; USFWS 2008*) – when considered as interdependent components of systematic conservation planning processes (e.g., **Landscape Conservation Design**) – are the foundation of the Service's adaptive management framework.

Landscape Conservation Design is a process [to design] and a product [a design] that achieves partners' missions, mandates, and goals while ensuring sustainability of ecosystem services for current and future generations of Americans. It is an integrated, collaborative, and holistic process that is grounded in the interdisciplinary science of landscape ecology, the mission-oriented science of conservation biology, and the art of design. The process results in a science-based, technologically-advanced, spatially-explicit product that identifies **targets** of interest to partners, articulates measurable **objectives** for those targets; assesses current and projected landscape patterns and processes; and identifies a **desired future condition**, conservation/development trade-offs, and implementation **strategies**. When delivered in a coordinated fashion, strategies derived from landscape conservation design processes can meet both societal values and needs while maintaining ecological integrity and biodiversity.

This document demonstrates the relationship between biological planning and conservation design; provides a framework for undertaking landscape conservation design processes; describes **goals**, objectives, and minimum standards for each phase of the process; and demonstrates the relationship between each landscape conservation design phase and the elements of **Strategic Habitat Conservation** (Appendix B). This document may help to inform development of the Department of the Interior's 5-Year Strategic Plan, and the work of the USFWS's Business Practices Core Team.

[1] Terms in **bold** are defined in Appendix C: Glossary.

Phase 1: Kick-Off

Goal

To facilitate partners'[2] understanding, agreement, and support for implementation of landscape conservation design processes and products.

Objectives

1. To build and maintain a partnership that supports initiation of an integrated, collaborative, and holistic landscape conservation design process.
2. To articulate the purpose and need for the landscape conservation design product.

Discussion

A single **bridging entity** is responsible for engaging stakeholders and coordinating development of the landscape conservation design (Langhammer et al. 2007; United Nations 2008; Jacobson and Robertson 2012). The bridging entity assesses the most critical and influential stakeholders, develops a strategy for engaging them, and assembles partner agencies, tribes, organizations, etc. (Abell et al. 2002; TNC & WWF 2006; Lambert et al. 2009; Pressey and Bottrill 2009). The bridging entity ensures the partnership is maintained by clearly defining a process for gathering and applying partners' ideals, engages experts, facilitates consensus, uses agreed upon methodology for development of design products, evaluates progress toward a measureable objectives at each step in the process, develops accountability methods, and documents the process (Brown et al. 1975; Langhammer et al. 2007; Nassauer and Opdam 2008; Ehler and Douvere 2009; Lovell and Johnston 2009; Ries 2011).

The bridging entity facilitates partners' discussions to collaboratively articulate the purpose and need for the design process and product and includes an articulation of a "problem statement" (Nassauer and Opdam 2008; Ehler and Douvere 2009; Chapin et al. 2010). Partners identify a shared expression of what is currently not working in the system of interest to them, what needs to change as a result of implementation strategies identified throughout the design process, and what can adequately be addressed by the group (as determined by interest level, resources, time availability, etc.) (Brown et al. 1975). Ultimately, the partners are asking themselves "Should this product be built?" (Ries 2011). Partners determine areas of agreement/disagreement regarding design processes and products, identify capacities and resources that could be contributed to the collaborative design process, and establish an appropriate authority and financing mechanism (e.g., MOA) for development and implementation of the landscape conservation design (TNC & WWF 2006; Ehler and Douvere 2009; Chapin et al. 2010).

Minimum Standard

1.1 Document an agreement between partners to engage in collaborative design processes leading to the development of a design product that addresses their specific needs.

[2] "Partners" in this context are typically at the decision-making level.

Phase 2: Pre-Assessment

Goal

To facilitate partners'[3] agreement on the technical aspects of the landscape conservation design's assessment of current and projected landscape conditions prior to its development.

Objectives

1. To assemble a multidisciplinary **technical team** to develop/implement a work plan.
2. To articulate a **vision** and **goals** for development of the assessment.
3. To identify the geographic planning unit; targets, **attributes**, and measureable objectives; **direct threats** and **limiting factors; assumptions;** and data availability/needs.
4. To agree upon key principles and methods for conducting the assessment.

