USFWS Species Status Assessment Framework

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Version 3.3

The US Fish and Wildlife Service is using an integrated and conservation-focused analytical approach, the Species Status Assessment Framework, to assess the species biological status for the purpose of informing decisions and activities under the Endangered Species Act.

USFWS Species Status Assessment Framework

An Integrated Analytical Framework for Conservation

Citing the SSA Framework document:

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Contributors to this Version of the SSA Framework include members of the 2015 Framework Implementation Team.

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Executive Summary

The SSA Framework is an analytical approach developed by the U.S. Fish and Wildlife Service (Service) to deliver foundational science for informing all Endangered Species Act (ESA) decisions. An SSA requires integration of comprehensive project planning; clear roles and responsibilities; early identification of decision context and resolution of issues and concerns; rigorous scientific assessment; and separation of the science and the recommendation steps. The result will be better assessments, improved and more transparent and defensible decision making, clearer and more concise documents, less rewriting at multiple review stages, and fewer "redos" resulting from legal challenges.

This document lays out the basic concepts in the Species Status Assessment (SSA) Framework and the minimum requirements for an SSA. It is one of many support tools for implementing our new approach for assessing the biological status of species. Other tools include a team of trained regional staff (the SSA Framework Implementation Team or "FIT") to assist field and regional staff with implementing an SSA and a SSA Google Site for Staff (https://sites.google.com/a/fws.gov/ssa/)that offers details on the SSA Framework, training, tools and completed examples.

Ideally, the SSA is conducted at or prior to the candidate assessment or 12-month finding stage, but can be initiated at any time. The SSA is designed to "follow the species" in the sense that the information on the biological status is available for conservation use and can be updated with new information. Thus, the SSA provides a single source for species' biological information needed for all ESA decisions (e.g., listing, consultations, grant allocations, permitting, HCPs, and recovery planning). The biological analysis and the resulting stand-alone science-focused assessment allow for State and partner engagement in the science used to base ESA decisions. Early identification of what most influence the species' condition affords timely opportunities to work with partners to implement conservation efforts in advance of potential ESA decisions.

An SSA begins with a compilation of the best available information on the species (taxonomy, life history, and habitat) and its ecological needs at the individual, population, and/or species levels based on how environmental factors are understood to act on the species and its habitat. Next, an SSA describes the current condition of the species' habitat and demographics, and the probable explanations for past and ongoing changes in abundance and distribution within the species' ecological settings (i.e., areas representative of geographic, genetic, or life history variation across the range of the species). Lastly, an SSA forecasts the species' response to probable future scenarios of environmental conditions and conservation efforts. Overall, an SSA uses the conservation biology principles of resiliency, redundancy, and representation (collectively known as the "3Rs") as a lens to evaluate the current and future condition of the species. As a result, the SSA characterizes a species' ability to sustain populations in the wild over time based on the best scientific understanding of current and future abundance and distribution within the species' ecological settings.

An SSA is in essence a biological risk assessment to aid decision makers who must use the best available scientific information to make policy-guided decisions. The SSA provides decision makers with a scientifically rigorous characterization of species status that focuses on the likelihood that the species will sustain populations within its ecological settings along with key uncertainties in that characterization. The SSA does not result in a decision directly, but it provides the best available scientific information for comparison to policy standards to guide ESA decisions.

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1. SSA Framework Overview

The Species Status Assessment (SSA) Framework entails three iterative assessment stages (Figure 1):

1. **Species' Needs.** An SSA begins with a compilation of the best available biological information on the species (taxonomy, life history, and habitat) and its ecological needs at the individual, population, and species levels based on how environmental factors are understood to act on the species and its habitat.

2. **Current Species' Condition.** Next, an SSA describes the current condition of the species' habitat and demographics, and the probable explanations for past and ongoing changes in abundance and distribution within the species' ecological settings (i.e., areas representative of the geographic, genetic, or life history variation across the species' range).

3. **Future Species' Condition.** Lastly, an SSA forecasts the species' response to probable future scenarios of environmental conditions and conservation efforts. As a result, the SSA characterizes species' ability to sustain populations in the wild over time (viability) based on the best scientific understanding of current and future abundance and distribution within the species' ecological settings.

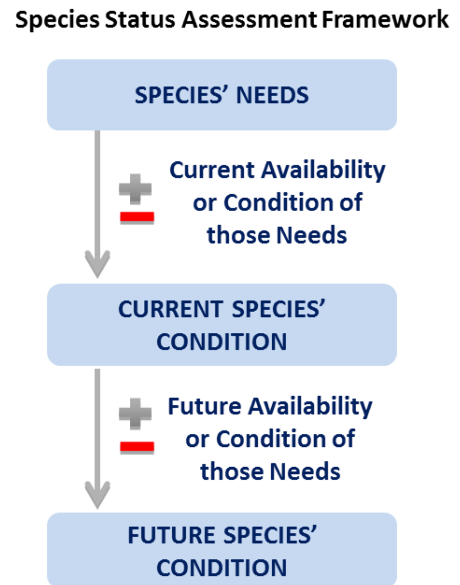


Figure 1. SSA Framework's three basic stages.

Throughout the assessment, the SSA uses the conservation biology principles of resiliency, redundancy, and representation (collectively known as the "3Rs") as a lens to evaluate the current and future condition of the species. Representation describes the ability of a species to adapt to changing environmental conditions, which is related to distribution within the species' ecological settings. Resiliency describes the ability of the species to withstand stochastic disturbance events, which is associated with population size, growth rate, and habitat quality. Redundancy describes the ability of a species to withstand catastrophic events, which is related to the number, distribution, and resilience of populations. Together, the 3Rs, and their core autecological parameters of abundance, distribution and diversity, comprise the key characteristics that contribute to a species' ability to sustain populations in the wild over time. When combined across populations, they measure the health of the species as a whole.

