Targets of Protection and Related Endpoints:
Structures and Functions of Organisms, Populations, and Ecosystems

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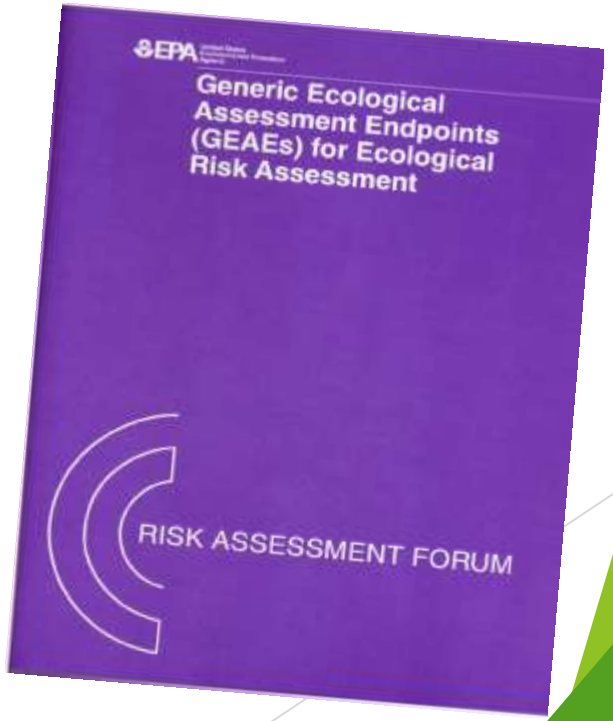
Assessment Endpoint: Definition

An assessment endpoint is the formal expression of an actual environmental value of concern that can be evaluated objectively either through direct measurement/observation or through a logical relationship with a surrogate measurement or observation

Presents policy and technical foundation for adopting a wide range of assessment endpoints (US EPA 2003).



An updated version due out soon from the US EPA will include Ecosystem Service Endpoints

Assessment Endpoints

- An Assessment Endpoint, at minimum, includes an entity and an attribute – but a location and time period are useful though optional in many cases
  - An entity (e.g., a species or population of interest)
  - An attribute (e.g., number, size, rate, condition)
  - A location (e.g., a specific reach of a stream)
  - A time period (e.g., 2015 through 2020)
- Examples — Ecological Receptors: {entity} {attribute} {location} {time}
  - The growth of trout in Fish Creek over the next five years

    An organism attribute associated with the individuals in an assessment population
  - The productivity of the trout population in Fish Creek over the next five years

    A population attribute associated with an individual assessment population
  - The average productivity of trout populations in Region Y over the next five years

    A population attribute associated with a set of populations

Organism-based Focus

Advantages

- Direct and read-across correspondence to toxicity tests
- Often includes multiple effects endpoints (growth, survival, fecundity)
- Effects endpoints mostly amenable to acute and chronic exposures
- Dose (internal) can be measured directly or through use of -omics

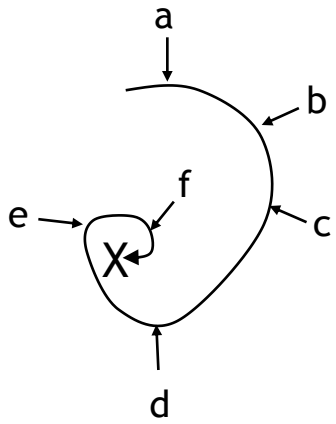
Limitations

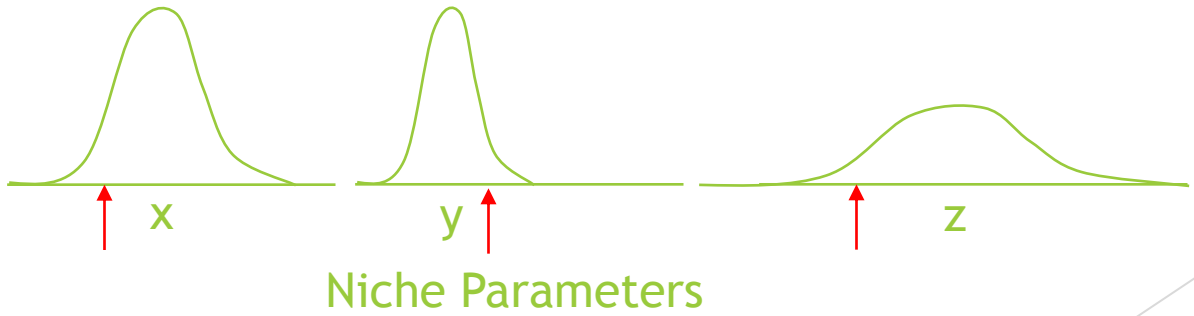
- Indirect or secondary effects not observable in most standard tests
- Dynamics of population effects not captured
- Effects of multiple, concurrent stressors seldom considered
- Test organisms usually in near optimal conditions unlike in real world settings