Discussion

Assembling a high-functioning, multidisciplinary technical team consisting of ambitious leaders and technical experts in a wide variety of natural resource and human dimension disciplines is paramount to the success of the design process including development of its assessment of current and projected landscape conditions. Decision-makers from partner agencies/tribes/organizations etc. select specialists holding advanced degrees or equivalent professional experience for participation on the technical team. The bridging entity identifies a neutral facilitator with expertise in project management to coordinate the design process. Additional subject matter experts should be involved throughout the design process, from initial formulation of the landscape conservation design's vision thru its completion (Noss 2003; TNC and WWF 2006; Nassauer and Opdam 2008; Lovell and Johnston 2009).

The technical team articulates a clear purpose for the landscape conservation design's assessment of current and projected landscape condition to ensure a common understanding of the desired end product (Lambert et al. 2009). It is also responsible for identifying the geographic planning unit and key resources of interest to partners (i.e., targets). Targets may include but are not limited to: a) imperiled, rare, unique, high-value species, **focal** and/or other **surrogate species**, b) biotic and abiotic resources, and c) **human well-being** as it relates to ecosystem services (Brown et al. 1975; Abell et al. 2002; Noss 2003; TNC and WWF 2006; Langhammer et al. 2007; USFWS and USGS 2006; USFWS 2008; Ehler and Douvere 2009; Lambert et al. 2009; Pressey and Bottrill 2009; Lower Mississippi Valley Joint Venture Management Board 2013). Targets are carefully selected and substantiated, as they are the **surrogates**[4] used to represent partners' interests and drive development of the landscape conservation design (Noss 2003). Agreement on targets' attributes and measurable objectives (e.g., **population objectives**) is of paramount importance since they are required to assess the current and projected condition of targets, as well as the **desired future condition** and **conservation deficit** (see *Phase 5: Pre-Design*). Objectives may be more useful if they are comprised of desired abundance and performance indicators (TNC and WWF 2006; USFWS and USGS 2006; Nassauer and Opdam 2008; USFWS 2008; Lovell and Johnston 2009; Pressey and Bottrill 2009).

[3] "Partners" in this context are typically at the technical level.

[4] See *DRAFT Guidance on Selecting Species for Design of Landscape-Scale Conservation* (USFWS 2012).

The technical team is responsible for identifying overarching threats to the geographic planning unit, and direct threats to each target and to the maintenance of limiting factors. Limiting factors are often related to the appropriate area, type, quality, or configuration of habitat necessary to sustain populations at objective levels (Abell et al. 2002; TNC and WWF 2006; USFWS 2008). Identifying targets, threats, and limiting factors helps facilitate identification of available data (and gaps); helps the team distinguish between what is known and what is presumed (i.e., assumptions), and helps to ensure the best use of available data while highlighting priorities for research (Abell et al. 2002; USFWS and USGS 2006; Pressey and Bottrill 2009).

The technical team articulates a common understanding of the various principles and methods to be used in assessing the current and projected landscape condition, documents assumptions underlying various aspects of the methodology employed as testable hypotheses, and is transparent about decisions made (Noss 2003; Leitao et al. 2006; TNC and WWF 2006; USFWS and USGS 2006; USFWS 2008; Laurent et al. 2010). Examples of some principles and methods considered include: a) incorporation of existing information from existing plans and designs, b) assessing the quality and applicability of combining data, c) identification of landscape metrics developed to measure abiotic, biotic, and socio-cultural resources, d) the identification of spatial and temporal **landscape change scenarios**, e) the applicability of vulnerability as a component of the assessment, f) the solicitation and application of expert opinion throughout the process, etc. (Abell et al. 2002; Leitao et al. 2006; Langhammer et al. 2007; Chapin et al. 2010). The technical team also initiates discussions leading towards the development of evaluation criteria to gauge success of the landscape conservation design product once it is finalized and implemented.

Minimum Standards

2.1 Assemble a multidisciplinary technical team.

2.2 Identify and describe the Landscape Conservation Design's:

- a) Geographic planning unit
- b) Targets (e.g., FWS surrogate species)[5], attributes, and measureable objectives (e.g. population objectives[6])
- c) Direct threats and limiting factors[7]
- d) Assumptions
- f) Data availability/needs and sharing agreements/contracts

2.3 Agree on the principles, methods, and criteria to be used in development of the assessment of current and projected landscape conditions.

[5] SHC Sub-element 1.2: Subset of Priority Species (USFWS and USGS 2006).
[6] SHC Sub-element 1.3: Formulate Population Objectives (USFWS and USGS 2006).
[7] SHC Sub-element 1.5: Identify Limiting Factors (USFWS and USGS 2006).

