Rainforest Fauna

and ecological theory

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Organizing Themes

tropical vs. temperate

sources of diversity

ecological roles / guilds

generalist <---> specialist

vertical stratification

Tropical vs. Temperate Fauna

▼ large terrestrial mammals

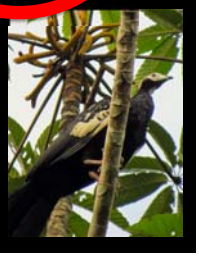
▲ arboreal mammals

▲ year-round frugivores

≈ insectivores

▲ epiphytes

▲ biotic selection pressures



Centers of Biodiversity

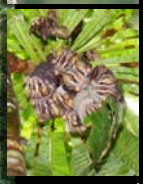
insectivores
bats, flycatchers

frugivores

arboreal mammals

insects (beetles, ants)

the canopy!



Feeding Guilds

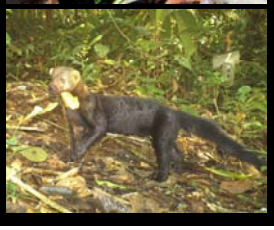
"Species that utilize +/- the same food resources"

- **terrestrial herbivores**
  tapir, deer
- **canopy herbivores**
  howler monkey, sloth
- **frugivores**
  tanagers, toucans, monkeys
- **nectarivores**
  hummingbird
- **granivores**
  parrot, agouti
- **carnivores**
  jaguar, snake, falcon
- **insectivores**
  flycatcher, bat
- **piscivores**
  dolphin, fish
- **scavengers (carrion)**
  vulture, fly
- **omnivores**
  monkey, coati

+ and many specialized guilds (e.g., 'sanguivore')

Specialists <---> Generalists

- **monophagy**
  + specialized morphology
  – risky; nutrients?
- **oligophagy**
  "eat several food types"
  mix of both strategies
- **polyphagy**
  + plentiful, balanced diet
  – generalist morphology



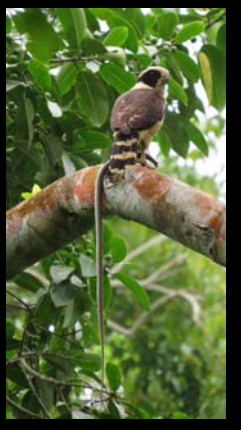
Vertical Stratification

- **forest layers**
  floor (herbs) to canopy
- **arboreal habit**
  mammals, reptiles
  amphibians, insects
- **the canopy**
  high productivity (sunlight)
  fruits & leaves
  water (bromeliads & frogs)

fossorial, terrestrial, scansorial, arboreal, volant, aquatic

Predation & Predators

- **abiotic vs. biotic pressure**
  generalist ('switching') predators
  recall Biodiversity Hypotheses
- **defenses against predators**
  recall Ecological Interactions
- **predators**
  birds: forest-falcons, eagles
  reptiles: snakes, lizards
  mammals: tayras, otters
  cats (Felidae)



Tropical Felids

Top ('Apex') Predators:
arboreal & terrestrial
diurnal & nocturnal
size-selective

Predators & Competition:
reduce prey density
reduce intra-specific comp.

Home Range:
large area (10-100 km^2)
large prey populations

All cats are threatened by hunting & habitat loss

Competition b/w Felids: Evidence

Barro Colorado Island:
pre-lake: jaguars and ocelots
post-lake: jaguars depart

"Competitive Release":
ocelots alone
take larger prey items

***Fundamental* vs. *Realized* Niche:**
what you can take vs. what you do take

Classic study *(Connell 1961):*
Balanus & *Chthamalus* barnacles:
removed ***B***, ***Ch*** expanded area

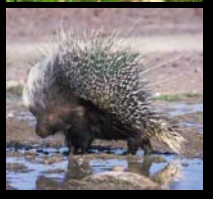
Optimal Foraging Theory - Predator

How to choose between eating poor (low-energy) prey, and searching for more?

