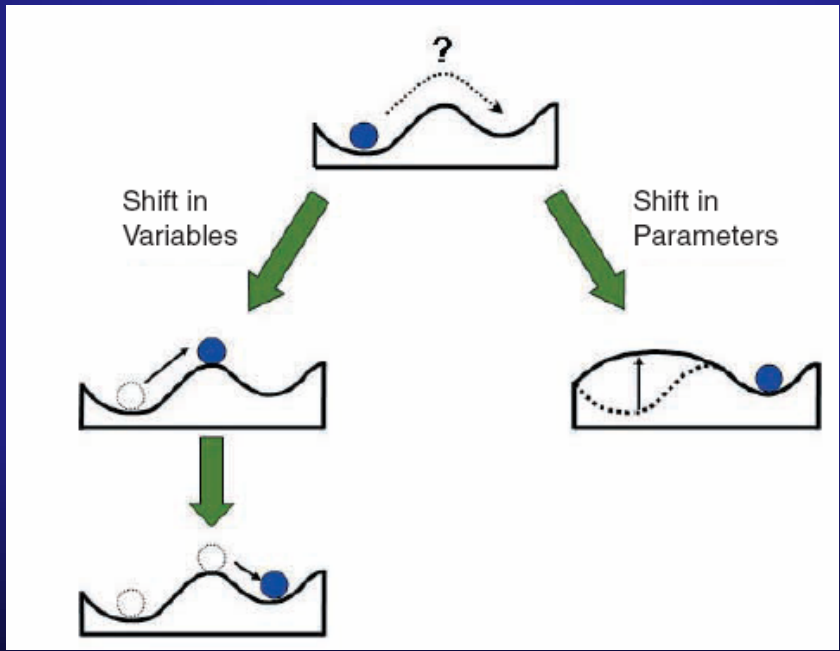
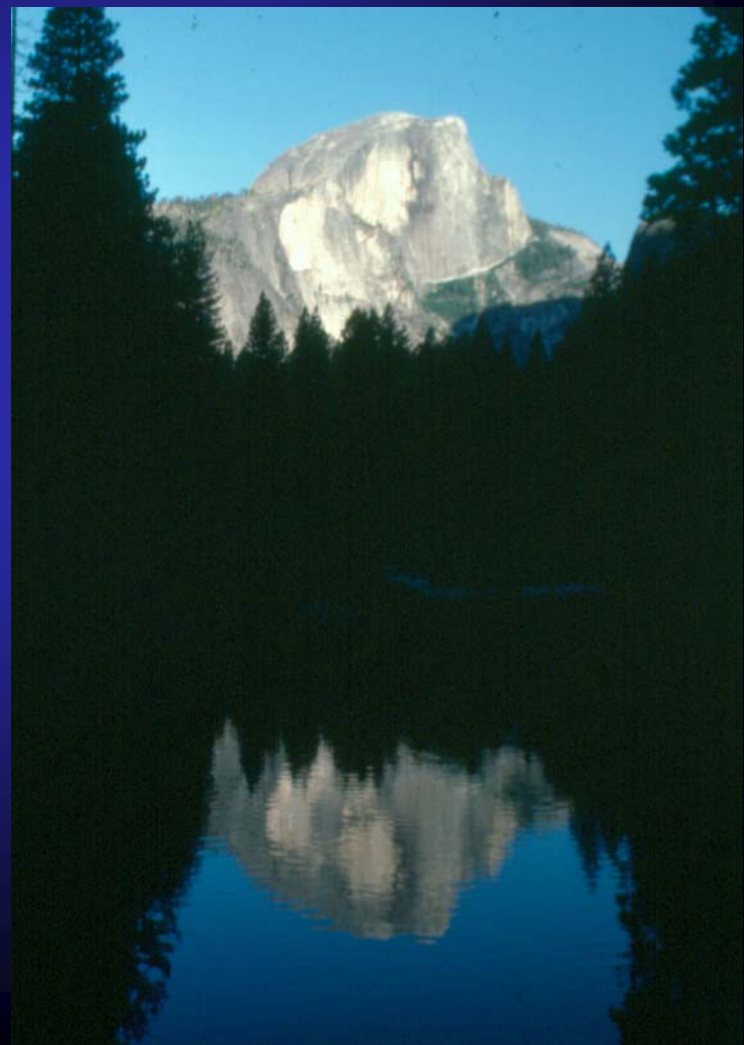
On Thresholds and Assessment Points: Making Sense Out of Data

John Gross
NPS I&M Program
NARSEC 2007
March 8, 2007



(Beisner et al. 2003)

1. NPS planning context
2. Semantics and definitions
3. Framework for thresholds
4. Challenges and invitation



Park Planning/Strategic Planning Relationship

General Management Plan (GMP): describes long-range management prescriptions – visitors, resources, etc.