Although each stage of the assessment builds on the information developed in previous the stage(s), insights gained along the way could cause a return to a previous stage to update information. For example, insight into probable climate-mediated reduction in snow cover within a species' range gained while projecting the future species' condition could trigger a return to consider the predator-prey relationship or over-winter survival associated with habitat conditions that had not historically occurred. In this sense, the SSA can be iterative.

2. SSA Application

The purpose of the SSA Framework is to provide a consistent, integrated, conservation-focused, and scientifically robust approach to assessing a species' biological status such that the information and analysis are useful to all decisions and activities under the ESA. As a reflection of the analytical requirements of the various ES programs, the framework is foundational to integration. Integration will improve both efficiency (time and cost savings) and conservation effectiveness. The aspect of the framework that resonates with the larger integration philosophy is the ability of all ES programs to use the same analytical approach for biologically based ESA decisions.

The SSA Framework is, therefore, designed to be applicable to the full range of ES programs: determining appropriate ESA protections, developing the best conservation strategy, evaluating impacts from proposed projects and designing conservation measures targeted to reduce those impacts, permitting research, and allocating funds for partners and stakeholders to implement conservation actions (Figure 2). The use of this common analytical framework eliminates redundant efforts and documentation, and thereby, yields significant savings in time and costs. Ideally, the SSA is conducted at or prior to the candidate assessment or 12-month finding stage for species being considered for protection under the ESA but can be initiated at any point. The SSA is intended to "follow the species" in the sense that the information on the biological status developed at an early stage is available for ESA decision-making use and is updated over time prior to subsequent decisions or actions.

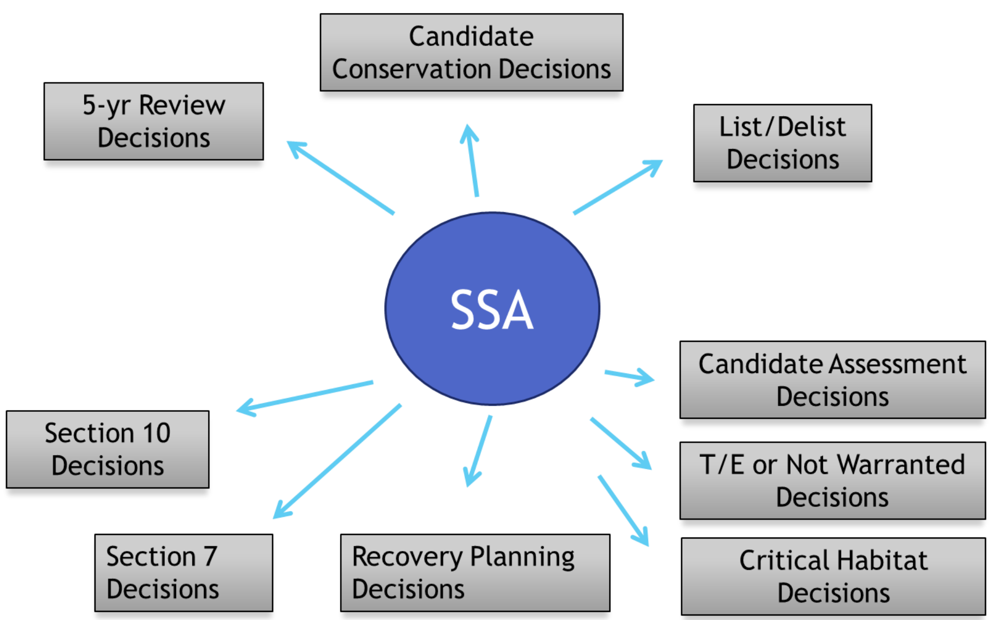


Figure 2. The Species Status Assessment Framework supports all Endangered Species Act decisions.

The SSA does not result in a decision document; rather, it provides the biological information and scientific analysis in support of ESA decisions. For further explanation of how to use the SSA in specific ESA decision contexts see the supporting document on the SSA Google Site for Staff, "Decision Context for SSAs", which presents a normative view of the SSA framework within an ESA decision context. Discussions between decision makers, biological staff, and others conducting analyses about the science and related policies prior to development of the SSA can help ensure that the metrics used (e.g., abundance, relative abundance, abundance class, distribution, population growth rate, or probability of persistence) and complexity of the assessment (e.g., spatial and temporal scales) are acceptable to the decision maker(s) given the context of the decision(s).

3. SSA Documentation

After completion, the SSA will be documented in a stand-alone report. The level of detail in an SSA report is species and situation-dependent. In general, SSA reports should be succinct and when appropriate use diagrams, graphs, and tables to help convey the results of SSA analyses. The SSA should be revised and updated as new information is available or better analytical techniques are developed – or at least once every five years for listed species, thereby providing the biological analysis for 5-year status reviews.

As the SSA Framework is expected to evolve and be revised over time, cite the date and reference the version of the SSA Framework (see citations page of this Framework document).

Completed SSA reports should be made publically available. Refering to a species SSA rather than including the assessment in our ES products will be a significant time and cost savings. In addition, by referencing the SSA ranther than incorporting it into each ESA product it is updateable in realtime. For referencing the SSA within program products (biological opinions, federal register documents, recovery plans, etc.) and to keep an accurate administrative record, use a standard naming convention with updates to the SSA document clarified using versioning, as below.

> Suggested citation for an initial SSA would be:
>
> USFWS. 2014. Species Status Assessment for Species X (*Latin name*). August 2014 (Version 1.0). U.S. Fish and Wildlife Service, Region 2. Albuquerque, NM. xx pp + Appendices.
>
> A subsequent citation would be:
>
> USFWS. 2020. Species Status Assessment for Species X (*Latin name*). July 2020 (Version 2.0). U.S. Fish and Wildlife Service, Region 2. Albuquerque, NM. xx pp + Appendices.