Phase 3: Assessment

Goal

To obtain an understanding of the relationship between targets and the direct threats that cause or contribute to limiting factors.

Objectives

1. To characterize the landscape through holistic study and integration of abiotic[8], biotic, and socio-cultural resources.
2. To delineate, analyze, and assess **landscape pattern**, **landscape function**, and **change** temporally through the use of **projective scenario** modeling.

Discussion

Empirical (data-based) and conceptual (experienced-based) models are used to assess the current and projected landscape condition and its ability to sustain targets at objective levels (USFWS and USGS 2006, USFWS 2008). They are used to predict population persistence over time, identify potential source and sink areas, allow the demographic value of individual sites to be assessed within a broad geographic context, and predict the demographic and distributional consequences of landscape change. Landscape change scenarios, including those influencing landscape patterns, landscape function, and **landscape values** are based on extrapolation of historic and current trends (Weber et al. 2001; Noss 2003; Fontaine and Rounsevell 2009). Species distribution models are commonly used when distributional data are sparse or contain presences only (Elith and Leathwick 2009). Spatially explicit expert or conceptual habitat-suitability models can be applied to explore dynamics not reflected in empirical data or as a tool to engage stakeholders if distribution data are limited (Noss 2003). Population models can be used to predict future conditions based on the outputs of habitat-suitability models (Schumaker et al. 2014). Conditions and trends of non-species targets (e.g., ecosystem services) can be modeled to identify ecosystem risks and opportunities (World Resources Institute 2008). Threat-related surrogates (e.g., climate change, population/housing/road density, grazing leases, timber concessions, etc.) are used and mapped to the extent socioeconomic data allow (Noss 2003). Threats are described in relation to limiting factors for each target and classified as either key or secondary to provide guidance during implementation decision-making. Target response to threats and limiting factors under various spatial and temporal scenarios are analyzed (Chapin et al. 2010; Broska 2013). Models should explicitly state their assumptions so that they can be tested and refined over time (Laurent et al. 2010).

Minimum Standards

3.1 Apply models[9] to delineate, analyze, and assess the current state of the ecosystem.

3.2 Apply projective scenarios[10] to delineate, analyze, and assess threats and their relationship to targets' limiting factors under various spatial and temporal scenarios.

3.3 Identify assumptions made in development and use of models.

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[8] i.e., "enduring features" or "**land facets**"; typically physical features (Leitao et al. 2006; Beier and Brost 2010).

[9] SHC Sub-element 1.4: Assess the Current State of Species Populations (USFWS and USGS 2006).

[10] SHC Sub-element 1.6: Apply Models Describing Population-Habitat Relationships (USFWS and USGS 2006).

Phase 4: Post-Assessment

Goal

To facilitate partners'[11] understanding and obtain agreement on the assessment's results and build support for continuation of the landscape conservation design process.

Objective

1. To review, diagnose, and synthesize the assessment's data to create **alternative futures**.
2. To identify data gaps that may be essential in future iterations of design processes.

Discussion

Phase 3: Assessment generates a variety of information (e.g., various model outputs, socio-economic factors, threats and limiting factors related to biodiversity and natural resources, etc.). Before this information can inform *Phase 6: Design*, it must be summarized and synthesized. This may include creating diagrams linking root causes or driving forces to threats and targets, linking drivers and sources of socio-economic factors to ecosystem services, conservation targets, and landscape processes; and diagnosing current and projected conditions (Leitao et al. 2006; TNC and WWF 2006; Nassauer and Opdam 2008; Lambert et al. 2009; Lovell and Johnson 2009; Game et al. 2013). The scenarios generated in *Phase 3: Assessment* are often projections of individual components of the landscape (e.g., fish and wildlife population dynamics, species distributions, socio-economic projections, ecosystem services). Synthesis of multiple projective scenarios into scenarios of future landscape condition – **alternative futures** – is necessary in advance of *Phase 5: Pre-Design* (Ehler and Douvere 2009). Scenarios may be in the form of narratives or spatially-explicit maps, digital imaging simulations, drawings, etc. (Nassauer and Corry 2004). Alternative futures will vary by the degree of landscape change and sensitivity of targets to those changes (as simulated).

