Location-based Approaches to Conservation.

One approach to conservation is to focus on maintaining viable populations of particular species. (The ***species-based*** or PVA approach… more later)

Critics of the species-based approach argue that conservation demands are too pressing to work one species at a time.

The main alternative to the species-based approach is to focus on communities or ecosystems instead of species, using a ***location-based*** approach.

Kiester et al. p. 1333 "Biodiversity is largely a matter of real estate. And as with other real estate, location is everything."

Giving land legal status as a ***protected area*** is the normal mode of action in the location based approach. Note that this generally assumes that ***human impacts and activities are the major problem***.

"Protected" can mean more than one thing.

IUCN (International Union for the Conservation of Nature) classification system for protected areas:

1. Strict nature reserves and wilderness areas – emphasize ecosystem protection in undisturbed states. E.g. roadless, non-motorized areas.
2. National parks – emphasize ecosystem protection in relatively undisturbed state, allows also for recreation, no extraction.
3. National monuments & landmarks – similar to national parks but usually smaller, emphasize unique biological, geographic or cultural features. Less emphasis on protection of ecosystems.
4. Managed sanctuaries and reserves – similar to strict reserves, but allow for active management to create, maintain or restore "desired" conditions.
5. Protected landscapes/seascapes – nondestructive traditional human uses allowed (e.g. Ngorongoro Crater, discussed in Thirgood et al).
6. Managed resource protected areas – allow extraction or production of natural resources in a manner consistent with preservation of biodiversity.

Inevitably, the main issue for location-based conservation is:

Where should conservation efforts be directed?

1. Fall back on ***species approaches***, to some degree. *Advantage* – we usually know more about species distributions and requirements than we know about the needs of entire communities or ecosystems. *Disadvantage* – does not guarantee maintenance of functioning systems.

A. ***Umbrella*** species – conserve species with large area requirements, assuming that many other species will come along for the ride.
B. ***Flagship*** species – conserve species for which public support and resources can be mobilized, assuming that many other species will come along for the ride.
C. Flagships and Umbrellas often the same species – large vertebrates. Many examples of successful use, e.g. Elephants and tigers.
D. ***Sensitive or Indicator*** species – conserve species whose presence indicates ecosystem function is intact, assuming that habitat that supports indicator will support may others. Examples include amphibians (indicators of pollution) and pollinators (indicators of plant community integrity).

2. Use ***community/ecosystem*** approaches. *Advantage* – explicit focus on maintaining functioning systems. *Disadvantage* – we usually know less about community needs & functions than we do about spcies.

GAP Analysis or ***Hotspot*** Analysis are common methods of comparing conservation priorities with existing protected areas, to identify locations of use for conservation action.

Uses GIS and remote sensing heavily.

(Ohead: Primack 4.2)

General approach, as described by Michael Scott head of USGS GAP program:

1. Map ***land cover*** type at 1:100,000 scale – enough detail to assess habitat types well. Remote sensing for this.
2. Directly map ***animal distributions*** where possible. Need on the ground work for this, but use existing information where possible (museum records, breeding bird surveys, 'expert opinion').
3. Relate animal distribution data to land cover data, for areas with animal data.
4. Extrapolate distributions on basis of land cover data.
5. Map ***protection status and land use.***
6. Relate protection status map to distribution maps, to identify areas of high priority for protection or active management.

7. Five principles for establishing priority are ***hotspots***, ***complimentarity, gaps in protection***, ***sweep analysis***, and use of ***multiple scales***.

A. Hotspots – locations that include the maximum number of species of interest. Can be:
   1. Total species diversity
   2. Endemic species diversity

3. Endangered species diversity

B. ***Complimentarity*** – locations that do not necessarily include the maximum number of species of interest, but form a SET of locations that have complimentary sets of species, maximizing the total protected across all locations.

C. ***Gaps in current protection.*** First, use hotspots or complimentarity to define locations most useful to conservation goals. Then, ask which are:
   1. Useful to conservation
   2. Unprotected
   3. Facing immediate threats

D. ***Sweep analysis.*** Apply A,B & C to set priorities for one set of organisms (say plants) Then determine how well another, independent set of organisms would be protected by the same actions. How well are other taxa "swept up" by a focus on on one taxon.