4. Assistance

This document is one of several available support tools for conducting an SSA. Additionally, a team of trained FWS staff (the SSA Framework Implementation Team or "FIT") is available to assist field and regional staff and their project teams in applying the SSA Framework. We are also maintaining an SSA Google Site that provides further documentation on the SSA Framework, training, tools, and examples of completed SSA reports. Lastly, we have a National Strategy for Implementation (found on the SSA Site), which provides direction and goals for future implementation.

5. Terminology

Consistent use of defined and unambiguous terminology is required to reduce linguistic uncertainty and ensure that the SSA information is useful across all ES programs. SSA terminology is based upon scientifically accepted terms commonly used in conservation biology literature. The SSA Framework tries to avoid using terms common to ESA policy or regulations to avoid confusing the scientific analysis with the policy-based decision. Some of the more important SSA terms, their definitions, and how they are used within an SSA are defined throughout the text of this document and additional definitions are included in the Glossary as an Appendix. Several particularly relevant terms are explained below.

Threats

The word "threat" does not have a common definition across all ESA programs (see footnote 2 in the January 16, 2009, Department of Interior Solicitor Memorandum, M-37021). Instead of the word threat, the SSA Framework asks for specificity on the source of an environmental stressor or a direct effect, and how that "cause" affects individuals, populations, and the species using demographic parameters (i.e., "effects").

Viability

The term viability is a commonly accepted term in the conservation literature to denote the ability of a species to sustain populations in the wild over time. Thus, the term viability is an efficient way to refer to the result of an SSA. Viability is not a specific state, but rather a continuous measure of the likelihood that the species will sustain populations over time. In addition, the term viability denotes a trajectory opposite to extinction and a focus on species conservation.

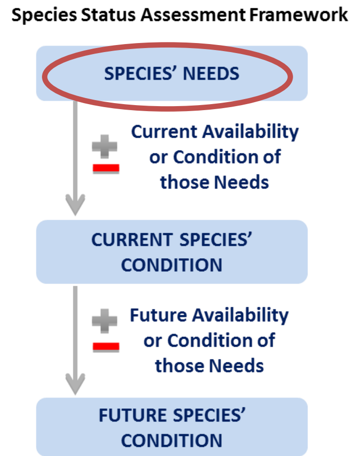
Models and Modeling

An ecological model is a representation of a complex ecological system for the purpose of summarizing information essential to a particular purpose. In this case, the purpose is completing an SSA, and the ecological system comprises a species and its environment. A model-based approach to an SSA provides an explicit, transparent and, therefore, repeatable method of analysis, which supports peer review of both the methodology and the conclusions. Explicit logic chains developed with the help of conceptual or quantitative modeling will aid in identifying gaps in knowledge and will support an explicit assessment of how various sources of uncertainty might affect a decision through sensitivity analyses. The model-based approach also provides a way to integrate new information in future analyses.

Models can be as simple or complex as necessary in order to understand the system, relay that understanding to others, and support decisions. Models (either conceptual or quantitative) serve as a means to explain our hypotheses and current knowledge about the ecology of the species and its environment. Models can be useful for projecting the future status of the species. Therefore, models should not be overly complicated, but they do need to be oriented to the information needs of the SSA and its decision context.

> For an easy-to-read summary of the application of ecological models, see *Starfield, A.M. 1997. A pragmatic approach to modeling for wildlife management. J. Wildl. Manage. 61:261-270.*

Stage 1: Species' Ecological Needs



Assessing the species level of viability is achieved by completing the above assessment framework. Credit: USFWS

The goal of a species status assessment is to assess the biological condition of a species over a defined period of time. A species' biological condition should be evaluated relative to its degree of resiliency, redundancy, and representation. Briefly, resiliency describes the ability of the species to withstand stochasticity; redundancy describes the ability of the species to withstand catastrophic events; and representation describes the ability of the species to adapt over time to long-term changes in the environment. In general, the more redundant, representative, and resilient a species is, the more likely it is to sustain populations over time, even under changing environmental conditions.

Stage 1 is an exploratory stage to begin to understand how the species maintains itself over time. This exploration identifies the life history and aspects of the species' ecology including the biological requirements of the species at the individual or life stage, population, and species (rangewide). The key to this stage of the assessment is to gather the best available biological information on the species (taxonomy, life history, habitat) and the species' ecological needs described broadly at the appropriate scales (e.g., individual, population, and/or species levels) based on how environmental factors are understood to act on the species and its habitat. While doing so, consider how availability of various resources influences individual survival, how abundance and growth rate (demographics) and meta-population dynamics influence population's ability to bounce back from disturbance (resilience), and how the number and distribution of populations influence the species ability to withstand catastrophic events (redundancy). Identify areas representing important geographic, genetic, or life history variation (i.e., the species' ecological settings), which could be reservoirs of adaptive potential (Figures 3 and 4), and whether there is any information to indicate these may change in the future given changing climates. Exploration of these relationships at the various levels lays the foundation for the next stages of the SSA Framework.

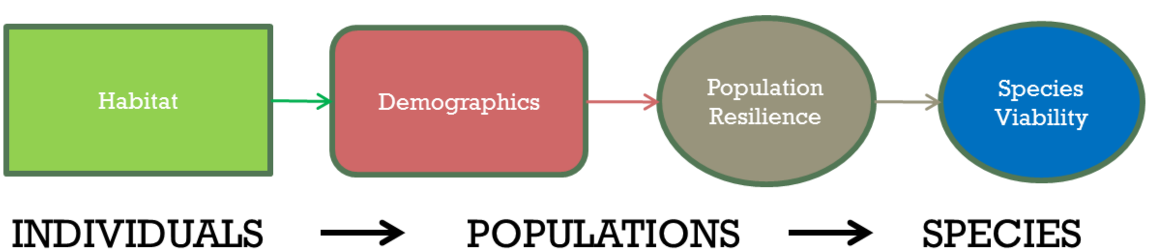


Figure 3. Simple conceptual model of relationship between habitat, demographics, and population resiliency.

