

Assessing Extinction in Freshwater Fishes

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Part 1: Jason Baumsteiger
Understanding Extinction

Part 2: Peter Moyle
Extinction in California fishes



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A Quick Clarification...

Most laws require a group of organisms be defined as a “distinct entity”.

But there are lots of “distinct” groups.

Species

Subspecies

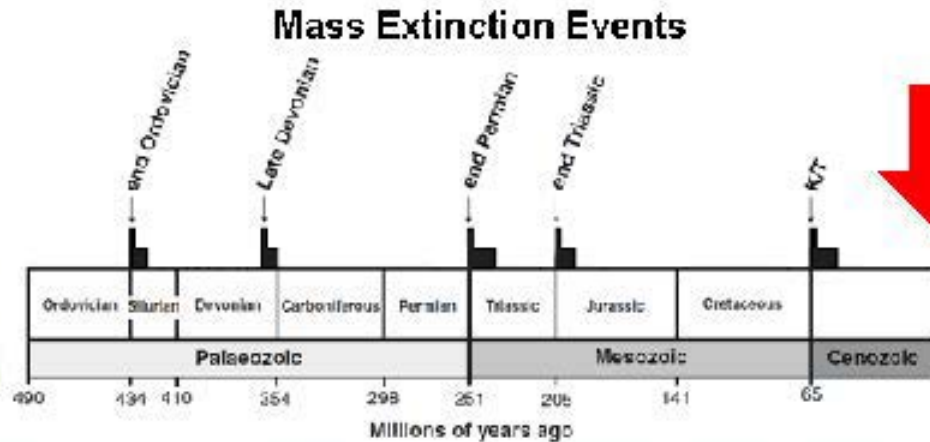
Distinct Population Segment (DPS)

Evolutionarily Significant Unit (ESU)

Management Unit (MU)

To avoid this problem, we will simply use the term **lineage** .

Lots of things are driving lineages to extinction, leading to the ongoing 6th mass extinction event.



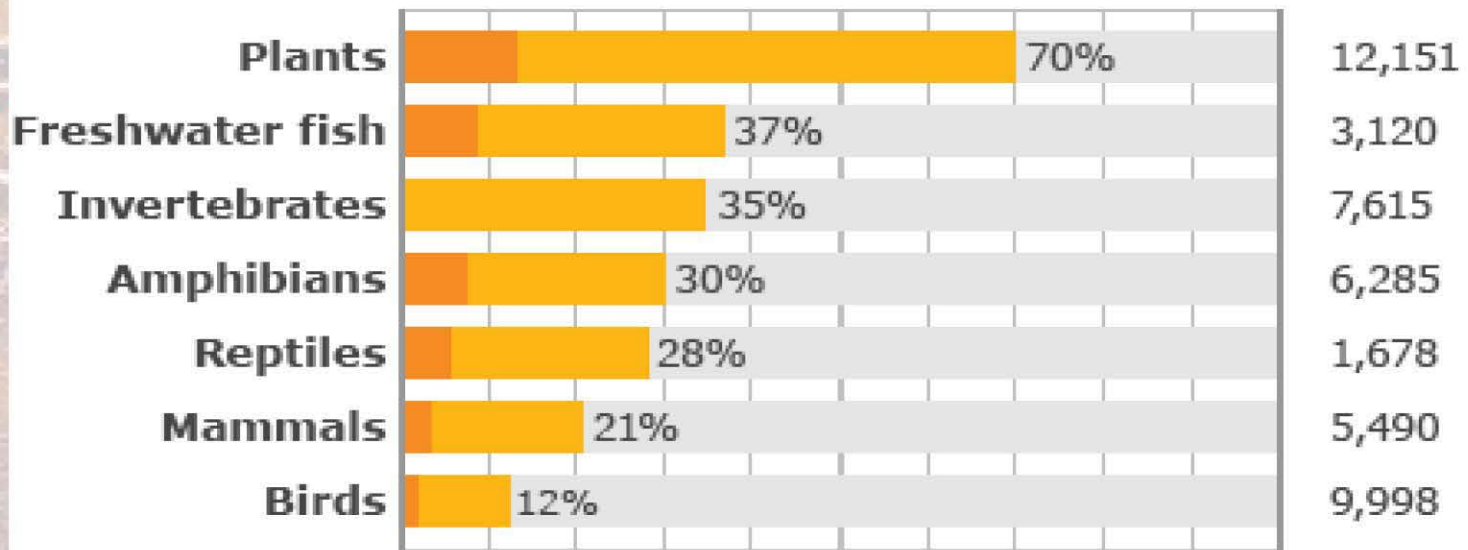
Freshwater fishes are prime candidates for multiple extinctions in the near future.