10-20 years

Resource Stewardship Strategies:

- Provide quantifiable, measurable objectives to develop management strategies and measure success of actions
- Develop park's science strategy to **achieve & maintain desired future resource conditions**

10-20 years

Five-year Strategic Plan

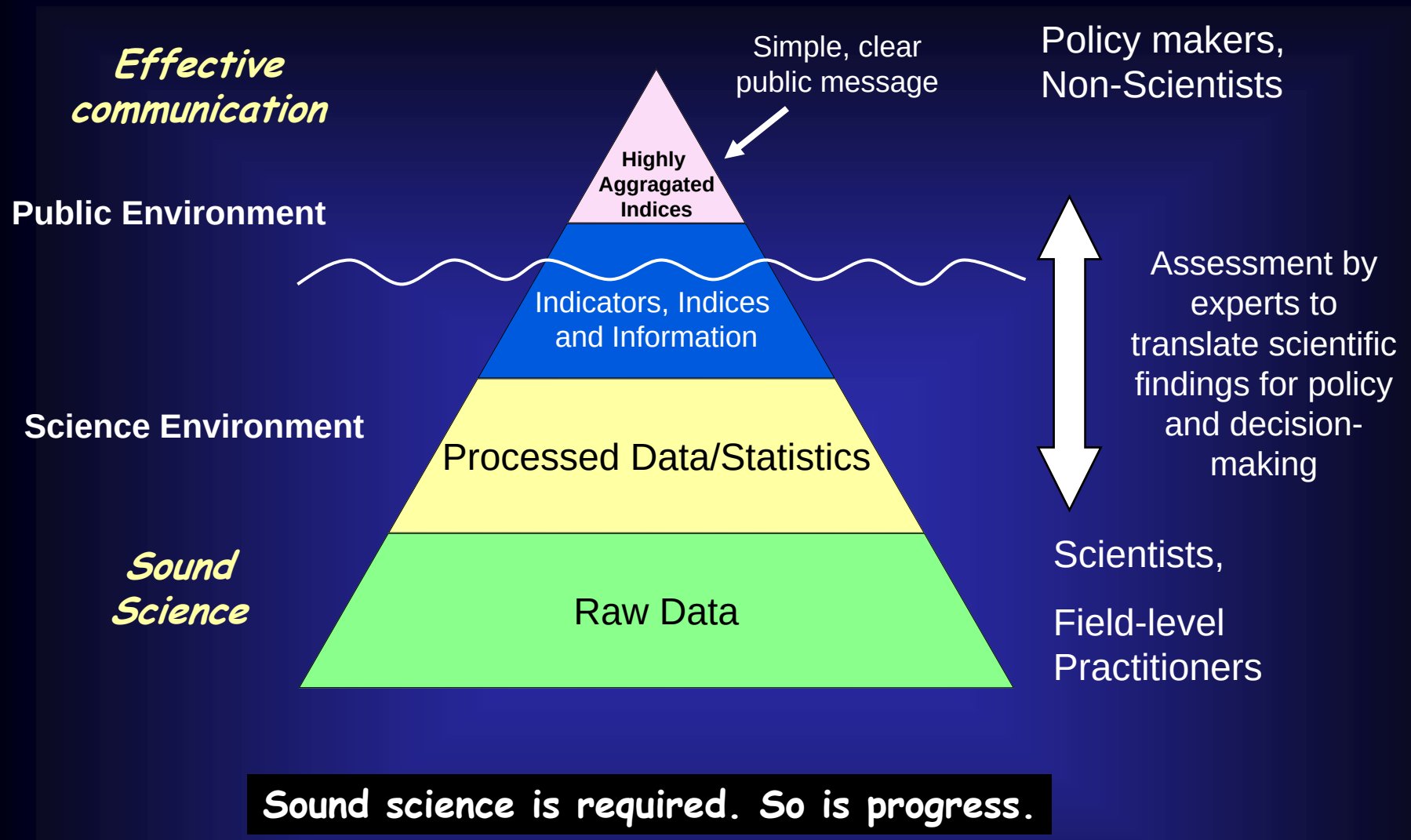
- Developed for performance management purposes (GPRA)
- Designed to implement broadly-defined strategies from Resource Stewardship Plan

Detailed Implementation Plans:

(e.g. Fire Management Plan, River Management Plan, Cultural Landscape Management Plant, etc.)

