Science, Service, Stewardship

Extinction Risk Assessments under the Endangered Species Act

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Endangered Species Act

- ESA section 4(a)(1) requires the Secretary to determine whether any species is E or T because of any of the following factors:
  - Habitat destruction, modification, or curtailment
  - Overutilization
  - Disease or predation
  - Inadequacy of existing regulatory mechanisms
  - Other natural or manmade factors

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Basis for listing species as threatened or endangered under the ESA

Section 4(b)(1) of the ESA requires the agencies to make listing determinations solely on the basis of the best scientific and commercial data available after conducting a review of the status of the species and after taking into account those efforts, if any, being made by to protect the species.

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Definitions of key terms

- Species includes any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature
- Endangered species = any species in danger of extinction throughout all or a significant portion of its range
- Threatened species = any species likely to become endangered within the foreseeable future throughout all or a significant portion of its range

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Significant portion of its range

A portion of the range of a species will be considered "significant" if its contribution to the viability of the species is so important that, without that portion, the species would be in danger of extinction (Draft Policy on Interpretation of the Phrase "Significant Portion of its Range" in the Endangered Species Act's Definitions of "Endangered Species" and "Threatened Species," 76 FR 76987; December 9, 2011).

http://www.gpo.gov/fdsys/pkg/FR-2011-12-09/pdf/2011-31782.pdf

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Foreseeable future

- Timeframe over which predictions about the future in making determinations about the future conservation status of the species can be reasonably relied upon
- Can be in the form of extrapolation of population or threat trends, analysis of how threats will affect the status of the species, or assessment of future events that will have a significant new impact on the species.
- Need to consider the life history of the species, habitat characteristics, availability of data, kinds of threats, ability to predict threats, and the reliability of models used to forecast threats.

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Status review

- A status review summarizes the best available information on the species (e.g., population structure, demographics, genetic diversity, life-history, threats, and an extinction risk assessment).
- Recommendations on whether to propose a listing as T or E are based on the status review, any other relevant biological and threat data, consideration of conservation efforts, and all relevant laws, regulations, and policies.
- The status review report itself should not make any recommendations on whether a species is T or E.

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Extinction risk assessment

- Integrates demographic information with threats to estimate the probability of extinction
- Can be quantitative, semi-quantitative, or qualitative
- Methodology is case-specific, depending on life history parameters and the quality of data

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Southern Resident killer whale (*Orcinus orca)*

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Southern Resident killer whale

- Team developed a population model to assess extinction risk 50, 100, 200, and 300 years out.
- Age-structured, sex-structured, pod-structured
- Demographic and environmental variance
- An Allee effect based on killer whale breeding biology
- Density dependence
- Large mortality events to simulate possibility of a catastrophe, such as an oil spill
- Uncertainty from sampling error in survival estimates

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Southern Resident killer whale (cont.)

- Most optimistic model (29-year dataset) resulted in <0.1-3% in 100 yr and 2-42% in 300 yr
- With a quasi-extinction threshold (≤ 10 males or 10 females), 1-15% in 100 yr to 4-68% in 300 yr
- Higher percentages in each range associated with higher probability and magnitude of catastrophic mortality events, as well as with a smaller K
- Most pessimistic model (last 10 yrs) – 6-19% in 100 yrs and 68-94% in 300 yr
- With a quasi-extinction threshold, 40-67% in 100 yr to 76-98% in 300 yr.

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Atlantic bluefin tuna (*Thunnus thynnus)*

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Atlantic bluefin tuna

- The five section 4(a)(1) factors were examined for their historical, current, and/or potential impact on bluefin tuna status
- Current and potential threats, along with current distribution and abundance, determine present vulnerability to extinction.
- Information about historical threats was included to assist interpretation of historical population trends.
- The relationship between historical threats and population trends also provides insights that may help to project future population changes in response to current and potential threats.

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Atlantic bluefin tuna (May 2011)

- Long-term projections (2010 – 2100) of abundance were made, using ICCAT Standing Committee on Research Statistics protocols
- The probability of extinction was calculated (with different total allowable catch assumptions) for each DPS separately (assuming low intermixing)
- In one set of analyses, the threshold for the number of spawners was set to below 2 fish
- A second set of analyses was performed with the threshold set at 500 spawners, rather than 2.