E. ***Analysis at multiple spatial scales***. Broad scale analysis (state-wide, nation, continent) identifies broad areas of priority. There is likely to be important local variation in site quality, connectivity, level of threat. Broad analysis serves to focus effort in likely spots, but finer-scale work is then needed in those likely spots.
   1. If 'proxy data' or expert opinion were used for animal distributions, need real data.
   2. Need finer scale assessments of land cover variables. Habitat quality, patch sizes, connectivity, etc.
   3. Possibly also fine-scale analysis of threats.
   4. Kiester et al "once initial priorities have been set, other conservation biology research activities … determine reserve boundaries and management techniques necessary to maintain viable populations and ecosystem processes".

Kiester et al. 1996. First example of GAP analysis for an entire state (Idaho). Part of USGS nationwide gap analysis.

Goal – Select areas to maximize the number of species ranges protected, for all terrestrial breeding vertebrates.

Compare GAP priorities with traditional species-based (ETC – endangered, threatened, candidate) approach.

GIS coverages for (THINK ABOUT STRENGTHS AND WEAKNESSES OF THESE):

1) Vegetation classes (118 classes) mapped as irregular polygons) using:
   Existing veg maps
   Landsat multispectral reflectance data
   1944 polygons (min = 259 ha., median = 2537 ha [10 mi^2])
2) Species distributions within appropriate habitat for breeding terr verts (357 species) mapped into hexagonal grid with 640 km^2 cell size. Species occurrence

within a polygon does not reflect abundance, simply present/absent. Species distributions were modeled rather than measured, using information on variables usch as vegetation type, temperature, 'faunal regions', riparian zones, water bodies, etc.

3) Using same grid, vegetation class diversity = # of veg classes found (in any amount) within 640 km^2 hexagon.
4) Point locations of ETC species used to make set of ETC species present in each cell. (14 ETC terr verts.)
5) Mapped borders of all managed lands to determine existing protection from risk of extinction.

Initial decision rules were:

a. Species is protected if it occurs in $\geq$3 areas of $\geq$10,000 ha (40 mi^2) each that are 'protected'.
b. Area is 'protected' if it has a management plan that 'generally maintains biodiversity'
c. Excluded species whose range 'barely enters Idaho' defined as occurring in < 10% of Idaho for which Idaho is <10% of its total range.
d. This process left 83 terrestrial verts that were unprotected but of concern to the state.

Mapped distributions of the 357 species, and of the 83 unprotected and of concern.

(Oheads: Figs 1 & 2)

<u>Goals</u>:

1. Select a sequence of polygons so that each step adds maximum # of the 83 species.
2. Identify the smallest set of polygons that, taken together, would hold all 83.
3. Also applied logic of goals 1 & 2 to GIS coverages of vegetation classes (habitat protection approach) 14 ETC terr verts (narrower approach) and all 357 terr verts (broader approach).
4. Sweep analysis: which of the coverages best 'sweeps up' the other coverages.

(Ohead: Figs 3 & 4)

Best subsets of polygons to protect all 357 terr vertebrates - note that some polygons tie as the next best one to enter the set.

One from each subset is needed.
32 equally good combinations of 4 polygons. Subset 1 & 2 are unique polygons ("irreplaceable").
57 equally good combinations of 5 polygons. (1 & 2 irreplaceable).

(Ohead Figs 5 & 6)

Same best subsets analysis, for the 83 unprotected terr verts.

16 equally good sets of 4 (Subsets 1 & 3 are irreplaceable)
32 equally good sets of 5 (“ “ “ “ “)

(Ohead Fig 7)

Fig 7 gives accumation curves for protection obtained as a function of polygons protected, for all 4 layers.

As few as 7 polygons will include 96% if the 357 verts.
As few as 6 polygons include 100% of the 83 unprotected verts.
But 30 polygons are needed for 100% of the 14 ETC verts

(Note – this is in a way obvious. Species are ETC because they are harder than average to conserve in the face of habitat loss.)

