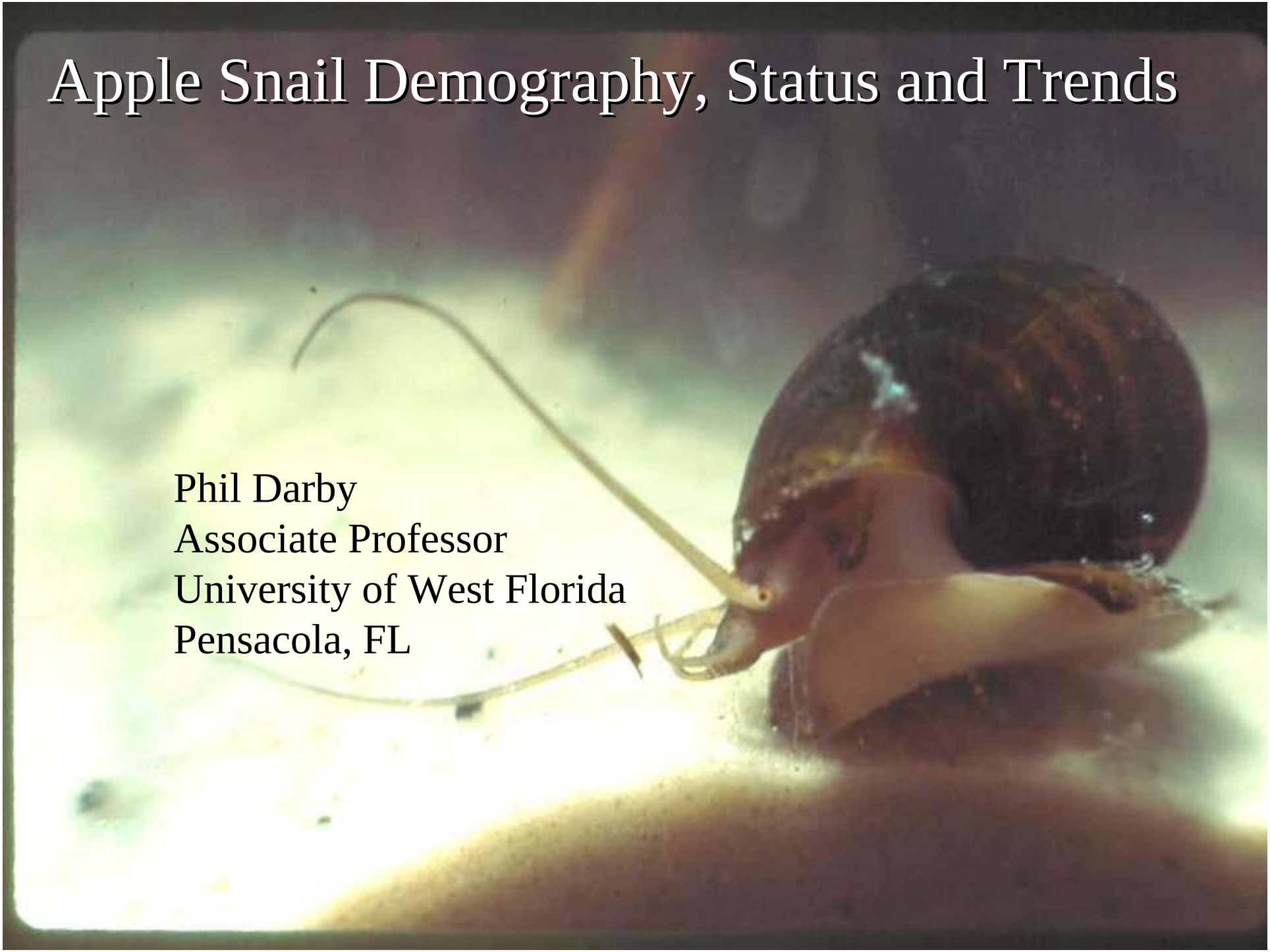
Apple Snail Demography, Status and Trends