Species under threat globally

% of species assessed so far that are threatened:

 Critically Endangered where known  Endangered or Vulnerable

Number
of species
assessed



Source: IUCN

Human Impacts are Unavoidable

Indirect

- Affect the whole system
- Natural selection is the primary driver
- Can have a 'natural' alternative



Direct

- Lineage-specific
- Artificial selection is the primary driver
- Only humans can cause these changes



Ideas important in preventing *and* assessing extinction.

Important Discernment

In order to properly assess extinction:

Direct methods for “saving” a lineage can also lead to its further loss



Big difference when we replace Natural Selection with Artificial Selection

Direct effects		
Tenets	Natural Selection	Artificial Selection
Variation in traits	<i>Different</i> combinations of traits throughout lineage	<i>Specific</i> traits selected for or prevented
Differential reproduction	Mating success and fecundity is <i>variable</i>	Mating success and fecundity is <i>maximized</i>
Heredity	Surviving adults pass on their specific genome	Artificial mating; genetic modification
Selective pressure on traits	Pre-zygotic barriers; Predation; Biological interactions (mutualism, commensalism, parasitism); Limited resources; Variable habitat; Co-evolution; Competition	No pre-zygotic barriers; No predation ; No biological interactions; Supplemental feeding; Artificial habitats; Isolation; No competition

An Example

Through artificial breeding, wolves were domesticated and certain traits selected for, giving us ?

Can we release pugs back into Montana and expect them to be wolves again?

Have an almost identical genome, but are they the same thing?



To assess extinction, right now we use The International Union for Conservation of Nature (IUCN) Guidelines