Assessments of current and projected landscape conditions are informed by the best available science. Future iterations of assessments can be improved by including new data and information as the knowledge base of the region and/or targets increases. Data gaps identified in *Phase 4: Post-Assessment* should direct assumption-based research efforts (Abell et al. 2002; Langhammer et al. 2007; USFWS 2008; Laurent et al. 2010). The geographic planning unit boundaries, targets, attributes, assumptions, etc. should be revisited in an effort to identify new data that can contribute to the process. This information can be obtained from a variety of sources including expert opinion/traditional knowledge, research, etc. (Abell et al. 2002).

Minimum Standards

4.1 Create scenarios of future landscape condition.

4.2 Evaluate effectiveness/impact of assumptions made on the assessment's development.

4.3 Identify data limitations and gaps to direct research and improve development of future assessments.

[11] "Partners" in this context are typically at the decision-making level.

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Phase 5: Pre-Design

Goal

To facilitate partners'[12] agreement on the technical aspects of the landscape conservation design product prior to its development.

Objectives

1. To articulate a vision and goals for development of the landscape conservation design.
2. To articulate a desired future condition.
3. To assess the conservation deficit.
4. To agree upon key principles, methods and selection criteria for identifying **priority areas**.

Discussion

Partners articulate a clear purpose (i.e., vision and goals) for the landscape conservation design to ensure a common understanding of the desired end product (Lambert et al. 2009). The products derived from *Phase 4: Post-Assessment* – including alternative futures – are used by decision-makers and/or technical team members to articulate a desired future condition, although the desired future condition may also be identified through synthesis of partners' existing goals and objectives and/or revision of them if projective scenarios were not considered during their development (Nassauer and Corry 2004; Leitao et al. 2006; Cross et al. 2012; Holway et al. 2012). Another approach includes identification of the projected conditions that are undesirable (Chapin et al. 2010).

Collectively, a diversity of goals and objectives will be reflected in the desired future condition in order to meet both societal needs while ensuring sustainability of targets (Noss 2003; Chapin et al. 2010). Goals and objectives are crafted to reflect the desired future condition of each target, particularly habitat targets that represent means to achieving those conditions (Margules and Pressey 2000; Noss 2003; Leitao et al. 2006; TNC and WWF 2006). For the USFWS, a desired future condition would include habitat objectives explicitly linked to species populations as based on population-habitat models, etc. Once habitat objectives are identified, an assessment of the conservation deficit is determined (i.e., the difference between the current/projected state and the desired future condition). This assessment is paramount to implementation of *Phase 6: Design*. Explicit habitat objectives based on population-habitat relationships determine the extent of actions required to achieve target objectives (USFWS and USGS 2006, USFWS 2008).

Partners articulate a common understanding of the various principles, methods, and selection criteria used to identify priority areas, documents assumptions underlying various aspects of the methodology employed as testable hypotheses, and is transparent about decisions made (Noss 2003; Leitao et al. 2006; TNC and WWF 2006; USFWS and USGS 2006; USFWS 2008; Laurent el al. 20010). Examples of some principles and methods considered include: a) evaluating the biological importance and ecological integrity of potential priority sites, b) the applicability of **adequacy**, **complementarity**, **comprehensiveness**, **connectivity**, edge effect, **efficiency** (cost), **irreplaceability**, thresholds, patch size, and **representativeness** in priority setting (Forman 1995; Langhammer et al. 2007; Wilson et al. 2009; Lower Mississippi Valley Joint Venture Management Board 2013), c) determining the role of time-

[12] "Partners'" in this context may include decision-makers and members of the technical team.

sensitive management activities and capacity capabilities in priority setting criteria making, and d) synthesizing alternative priority areas into a landscape conservation design (Abell et al. 2002; Broska 2013).

Minimum Standards

5.1 Agree on a collaboratively-defined desired future condition[13].

5.2 Assess and articulate the conservation deficit: the difference between the current/projected condition and the desired future condition[14].

5.3 Agree on design principles, methods, and evaluation criteria for identifying priority areas[15].

[13] SHC Sub-element 2.3: Formulate Habitat Objectives (USFWS and USGS 2006).
[14] SHC Sub-element 2.3: Formulate Habitat Objectives (USFWS and USGS 2006).
[15] SHC Sub-element 2.2: Designate Priority Areas (USFWS and USGS 2006).

Phase 6: Design

Goal

To develop a landscape conservation design product that addresses the conservation deficit and achieves the desired future condition.