Catch (mt)	2010	2011	2020	2030	2040	2050	2060	2100
0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1,000	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1,250	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%
1,500	0.0%	0.0%	0.0%	0.0%	0.2%	0.4%	0.5%	0.7%
1,750	0.0%	0.0%	0.0%	0.1%	0.7%	1.4%	1.6%	2.3%
2,000	0.0%	0.0%	0.0%	0.5%	2.1%	3.4%	4.7%	5.4%
2,250	0.0%	0.0%	0.0%	0.8%	4.3%	8.4%	11.7%	14.8%
2,500	0.0%	0.0%	0.0%	2.3%	9.2%	19.0%	24.7%	29.5%
2,750	0.0%	0.0%	0.0%	4.2%	19.6%	33.8%	41.9%	54.0%
3,000	0.0%	0.0%	0.0%	6.5%	33.0%	51.0%	62.2%	77.9%
3,500	0.0%	0.0%	0.0%	17.8%	63.0%	83.7%	90.6%	95.4%
4,000	0.0%	0.0%	0.0%	35.4%	84.9%	96.4%	97.9%	98.9%
5,000	0.0%	0.0%	0.3%	73.1%	98.7%	99.7%	99.9%	99.9%

Table 9.2. Forecasted probability that the western bluefin tuna DPS will go extinct by year and catch level (assuming the high and low recruitment potential scenarios are equally plausible). Current management recommendations under ICCAT specify a TAC of 1,750 mt.

Pacific herring
(*Clupea pallasi)*

Yelloweye rockfish
(*Sebastes ruberrimus)*

Pacific cod
(*Gadus macrocephalus)*

Black abalone
(*Haliotis cracherodii)*

Chinook salmon
(Oncorhynchus tshawytscha)

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Risk matrix method

- Described in detail in Wainwright and Kope (1999)
- Pacific salmonid status reviews (e.g., Good et al. 2005, Hard et al. 2007)
- Reviews of Pacific hake, walleye pollock, Pacific cod (Gustafson et al. 2000)
- Puget Sound rockfishes (Stout et al. 2001a, Drake 2010)
- Pacific herring (Stout et al. 2001b, Gustafson et al. 2006)
- Black abalone *(VanBlaricom et al. 2009)*

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Risk matrix method (cont.)

- Absolute abundance, spatial & temporal distributions;
- Current abundance;
- Trends in abundance;
- Natural and human-influenced factors that cause variability in survival and abundance;
- Possible threats to genetic integrity; and
- Recent events that have predictable short-term consequences for the abundance of a DPS.
- Additional risk factors, such as disease prevalence or changes in life history traits, also may be considered.

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Risk matrix method (cont.)

- Collective condition of individual populations is summarized at the DPS level according to 4 demographic risk criteria:
  - abundance, growth rate/productivity, spatial structure/connectivity, and diversity.
- Criteria outlined in McElhany et al. (2000)
  - Reflect concepts that are well-founded in conservation biology and generally applicable to a wide variety of species.
  - Describe demographic risks that individually and collectively provide strong indicators of extinction risk.

Table X. Template for the risk matrix used in team deliberations. The matrix is divided into five sections that correspond to the four Viable Salmon Population parameters (McElhany et al. 2000) plus a recent events category.

Risk Category	**Score**
Abundance Comments:	
Growth rate/productivity Comments:	
Spatial structure and connectivity Comments:	
Diversity Comments:	
Recent events	

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Risk matrix method – scoring population viability criteria

1. Very low risk: It is unlikely that this factor contributes significantly to risk of extinction, either by itself or in combination with other factors.
2. Low risk: It is unlikely that this factor contributes significantly to risk of extinction by itself, but some concern that it may, in combination with other factors.
3. Moderate risk: This factor contributes significantly to long-term risk of extinction, but does not in itself constitute a danger of extinction in the near future
4. High risk: This factor contributes significantly to long-term risk of extinction and is likely to contribute to short-term risk of extinction in the foreseeable future.
5. Very high risk: This factor by itself indicates danger of extinction in the near future.

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Risk matrix method – recent events

- Considers events that have predictable consequences for DPS status in the foreseeable future but have occurred too recently to be reflected in the demographic data.
  - + + expect a strong improvement in status of the DPS
  - + expect some improvement in status
  - 0 neutral effect on status
  - – expect some decline in status
  - – – expect strong decline in status

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Risk matrix method (cont.)