Multiple Stressors

- Arguably no organism resides at the optimum position for all of its niche parameters (i.e., “stress” is a constant).
- Acclimation is an important survival mechanism for organisms – a means of finessing the effects of specific stressors.
- Adaptation is an important evolutionary mechanism that adjusts population fitness to changing environments.
- Cumulative effects of stressors confound predictive capacity regarding particular stressor effects.

Death Spiral





Population-based Focus

Advantages

- Addresses the most commonly claimed regulatory target (i.e., protect population)
- Indirect or secondary effects assessed (e.g., effects on food source, prey; effects on predators)
- Considers multiple, concurrent stressor effects.

Limitations

- Little or no ecotoxicity data available
- Level of effort and costs to obtain experimental data much greater than organism-based studies
- Phenology restricts the times that studies can be done

Ecosystem-based Focus

Advantages

- Inherently addresses complexity (interactions among abiotic and biotic components)
- Addresses temporal and spatial dynamics
- Field studies and models can be more explanatory in terms of system trajectories
- Can be simulated using cosms

Limitations

- Each setting is unique – lessons from one place or time to another may not be transferable
- Costs can be considerable
- Systems responses may take years, even multiple decades before they are observable

Ecosystem Services Focus

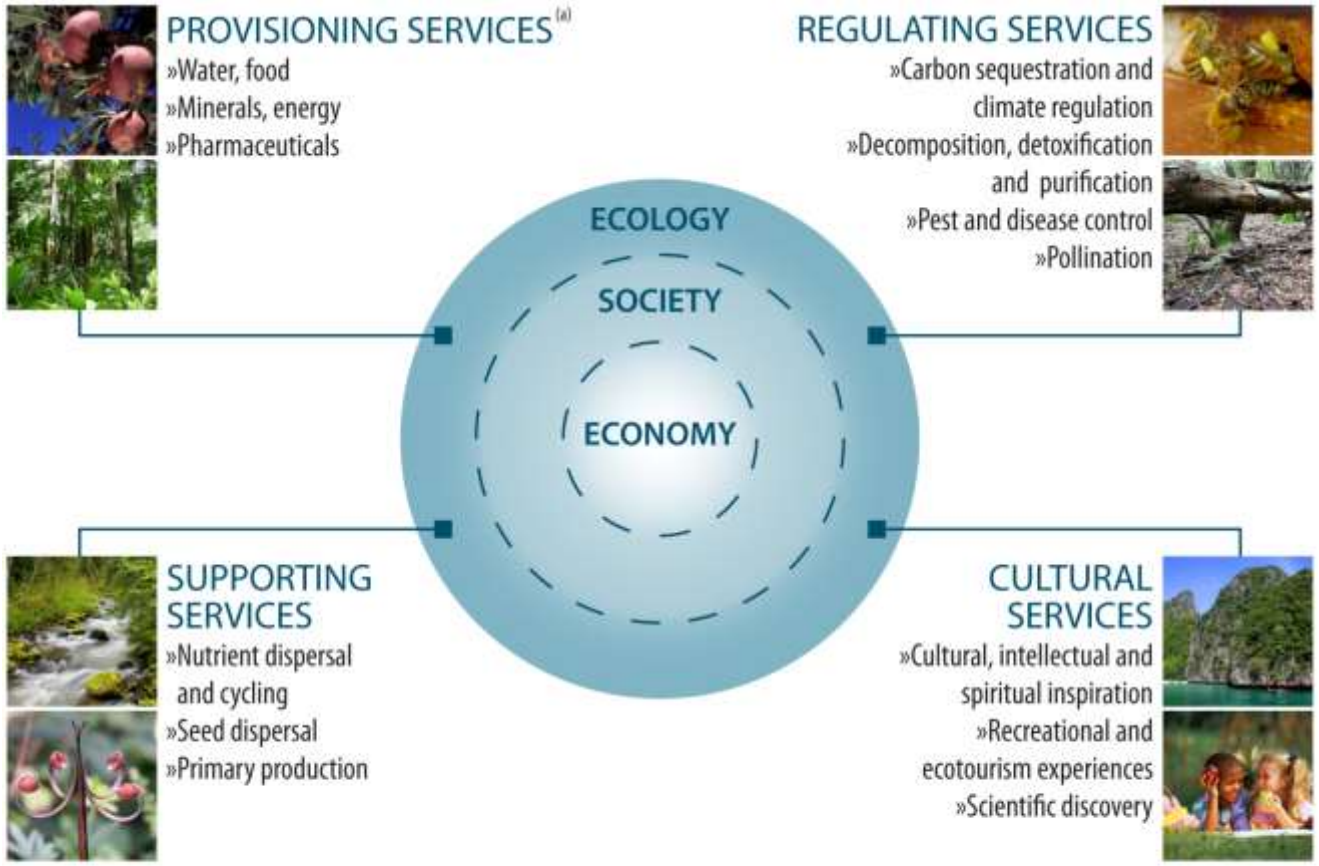
- Explicitly considers the delivery of goods and services that people care about
- Ecosystem services endpoints can be used in the existing ecological risk framework
- May be especially important for ionizing radiation settings especially in areas with
  - little demonstrable adverse effects to plants or wildlife
  - but subject to exclusion of humans as a safeguard for human health (and thus constituting a loss in terms of many ecosystem services, particularly provisioning services).

