

## Risk Sensitivity

•Two different meanings for “Risky Foraging”:

•Risk of Predation

•Example: Another Milinski stickleback experiment

•Risk of variable food payoff\*

•Les Real’s bumble bees and paper flowers

•Definitions:

•Risk-sensitive

•Risk-averse

•Risk-prone

•Why be risk-prone?

•Threshold requirement condition



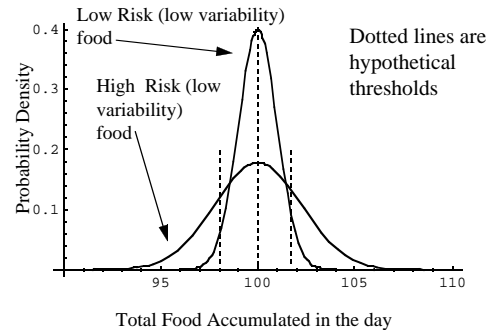
## Z-score model

Provides a way of explaining risky versus non-risky food choices when the sum of all the food items must exceed some threshold (i.e. survival is a *step function* of energy obtained)

•e.g. energy stores accumulated over the day in order to survive the night

•Assumption that food is obtained in small parcels throughout the “day” and food quality of items is independent from one to the next

•(This requirement satisfies the Central Limit Theorem assumptions. CLT yields normal distribution)



In its simplest form:

•Discrete choice nature of the model---either predicts risk-averse yes! or risk-prone yes!

•Hunger-level sensitive risk-sensitivity

•When energy-reserves are depleted animal should be more risk-prone.

•Forms the basis for the hypothesis in Cartar’s bumble bee paper. Bees facing energy shortfall



should forage on the more variable (but equal mean) payoff flower type

Going over Cartar 1991:

## Natural History Features

Life on the island: Three summers on Mitlenatch

•Bee Colonies Transplanted from S-F U. campus

•Cycle of Bumble bee colony

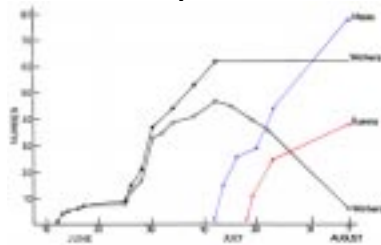


Figure legend: The development of a free foraging *B. terricola* colony. Cumulative totals of the bees are given by the shaded symbols. The open circles signify the actual number of workers in the colony at that date. source: <http://indec01.mtrovial.ab.ca/bumble/>



A Laboratory-raised colony



Brood Clump and HoneyPot ---the communal feeding trough  
•Hive temp  
•Energy reserves

Two types of plants provide nectar for the colonies:

- Seablush
- Dwarf huckleberry

The big assumption about nectar levels in flowers is:

The “Null-Hypothesis” is an Ideal Free Distribution type of prediction

- Two flavors of the IFD argument
- Both qualitatively predict that risk-aversion should decrease when energy stores decrease

Estimating profitabilities of flower types:

1. Measure nectar levels at the end of the day
2. Measure time required for bees to forage on the different flower types (Quite a lot of work!)
3. Combine those estimates into profitabilities

Main result: Same Expected Profitabilities BUT dwarf huckleberry was more variable.

AHA! Two different food types:  
High Variance = Risky

and

Low Variance =  
Not so risky

A Dwarf huckleberry congener



## Honey Pot Manipulations

Artificially creating the spectre of energy shortfall

- Between 1430 and 1600 in the afternoon he drained some honey pots and added sugar solution to others
- Scientific Method things to Note:
  - Randomization
  - Minimization of carryover effects
  - Balancing the number of foraging bees

•Results: Counting Color-coded bumble bees

	<i>Treatment</i>	
	Reserves Enhanced	Reserves Depleted
Dwarf H.	24 (47%)	61 (68%)
Seablush	27 (53%)	29 (32%)

\*Only late in the afternoon.

\*Statistically significant differences in the above table.

•Indicates a preference for the “higher risk” flower when stores are depleted (wow...even with other avenues available to them---more foragers, nectar/pollen switch, etc.)

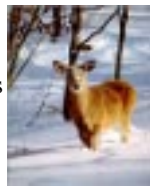
Extensive OFT modelling in

## White-tailed deer

Schmitz 1990



Majestic beasts and also valuable for sport hunting economy.