Objectives

1. To identify a portfolio of alternative priority areas, apply selection criteria to evaluate each priority area, and select a final portfolio of priority areas.
2. To identify a portfolio of preliminary management strategies.
3. To prioritize areas and preliminary management strategies.
4. Document the results of the design process.

Discussion

A portfolio of alternative priority areas is identified using *Phase 3: Assessment* modeling in combination with a variety of decision support tools (e.g., expert workshops, spatially-explicit optimization tools, etc.) (Margules and Pressey 2000; Groves et al. 2002; TNC and WWF 2006). The alternative priority areas are assessed against the results of future threat scenarios (Wade et al. 2011; Kane et al. 2013), evaluated against the criteria developed in *Phase 5: Pre-Design* to determine the priority areas' ability to "make up" the conservation deficit and achieve the desired future condition (Watson et al. 2011; TNC and WWF 2006). The portfolio of priority areas that best satisfy the evaluation criteria is selected and is, in effect, the delineation portion of the landscape conservation design. The identification of multiple portfolios of priority areas that satisfy evaluation criteria would provide for implementation **flexibility**. Maintaining flexibility when identifying priority areas is necessary in order to take advantage of opportunities, changing goals and/or objectives, and meeting evolving needs of the partnership (Wilson et al. 2009; Ardron et al. 2010).

Partners[16] use scenario planning techniques to identify of a suite of preliminary management strategies that are feasible and could be applied to "make up" the conservation deficit and achieve the desired future condition (Nassauer and Corey 2004; USFWS 2008; Pressey and Bottrill 2009; Holway et al. 2012). Starting with the desired future condition, the scenarios identify possible management intervention points, and simulate the impacts of various management strategies to assess the effectiveness and cost/benefits of each for achieving the vision (IPCC 2001). Preliminary management strategies considered for implementation (including monitoring and research) are described and prioritized for the geographic planning unit, sub-region, and/or priority area (if appropriate[17]); and implementation sequencing and timeframes, and responsible parties are identified and documented (Brown et at 1975; Abell at al 2002; TNC and WWF 2006). Institutional plans and policies are reviewed for barriers towards implementation and revised as appropriate (Chapin III et al. 2010; Lambert et al. 2009).

[16] "Partners" in this context are typically at the decision-making and technical levels.

[17] National Environmental Policy Act (NEPA) compliance requirements restrict pre-decisions. "Preliminary" management strategies can be used by federal partners as "Alternatives" which are scoped with the public in accordance with NEPA.

The results of the design process are presented in a format that is easily understood by non-technical readers (Brown et al. 1975; Noss 2003; Lambert et al. 2009). The documentation identifies the principles, methodology, assumptions, criteria, and decisions made throughout the process (Noss 2003). Documentation consists of spatially explicit products, priority area site descriptions (including priority levels), databases, and metadata describing tabular and spatial data (Brown et al. 1975; Noss 2003; TNC and WWF 2006).

Minimum Standards

6.1 Identify, evaluate, and select a portfolio of prioritized areas[18].

6.2 Identify, evaluate, and select a suite of implementation strategies[19].

6.3 Develop a preliminary implementation agreement[20].

6.4 Compile information and products generated during the design process; document the results for peer-review.

[18] SHC Sub-element 2.2: Designate Priority Areas (USFWS and USGS 2006).

[19] SHC Sub-element 2.1: Develop Species Habitat Decision Support Tools (USFWS and USGS 2006).

[20] SHC Sub-element 2.1: Develop Species Habitat Decision Support Tools (USFWS and USGS 2006).

Phase 7: Post-Design

Goal

To ensure the landscape conservation design product is appropriately finalized, implemented[21], evaluated[22], and revised.

Objectives

1. To ensure the landscape conservation design product is transparent about its intentions, communicated, and shared.
2. To ensure implementation, monitoring, evaluation, and revision.

Discussion

The landscape conservation design product, including the preliminary implementation strategy, is peer-reviewed and revised consistent with policy (Noss 2003; OMB 2004; TNC and WWF 2006; Langhammer et al. 2007). Landscape conservation design is an iterative and adaptive process, and revisions to the design product should be anticipated, adequately prepared for, and conducted. Once finalized, the product is widely communicated including articles in journals and magazines geared towards general audiences, and papers published in professional journals to help assure the design's scientific defensibility and allow for information transfer (Brown 1975, Noss 2003, USFWS 2008).