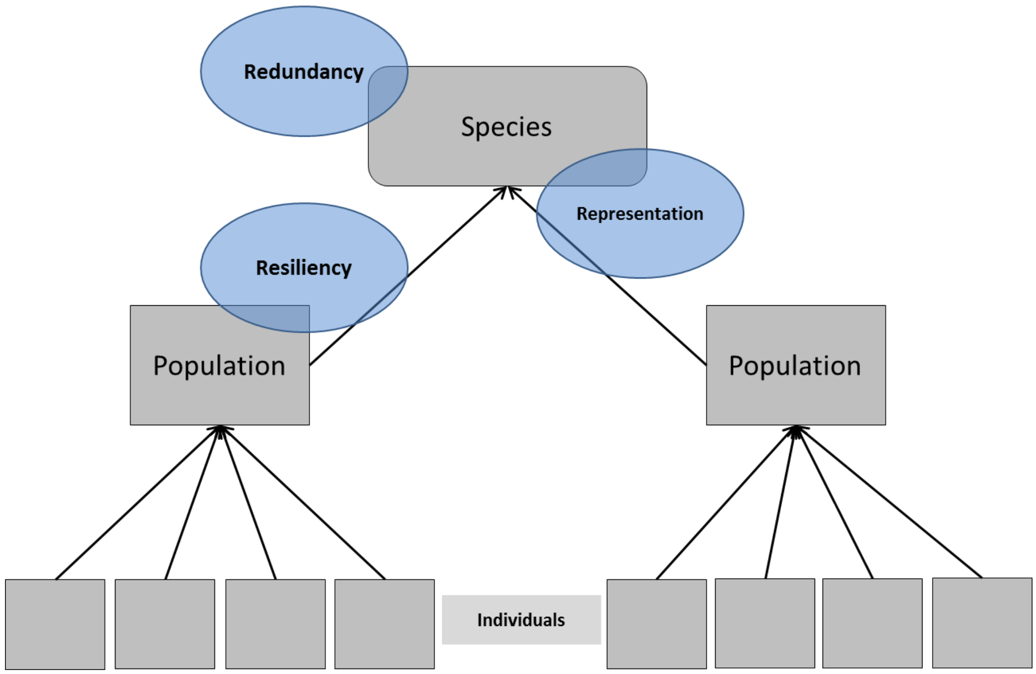


Figure 4. Resiliency is measured at the population level, representation is measured at the species and, possibly, population level, and redundancy is measured at the species level. In practice the 3Rs are interrelated – resiliency supports redundancy, representation supports resiliency, etc.

Individual Level

> A **life history profile** clearly documents growth and reproduction of all life stages and the factors that influence on each life stage.

The starting point of our analysis begins with an understanding of the species' life history. A species' life history, including trophic niches, reproductive strategies, biological interactions, and habitat requirements, determines how individuals at each life stage respond to natural and anthropogenic influences. Developing a life history profile is a good starting point for describing what influences individual survival and reproduction. In addition to basic needs, a life history profile documents those characteristics that make the species sensitive or resilient to particular natural or anthropogenic influence. For example, species with breeding-site fidelity may be especially vulnerable to disturbance; or a generalist might be able to switch food sources as one gets scarce. The life history profile provides information for the assessment of the species' current condition (see Stage 2) and for the species' response over time (in other words, for understanding aspects influencing the species status) (see Stage 3).

To explore the needs of individuals we seek to answer what influences the successful completion of each life stage. For example, a species with the lifecycle depicted in Figure 5, we ask what influences survival, growth, and reproduction at egg, juvenile, and adult life stages. The answers to these questions help us understand what the species needs for survival, growth (in moving from one life stage to another), and reproduction at the individual level.

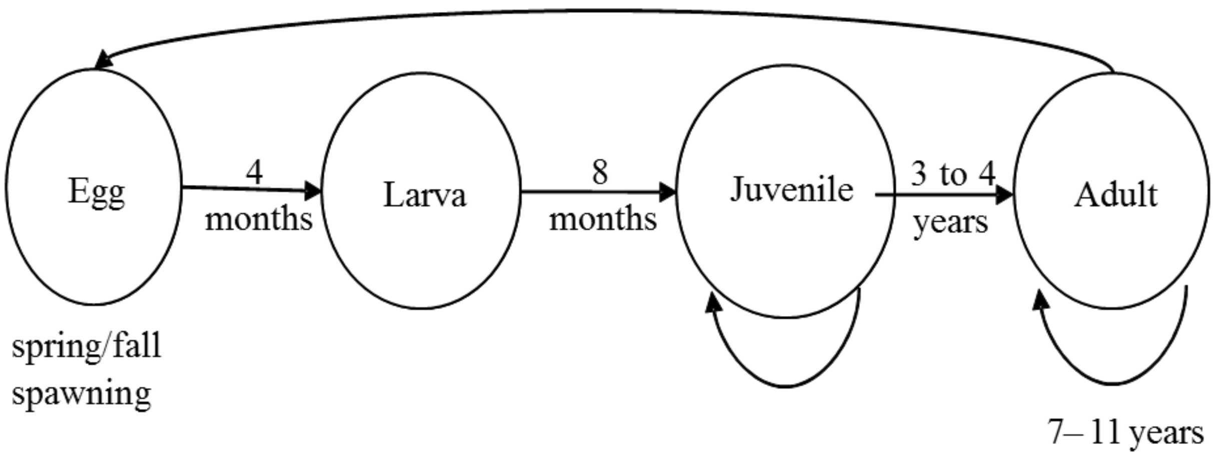


Figure 5. An example of an aquatic species with four life stages. Identifying what influences survival and growth at each stage will describe the individual's biological needs. Understanding what influences successful reproduction begins to build the bridge from individual to population level.

Population Level

The life history profile describes survival and reproduction needs at the level of the individual or life stage. At the population level, we describe the resources, circumstances, and demographics that most influence resiliency of a population. These may vary if populations inhabit different ecological settings. Species viability corresponds to the resiliency of its populations, and therefore, it is necessary to understand and determine for the analysis how populations should be defined for the species. For some species, identifying population structures (such as meta-populations) may be helpful and necessary.