Herbert Hoover NHS – Resource Stewardship Strategy **(simplified table)**

Significant Resources*	Indicators	Current Condition	Target Condition
Prairie Community	Shannon Diversity – Native Plants	1.51	>2.63
	Invasive Plant Relative Cover	11%	<8%
	# of Grassland Bird Species	5	5
Stream Community	State Water Quality Standards	Not Met	Met
	IBI	5.5	4.3


Effective communication
Simple, clear public message
Policy makers, Non-Scientists
Public Environment
Highly Aggragated Indices
Indicators, Indices and Information
Assessment by experts to translate scientific findings for policy and decision-making
Science Environment
Processed Data/Statistics
Sound Science
Raw Data
Scientists,
Field-level Practitioners
Sound science is required. So is progress.

Rangeland Ecol Manage 59:225–236 | May 2006

Invited Synthesis Paper

A Unified Framework for Assessment and Application of Ecological Thresholds

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Abstract

The goal of this synthesis is to initiate development of a unified framew
ecological theory and processes with management knowledge and applicat
threshold mechanisms, elaboration of threshold components, introducti
presentation of an
because they have
sequences for land
feedbacks that ma
the development o
ecological benchma
determine threshol
follow once a thres

Threshold Concepts and Their Use in Rangeland Management and Restoration: The Good, the Bad, and the Insidious

Brandon T. Bestelmeyer[1,2]

Available online at www.sciencedirect.com

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BIOLOGICAL CONSERVATION

Biological Conservation 124 (2005) 301–310

www.elsevier.com/locate/biocon

The concept and utility of 'ecological thresholds' in biodiversity conservation

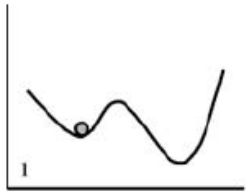
Andrew J. Huggett *

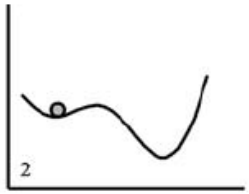
CSIRO Sustainable Ecosystems, Private Bag 5, PO, Wembley, WA 6913, Australia

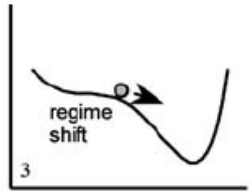
Ecosystems (2006) 9: 1–13
DOI: 10.1007/s10021-003-0142-

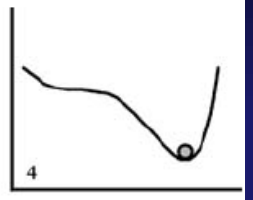
Ecological Thresholds: The Key to Successful Environmental Management or an Important Concept with No Practical Application?

Thresholds in ecology – the usual view









clear-water lakes	phosphorous accumulation in agricultural soil and lake mud	flooding, warming, overexploitation of predators	turbid-water lakes
coral-dominated reefs	overfishing, coastal eutrophication	disease, bleaching hurricane	algae-dominated reefs
grassland	fire prevention	good rains, continuous heavy grazing	shrub-bushland
grassland	hunting of herbivores	disease	woodland
kelp forests	functional elimination of apex predators	thermal event, storm, disease,	sea urchin dominance
pine forest	microclimate and soil changes, loss of pine regeneration	decreased fire frequency, increased fire intensity	oak forest
seagrass beds	removal of grazers, lack of hurricanes, salinity moderation, spatial homogenization	thermal event	phytoplankton blooms
tropical lake with submerged vegetation	nutrient accumulation during dry spells	nutrient release with water table rise	floating-plant dominance

(Folke et al 2004)

Semantics are problematic

Ecological Thresholds:

- Sudden transition from one (perhaps irreversible) state to another
- Non-linear dynamics
- "Abrupt changes" in ecosystem

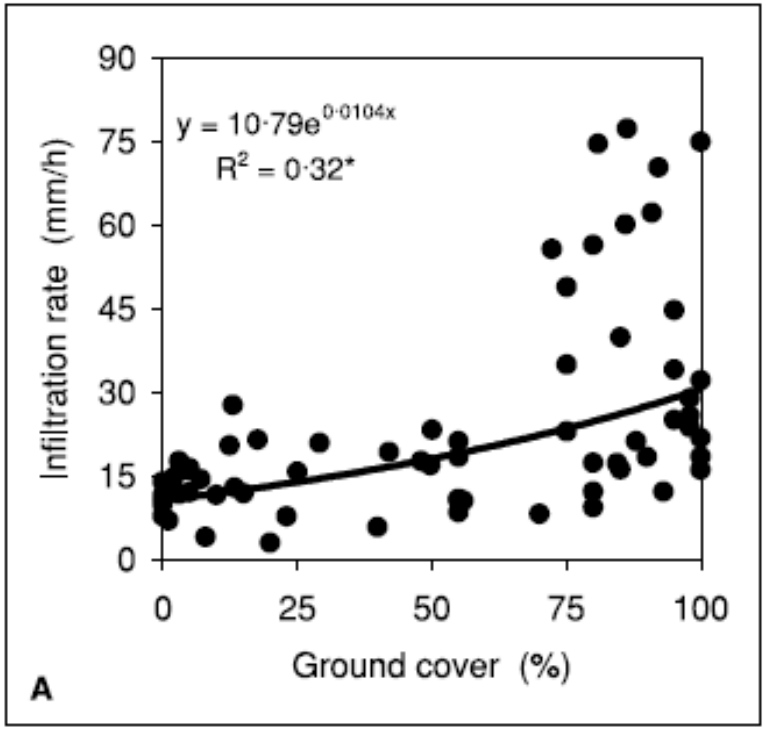
Management Thresholds:

