Foraging

optimal and otherwise
economics and markets

What models can do:

- Help find sensible hypotheses
- Derive predictions from hypotheses
- Test predictions

Modeling in behavior

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- Help find sensible hypotheses
- Derive predictions from hypotheses
- Test predictions

only ONE of these –
and deriving predictions about how animals should behave, or what the outcome of a particular behavior should be, is most common

Modeling in behavior

What models can do:

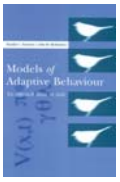
- Help find sensible hypotheses
- Derive predictions from hypotheses
- Test predictions

NOT just describe something – unless the model is used to predict the weather etc., and not an explanatory model

if you want to know more

- May (2004): Uses and Abuses of Mathematics in Biology. (Science 303: 790-793)
- Peck (2004): simulations should be treated like experiments - variability is expected, statistics and replication necessary (TREE 19: 530-534)
- Fussmann & Blasius (2004): in complex systems, subtle differences in functions can lead to different results - this is almost untestable (Biol. Lett.)
- Judson (1994): The rise of the individual-based model in ecology (TREE 9: 9-14)
- Hutchinson & McNamara (2000): emphazise that, and how, models can be tested (Anim Behav 59: 665-676)
- Gould & Lewontin (1979): critique of adaptationism (Proc R Soc London B 205: 581-598)

Who's who



Alasdair Houston

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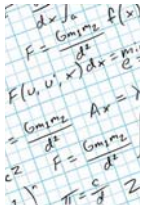
http://www.bio.bris.ac.uk/people/staff.cfm?key=59

Theorist; often works with John McNamara on state-dependent models of optimal behavior



Interesting results: why birds sing at dawn (signals male quality and reduces risk); models of bee load size, bird moulting, duck diving, cooperation

References:

Houston, AI & McNamara, JM. (1999) Models of Adaptive Behaviour: an approach based on state. Cambridge University Press

Behav Ecol 6: 393 – 396 Nature 380: 215 - 221

Foraging

What about it?

- Foraging strategies – how to forage on patchy food, risky food, hard-to-handle food
- Tests of selection theory: how optimal is animal behavior?
- How do foragers interact? (cooperative or competitive)
- And how do foragers interact with prey?

Optimal foraging

What is the optimal foraging strategy?

- Often determined with analytical model:

e.g., diminishing returns & submaximal loads → marginal value theorem

or handling time and prey choice

or state-dependent behavior

Optimal foraging

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- These are really models deriving hypotheses from assumptions (of the form: if these are the animal's limitations, and its behavior is optimized by evolution, this is how it should behave)

Optimal foraging

What do we gain if we know what the optimal strategy is?

Optimal foraging

What do we gain if we know what the optimal strategy is?

- Do animals forage optimally?
- What if it appears that they do not?
  - wrong currency (recall our fitness discussion)
  - constraints missing
  - simply not at adaptive optimum
  - the experiment doen't reflect the situation the animal is adapted to (or information limitation)

Optimal foraging

Cricicism

- Pierce & Ollason (1987): 8 reasons why optimal foraging theory is a complete waste of time
- May (2004): Uses and abuses of mathematics in biology
- Heinrich (1983): Do bumblebees forage optimally, and does it matter?
- Ginzburg & Jensen (2004): Rules of thumb for judging ecological theories

Load size in bees

- Controversy!!
- Bees fly home with submaximal loads especially at good and close food sources

→ marginal value? Only fits with energetic efficiency maximised – but: no direct evidence for diminishing returns; no evidence for expenditure-limited lifespan

→ collective optimisation?

Whos: Schmid-Hempel, Nunez, Varju, Houston

Currencies and 'utility'

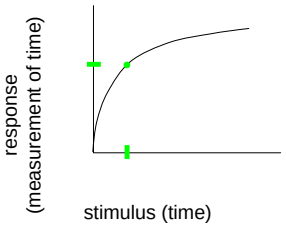
- Utility is an important term in economics, meaning 'that which the subject wants to maximise' - essentially = 'maximised currency'
- But what is this?
  - net rate of energy intake (B-C)/T
  - energy efficiency (B-C)/C
  - group intake
  - minimizing risk

Currency is not obvious

- but even worse: it may not always be maximised

Risk sensitivity or sensory limitation?

- In a choice between a time-variable and time-constant option, animals usually choose the time-variable one
- This can be explained by a sensory limitation: less sensitivity for larger values



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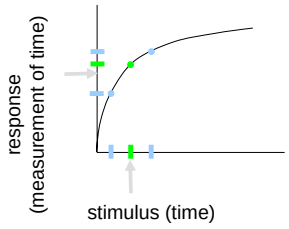

Whos: Kacelnik, Bateson

Biological markets

- An attempt to use results from economy theory in biological situations: especially balance of supply and demand
- Usually in species interactions; e.g. cleaner fish and clients: cleaner fish cheat less on unreliable clients
- Whos: Noe, Bshary, Hammerstein

Social foraging

- (game theory – more on that on Feb 6)
- Producers vs. scroungers
- Information centers
- Value of recruitment in cooperative foragers
- Whos: Giraldeau, Laland, Galef, Caraco