The ecology of the non-breeding period: lessons from long-term studies of the American redstart.

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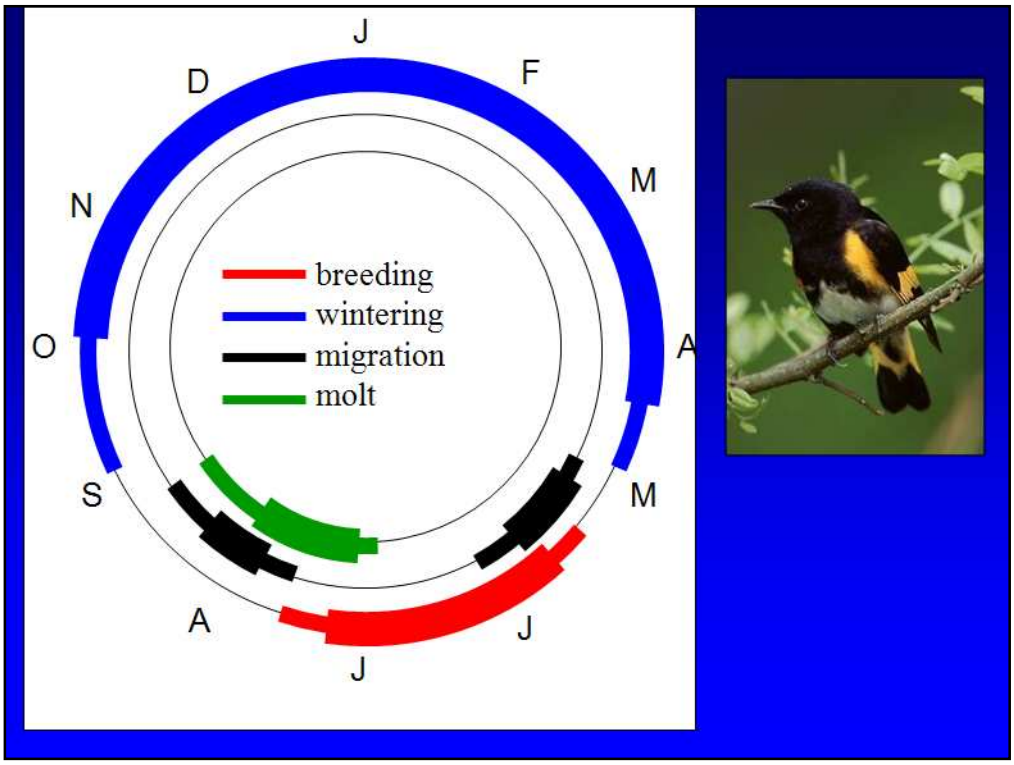
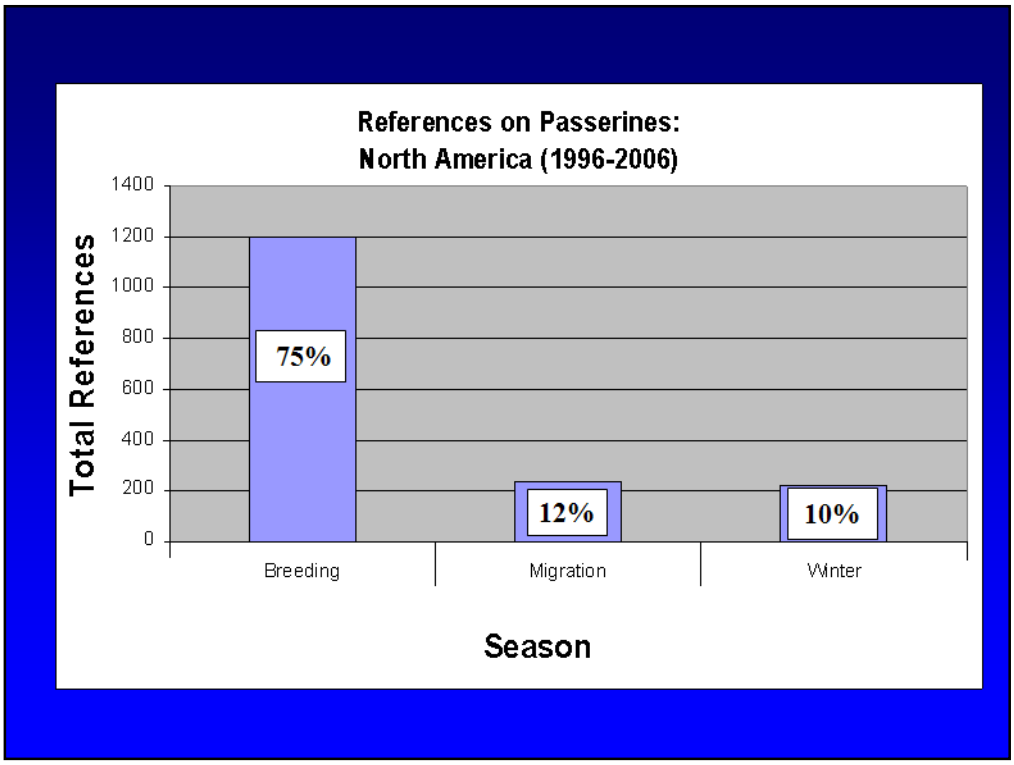


Migration is perhaps one of the most spectacular behaviors we see in nature. Birds travel enormous distances between stages of the annual cycle……after spending about 3 months on breeding areas…….migrants…

But….unfortunately our understanding of the biology of migratory birds has been hindered by several things. First we can't follow birds throughout the annual cycle. They are too small to track or attach transmitters…so we don't know where breeding pops …and where ..