- Each team member reviews relevant biological information for the species and assigns a risk score to each of the four demographic criteria.
- Scores are tallied (means, modes, and range of scores), reviewed, and the range of perspectives discussed by the team before making its overall risk determination.
- This helps to integrate and summarize a large amount of diverse information before team members assign an overall extinction risk

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Risk matrix method (cont.)

Overall extinction risk estimate:

- No simple way to translate the risk matrix scores directly into a determination of overall extinction risk.
- Team members use their best professional judgment.
- Should avoid presenting results in exactly three risk categories because of the potential implications of equating them with Threatened, Endangered, and Not Warranted determinations.

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Risk matrix method and PVAs

- Population viability analysis (PVA) is generally defined as the use of quantitative methods to predict the future status of a population.
- Future status typically refers to the probability of the population reaching some minimum size within some specified time horizon.
- For species such as rockfishes, data are limited, and the team does not conduct a formal quantitative PVA.
- Data might be available to allow an estimate in the trend in abundance of the species, and the team can consider this information.

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Section 4(a)(1) factors

- To the extent possible, links between demographic risks and the causative section 4(a)(1)factors should be described.
- Ideally, sufficient information will be available to assess extinction risk based on both demographic and threats-based information
- The extent to which this is possible depends on the quantity and quality of the available information.

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Helpful links

NMFS status reviews

http://www.nmfs.noaa.gov/pr/species/statusreviews.htm

McElhany et al. 2000

http://www.nwfsc.noaa.gov/publications/techmemos/tm42/tm42.pdf

Drake et al. 2010 (5 rockfish species)

http://www.nwfsc.noaa.gov/assets/25/7671_03072011_122127_RockfishSRTM108WebFinal.pdf

Wainwright and Kope 1999

http://icesjms.oxfordjournals.org/content/56/4/444.full.pdf+html

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Scalloped hammerhead

Team members review all relevant biological and commercial information for the species, including:

- absolute abundance of each DPS and its spatial and temporal distribution;
- current abundance in relation to historical abundance and trends in abundance based on indices such as catch statistics;
- natural and human-influenced factors that cause variability in survival and abundance; and
- possible threats to genetic integrity

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Scalloped hammerhead (cont.)

- Each team member assigned a risk score to each of the four demographic criteria (abundance, growth rate/productivity, spatial structure/connectivity, diversity).
- Risks for each demographic criterion were ranked on a scale of 1 (no or very low risk) to 5 (very high risk).

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Scalloped hammerhead (cont.)

1 = No or very low risk: It is unlikely that this factor contributes significantly to risk of extinction, either by itself or in combination with other factors

2 = Low risk: It is unlikely that this factor contributes significantly to risk of extinction by itself, but some concern that it may, in combination with other factors.

3 = Moderate risk: It is likely that this factor in combination with others contributes significantly to risk of extinction.

4 = High risk: It is likely that this factor, by itself, contributes significantly to risk of extinction

5 = Very high risk: It is highly likely that this factor, by itself, contributes significantly to risk of extinction

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Scalloped hammerhead (cont.)

Overall extinction risk assessment:

1 = No or very low risk: It is unlikely that this DPS is at risk of extinction due to projected threats or trends in abundance, productivity, spatial structure, or diversity.

2 = Low risk: It is unlikely that this DPS is at risk of extinction due to trends in abundance, productivity, spatial structure or diversity; however ,current threats (or projected threats) may be (or will be) altering those trends but not yet by enough to cause the species to be influenced by stochastic or depensatory processes.

3 = Moderate risk: A species has a moderate risk of extinction if it exhibits a trajectory indicating that it is approaching a level of abundance, productivity, spatial structure, and or/diversity that places its current or future persistence in question. A DPS may be at moderate risk of extinction due to declining trends in abundance, productivity, spatial structure, or diversity and current or projected threats that inhibit the reversal of these trends.

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Scalloped hammerhead (cont.)

4 = High risk: A species with a high risk of extinction is at or near a level of abundance, productivity, spatial structure, and or/diversity that places its current or future persistence in question. Similarly, it may be at high risk of extinction if it faces clear and present threats that are likely to create such demographic risks.

5 = Very high risk: A species is at a very high risk of extinction if it is strongly influenced by stochastic or depensatory processes, facing current threats exacerbating the demographic risks, and indicating imminent extinction.