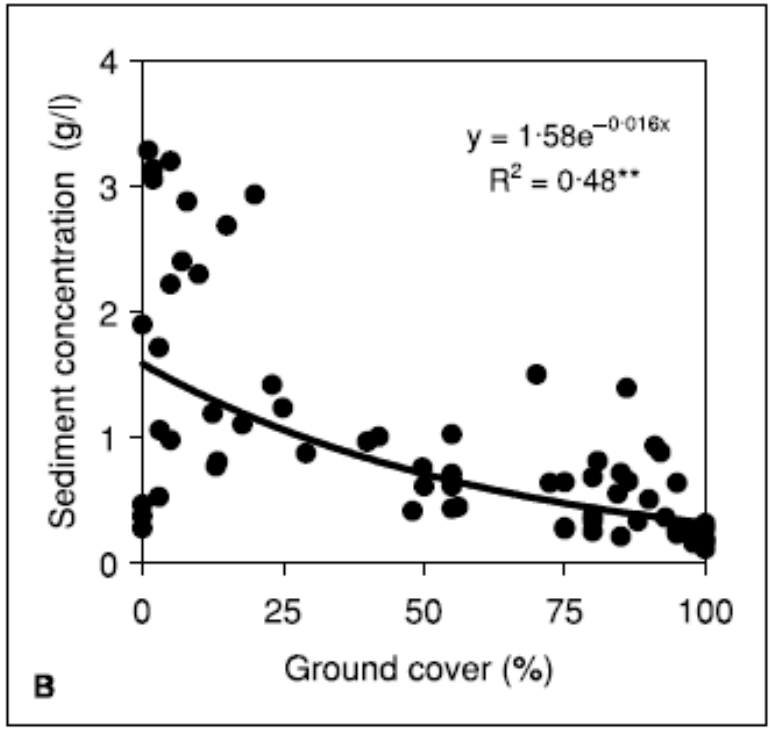
- Exceeding regulatory limit (air, water quality)
- Indicates need for management action (visitor capacity exceeded)

Assessment point

- State, value, condition, or rate of change that triggers action
- For us, primary focus on scientific evaluation. What are environmental consequences? What are *recommended* actions and likely outcomes of actions?

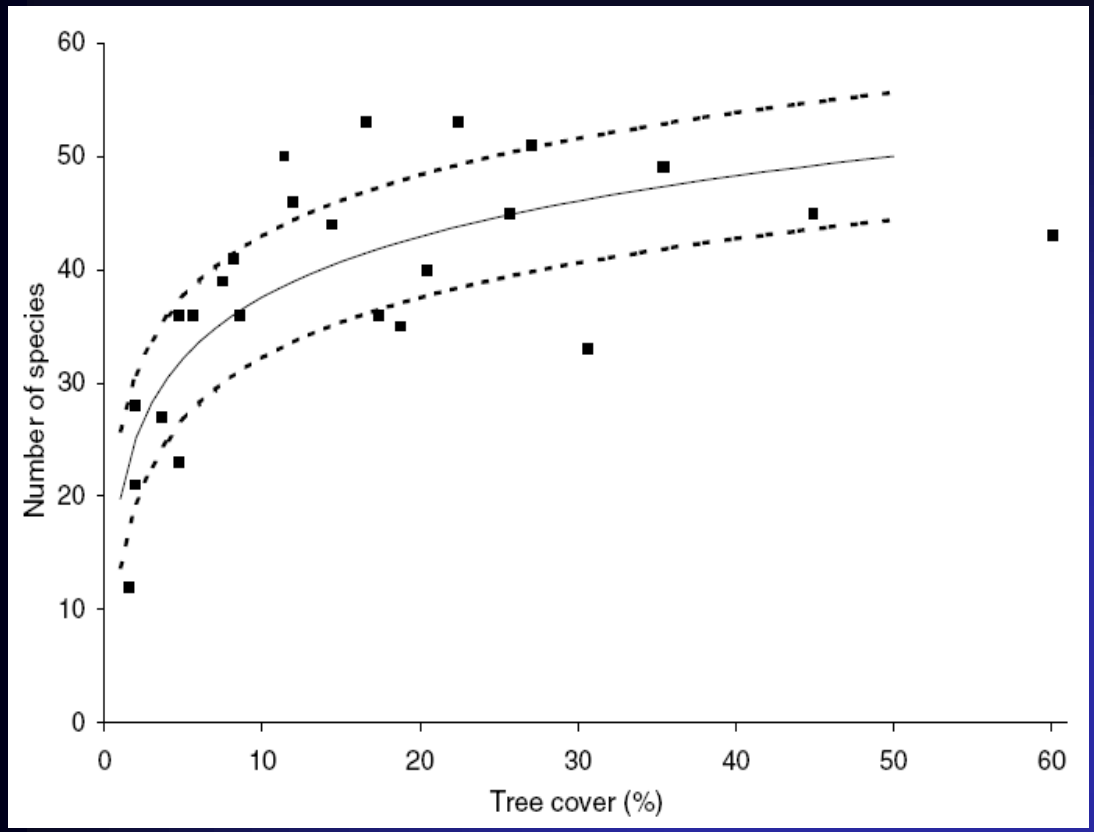
Actions - mild to extreme - examine data to close campground, etc.