Second….

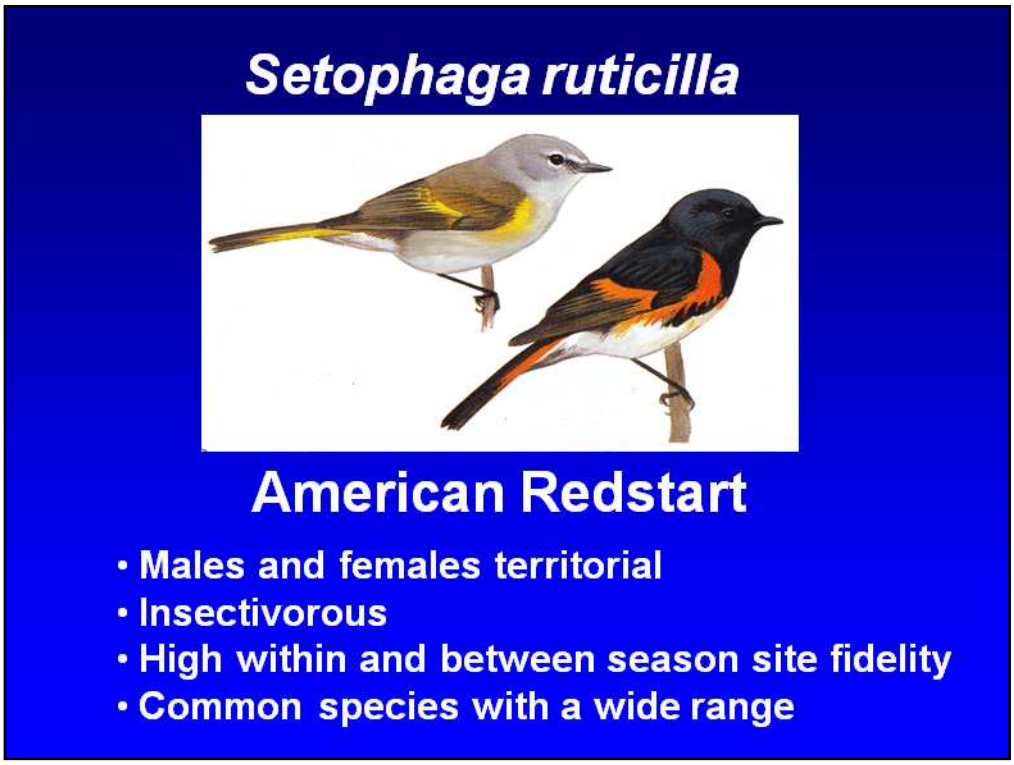


Second, (next slide) we have seen an enormous bias in when during the annual cycle most research has taken place…….in a review over the past 10 years of all work on migratory birds…..I will present passerines here…

The fact that less then 3% have examined seasonal interactions is really not surprising because we have been challenged by our inability to follow birds throughout the annual cycle. Understanding how periods of the annual cycle interact, however, is essential. As I think we will see today, such seasonal interactions can explain important variation that we see in a variety of biological functions

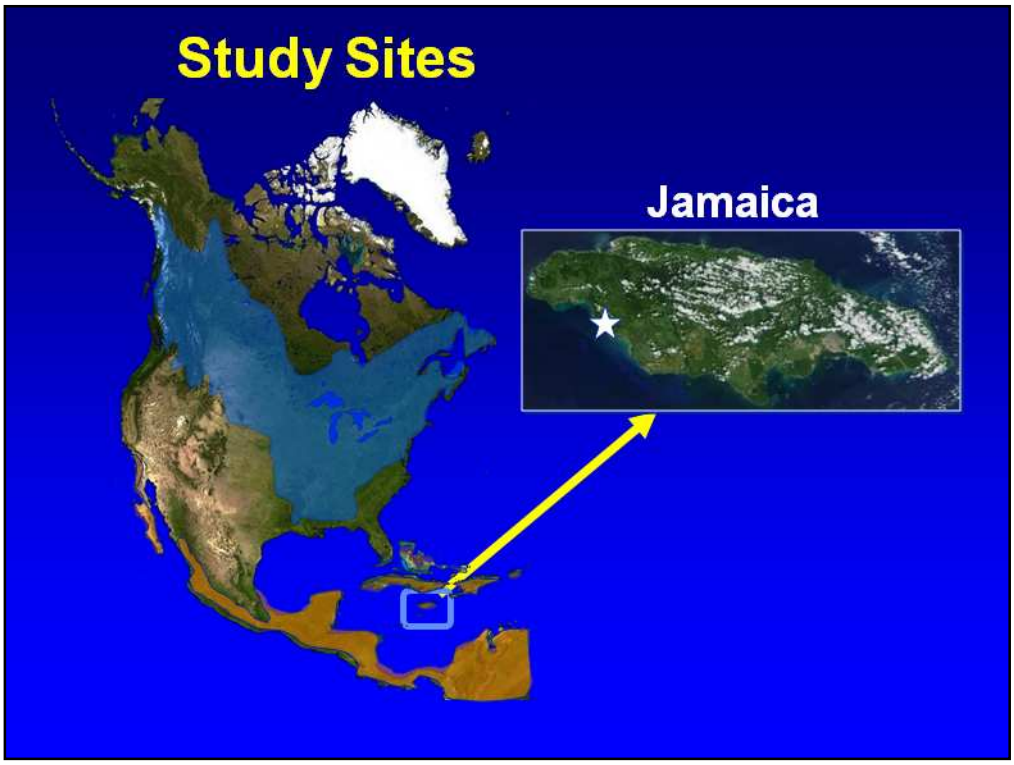
But first we need to understand the natural history and the biology of each period. Today, I am going to describe to you research on the winter ecology of migrant species during the non breeding species thata represents one of the longest if not the longest studies of a migrant during th enon breeding species.