Phil Darby
Associate Professor
University of West Florida
Pensacola, FL

Unique Environments

Support This

Unique Species

1) hydrology

2) habitat
   foraging
   nesting

3) apple snails

Unique Environments

Support <u>These</u>

Unique Species

1) hydrology

2) habitat

foraging **(snail densities)**

nesting

3) apple snails

a) hydrology

b) habitat

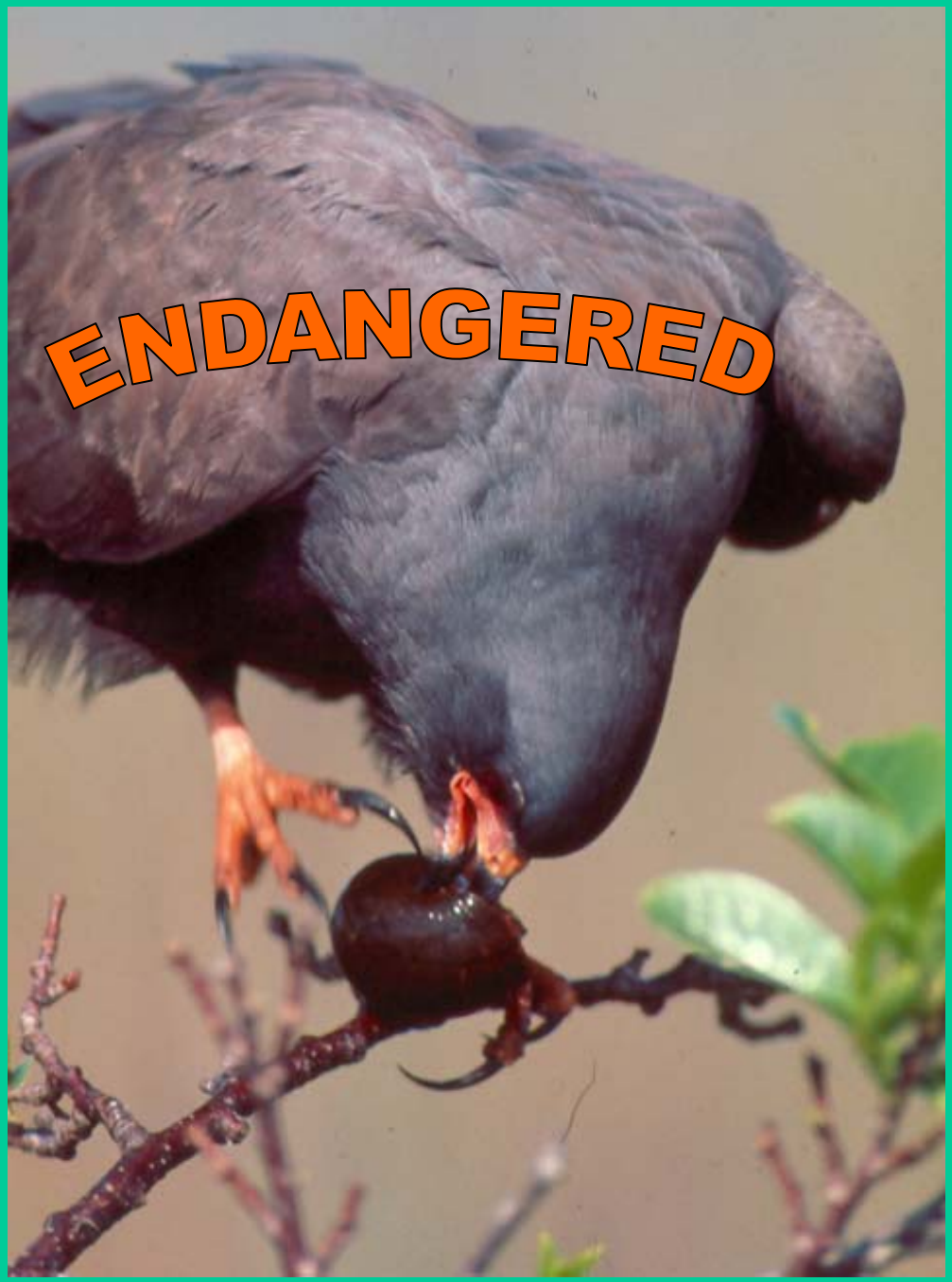
MAJORITY POINT OF VIEW

Snails are something for birds to eat…..