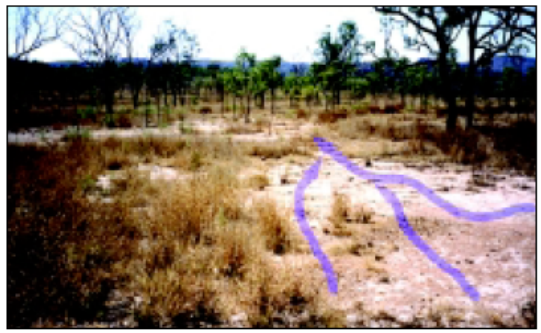


(Roth 2003)

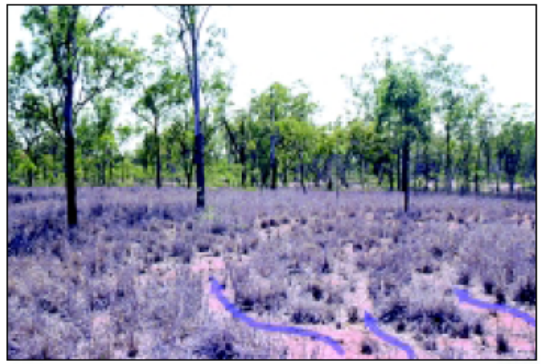
Thresholds *do* exist!



Australian woodland birds (Radford et al. 2005).



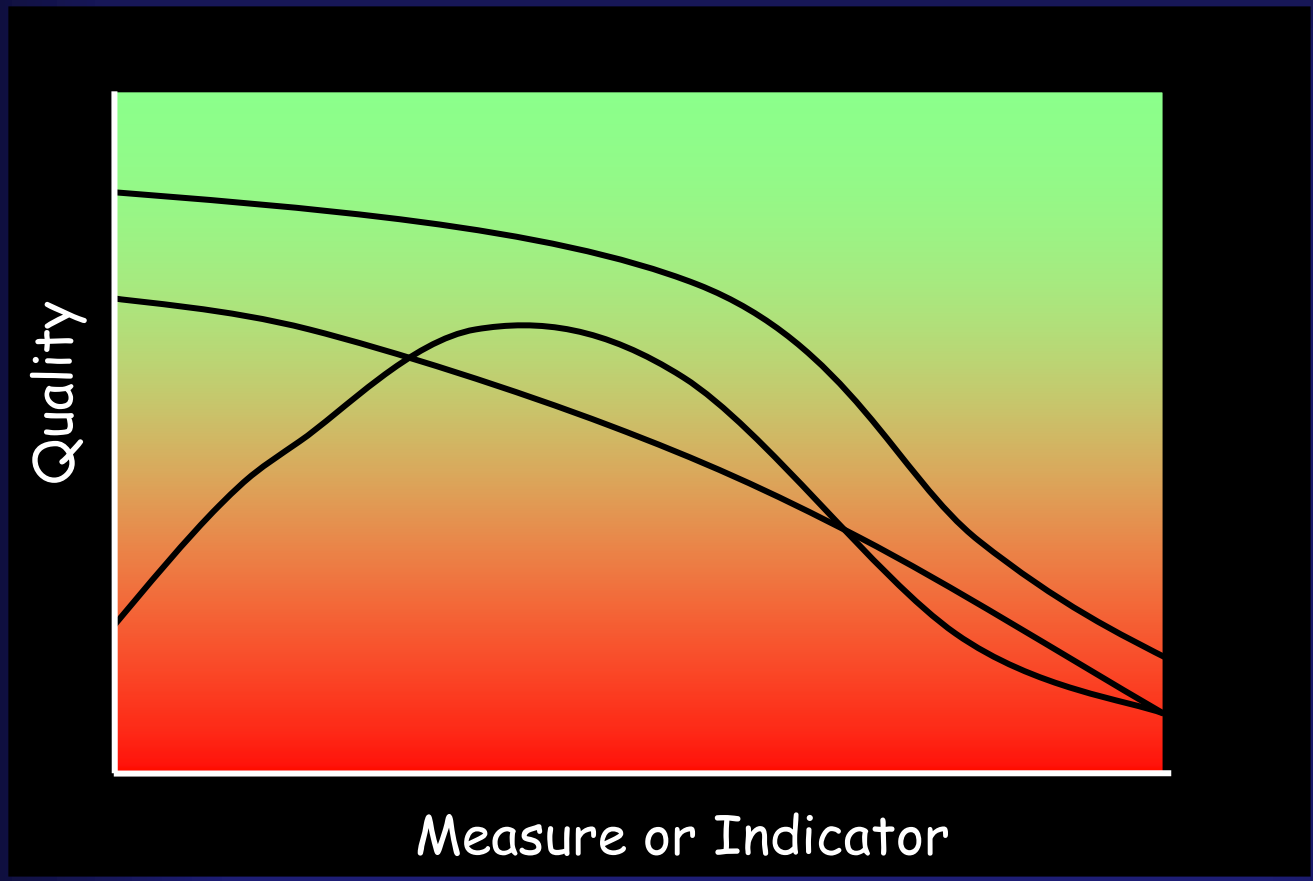
A 'leaky' system sheds water and nutrients, reducing pasture productivity.