A bit of history…Dick and Tom…..



….lead into the long term studies in Jamaica

A bit of history…Dick and Tom…..

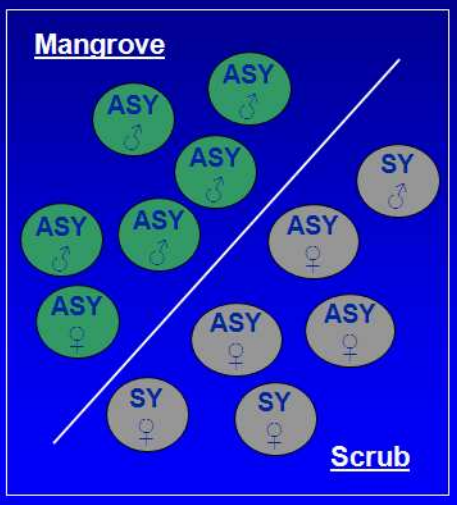

Study Sites
Jamaica

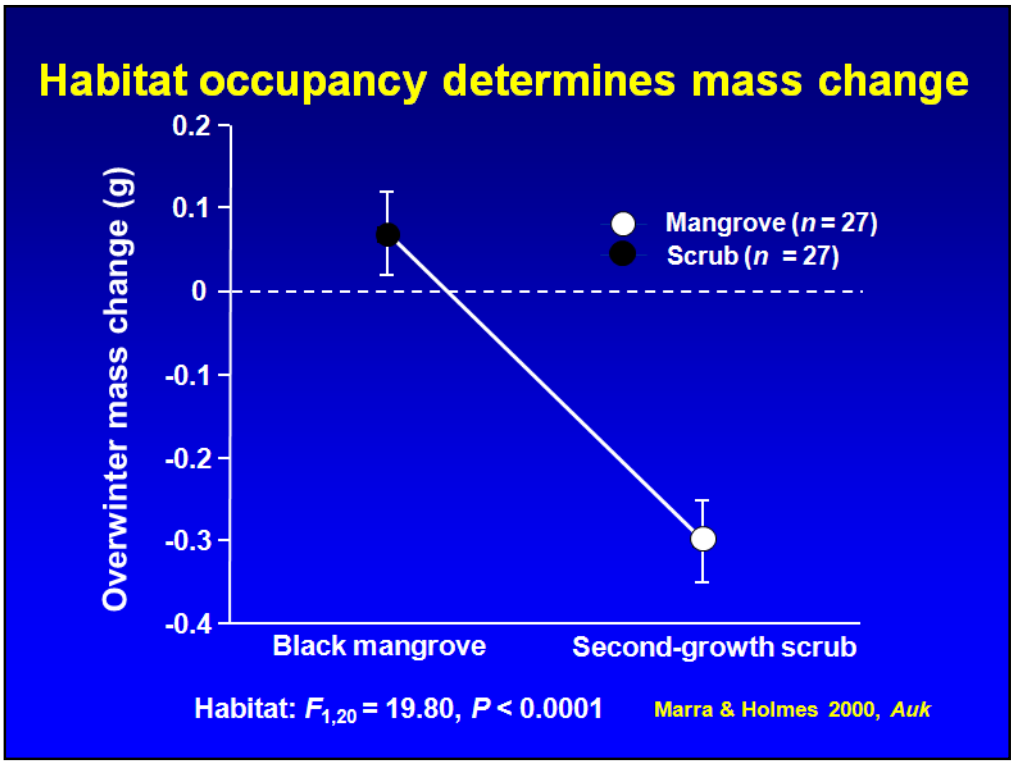
Winter habitat quality gradient

	Black mangrove	Second-growth scrub
Standing water	*present*	*rarely*
Canopy cover	*closed*	*open*
Temperature	*cool*	*hot*

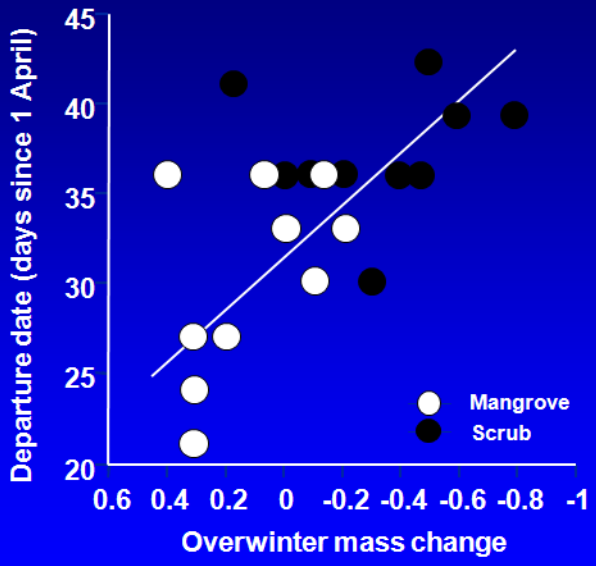
Sexual habitat segregation

- ASY males predominate in mangrove (♂ ≈ 70 %)
- Females and SY males are forced into scrub (♀ ≈ 70 %)