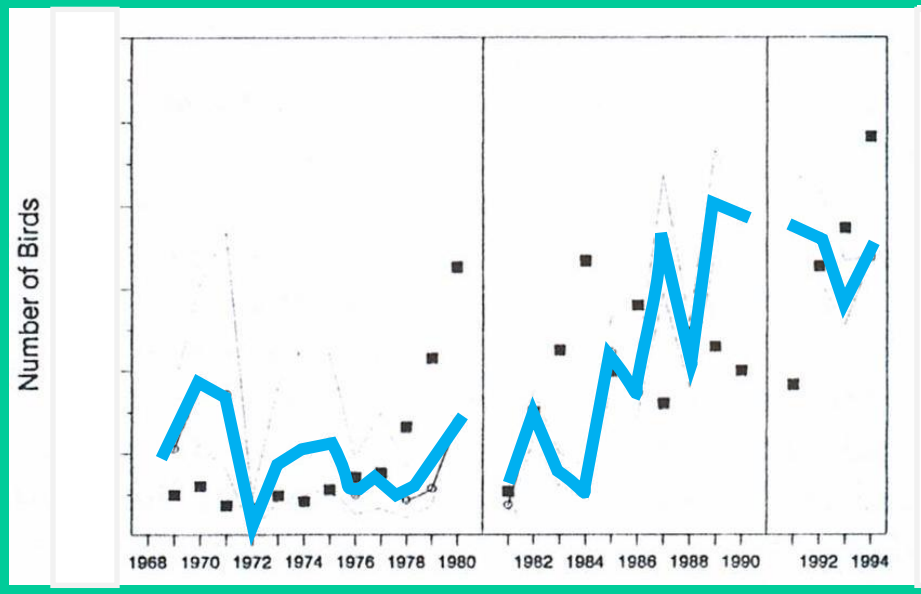
…but mostly

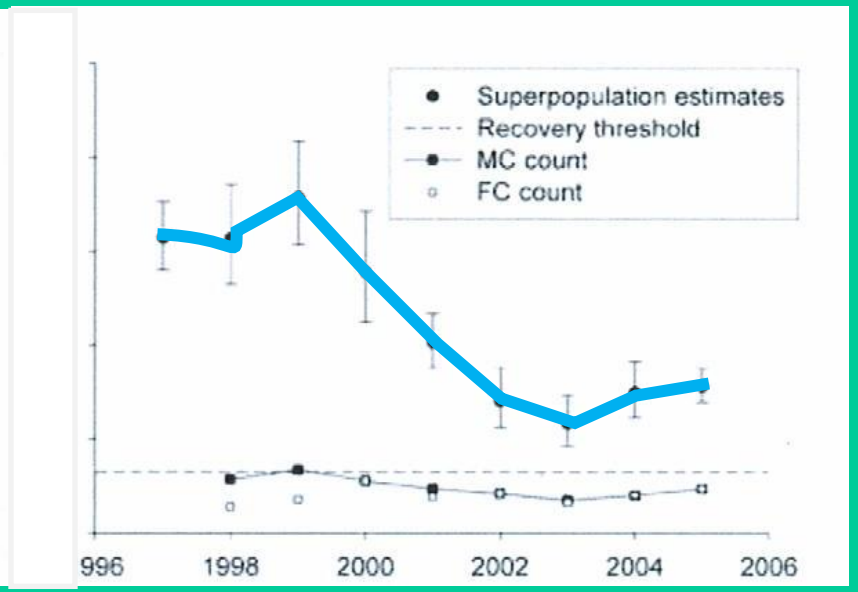
and all
Evidence Indicates

No snails, no kites



As kites were being monitored ……





Bennetts et al. 1999

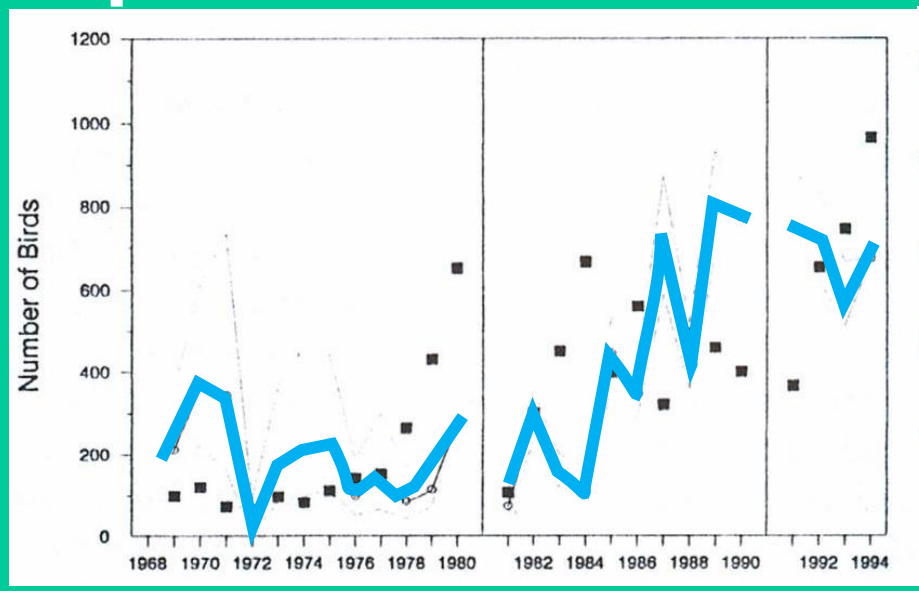
"Census"

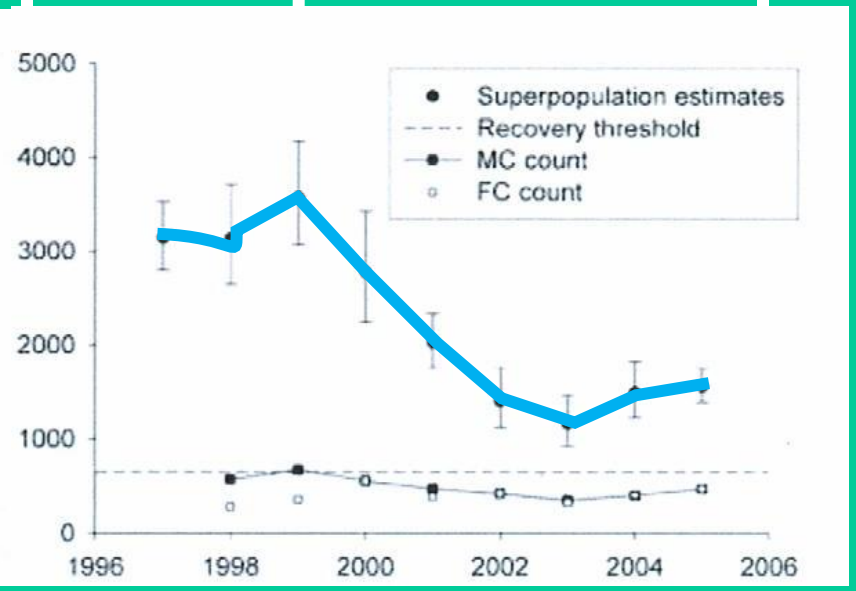
Martin et al. 2007

Mark-Resight

A PARADIGM SHIFT FOR SNAILS

dry downs bad for snails





1970s → 1990s

Based on <u>kite</u> response to dry downs:

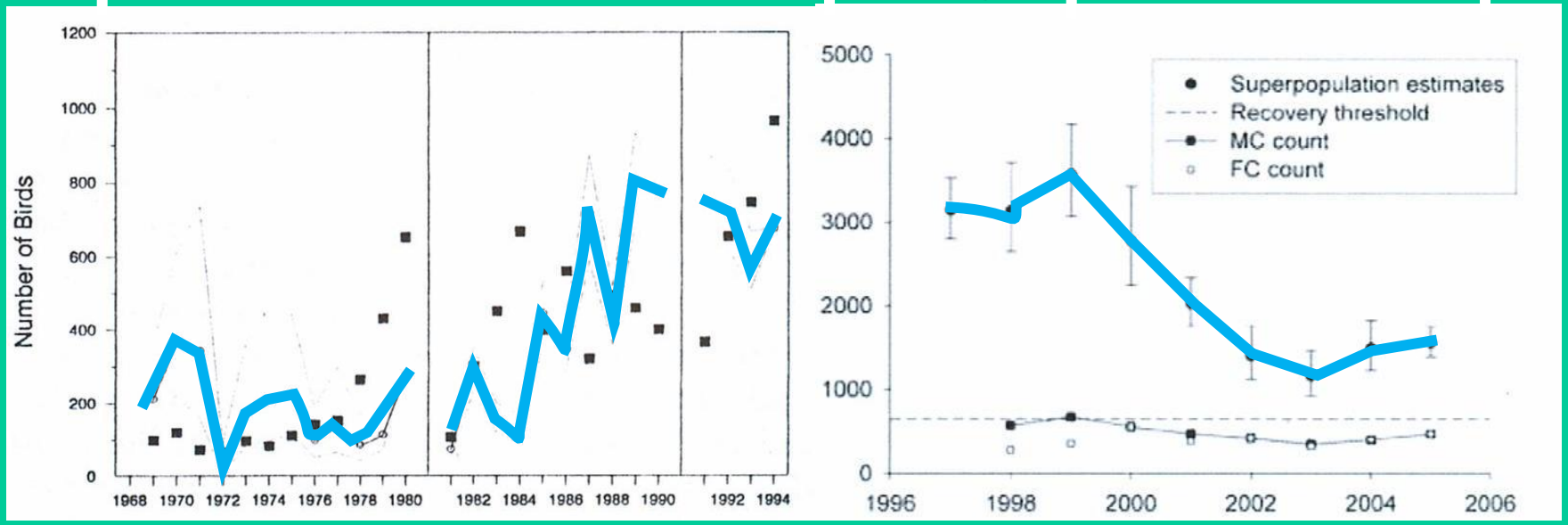
Drying events are bad for <u>snails</u>

- **Stieglitz and Thompson (1967)**
- **Martin and Doebel (1977)**
- **Beissinger (1988)**
- **Beissinger (1995)**