Resiliency describes the ability of a species to withstand stochastic disturbance. Resiliency is positively related to population size and growth rate and may be influenced by connectivity among populations. Generally speaking, populations need abundant individuals within habitat patches of adequate area and quality to maintain survival and reproduction in spite of disturbance.

Species Level

At the species level, we explore what influences redundancy and representation. We use the evolutionary history and historical distribution of the species as a starting point to understand how the species functions (or functioned) to maintain populations across its range.

Representation describes the ability of a species to adapt to changing environmental conditions over time. It is characterized by the breadth of genetic and environmental diversity within and among populations. Measures may include the number of varied niches occupied, the gene diversity, heterozygosity or alleles per locus. Our analysis explores the relationship between the species life history and the influence of genetic and ecological diversity and the species ability to adapt to changing environmental conditions over time. The analysis identifies areas representing important geographic, genetic, or life history variation (i.e., the species' ecological settings).

Redundancy describes the ability of a species to withstand catastrophic events; it's about spreading risk among multiple populations to minimize the potential loss of the species from catastrophic events. Redundancy is characterized by having multiple, resilient populations distributed within the species' ecological settings and across the species' range. It can be measured by population number, resiliency, spatial extent, and degree of connectivity. Our analysis explores the influence of the number, distribution, and connectivity of populations on the species' ability to withstand catastrophic events (e.g., rescue effect).

Exploring and describing the relationships of what influences the 3Rs given the species' unique life history does not conclude whether the species is viable. Rather it sets out the foundational relationships, hypotheses, and assumptions that will be integral to the remainder of the assessment. These relationships- whether linear, non-linear, or circumstance dependent - are important because we are <u>not</u> determining the species' future state (i.e., is a species viable or not), but rather the likelihood that the species will sustain populations over time.

Outcome

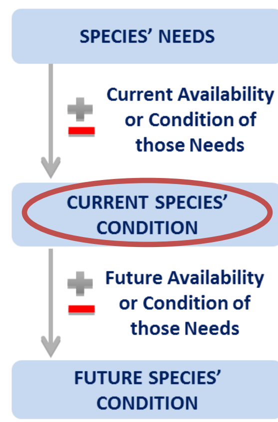
Expected outcomes of the species needs assessment include a documentation of the analysis conducted (materials and methods), a life history profile, a description of the resources, circumstances and demographics influencing population resilience. And an exploration of how the species functions (or functioned) to maintain populations across its range given its evolutionary history and historical distribution. The 3Rs should be used as an organizing structure as they assist in assuring that the conservation biology bases are covered. Levels of certainty should be explicit.

Stage 2: Current Species' Condition

The next stage of the SSA is to describe the current condition of the species' habitat and demographics, and the probable explanations for past and ongoing changes in abundance and distribution within areas representing important geographic, genetic, or life history variation (i.e., the species' ecological settings). The exploration of species' ecological needs, assessed in Stage 1, provides the understanding to explain changes in abundance and distribution. The current species' condition is an empirical assessment based on available data and knowledge. (In contrast to the future species' condition, assessed in Stage 3, which is a predictive assessment based on projections of species response to probable future scenarios).

Here we assess the quality, quantity, and connectivity of habitat available for survival and reproduction of individuals to support population resilience. We assess and document the current population sizes and growth rates and the number and distribution of the populations within the species' ecological settings.

Species Status Assessment Framework



Assessing the species level of viability is achieved by completing the above assessment framework. Credit: USFWS

> The current species' condition will be the baseline against which subsequent assessments can be compared to track changes in the species' condition over time.

We also seek to answer the question, "What environmental changes, natural or anthropogenic, have occurred in the past to result in the current condition?" At the end of this stage we should have an understanding of the current condition of the species and the major drivers of that condition.

Cause and Effects

An important part of this stage is to explain the reasons why the species' current condition is what it is. Initially, we are identifying the anthropogenic and natural factors that influence the habitat and demographics of the species, and thus its populations (Figure 6a and 6b). The cumulative effects on those populations determine conditions related to redundancy and representation.

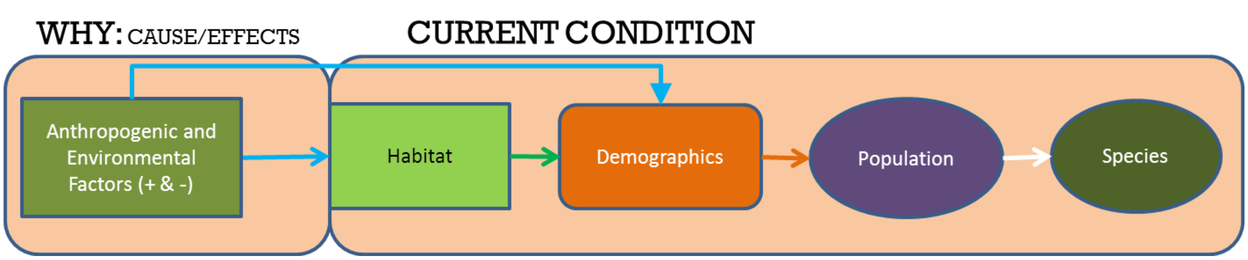


Figure 6a. Conceptual model of current species' condition.