Habitat occupancy determines mass change
Overwinter mass change (g)
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
Mangrove (n = 27)
Scrub (n = 27)
Black mangrove
Second-growth scrub
Habitat: F1,20 = 19.80, P < 0.0001
Marra & Holmes 2000, Auk

Maintaining mass allows early departure



$r^2 = 0.36$, $P < 0.004$, $n = 20$

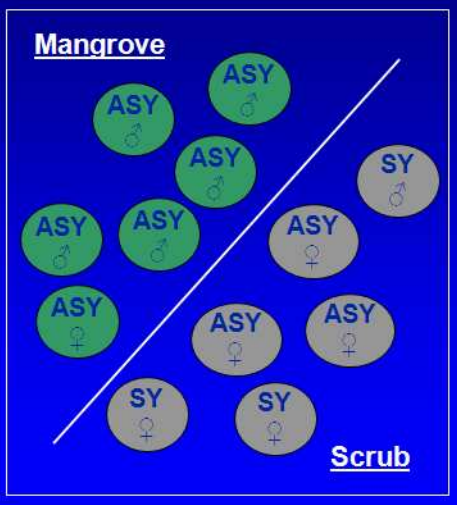
Marra et al. 1998, *Science*

Performance is driven by habitat occupancy

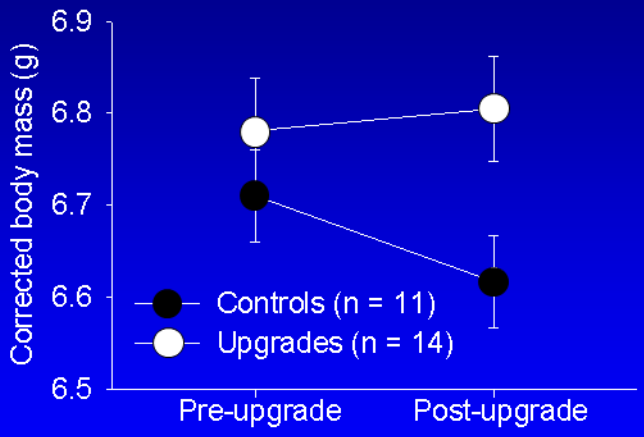
	Black mangrove	Second-growth scrub
Physical condition	*maintain*	*decline*
Spring departure date	*early*	*late*
Annual Survival	*high*	*low*

Experimental removals

- Removed behaviorally dominant redstarts from mangrove
- Provided territorial vacancies for redstarts from scrub to colonize



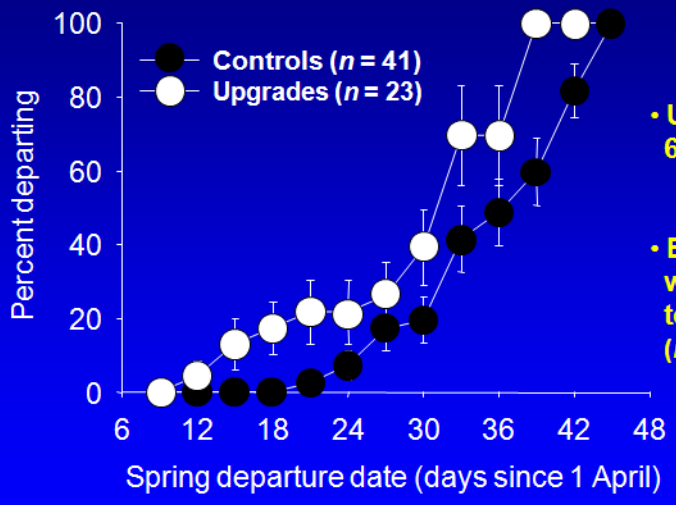
Experimentally altering body condition



- Upgrades maintained body mass
- Controls lost up to 8 % body mass

Treatment × Season: $F_{1,20} = 47.71$, $P = 0.01$ (Studds & Marra 2005, Ecology)

Experimentally altering spring departure



- Upgrades departed 6 days earlier
- Body mass change was positively related to departure date ($r^2 = 0.20$, $P = 0.03$, $n = 25$)

Kaplan-Meier $\chi^2 = 6.79$, $P = 0.009$

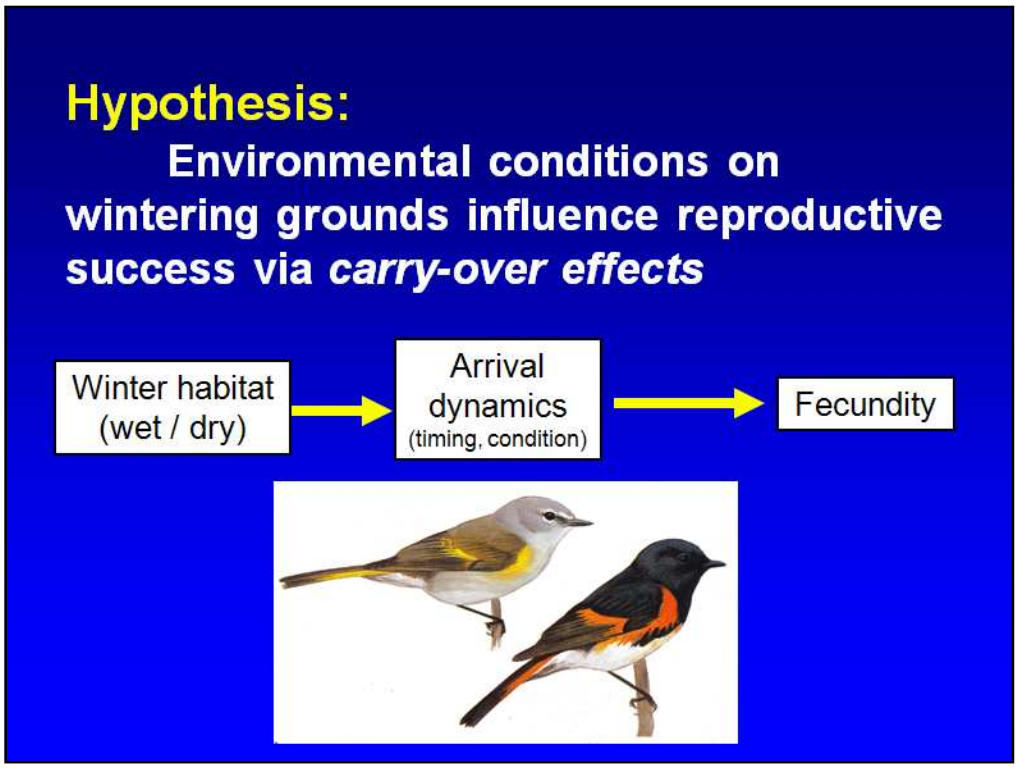
(Studds & Marra 2005, Ecology)