- Truly charismatic megafauna
- Northern latitudes/harsher winters
- Supplemental feeding programs “*ad libitum*”

Important question: How effective and efficient are these supplemental feeding programs. Schmitz claims it is not sufficient to just survey food use by deer in supplemented and non-supplemented areas:

“The efficiency of feeding programs can only be judged by predicting diets deer should select in different environments and comparing how well their diets match the predictions.” --- Oswald Schmitz

## One final flavor of optimal foraging

Up to now we have considered two different “currencies” that foragers might be optimizing.

1. Long term average intake
2. Probability of meeting minimal requirements

A final currency you should know about is time required to satisfy nutrient requirements (optimization now means “minimization”)

- Different than long term average intake
- Overall intake may affect fitness less than, say, avoiding being preyed upon or succumbing to climatic extremes while foraging:
  - Example: desert ant colonies

Bottom line: the proper currency should be intimately linked to fitness!

## Schmitz’s OFT Model

Assume that deer will forage optimally, then develop a model to predict what they ought to be eating.

Optimization of diet types subject to three factors which he calls his three constraints:

1. Processing Constraint
2. Time Constraint (How long can a deer forage per day?)
3. Energy constraint (how much is required?)
  - Energy typically limiting in northern environments in the winter....good!

Investigated the optimal diet composition subject to these constraints using two different optimality criteria we’ve seen before. They were:

## Applications of Foraging Theory in Conservation and Solving “Ecological Problems”

OK...How can we use this stuff?

There’s not an over-abundance of examples

Three though:

- Schmitz (1990): Evaluating supplemental feeding programs for white-tailed deer
- Monaghan (1996): Using seabirds to monitor fish populations
- Luck (long-term programme) biocontrol of citrus pests

## Data and Inputs

Brrrrrrrr...a long, cold winter watching deer.

- Rumen volume and turnover times
- Bulkiness of different forage types
- Time deer can spend foraging vs. temp
- Cropping rates (how quickly can they browse)
  - Measured many twigs
- Energy requirement model

## Observed Behavior:

- Non-supplemented deer foraged as predicted by the energy-intake maximizing criterion
- Optimal Behavior for supplemented deer would be to “eat nothin’ but the good stuff”
- Implication: Supplemented deer not being as efficient as they could be.
- Interpretation and management implications

Feeding stations and such...

# Fisheries and Seabirds

- Inextricably intertwined:
- Historical sideshow-->Seabirds Preservation Act of 1869 in Britain
- Fluctuations in fish popns due to fishing has a great impact on seabird populations
- Some background on fisheries stock assessment and the “development” of fisheries
- Monaghan works on Shetland seabird colonies.
- Main fishery = lesser sandeels. Yearly harvests in the North Sea around 10 BILLION kg!
- Small fishery opened for sandeels in 1974, peaked in 1982, then guess what happened?
- Populations of surface feeding birds had greatly reduced reproductive output
- Diving birds not so badly hit

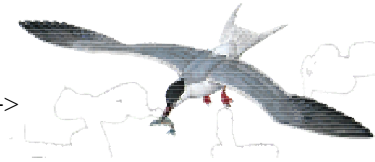
*On to a new topic:*

## Territoriality

- How I would like to traverse this topic:
  - Definitions
  - Varieties of Territories
  - Phyletic perspective on territoriality
- Costs and benefits of territories
  - More optimization ideas
- Mechanisms of territory maintenance
  - Some game theoretic ideas
- Effects of territoriality on larger ecological issues

## Surface Feeders:

Arctic Tern -->



<-- Kittiwake

## Diving Birds:

Guillemots and shags

## Bird-Related Indicators for Fish Abundance

Monaghan and colleagues' long term study investigating:

- Colony breeding numbers
  - Reproductive parameters
  - Body condition
  - Diet Composition
  - Foraging Behavior\*
- First three not very reliable because changes in foraging behavior could compensate for some effects
- Foraging behaviors of diving birds changed noticeably---birds worked harder!
- Surface feeders also changed their behavior:
- Longer foraging journeys when abundance was low (recall central place foraging)
  - Could reliably monitor by recording time that both parents remained at the nest
- Diet Composition is potentially useful (clearly) but would require much more work (empirical *and* theoretical) to make it a reliable indicator