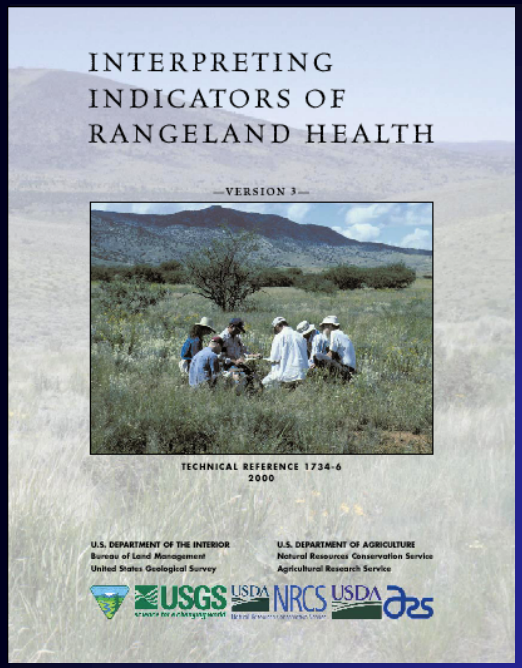


A 'stable' system traps water and nutrients within perennial grass tussocks.

(Ash et al. 2001)

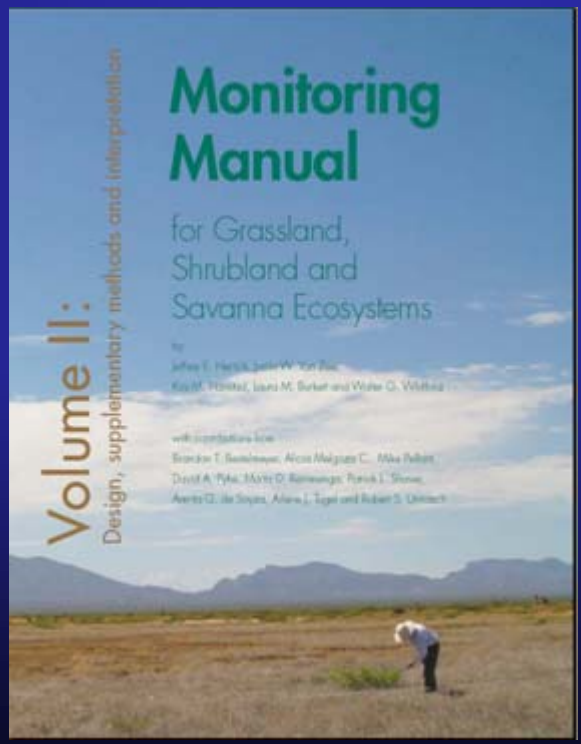
Where do we draw the line?





Qualitative Condition Assessment

	Degree of Departure from Ecological Site Description and/or Ecological Reference Area(s)				
Indicator	**Extreme**	**Moderate to Extreme**	**Moderate**	**Slight to Moderate**	**None to Slight**
1. Rills	Rill formation is severe and well defined throughout most of the area.	Rill formation is moderately active and well defined throughout most of the area.	Active rill formation is slight at infrequent intervals, mostly in exposed areas.	No recent formation of rills; old rills have blunted or muted features.	Current or past formation of rills as expected for the site.