….lead into the long term studies in Jamaica

A bit of history…Dick and Tom…..

Carry Over Effects

- Reproductive success
- Natal Dispersal



A. ***Individual*** characteristics

- physiological condition
- timing of migration
- behavior

B. ***Population*** characteristics

- reduced survival of individuals in poor territories
- sex ratio
- age ratio

Explain whatever's necessary drop the population thing….

Use verbal explanations - don't cite papers

→ **Pose question: how to measure end-of-winter conditions????**

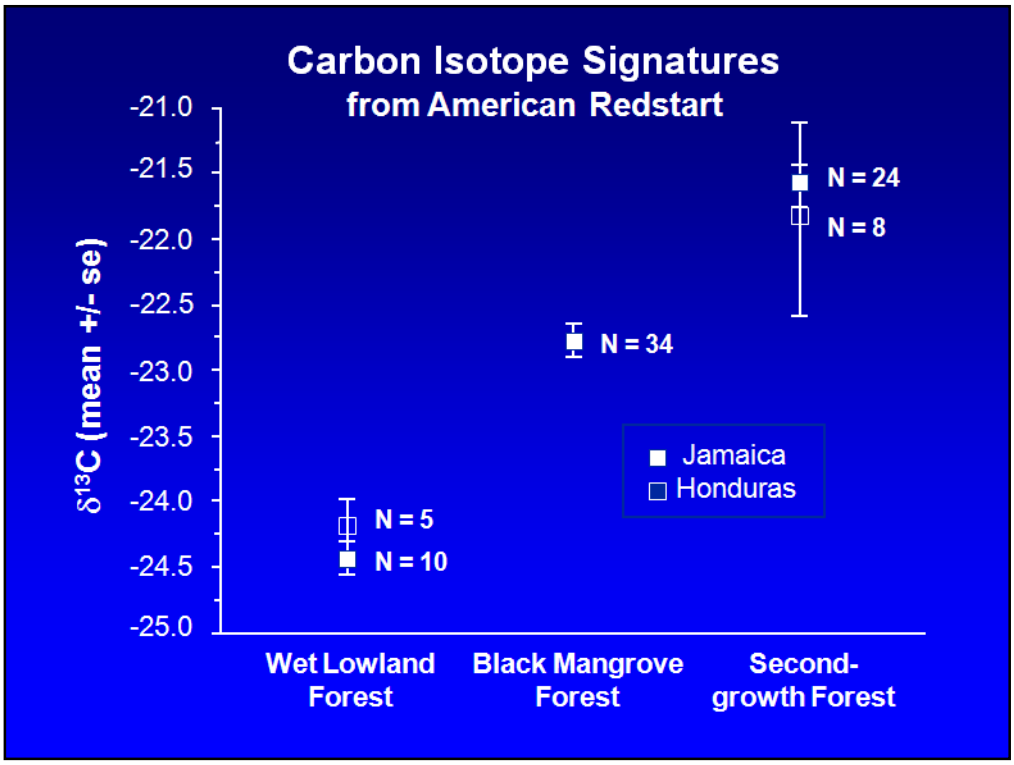
Stable isotopes as signatures of habitat quality

scrub

less negative $\delta^{13}C$

mangrove

highly negative $\delta^{13}C$


Carbon Isotope Signatures
from American Redstart
-21.0
-21.5
-22.0
-22.5
-23.0
-23.5
-24.0
-24.5
-25.0
δ13C (mean +/- se)
N = 24
N = 8
N = 34
N = 5
N = 10
Jamaica
Honduras
Wet Lowland Forest
Black Mangrove Forest
Second-growth Forest

Prediction:

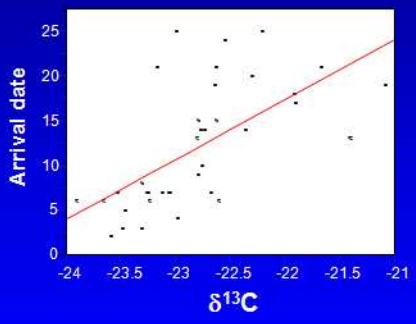
American redstarts arriving early will

1. have lower levels of $\delta^{13}C$ relative to redstarts arriving later.

2. be in better physical condition than those arriving later.