Importance of Habitat in EcoRA

- Wildlife respond to differences in landscape features (attraction, avoidance)
- Spatial relationships between stressors and foraging activities influence exposure
  - Co-located distributions increase exposure
  - Disjoint distributions decrease exposure

Ecosystem Services – sustainability

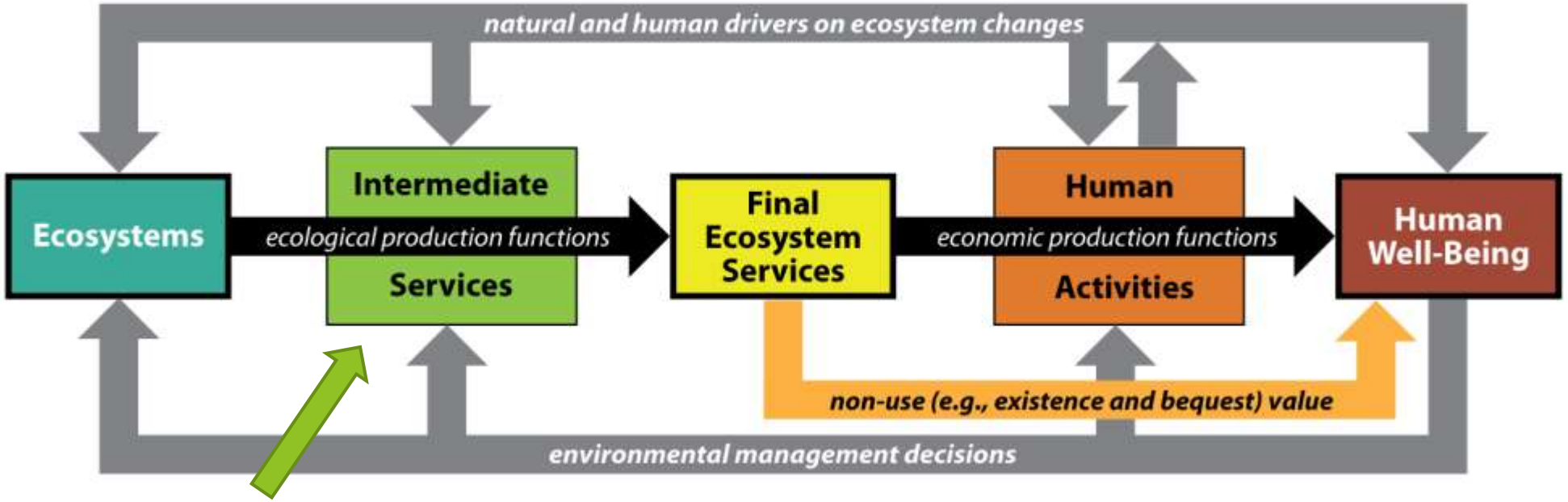
Ecosystem Services: the "benefits people obtain from ecosystems" (MA 2005)



[a]Services categories per: *Millenium Ecosystem Assessment 2005, "Living Beyond our Means: Natural Assets and Human Well-Being," Statement from the Board, pg. 7.

[McCormick et al. 2012.]