Quantitative Monitoring

- Gap Intercept
- Soil Stability Test
- Soil Compaction Test

Thresholds:

% bare ground:

< 25	Normal monitoring (every 3-5 yrs)
25-50	Monitor every year
51-70	Reduce grazing density
>70	Remove all livestock;

% shrub cover in grasslands

< 15	Normal monitoring (every 5 yrs)
15-25 or > 10% & incr > 3%/yr	Monitor every year; do not control burns
> 25	Control burn when sufficient ground cover

A Classification of Thresholds – Bestelmeyer (2006)

Pattern threshold
- Grass cover connectivity
- Shrub density
- Habitat fragmentation

Process threshold
- Erosion rate
- Fire spread/frequency
- Dispersal/colonization rate

Degradation threshold
- Soil depth
- Nutrient availability
- Habitat Occupancy

Classification thresholds
- States recognized for prevention of change
- States recognized for restoration

A 'leaky' system sheds water and nutrients, reducing pasture productivity.

A 'stable' system traps water and nutrients within perennial grass tussocks.

(Ash et al. 2001)

Frameworks for Ecological Thresholds – Common elements from terrestrial-centric scientists

Key messages:

Scale is critical, and variable

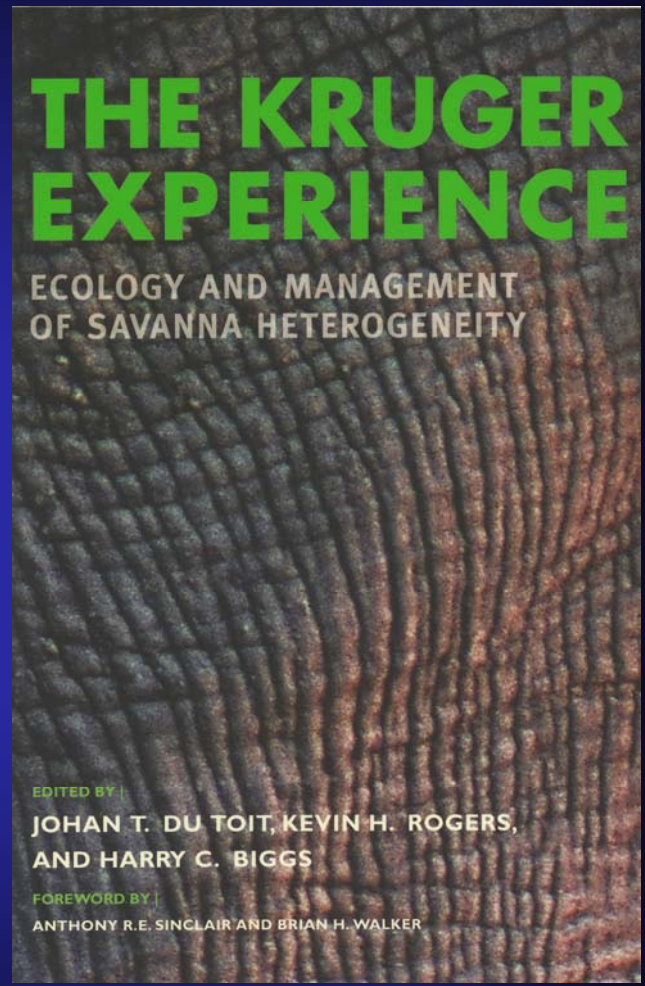
Kinds of thresholds include pattern, structure, process (functional), degradation. These differ with regard to appropriate management responses.

Physical assessment points are perhaps less ambiguous than biological.

Bestelmeyer. 2006. Restoration Ecol. 14: 325.
Briggs and Rogers. 2003. Kruger book, pp.
Briske et al. 2006. Rangeland Ecol. & Mgmt. 59: 225

Kruger's "Strategic Adaptive Management" plan:

"… It has a strong goal-setting component evidenced by a well-developed objectives hierarchy (Keeney 1992) and strongly articulated monitoring endpoints (called **thresholds of potential concern [TCPs]**). The objectives hierarchy and endpoints act as a nexus for connecting science, monitoring, and management in an innovative and motivating way. " (Biggs and Rogers 2003)