Upon completion of the landscape conservation design product, partners conduct site-specific planning (and environmental compliance, as necessary), and implement strategies applicable to their agency/tribe/organization, etc. Implementation includes monitoring and evaluation of the effectiveness of individual actions conducted at priority sites. The cumulative impacts of implementing actions across the larger landscape are also evaluated.

The landscape conservation design product is a "work-in-progress" for guiding action, and timely adjustments should be made based on conservation accomplishments, new information, policy changes, and socio-economic factors (Noss 2003; Langhammer et al. 2007; USFWS 2008). Information obtained from expert opinion/traditional knowledge, monitoring, and research are incorporated into revisions of the design product. The bridging entity reconvenes partners on a periodic basis to assess the availability of new information, the effectiveness of implementation strategies in achieving the desired future condition, and initiating revision as necessary (USFWS and USGS 2006; USFWS; 2008; USFWS 2013). The landscape conservation design process is iterative and ongoing rather than static and episodic.

Minimum Standards

7.1 Conduct peer review and revise as appropriate.

7.2 Finalize the landscape conservation design product including the implementation agreement.

7.3 Revise the landscape conservation design based on new information (including results derived from research and monitoring, expert-opinion and traditional knowledge).

[21] SHC Element: Delivery (USFWS and USGS 2006).

[22] SHC Element: Monitoring (USFWS and USGS 2006).

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Appendix A: LCD Minimum Standards Working Group

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Appendix B: List of LCD Minimum Standards and Crosswalk with Strategic Habitat Conservation Elements

Landscape Conservation Design Minimum Standards		Strategic Habitat Conservation Elements[23]
Phase 1: Kick-Off		
1.1 Document an agreement between partners to engage in collaborative design processes leading to the development of a design product that addresses their specific needs.		Guiding Principles
Phase 2: Pre-Assessment		**Biological Planning**
1.1 Assemble a multidisciplinary technical team.		Appendix C: Technical Skills and Infrastructure Needs
1.2 Identify and describe the Landscape Conservation Design's: a) Geographic planning unit b) Targets (e.g., FWS surrogate species), attributes, and measureable objectives (e.g., population objectives) c) Direct threats and limiting factors d) Assumptions e) Data availability/needs and sharing agreements/contracts		1.1: Identify priority species 1.2: Subset of priority species; 1.3: Formulate population objectives 1.5: Identify limiting factors Element 4: Monitoring and Research Appendix E: Geospatial Data and Technology Recommendations
2.3 Agree on the principles, methods, and criteria to be used in development of the assessment of current and projected landscape conditions.		
Phase 3: Assessment		
2.1 Apply models to delineate, analyze, and assess the current state of the ecosystem.		1.4: Assess the current state of species populations
2.2 Apply projective scenarios to delineate, analyze, and assess threats and their relationship to targets' limiting factors under various spatial and temporal scenarios.		1.6: Apply models describing population-habitat relationships.
2.3 Identify assumptions made in development and use of models.		Element 4: Monitoring and Research
Phase 4: Post-Assessment		
3.1 Create scenarios of future landscape condition.		
4.2 Evaluate effectiveness/impact of assumptions made.		Element 4: Monitoring and Research
4.3 Identify data limitations and gaps to direct research and improve development of		The Science and Practice of Conservation: Scientific Findings Inform Management

[23] As identified in *Strategic Habitat Conservation: Final Report of the National Ecological Assessment Team* (USFWS and USGS 2006).

Landscape Conservation Design Minimum Standards		Strategic Habitat Conservation Elements[23]
future assessments.		
Phase 5: Pre-Design		**Conservation Design**
5.1 Agree on a collaboratively-defined desired future condition.		2.3: Formulate Habitat Objectives.
5.2 Assess and articulate the conservation deficit: the difference between the current/projected condition and the desired future condition.		2.3: Formulate Habitat Objectives.
5.3 Agree on design principles, methods, and evaluation criteria for identifying priority areas.		2.2: Designate Priority Areas.
Phase 6: Design		
6.1 Identify, evaluate, and select a portfolio of prioritized areas.		2.1: Develop Species Habitat Decision Support Tools; 2.2: Designate Priority Areas.
6.2 Identify, evaluate, and select a suite of implementation strategies.		
6.3 Develop a preliminary implementation agreement.		2.1: Develop Species Habitat Decision Support Tools; Guiding Principles
6.4 Compile information and products generated during the design process; document the results for peer-review.		
Phase 7: Post-Design		
7.1 Conduct peer review and revise as appropriate.		
7.2 Finalize the landscape conservation design including implementation agreement.		
7.3 Revise the landscape conservation design based on new information (including results derived from research and monitoring).		Element 4: Monitoring and Research