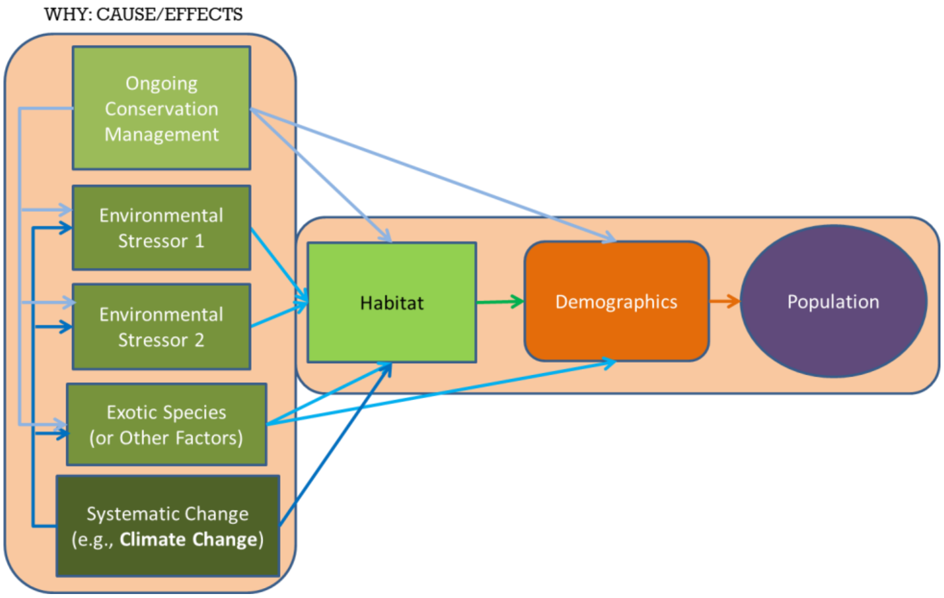


Figure 6b. Conceptual model of current species' condition and the causes of that condition identified.

Individual Effects

Individuals can be affected directly by a stressor (e.g., vehicular strike) or secondarily through changes to the quality and/or quantity of their habitat (see Figure 6b). Correctly identifying the type of effect, exploring the likelihood of an effect (see Figure 7), and understanding which stressors are responsible for the greatest or least demographic consequence are key both to the analysis at the population level and conservation recommendations. As part of the consequences analysis, describe how the effect on individuals contributes to population condition, i.e., how it affects the resiliency of and diversity within the population. Then incorporate the population-level effects into the overall analysis of the range-wide condition of the species. You may find that starting with population level effects will focus your individual effects analysis as it provides a context for the review of individual effects.

Figure 7 shows a conceptual model (Effects Pathway model) of an impact (cause or effect) analysis that focuses on effects to individual survival and reproduction. The goal of this analysis is to identify and understand how natural and anthropogenic factors may affect individuals. Factors can have negative, positive, or no influence on individual fitness and ultimately on population resiliency. The effects pathway model provides a clear chain of logic that demonstrates our understanding of how effects on individuals may contribute to the condition of the population, i.e., how factors may affect the resiliency of the population. Then we incorporate the population-level effects into the overall analysis of the range-wide condition of the species. Developing the clear chain of logic for how factors affect the species or the resources it needs, or conversely showing why a factor does not or cannot affect a species (e.g. there is no exposure or a resource to the stressor in time and/or space) is a valuable tool for communication to others as well.

For more specific information about using effects pathways, see the **SSA Site** the internal to FWS **Effects Pathway Manager (EPM) software in ECOS**. Log in and go to EPM on applications page.

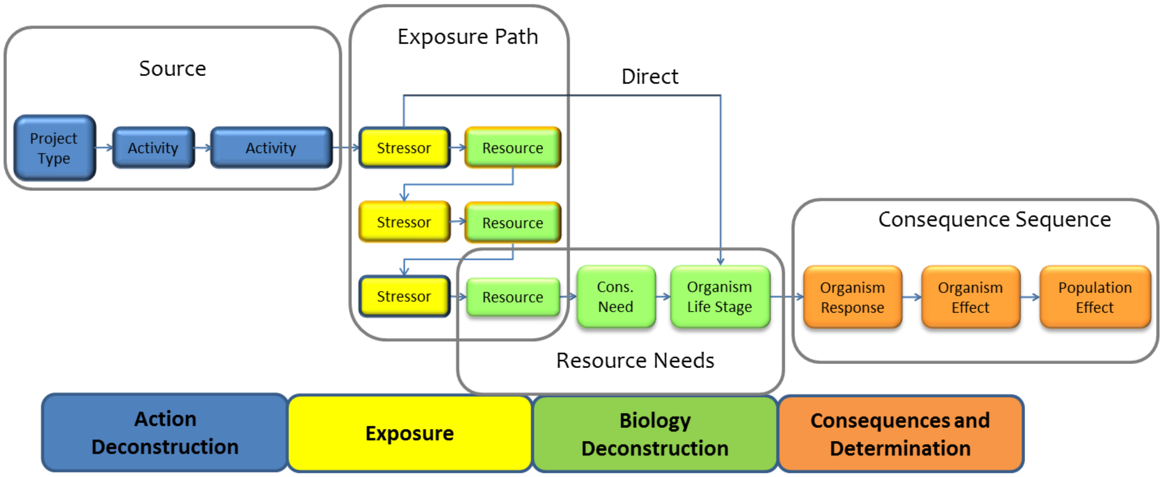


Figure 7. The conceptual cause and effects pathways model focuses on effects to individuals. This model can be used in conjunction with the Core Conceptual Model to better understand, document, and articulate the relationships between individual effects and population level effects.

Population and Species Level Effects

The "Species' Current Condition and the Causes of that Condition" (see Figure 6) provides the initial conceptual model to conduct an analysis of the anthropogenic and natural factors most likely to be driving the population's resiliency and develop pathways through which these factors affect populations. In fact you may find that exploring population or species level effects first quickly focuses your exploration of prime drivers at the individual level or population level. The conceptual model captures the most current and plausible hypotheses about the ways in which factors singly and collectively affect habitat and/or demographics and populations/species. In addition, the conceptual model helps identify potential conservation actions by identifying important pathways those conservation actions could interrupt; quantifying the cumulative, synergistic and antagonistic relationships among these factors by identifying the effect on population size and growth rate; setting the stage for the ranking of each factor's relative influence on habitat and/or population demographics; and thereby help identify necessary conservation actions and their priority in application, respectively.