Searching vs. Handling Time:
ST: find prey item
HT: capture, kill, eat prey

If ST >> HT:
predator = ***??***

If HT >> ST:
predator = ***??***



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(eat first thing you find)

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If ST >> HT:
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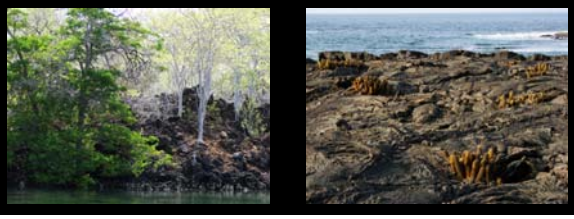
(eat first thing you find)

If HT >> ST:
predator = **specialist**
(choose high energy prey)

O.F.T. - Environmental Productivity

If environment is PRODUCTIVE:
predator = **??**

If environment is UNPRODUCTIVE:
predator = **??**



O.F.T. - Environmental Productivity

If environment is PRODUCTIVE:
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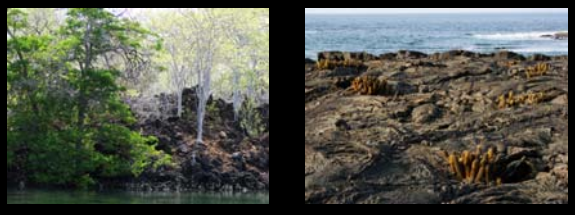
(eat whatever you can find)



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Optimal Foraging Theory:
maximize net energy intake per unit time,
by minimizing costs and maximizing calorie input

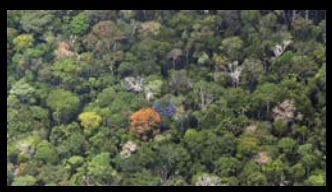
O.F.T. - Patchy Environment

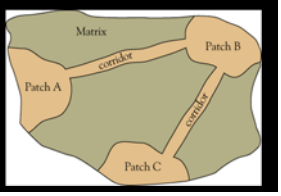
food resources are variable, and isolated

***Marginal Value Theorem**: maximize net gain by balancing intake, travel time & cost, and foraging time*

Giving-Up Density (GUD):
how much food do you leave behind?

Giving-Up Time (GUT):
how long do you stay before travel?





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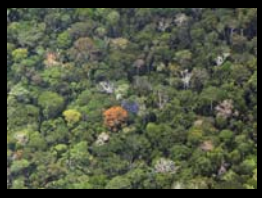
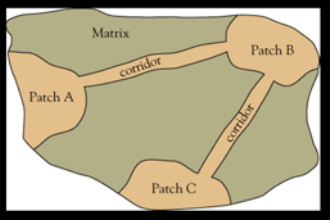


If patch quality is poor:
*GUT is longer or shorter = **??***

If travel costs high (great distance):
*GUT is longer or shorter = **??***

If patch quality is variable:
*GUT is longer or shorter = **??***



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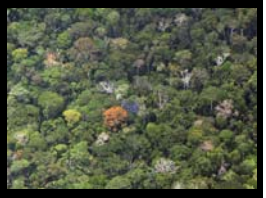

If patch quality is poor:
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(leave soon, in hopes of finding better patch)

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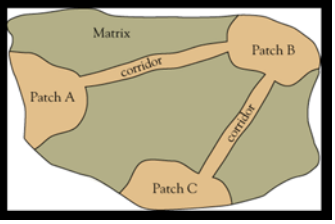

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If travel costs high (great distance):
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(stay, to get as much food from the patch as possible)

If patch quality is variable:
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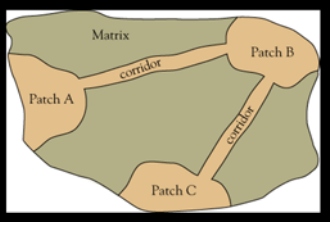

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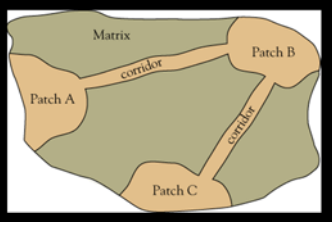

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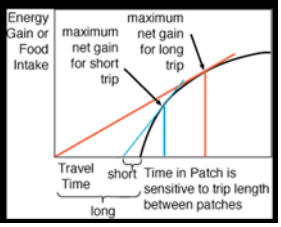
Ideal Free Distribution: *foragers distribute into patches proportional to resource availability*



Seed Dispersal

- **Year-round Fruit**
  many species = *frugivores*
  zoochory = 50-90% of plants
- **Benefits to Plant**
  numerous!
  Ecological Interactions lecture
- **Rainforest Dispersers**
  monkeys, birds, rodents, bats, insects, even fish (!)

arillate seed, another form of reward
***ARIL** = fleshy, oily, seed cover*

Primates and Seed Dispersal

New World Primates:
arboreal (prehensile tails)
frugivores, omnivores, folivores

Old World:
terrestrial & arboreal
'no' prehensile tails
less reliant on fruit

Seed Dispersal:
Spider Monkeys:
>200,000 fruits/y
>250 species
> 500m dispersal distance

color vision: detect fruit ripeness
manual dexterity: manipulate fruits
co-evolution

Squirrel & Capuchin Monkeys

Golden-Mantle Tamarins

Seed Dispersal

- **Passive**
  fruit *falls* from tree
- **Primary Dispersal**
  fruit eaten by disperser
  deposited in feces
- **Secondary Dispersal**
  deposited seeds *picked up*
  second species re-disperses

dung beetle, monkey feces, & seeds

How do plants encourage dispersal, and discourage seed predation ?