Least Concern

Near threatened

Vulnerable

Endangered

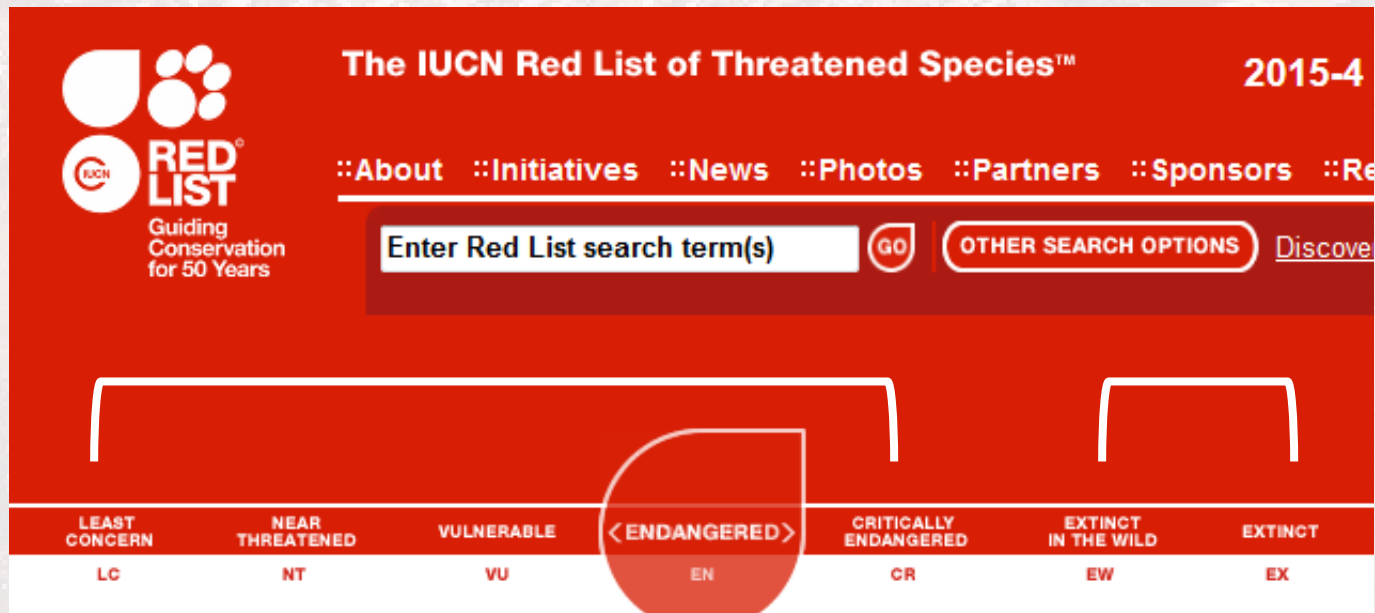
Critically Endangered

Extinct in the Wild

Extinct

Wait 50 years before declaring extinct

“There is no reasonable doubt that the last individual has died.”



Is extinction really a black or white issue?

(Presence/Absence)

- Is a lineage extinct if a single individual still exists?
- What if a lineage
 - is wholly reliant on humans?
 - is absent from its native range?
 - has no habitat left at all?
- What if it has been
 - genetically modified?
 - hybridized with another lineage?
- Most lineages are rather cryptic at small population sizes, leaving reasonable doubt if the last individual is gone.



Thus we believe *extinction has a gray area!*

What we propose... “Gray Extinction”!

Between threatened/endangered and extinction lies a gray area *where some level of extinction has been reached.*

5 categories in this “gray area”

- each assessed on whether direct effects are applied to “save” the lineage.

A final category represents “true” extinction.

Six categories of extinction

Ex¹ Mitigated extinction “Gray Extinction”

- Conservation-reliant
- Depends on human action (continuous or intermittent)
- Intentional hybridization or Genetic modification

Ex² Regional extinction

- Extinct in a geographically distinct part of its native range

Ex³ Native-range extinction

- No longer present in its native range but introduced elsewhere

Ex⁴ Wild extinction

- No longer present in any natural environment
- Captive populations in hatcheries or artificial habitats.

Ex⁵ Apparent extinction

- No verified observation anywhere
- A waiting period based on generation time

Ex⁶ Global extinction

- No verified observation anywhere, even after waiting period.

Apparent Extinction

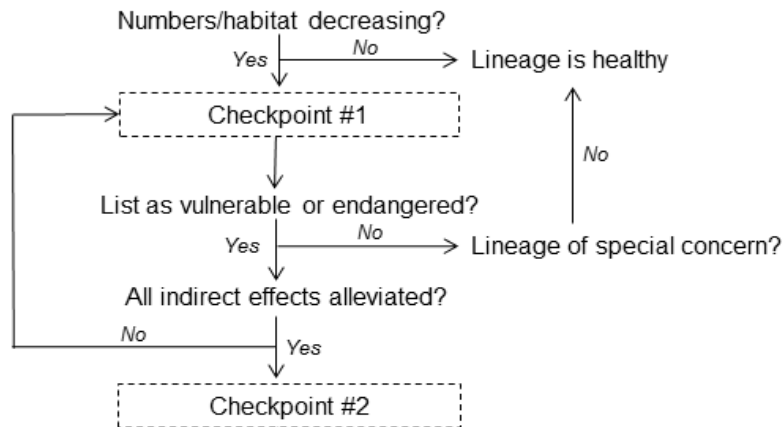
Rather than wait a set number of years (like 50),
we propose the wait time be based on generation time

0 – 5 year generation time - 10 generations
> 5 year generation time - 5 generations