We can begin to do this by identifying what influences the species at the individual and population levels initiated in Stage 1; we add the anthropogenic and environmental factors (which may be different for each population), and analyzing their relative contribution to population-level demography, population distribution and diversity.

As we approach completing the cause and effects analysis of the current species' condition, the major drivers of the current condition are based on the observed effects on the species. These major drivers will be important to focus on as we move into Stage 3 where we develop probable future scenarios and the likely species' response i.e., future condition of the species. The analysis of consequences should consider both positive and negative effects, and the relative importance of areas or individuals, to identify the "net" current condition of the species.

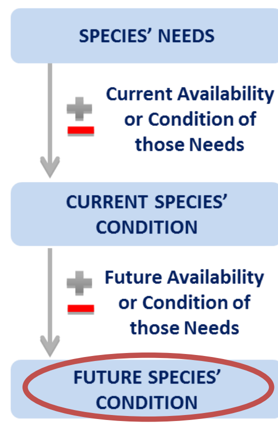
Outcome

The outcome of Stage 2 is a description of the current conditions, including causal relationships across individuals, populations, and the species. This includes (1) current population structure, distribution, abundance, demographic rates, genetics, and habitat/resources; (2) changes from historical to current distribution; (3) an explanation of the causes and effects that resulted in the current species' condition with respect to the life history and habitat needs identified in Stage 1; (4) the implications of any missing or diminished resources or circumstances affecting the demographic parameters at the population level, and the number, distribution, and connectivity of populations within the species' ecological settings. As with Stage 1, analytical methods need to be clearly described and levels of certainty should be explicit. The 3Rs should be used as an organizing structure as they assist in assuring that the conservation biology bases are covered.

Stage 3: Future Species' Condition and Status

In the last stage, an SSA forecasts the species' response to probable future scenarios of environmental conditions and conservation efforts. This involves an analysis and description of anticipated future environmental conditions and the projected consequences on the species' ability to sustain populations in the wild over time. Resiliency, redundancy, and representation (i.e., the 3Rs) help ensure that all levels of biological organization are considered in the status assessment. The predictions start with the current species' condition (Stage 2) and an understanding of how the species interacts with its environment (Stage 1). In other words this stage brings together the knowledge gained in the 2 prior stages with information on probable future scenarios to conduct a risk analysis resulting in predictions of future species' condition.

Species Status Assessment Framework



Assessing the species level of viability is achieved by completing the above assessment framework. Credit: USFWS

It is essential that the timeframe used in the assessment is both biologically meaningful and consistent with the information available. A biologically meaningful timeframe means the time periods are long enough to encompass multiple generations so the species responses can be predicted. Consistency implies that the time periods are appropriate for the information available on the stressors and conservation efforts that are likely to occur and predictions of the species responses to these future environmental changes.

As explained previously, resiliency, redundancy, and representation (i.e., the 3Rs) are considered at each stage of the assessment. Generally speaking, higher levels of resiliency, redundancy, and representation translate to a greater likelihood that the species can sustain populations over time. However, the relationship between the 3Rs and species condition may not be linear. Resiliency is related to population size and growth rate; redundancy is related to number and distribution of populations within the species' ecological settings; and representation is related to the ability of the species to sustain populations within ecological settings to conserve important geographic, genetic, and life history variation. Viability will increase with the 3Rs as abundance, distribution, and diversity increase from low levels and will reach an asymptote as abundance, distribution, and diversity exceed some thresholds.

Predicting Future Conditions (Cause and Effects)

In Stage 2, we described the positive and negative effects of past and current anthropogenic and natural factors to explain the current condition of the species. Now, in Stage 3, we identify anthropogenic and natural factors that are occurring or will likely occur, what their positive, negative, or neutral effects may be on habitat and demographics, and predict the future condition of the species in light of those factors. The current condition of the species is the starting point for predicting the future condition of the species. We use the same methodology for cause and effects in Stage 3 as used in Stage 2, with the only difference being that now we look forward rather than backward (Figure 8).

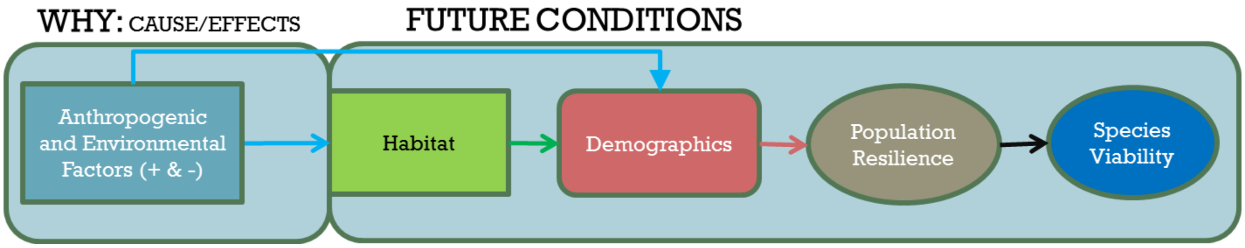


Figure 8. Conceptual model of species future condition and viability and the Causes of that Condition.

Characterizing Predicted Future Status

The outcome of Stage 3 is a characterization of the species response to future scenarios of anthropogenic and environmental factors (Figure 8). The metrics for future species' condition are related to abundance, distribution, and diversity (geographic and genetic), which are core autecological parameters (meaning they measure the relationships between an individual species and its environment). The numerical resolution and spatial and temporal scale of the metrics will depend on data availability and the information needed by the decision maker. Judgment will be required by the assessment team as to what resolution can be supported reliably. In some cases, only categories of abundance or distribution can be projected reliably, while in other cases, the data will be available to support rigorous prediction of abundance or occupancy. Prediction of viability as a probability can be derived from abundance and distribution, if warranted. The assessment should include a range of plausible and likely future scenarios for anthropogenic and natural factors that will result in a range in the species response. Uncertainty will arise both from the likelihood of various scenarios and from variation in the predicted species response to a specific scenario.