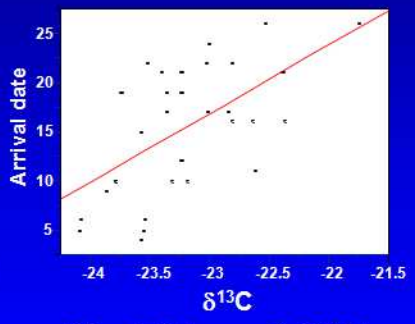
$\delta^{13}C$ and arrival date in ASY males

2001

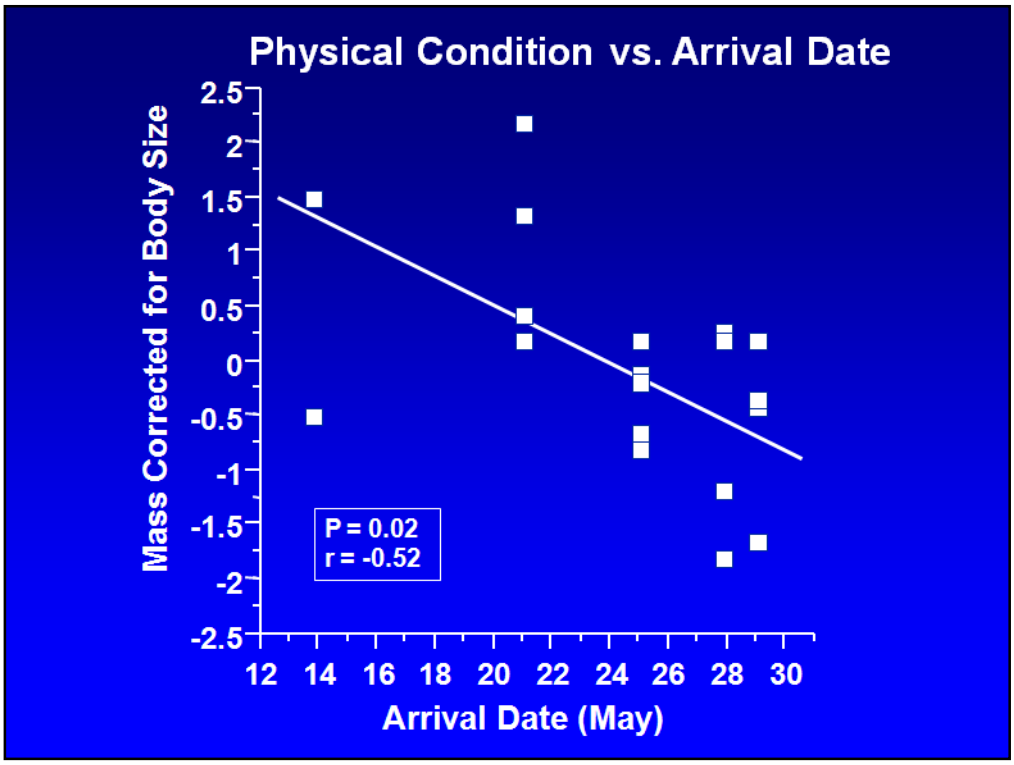


$R^2 = 0.38$, $p < 0.0001$
n=35

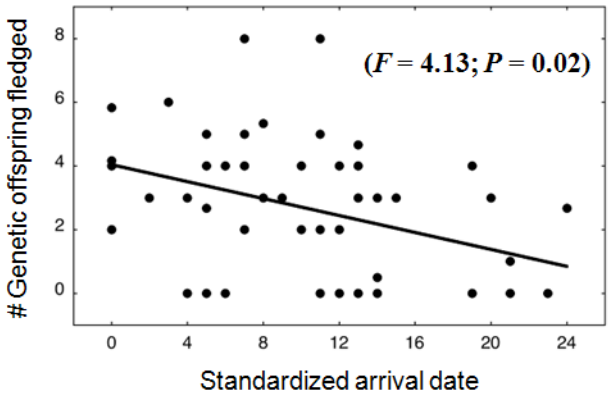
2002



$R^2 = 0.34$, $p = 0.0004$
n = 32

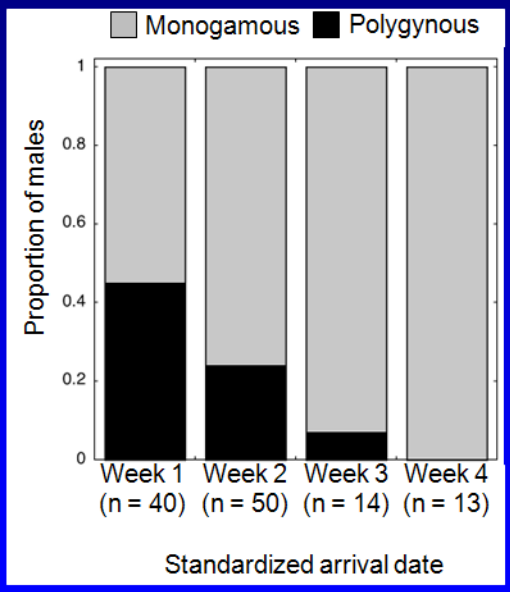

Physical Condition vs. Arrival Date
Mass Corrected for Body Size
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
P = 0.02
r = -0.52
12
14
16
18
20
22
24
26
28
30
Arrival Date (May)

Genetic Offspring and Arrival



(*Reudink et al.* in revision)