Appendix C: Glossary

Adequacy	The ability of conservation measures to ensure the persistence of all targets contained within it. Adequacy is affected by the size and spatial arrangement of the reserve network (Ardron et al. 2010).
Alternative Futures	See "Scenarios".
Assess	To evaluate or estimate the amount, value, quality or rate of something (Merriam-Webster 2014).
Attribute	Aspects of a **target's** biology or ecology that if present, define a healthy target and if missing or altered, would lead to the outright loss or extreme degradation of that target over time (Conservation Measures Partnership, 2013)
Biological Planning	An element of the U.S. Fish and Wildlife Service's Strategic Habitat Conservation adaptive management framework. The process of identifying priority species and subsets of priority species (i.e., surrogate species), measurable population **objectives**, identifying threats and **limiting factors**, assessing the current status of populations, and applying models to describe the relationship between populations and habitats (USFWS and USGS 2006).
Bridging Entity	Entities with broader scope than the organizations being convened and that can avoid or resolve conflict that can result from differing perspectives, values, power, and interests (Olsson et al. 2007). Bridging entities are used to facilitate the circumstances necessary for adaptive co-governance to occur, including providing a platform for equal participation among stakeholders and for knowledge exchange/social learning to occur (Folke et al. 2005).
Complementarity	A measure of the extent to which an area, or set of areas, contributes unrepresented targets to an existing area or set of areas (Margules and Pressey 2000).
Comprehensiveness	A comprehensive conservation system is one that contains every target of biodiversity interest that occurs within a particular region. It should ideally take into consideration biodiversity composition (genetic, species and community diversity), structure (physical organizations) and function (ecological and evolutionary processes) (Noss 1990).
Connectivity	The degree to which the landscape facilitates or impedes the movement of organisms (D'Eon et al. 2002).

Conservation Deficit	The difference between a target's current state and a desired state (USFWS and USGS 2006).
Conservation Design	An element of the U.S. Fish and Wildlife Service's Strategic Habitat Conservation adaptive management framework. The application of decision support tools that combine expert opinion, geospatial data, and the results of models to provide estimates of habitat required to attain population **objectives**, identify **priority areas** and management strategies to achieve population objectives (USFWS and USGS 2006).
Direct Threat	Proximate human activities or processes that cause, are causing, or may cause the distribution, degradation, and/or impairment of targets. Direct threats are synonymous with sources of stress and proximate pressures. Threats can be past (historical), ongoing, and/or likely to occur in the future. Natural phenomena are also regarded as direct threats in some situations. (Conservation Measures Partnership 2013).
Desired Future Condition	See "Scenarios".
Efficiency	The ability to achieve conservation **objectives** for the least possible cost (Ardron et al. 2010).
Flexibility	The ability to find many good solutions to large and complex problems. Flexible solutions provide options to achieve conservation **objectives** in a number of ways (Ardron et al. 2010).
Focal Species	See "Targets".
Functionality	The quality of having a practical use; the particular use or set of uses for which something is designed (Merriam-Webster 2014).
Goals	Formal statements of the ultimate impacts (qualitative and aspirational) to be achieved. Goals are linked to targets and represent the desired status of targets over the long term (Conservation Measures Partnership 2013).
Human Well-being	See "Targets".
Irreplaceability	The extent to which the options for a representative conservation system are lost if the site or target is lost (Pressey et al. 1994; Langhammer et al. 2007).
Land Facets	Recurring landscape units of relatively uniform topography and soils that will persist and support biodiversity in the face of a changing climate (Brost and Beier 2010).
Landscape Pattern	The arrangement and composition of patches in a landscape. Consists of core habitat, corridors, and matrix (Leitao et al. 2006).

Landscape Function Ecosystem processes and services as determined by patch size, shape, spatial distribution, and **connectivity** (Leitao et al. 2006).

Landscape Change The alteration of pattern and function over time - resulting from succession and human and natural disturbance (Leitao et al. 2006).

Landscape Conservation Design A process (to design) and a product (a design) that achieves partners' missions, mandates, and goals while ensuring sustainability of ecosystem services for current and future generations of Americans.