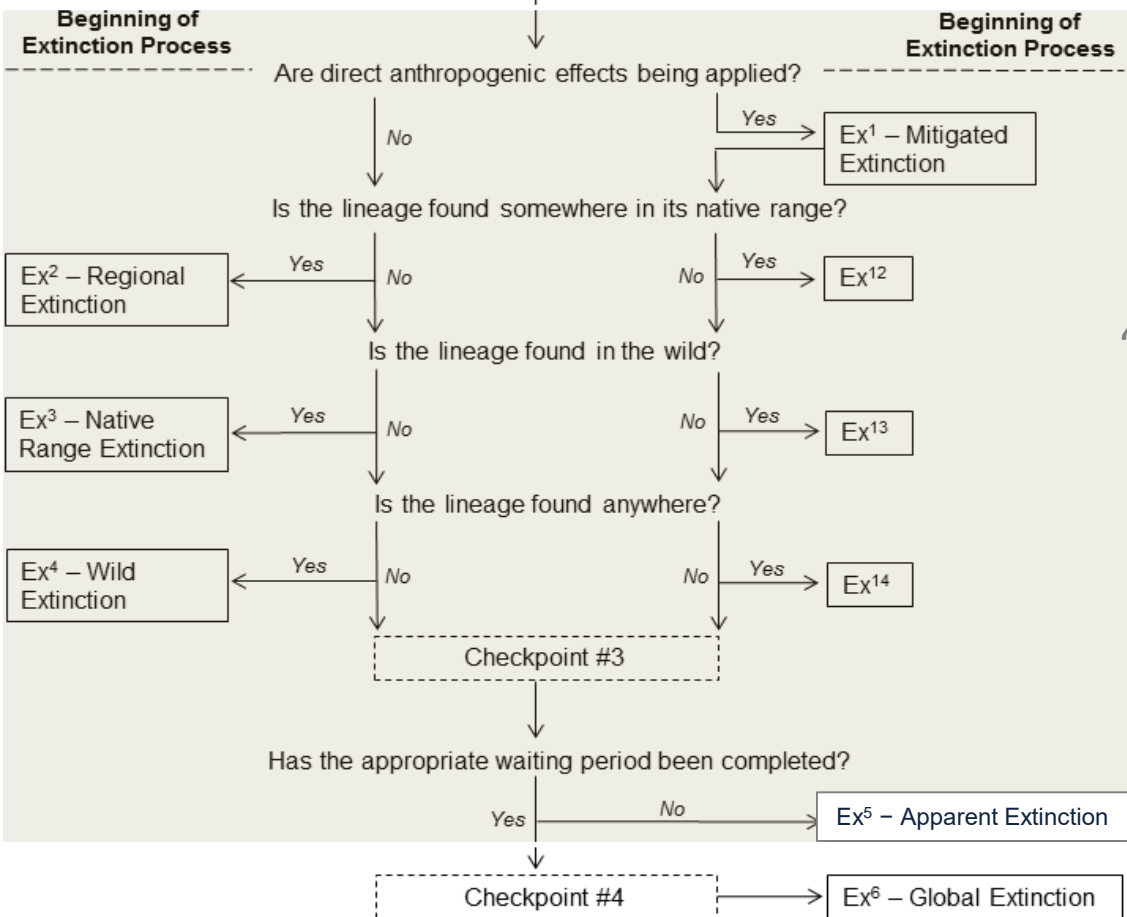
Pupfish (1 year) vs. Sturgeon (5-11 years).





Traditional IUCN categories

Guidelines assesses a lineage's status in our categorical system or traditional IUCN categories



“Grey Extinction”

Checkpoints (in dashed boxes) are evaluation points for assessment by a committee

Total Extinction

Conservation Relevance

1. Listings do not show how much of the lineage may already be lost.
Therefore emphasizing “gray extinction” improves prevention
2. Lineage-specific efforts are:
 - Costly
 - Often permanent
 - Alter the evolutionary trajectory
 - Should be only used as a last resort to save a lineage
 - But in the end, something is better than nothing.**
3. Instead indirect methods should be applied:
 - Highlighting large-scale habitat/ecosystem restoration
 - Costs are more timely
 - Benefits all lineages, not just a single one
4. Our guidelines/categories represent an initial foray into recognizing the difficult problems with assessing extinction and hopefully will bring to light additional ideas as we move forward.

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Questions?



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