Polygyny and Arrival



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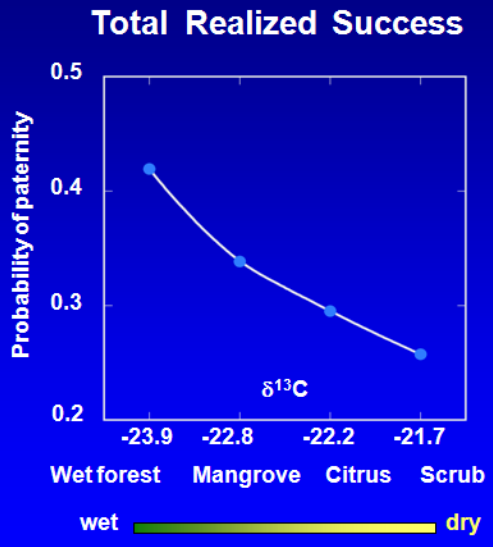
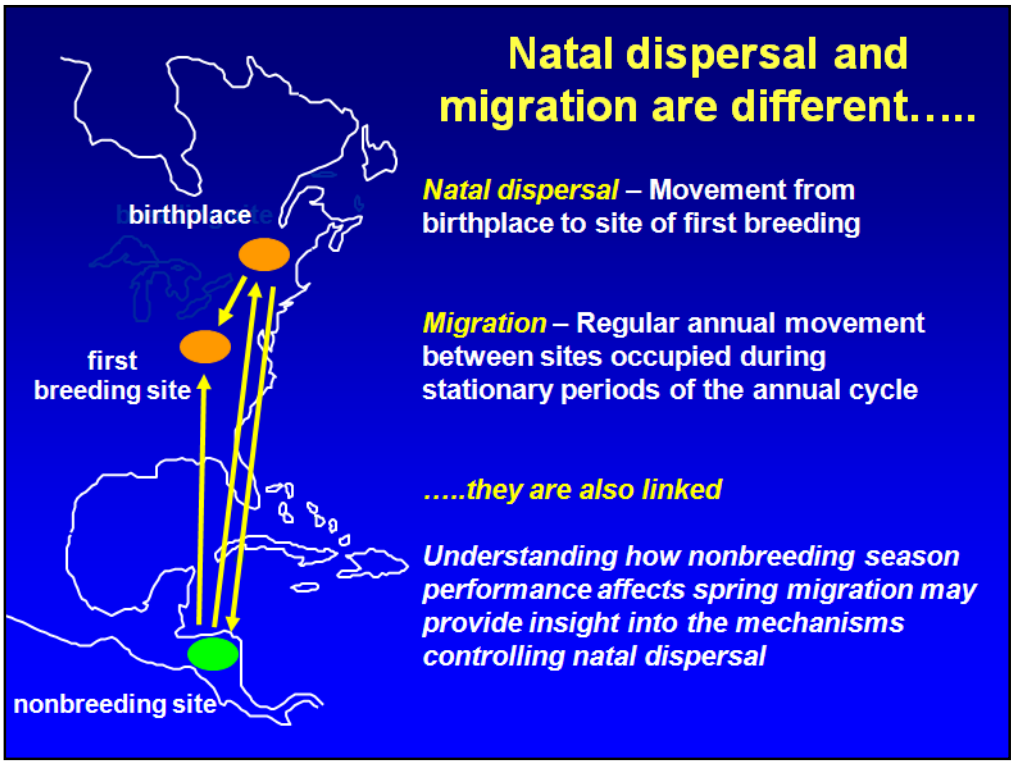
Modeling carry-over effects



Carry-over Effects

- Reproductive success
- Natal Dispersal


birthplace
first
breeding site
nonbreeding site
Natal dispersal and
migration are different…..
Natal dispersal – Movement from
birthplace to site of first breeding
Migration – Regular annual movement
between sites occupied during
stationary periods of the annual cycle
…..they are also linked
Understanding how nonbreeding season
performance affects spring migration may
provide insight into the mechanisms
controlling natal dispersal

Question:

Can habitat-specific mass change and departure schedules determine patterns of natal dispersal?

Methods: Stable-hydrogen isotopes

- Stable-hydrogen isotopes vary with latitude

- Feathers sampled in the non-breeding period reflect origins in the previous summer

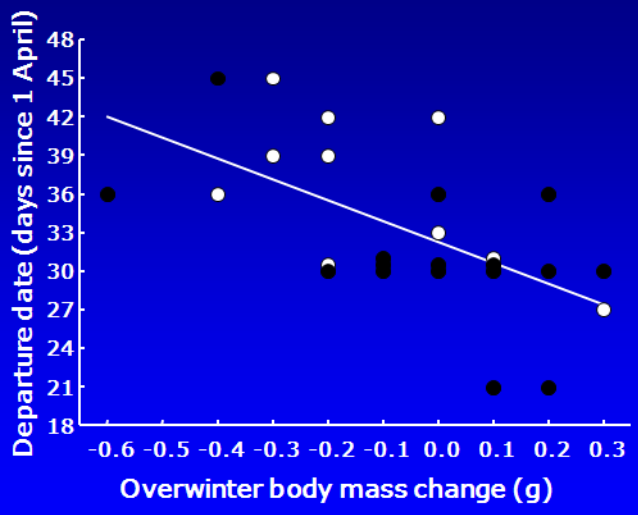
Methods: Feather sampling

- Plucked tail feather (r3) of immature (HY) birds to estimate latitude of birth

- Recaptured same birds as adults (AHY) to estimate latitude of first breeding attempt

- Captured AHY birds in successive years to estimate extent of dispersal between breeding seasons