A PARADIGM SHIFT FOR SNAILS

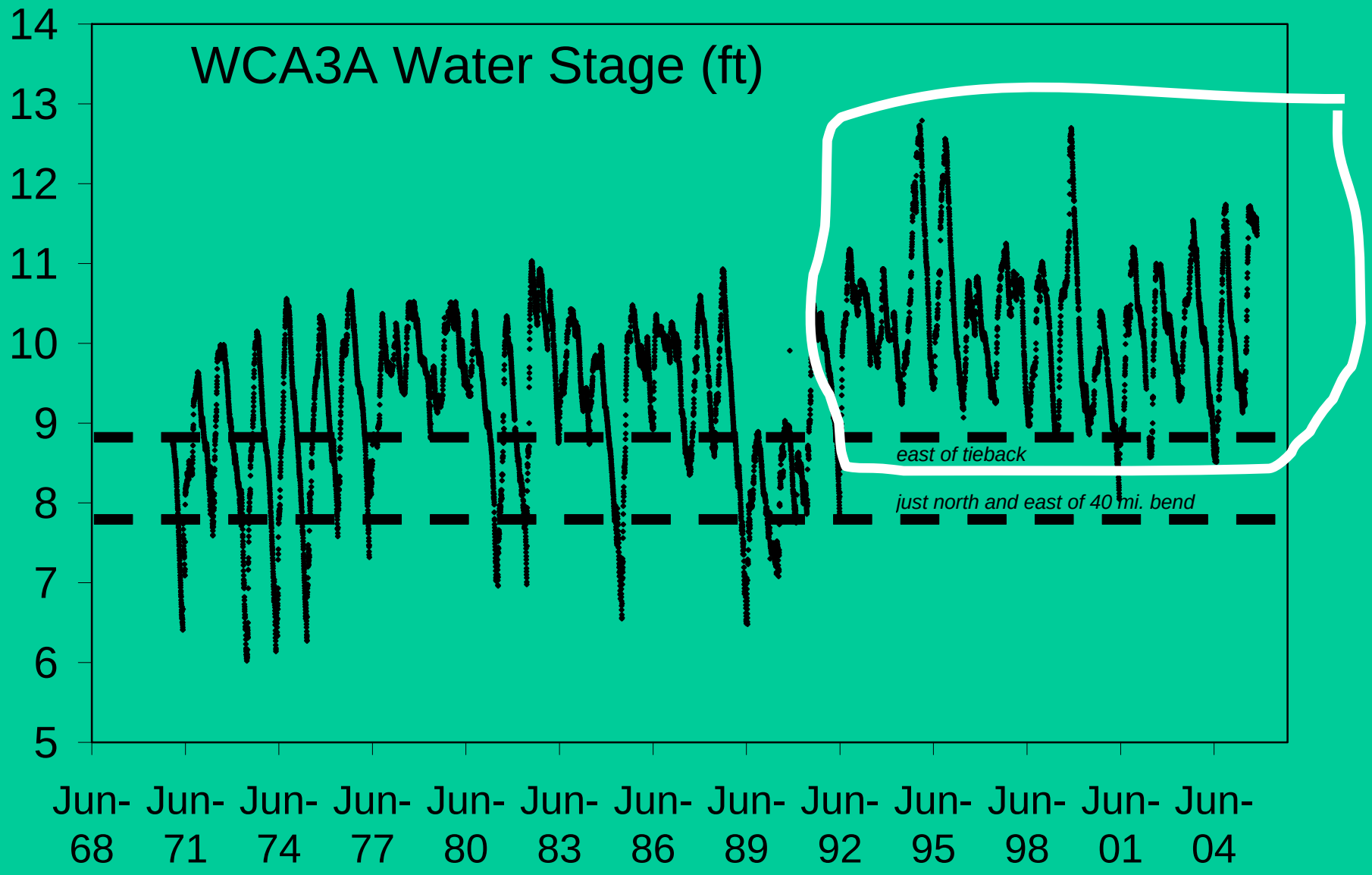
dry downs bad for snails

snails adapted to dry

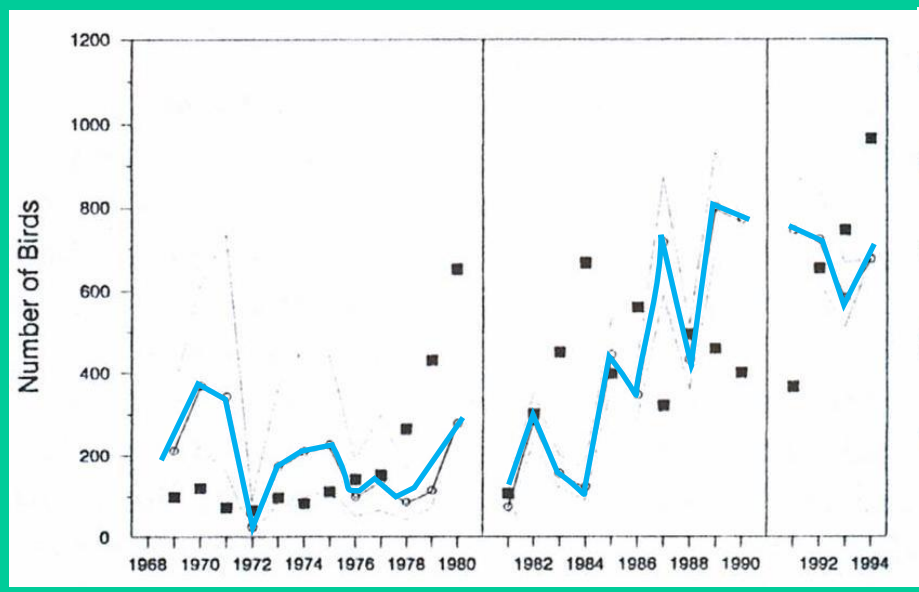


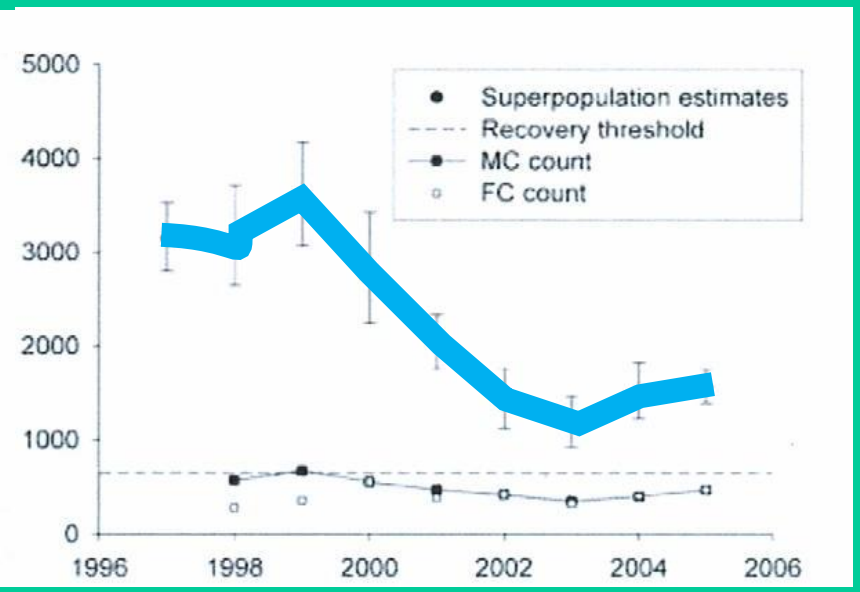
1970s → 2000

then in an era of relatively fewer drying events…



…..kites declined…





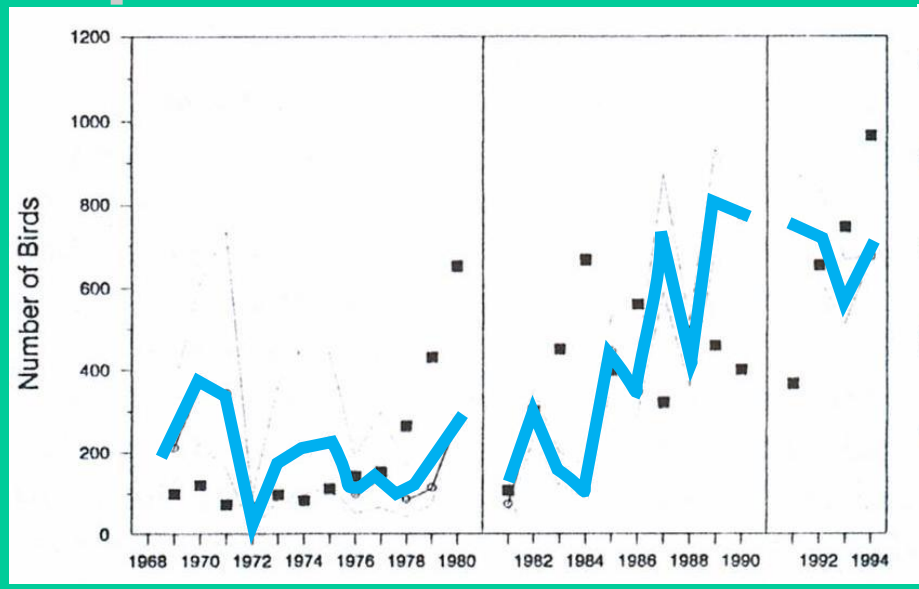
1996 → 2006

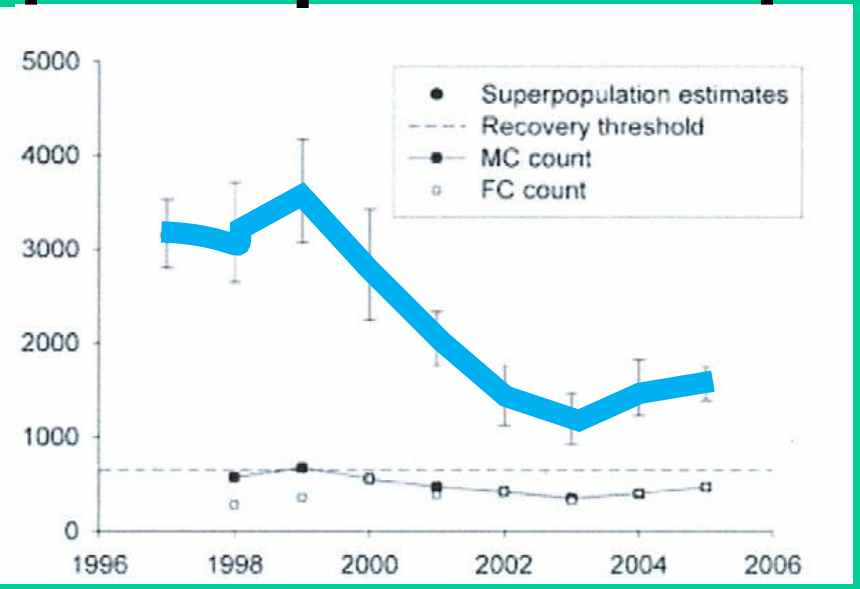
and the snail paradigm shift continued…