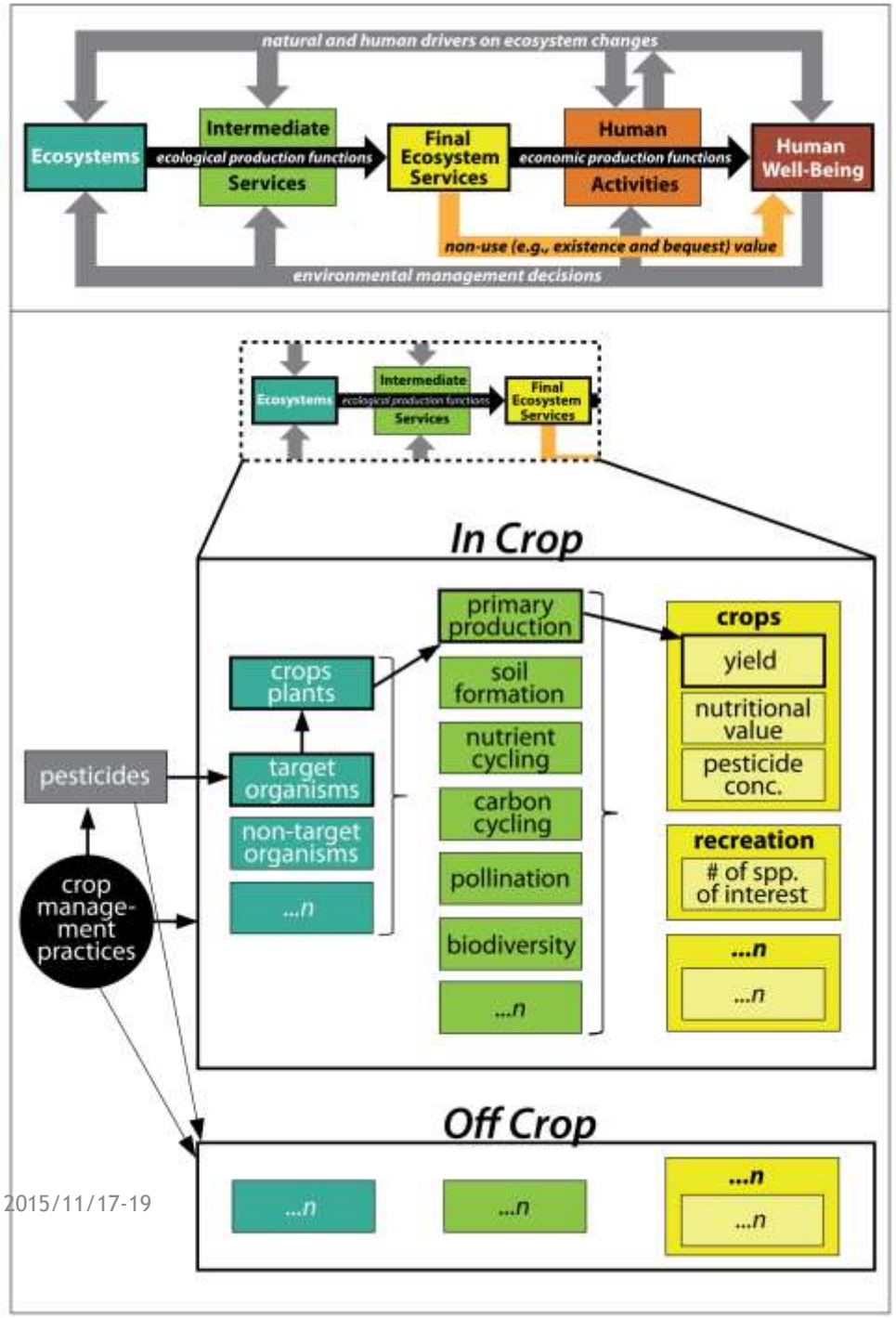
- …EPFs translate ecological changes into outcomes that people use or value.” [Wainger and Mazzotta 2011]
- “a description of the type, quantity, and interactions of natural features required to generate measurable ecological outputs” having “clear … relevance to human wellbeing.” [Munns et al. *in review*]



EPFs are *usable expressions (i.e., models) of the processes by which ecosystems produce ecosystem services, often including external influences on those processes*.

encompasses cardinal (fully quantitative), ordinal (rating, ranking), and qualitative (yes-no, plus-minus) expressions

A sample conceptual model that considers multiple ES, including some requiring consideration of trade-offs.



Closing Comments

- Organism-based Efforts
  - Provide high quality data that are relatively easy to corroborate through repeated experiments
  - Have the least relevance to the different regulatory entities – endpoints at population and higher levels of ecological organization
- Population-based Efforts
  - Quality data acquisition more difficult and costly than organism-based efforts
  - Higher relevance to stated protection goals
- Ecosystem-based Efforts
  - Generally, one-off studies due to the uniqueness of any ecosystem
  - Highest relevance to protection goals, including consideration of ecosystem services

Selected Literature

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