The outcome of Stage 3 will be used to *inform* decisions and will involve the application of standards from our policies, regulations, and the ESA (such as the definitions of "threatened species" and "endangered species" or "jeopardize the continued existence of").

Outcome

The SSA output is a description of a species' anticipated future status. That description should be based on the best scientific understanding of future abundance, distribution, and diversity (geographic or genetic). Viability therefore is not a specific state, but rather a continuous measure of the likelihood that the species will sustain populations over time. As with Stages 1 and 2, analytical methods need to be clearly described and levels of certainty should be explicit. Here the 3R metrics related to abundance, distribution, and diversity are used in the viability characterization helping ensure conservation biology bases are covered and the focus is on conservation.

Although not a required aspect of the SSA report a conservation strategy is a natural outgrowth of an SSA and could be developed as part of or a supplement to the SSA. This early identification of what most influence the species condition affords opportunities to work with partners to carry out conservation actions in advance of potential ESA decisions. If listed, the conservation strategy can inform subsequent actions.

Glossary

Causal (cause and effect) relationships are the relationship between one event, the cause, and a second event, the effect, where the second event is recognized to result as a consequence of the first.

Core autecological parameters are measures of the relationship(s) between an individual species and its environment. In the context of the SSA the recommended autecological parameters are abundance, distribution and diversity, or as data dictates, appropriate proxies.

Demographics are the numerical characteristics of a population. Typically used to understand how a species changes over time, demographics can be expressed as numbers, rates, and trends. In the SSA we are interested in how the demographic characteristics are influenced by natural or human caused events, and how characteristics such as population size (abundance), mortality rates and recruitment (the number of juveniles moving to adulthood) rates are influencing population growth over time; from which you can develop a trend in population growth.

Demographic stochasticity refers to the variability in population growth rates arising from random differences among individuals in survival and reproduction within a season. This variability will occur even if all individuals have the same expected ability to survive and reproduce and if the expected rates of survival and reproduction don't change from one generation to the next. Even though it will occur in all populations, it is generally important only in populations that are already fairly small. *Kent Holsinger 2013-08-29*

Ecological diversity is the variation in habitats or niches occupied by the species.

Ecological settings are areas representative of geographic, genetic, or life history variation throughout a species' range.

Environmental stochasticity is unpredictable spatiotemporal fluctuation in environmental conditions, often resulting from weather, disease, and predation or other factors external to the population. Environmental stochasticity influences the variability of birth and death rates and thus how population abundance fluctuates and affects the fate (e.g. persistence or extirpation) of populations (adapted from *2009 Masami Fujiwara, Southwest Fisheries Science Center, Santa Cruz, California, USA*).

Fitness is the ability of an individual (or organism) to survive and reproduce in its environment.

Genetic diversity is the total number of genetic characteristics in the genetic makeup of a species, subspecies, or population.

Genetic stochasticity refers to changes in the genetic composition of a population unrelated to systematic forces (selection, inbreeding, or migration), i.e., genetic drift. It can have a large impact on the genetic structure of populations, both by reducing the amount of diversity retained within populations and by increasing the chance that deleterious recessive alleles may be expressed. *Kent Holsinger 2013-08-29*

Life history profile is a clear documentation of all stages of a species growth and reproduction and the influences on each stage, a description of the resources, circumstances and demographics influence on population resilience.

Minimum viable population (MVP) is a lower bound on the population of a species, such that it can survive in the wild. This term is used in the fields of biology, ecology, and conservation biology. More specifically, MVP is the smallest possible size at which a biological population can exist without facing extinction from natural disasters or demographic, environmental, or genetic stochasticity.

Population is typically defined as a group of interbreeding individuals or organism that are more apt to breed among that group than outside the group. There are however, many approaches to defining species populations. Consistently problematic is defining population boundaries so that the number of populations can be clearly determined. Geneticists use measures of gene flow and genetic differentiation to distinguish one population from another. In a demographic sense, this can be achieved by careful measures of individual movement, which enables the delineation of populations that are sufficiently isolated from each other to have independent dynamics. Populations can also be distinguished with the use of some arbitrarily defined spatial and/or temporal context (e.g. linear distance between groups, or the presence of geographical barriers or other spatial disjunctions) or differences in phenology, morphology or physiology.

Persistence refers to the ability of a population to sustain itself over time.

Redundancy describes the ability of a species to withstand catastrophic events. Measured by the number of populations, their resiliency, and their distribution (and connectivity), redundancy gauges the probability that the species has a margin of safety to withstand or can bounce back from catastrophic events; combined with resiliency and representation to form the three-pronged biodiversity principles.

Representation describes the ability of a species to adapt to changing environmental conditions. Measured by the breadth of genetic or environmental diversity within and among populations, representation gauges the probability that a species is capable of adapting to environmental changes; combined with resiliency and redundancy to form the three-pronged biodiversity principles.

Resiliency describes the ability of the populations to withstand stochastic events. Measured by the size and growth rate of each population, resiliency gauges the probability that the populations comprising a species are able to withstand or bounce back from environmental or demographic stochastic events; combined with representation and redundancy to form the three-pronged biodiversity principles.

Resources are the habitats, **circumstances**, and other physical or biological features, including their state, condition or quality that is required by a species to fulfill its lifecycle and in support of population resiliency. Examples include: grassland, forest, natural ambient light, habitat structure, ability to roost undisturbed, host species, prey species, pollinators, aspect of slope; at the population level these may include a number or distribution of individuals in order to prevent inbreeding, connectivity to other populations, etc.

Viability is the ability of a species to sustain populations in the wild over time. “Over time” means beyond specified time periods that are as long as possible given our ability to predict future conditions and that are biologically meaningful considering the life history of the species.

Stochastic events refer to random or non-deterministic events. In the context of an SSA, the events of concern are those that disturb the species or its habitat that results in decreased population size or growth rate.