Steep accumulation curve – provides clear guidance in priorities.
Flat accumulation curve – less information, guidance.

(Ohead Fig 8)

Sweeping analysis:

Fig 8 shows, in the top line of each plot, how many species are protected by prioritizing on the basis of that criterion (ETC, unprotected, total verts, vegetation)

The other lines show how many species of that type would be protected by prioritizing on each of the other three criteria… how well that type would be swept up by the other types.

1. Total verts and unprotected verts do a good job of sweeping each other.
2. The remaining combinations are not so good.
3. Vegetation classes do not sweep anything very well (lowest sweeping line in all three cases)… What does that imply about strategies to conserve total diversity?
4. ETC also do not sweep well… what does that imply about strategies to conserve biodiversity?

Obviously, a very useful exercise in setting priorities and evaluatig the adequacy of current protected area to meet several goals (total verts, ETC)

Limitations?
1. No consideration of area requirements. If a species is represente din at least one unit, it is considered ‘covered’

2. Complementarity ignores connectivity and may even work against it.
3. As acknowledged by authors, details needed within the hexagons (which are large) before moving on. Habitat quality, actual animal distributions, animal numbers, trends, etc.
4. Creates a focus on '***efficiency***' – maximum number of species contained in a minimum area. Need to think carefully about what 'contained' means. See comments on Dobsen et al below.

Dobson et al. Geographic distribution of endangered species in the United States.

For species listed under ESA, there are county-by-county data on known presence.

Used these data to conduct a complimentarity-based identification of endangered species hotspots.

(Ohead: Figs 1 & 2)

Desert SW, SE coastal areas, Hawaii, Appalachia hold concentrations of endangered species.

Did the analysis for plants, mollusks, arthropods, fish, herptiles, birds, mammals, and examined 'sweeping up' by each of these groups.

Plants showed fairly good sweeping effect

- mainly because plants required the largest set of counties in order to protect the whole set of endangered plants. (Can see this effect in Fig 3c)
- 136 counties in the complementary set for plants, max of 57 for all other groups.
- For non-plant sweeping effects, range was 0.01 to 0.53 (proportion of other taxon protected).

(Ohead: Table 1)

"The extent to which endangered species are concentrated in hotspots of potential extinctions and the extent to which hot spots for different groups overlap will influence the strategies we adopt [for conservation]". True.

(Ohead: Fig 3)

Accumulation curves are pretty steep.

Interpretation in text: " Thus, our analysis should not be taken as a measurement of how much land must be protected to conserve endangered species."

Statement concluding abstract: “The amount of land that needs to be managed to protect currently endangered and threatened species in the United States is a relatively small proportion of the land mass.”

It is important to recognize a difference:

The analysis establishes the area required so that a species is SAMPLED in at least one county.

The goal is to establish areas that PROTECT a species’ persistence.

This is a major point in the paper by Karieva & Marvier for project paper 2.

Van Jaarsveld et al.

Data for 9119 species in Transvaal region of S Africa. Area of the UK in one of the most species rich areas of the world.

25km x 25 km grid (625 km2, similar to Kiester et al)

A) Examined degree to which:

1. Hotspots
2. Complimentary sets
3. Coverage of rare species

identify the same locations for protection.

(Ohead Table 1)

Not well.

B) Examined degree to which hotspots for one taxon identified hotspots for another taxon.

Again not well.

Also asked if locations identified using data at one taxonomic level agreed with locations identified using another taxonomic levels… this is the basis of the ‘***surrogacy***’ argument, that data from genera or families could be used in hotspot analysis.

(Ohead Fig 2)

This was also not well supported.

"Our results provide little support for the notion that species complementary sets are congruent across taxa, or that complimentary sets are congruent with richness, or areas harboring rare taxa, or both…. In addition, our results suggest that the use of higher taxa as surrogates … holds little promise at a scale relevant to practical conservation planning… These results underscore the value of sound species-related distribution data for conservation planning."