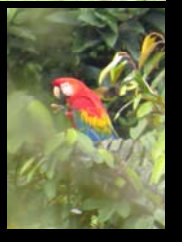
Dung Beetle (*Canthon*)

Seed Predation

- **Seed Predators:**
  macaws, peccaries
  monkeys, tapirs
- **Plant Defenses:**
  ???
- **Seed Toxins:**
  deter seed-eaters
  encourage *dispersal*
  salt licks: detoxify with minerals (Mg, etc.)

Seed Predation

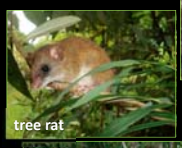
- **Seed Predators:**
  macaws, peccaries
  monkeys, tapirs
- **Plant Defenses:**
  hard seed coat
  mast fruiting (synchrony)
  toxic compounds
- **Seed Toxins:**
  deter seed-eaters
  encourage *dispersal*
  salt licks: detoxify with minerals (Mg, etc.)

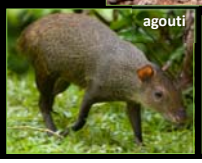


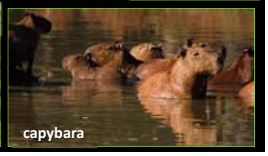
Parrot Salt Lick

Rodents (Cl. Rodentia)

- Hyper-diverse
  adaptive radiation
  arboreal , terrestrial, aquatic
  nocturnal & diurnal
  frugivore, omnivore, folivore
- Hyper-abundant
  r-selected
  important prey items
- Seed dispersers
- **Seed <u>predators</u>**

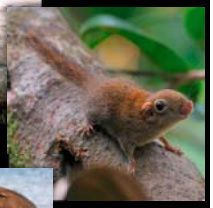






Rodents (Cl. Rodentia)

- Musimorph
  'mouse-form'
  terrestrial & arboreal
  highly successfuly (α diversity)
- Sciurimorph
  'squirrel-form'
  arboreal & scansorial
- Cavymorph
  'guinea pig - form'
  terrestrial (+ aquatic)
  excellent prey



Seed Predation by Rodents

- **Adaptations:**
  sharp incisors, strong jaws
  biochemical detox??
- **Trophic Cascade:**
  eliminate predators (felids, etc.)
  ▲*rodent populations* --> ▲*seed predation*
- **Rodents & Bruchid Beetles:**
  bruchids parasitize up to 90% of seeds
  a. rodents eat some seeds
  b. bury *non-parasitized* seeds
  c. some forgotten = 2° dispersal

**Rodents can actually <u>reduce</u> seed parasitism, increasing tree reproductive success*

Mammals - Bats

Diversity:
up to 50% of rainforest mammals
adaptive radiation
crepuscular & nocturnal

Feeding:
insectivory (70%)
frugivory (25% ... 40% in Neotropics)
pollinators & dispersers ("*chiropt-*")
even piscivores!

Piscivorous bat echolocating water ripples of fish , and extending clawed feet for the catch

Bat Echolocation

Physiology:
large ears, leaf noses
larger on insectivores
40% of brain for signal processing

Sound Frequency:
high: attenuates quickly
fine resolution
where ??

low: travels further,
poor resolution:
where ??

Bat Echolocation

Physiology:
large ears, leaf noses
larger on insectivores
40% of brain for signal processing

Sound Frequency:
high: attenuates quickly
fine resolution
forest interior

low: travels further,
poor resolution:
gaps, riparian areas

insectivores: high, low, *+ burst*
"jamming" by moths

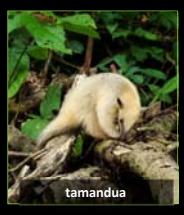
Bat Wings

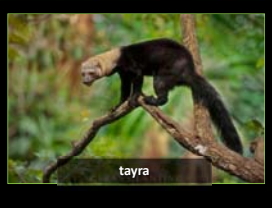
Wing Morphology:
elongated, modified hand bones
stretchy membrane
highly elastic skin
withstands punctures
Merkel cells - sense air flow

Wing Shape:
long and narrow = open-air fliers
speed, efficiency

short and broad = sub-canopy hunters
maneuverability

Other Mammals - Arboreal





Other Mammals - Terrestrial