What's good for kites is good for snails (avoid dry)

Snails tolerate dry

It can be too wet for snails





IN TERMS OF HABITAT AND HYDROLOGY

SNAIL NEEDS ≈ KITE NEEDS, <u>BUT</u>

SNAIL NEEDS ≠ KITE NEEDS

To Address Concerns about Kites We Have to Address the Snails*:

1) what habitat & hydrology supports snails?

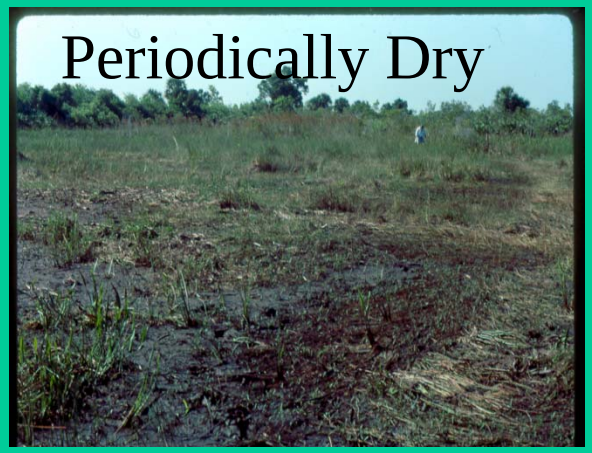
2) how many snails does it take to support kites?