Process: An integrated, collaborative, and holistic process that is grounded in the interdisciplinary science of landscape ecology, the mission-oriented science of conservation biology, and the art of design.

Product: A science-based, technologically-advanced, spatially-explicit product that identifies landscape targets of interest to partners, articulates measurable objectives for those targets, assesses current and projected landscape patterns and processes, and identifies a desired future condition, conservation/development trade-offs, and implementation strategies. When delivered in a coordinated fashion, strategies derived from landscape conservation design processes can meet societal values and needs while maintaining ecological integrity and biodiversity.

Landscape Value The contribution of **landscape patterns** to **human well-being** as estimated using economic indicators and/or valuation techniques. Landscape value should reflect benefits from both ecosystem services and traditional economic development.

Limiting Factors A primary factor constraining the growth of a population toward objective levels (USFWS and USGS 2006).

Objectives Specific and measurable outcomes that attain **goals** (Conservation Measures Partnership 2013). Objectives are typically SMART: Specific, Measurable, Achievable, Results-oriented, and Time-fixed (USFWS and USGS 2004). **Population objectives** represent a measurable expression of a desired outcome, and are expressed as abundance, trend, vital rates, or other measureable indices of population status (USFWS and USGS 2006).

Priority Areas Areas disproportionately important to meeting **Landscape Conservation Design goals** relative to the entire landscape. Priority areas do not need to be classified as current conservation units, nor is there an expectation that its land status would necessarily change as a result of being identified as a priority area.

Representativeness The ability of sites to represent, or sample, the full variety of biodiversity, ideally at all levels of organization (Margules and Pressey 2000).

Scenarios Stories or representations constructed to describe **alternative futures** (or contrasting trends) that might be very different from the present. Scenarios are used to explore future conditions and are helpful when uncertainty is high (Chapin et al. 2010). There are many types of scenario planning techniques that will inform the design process, but here we focus on the following:

Projective scenarios use historical and current trends to model a range of alternative futures (Nassauer and Corry 2004).

Alternative Futures are future landscape conditions (i.e., landcover pattern and functional consequences) that may be an outcome of a **scenario**. Alternative futures can be communicated with narratives or spatially-explicit maps, digital imaging simulations, drawings, etc. (Nassauer and Corry 2004).

Desired Future Condition is a landscape condition the partners have collectively defined and are interested in working to achieve (Brown et al. 1975; Abell et al. 2002; Leitao et al. 2006; Chapin et al. 2010).

Strategic Habitat Conservation The adaptive management approach adopted by the USFWS that establishes self-sustaining populations of fish and wildlife, in the context of landscape and system sustainability, as the overarching target of conservation. SHC informs decisions about where and how to deliver conservation efficiently with our partners to achieve predicted biological outcomes necessary to sustain fish and wildlife populations (USFWS 2013).

Strategy A group of actions with a common focus that work together to reduce threats, capitalize on opportunities, or restore natural systems. Strategies include one or more activities and are designed to achieve specific **objectives** and **goals** (Conservation Measures Partnership 2013).

Targets **Conservation targets** are elements of biodiversity (e.g., species, habitats, ecological systems, etc.) that are the focus of the design process. **Human Well-being targets** are those components of human well-being affected by the status of conservation targets (Conservation Measures Partnership 2013). Human well-being includes: 1) necessary material for a good life, 2) health, 3) good social relations, 4) security, and 5) freedom and choice (Millennium Ecosystem Assessment 2005).

Surrogate Species and targets are used as the basis for regional conservation planning efforts within a landscape or geographic area (USFWS 2013).

Focal Species are a type of surrogate species used for conservation assessment, especially a species that represents a guild or larger group of species that use habitat similarly. The use of focal species is a planning shortcut when collecting data or building models for priority species (USFWS and USGS 2006).

Technical Team — A body of personnel with expertise in conservation biology, data **analysis**, design processes, facilitation, geographic information systems, habitat suitability modeling, human dimensions (socio-economics), landscape ecology, population viability analysis, **scenario** planning, site-selection algorithms and other technical fields (Noss 2003; TNC and WWF 2006; Nassauer and Opdam 2008; Lovell and Johnston 2009).

Vision — A summary statement in general terms that describes the desired state or ultimate condition that partners are working to achieve. The vision serves as a source of inspiration among individuals and partners (Conservation Measures Partnership 2013).