Results:
HY body mass change and departure schedules

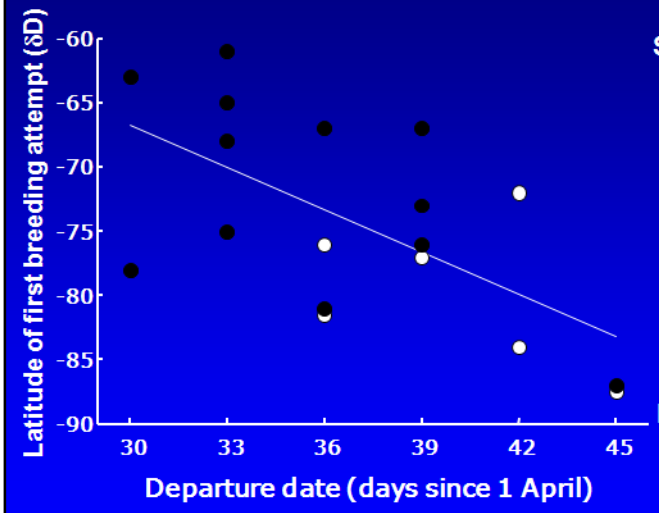


- Departure date negatively related to mass change
- Effect mediated by habitat occupancy: $F_{1,23} = 6.34$, $P = 0.02$

$r^2 = 0.49$, $P = 0.002$, $n = 26$

● Black mangrove
● Second-growth scrub

Results:
HY departure schedules and breeding latitude



South

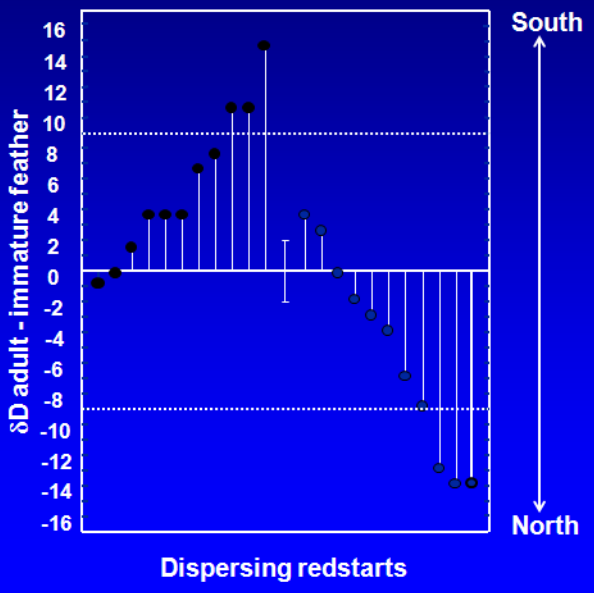
North

- Latitude of first breeding negatively related to departure in previous spring
- No effect of habitat: $F_{1,15} = 0.04$, $P = 0.83$

$r^2 = 0.39$, $P = 0.01$, $n = 18$

● Black mangrove
● Second-growth scrub

Results:
Natal dispersal distance and direction

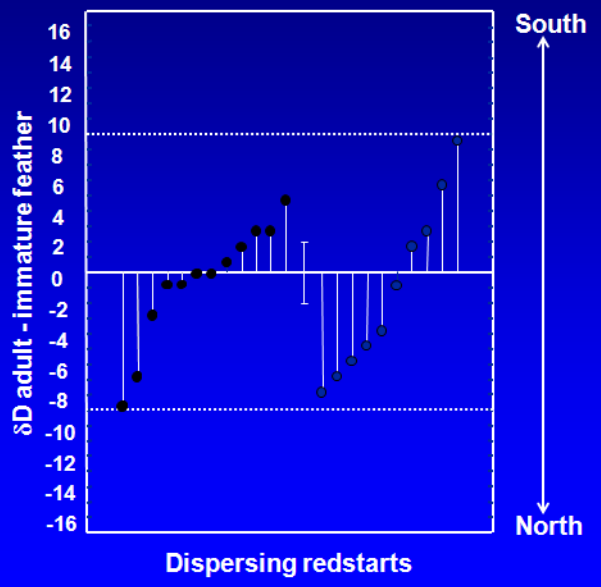


- Mangrove birds dispersed south of natal latitude (Wilcoxon signed rank $P = 0.004$)
- Scrub birds dispersed north of natal latitude (Wilcoxon signed rank $P = 0.004$)

● Black mangrove

● Second-growth scrub

Results:
Adult dispersal distance and direction



- Adult dispersal was negligible: Wilcoxon signed rank $P = 0.81$
- No effect of habitat: Wilcoxon signed rank $P = 0.53$
- Breeding fidelity may mask the consequences of habitat occupancy

● Black mangrove
● Second-growth scrub

Summary

- Body condition in spring affects departure schedules and distance traveled on spring migration in HY birds
- HY redstarts overwintering in mangrove habitat dispersed south of their natal latitude while birds in scrub dispersed north of their natal latitude
- Distance and direction of natal dispersal can be controlled by nonbreeding season habitat occupancy

Implications

- Orientation under genetic control, but departure timing and destination determined by conditions during the first winter

- Phenology may determine settlement of HYs

Conclusions

- Winter habitat occupancy drives patterns of reproductive success, natal dispersal and survival
- Seasonal interactions and carry-over effects influence the ecology and evolution of species

Conclusions

Research during the non-breeding season is urgently needed:

- basic natural history
- consequences of habitat occupancy
- role of climate density in driving individual performance
- estimates of seasonal interactions