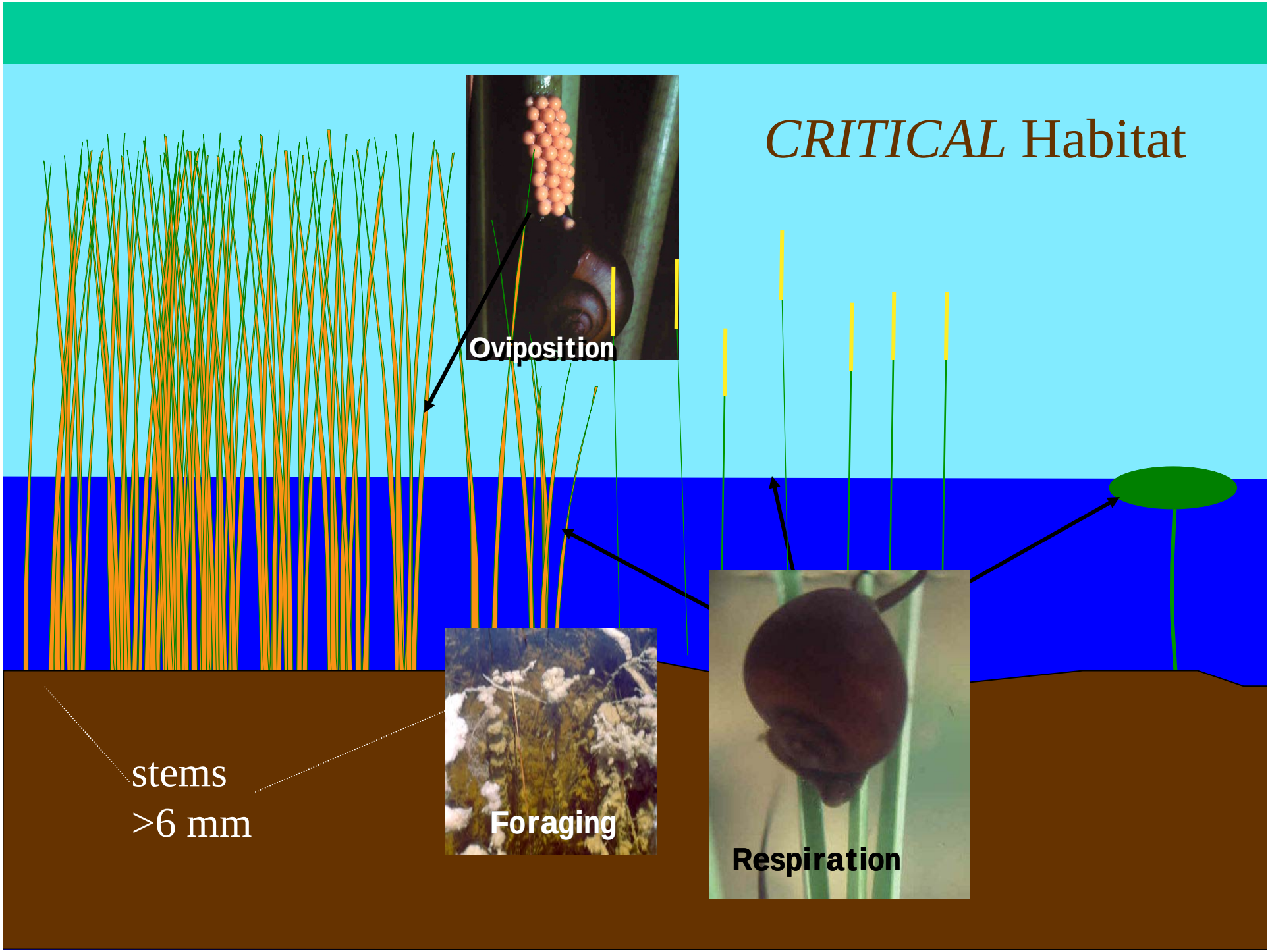
3) how many snails are out there now?

4) how can we increase snail density?