The concept of **Thresholds of Potential Concerns (TPCs):**

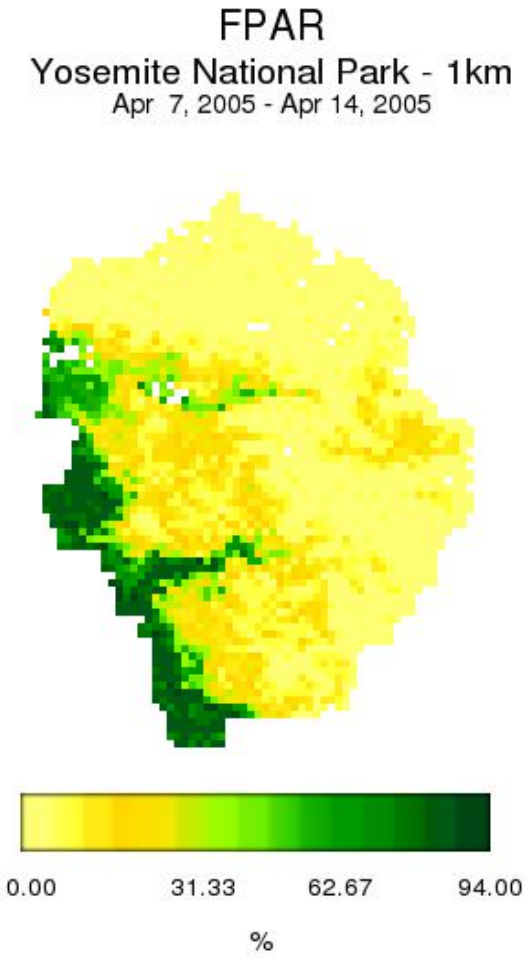
- TPCs are a set of operational goals …
- TPCs are defined as upper and lower levels along a continuum of change in selected environmental indicators. When this level is reached, or when modeling predicts it will be reached, it prompts an assessment of the causes of the extent of change.
- The assessment provides the basis for deciding whether management action is needed to moderate the change or to recalibrate the TPC.
- TPCs form the basis of an inductive approach to adaptive management because they are invariably hypotheses of limits of acceptable change ecosystem structure, function, and composition.

Kruger National Park implementation (Biggs and Rogers 2003)

Biophysical theme, Example of TPC, and Background	Simplified partial wording of TPC	Time and Space scales for collection and evaluation
Fire pattern, measured as long-term fire frequency Background: … fire pattern parameters such as frequency, seasonality, intensity, annual extent, and size distribution are surrogates of biodiversity (van Wilgen et al. 1998)	… proportion of area burnt vs. years since last fire should not exceed stated limits at 3 points … on an empirical .. curve typical of savanna systems: median (3.5-7.5 years), 80th percentile (5-10 years), and maximum postfire age (33 years)	Ongoing records of area burnt, at satellite image resolutions of 30 m, 250 m, and 1.1 km, calculated annually at end of fire seasons and currently computed over past 30 years for coarse resolutions.

(Biggs and Rogers 2003)

TOPS output - Fraction of photosynthetically active radiation absorbed (FPAR)



(slide from Nemani, Melton, et al. 2006)

A proposition ….

Attributes of effective assessment points:

- Quantitative
- Based on sound (some) documented science
- Linked to scientific evaluation (e.g., ecological consequences)
- Generally, note mitigation/remediation actions
- Not be stated as a demand
- Acknowledge the degree of uncertainty
- Contribute to iterative process of refinement

And a few challenges …

- We hope most parks are focused on the 'pristine' end of the scale, rather than 'impaired' or 'degraded'. This end of the continuum is relatively poorly described.
- Temporal scale: How do we identify 'correct' time scales, and integrate information about attributes that operate on different scales?
- We need a widely applicable, integrative, transparent, and management-relevant framework for developing and applying thresholds.
- Separation between responsibilities for monitoring / assessing data and enacting actions in response requires sensitive communication.

A couple questions …

Are "assessment points" a useful concept for evaluating and communicating about landscape-scale data? If not, what's a better alternative?

What are the best examples / case studies of RS/landscape-scale assessment points and / or thresholds?

- impervious surfaces and WQ
- fragmentation and avifauna
- land use and water quality
- bare ground and runoff

What assessment points can be derived from landscape graphs?

Are any of these examples sufficiently robust to propose regional guidelines?

This is not an easy task … USGS-funded proposals on this:

- Craig Snyder and Dave Smith - Ecological thresholds and structured decision analysis using aquatic macroinvertebrate as indicators of stream health in the Mid-Atlantic and Eastern Rivers and Mountains vital signs networks.
- James Nichols - Structured decision making, ecological thresholds and the establishment of management trigger points.
- Howard Ginsberg - Development of ecological thresholds for vital signs associated with the National Park Service's salt marsh vegetation and salt marsh nekton monitoring protocols.
- Glenn Guntenspergen and Hilary Neckles - Ecological thresholds and natural resource management.
- Amy Symstad – Determining thresholds or acceptable ranges of variability for aggregate measures of plant community composition.