Distribution and Abundance

I. Methods for studying Abundance & Distribution
II. Factors Limiting Abundance & Distribution
   A. Dispersal
   B. Behavior
   C. Abiotic Factors
   D. Biotic Factors

Definitions

Abundance = number of individuals
Density = number of individuals/unit area or volume
Population size = number of individuals in a population
Population = individuals of the same species in a specified area
Distribution = spatial pattern of abundance

I. Methods for studying Abundance & Distribution

A) Counts (census)

B) Estimates

Counts

• count all individuals in an area
  (example: human population census)
  — useful for large conspicuous organisms in small areas
  — seldom practical: too many organisms to count or too large an area to cover

Estimates

• sample subsets of the population and extrapolate to population

Estimates — sampling

Counts — sampling
Estimates

- desired characteristics of estimates:
  - unbiased (accurate)
  - repeatable
  - feasible

Estimates two types:

- **absolute** -- preferred
  - provides an estimate of the actual #, rate, etc.

- **relative** -- sometimes the only thing possible
  - does not provide actual estimate of parameter
  - estimates magnitude of parameter relative to something else
    (e.g., fish species X is twice as abundant as fish species Y, but the actual abundance of both is unknown)
  - must be "representative" to be useful
    (i.e., must have a consistent relationship with the true value of the parameter of interest)

Examples

- absolute estimates
  - transects
  - quadrats
  - mark-recapture

- relative estimates
  - trapping (e.g., light traps)
  - gill netting
  - calls (birds especially)
  - "artifacts" - burrows, molted exoskeletons, etc.
  - timed counts
  - % cover
  - amount of food eaten by organism of interest
  - surveys of fishermen

II. Factors Limiting Abundance & Distribution

1. Dispersal
2. Behavior
3. Abiotic Factors
4. Biotic Factors

Distribution = spatial pattern of abundance…

But ecologists who study distribution tend to study different things than those who study abundance

- Abundance – focus is on areas that are suitable for species of interest
- Distribution – focus is on what makes some areas unsuitable for species of interest

Factors that Limit Abundance & Distribution

1. **Dispersal** – can’t get there; or only in limited numbers
   - dispersion is especially important in marine systems
     - adults of marine marine species move little (are sedentary), but juveniles can disperse very long distances
     - prevailing ocean currents may limit or enhance dispersal
   - two important types of dispersal:
     - diffusion – gradual movement, spreading out from original area
     - jump dispersal – long distance dispersal at irregular intervals (e.g., colonization of islands)
Dispersal

Testing limitation of abundance by dispersal

- **Transplant experiment**
  - move organism outside of natural range
  - does it survive, reproduce, and spread?
  - example: three coral reef fishes (peacock grouper, bluestripe snapper, blacktail snapper)
    - abundant throughout tropical Pacific Ocean, but not in Hawaii
    - brought to Hawaii 1956-1961 to enhance fisheries
    - 3 species survived and reproduced and now have self-sustaining populations (7 other species did not)
    - interpretation: distribution limited by dispersal (1000’s of miles from any source population)

- **Unintentional transplant “experiments” — invasive species**
  - local marine examples:
    - Sargassum muticum & S. filicinum
    - Chinese mitten crab
    - isopod Sphaeroma quoyanum
    - yellowfin goby

Behavior — can get there but choose not to stay

= **Habitat Selection**

- Test by offering organisms different habitats
  - selection of habitats at time of settlement very important in marine organisms

- Habitat preferences may be:
  - genetic
  - learned

Example of habitat selection producing pattern of distribution:

Two coral reef fishes (Gutiérrez 1998)

- *Stegastes adustus*: only found on shallow reef crest
- *Stegastes planifrons*: found deeper on reef slope

Abiotic Factors

- temperature
- desiccation
- salinity
- turbulence
- light
- nutrients
- pH

Gutiérrez 1998

*Stegastes adustus*: juveniles only settle at crest – prefer dead coral

*Stegastes planifrons*: juveniles settle on slope – prefer live coral
3. Abiotic Factors

- Test by...
  - exposing organism to different regime (transplant)
  - alter the presumed limiting physical factor

  - is it the average or the extremes that matter?
    (e.g., average temperature or maximum temperature?)

4. Biotic Factors

- **Competition**: mussels outcompete barnacles & limit to upper intertidal
- **Predation**: lobsters at Catalina Island limit distribution of mussels
- **Food**: beach hoppers are only found with kelp wrack
- **Parasitism**: European green crabs are limited by parasitic castrators
- **Disease**: disease killed 99% of Diadema urchins in Caribbean
- **Mutualism/Commensalism**: anemonefishes found only with sea anemones

*Often many factors act together to limit abundance and distribution*