*acknowledging other issues for kites

Apple Snail Habitat



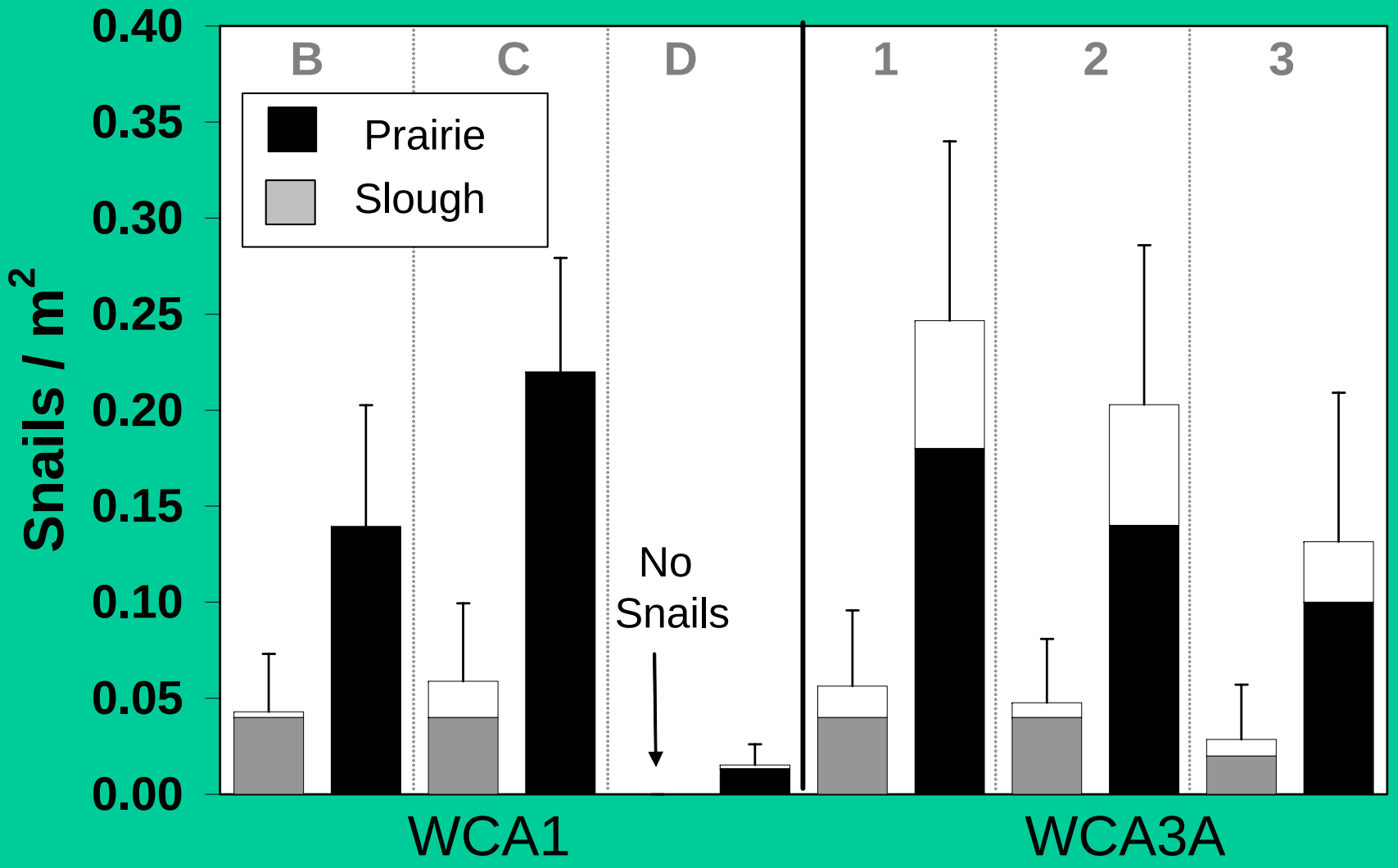

CRITICAL Habitat
Oviposition
Foraging
Respiration
stems
>6 mm

Comparing Community Types

Slough

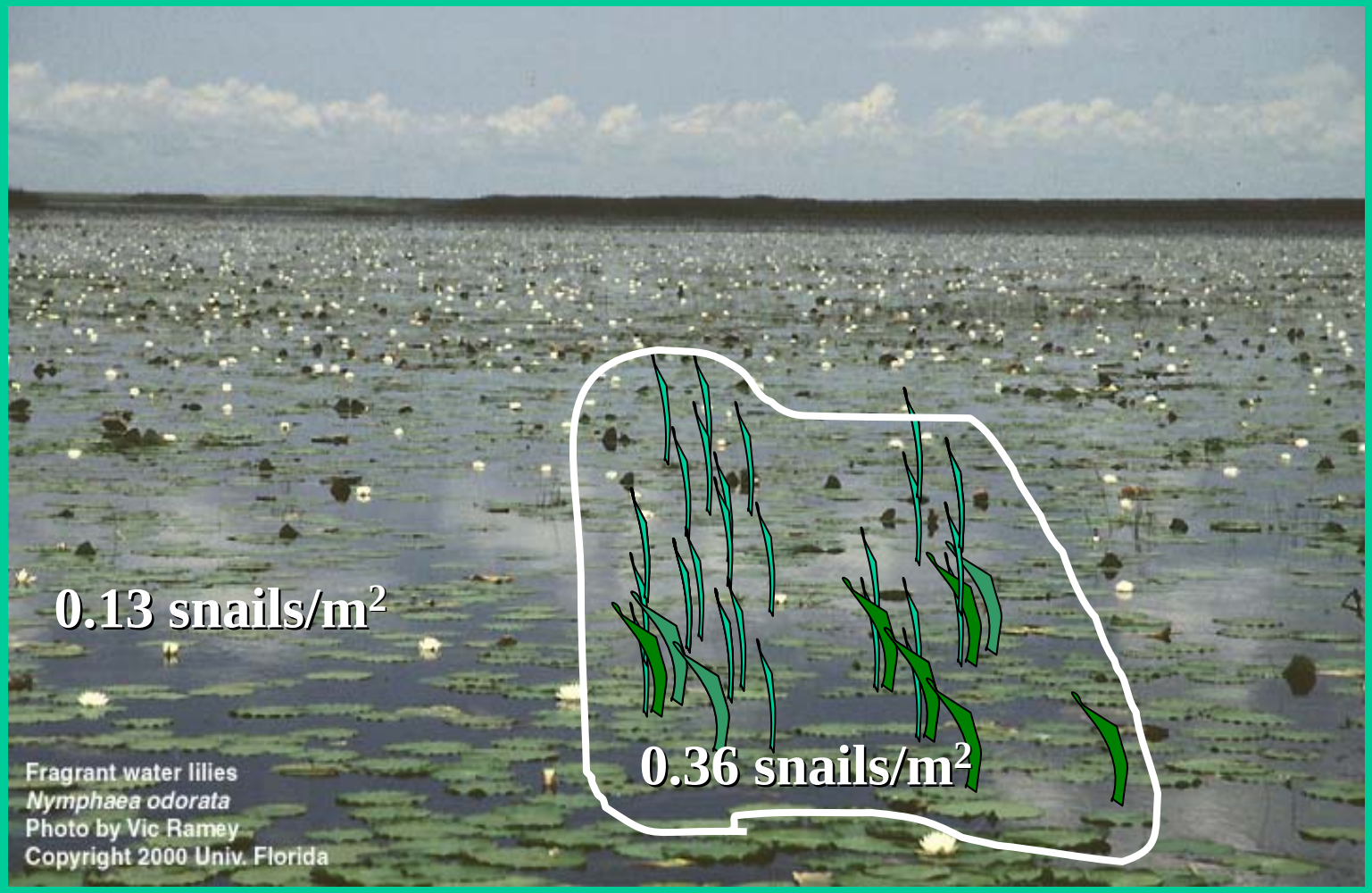
Wet Prairie

SNAIL DENSITIES ARE HIGHER IN PRAIRIE HABITAT



Karunaratne et al. 2006

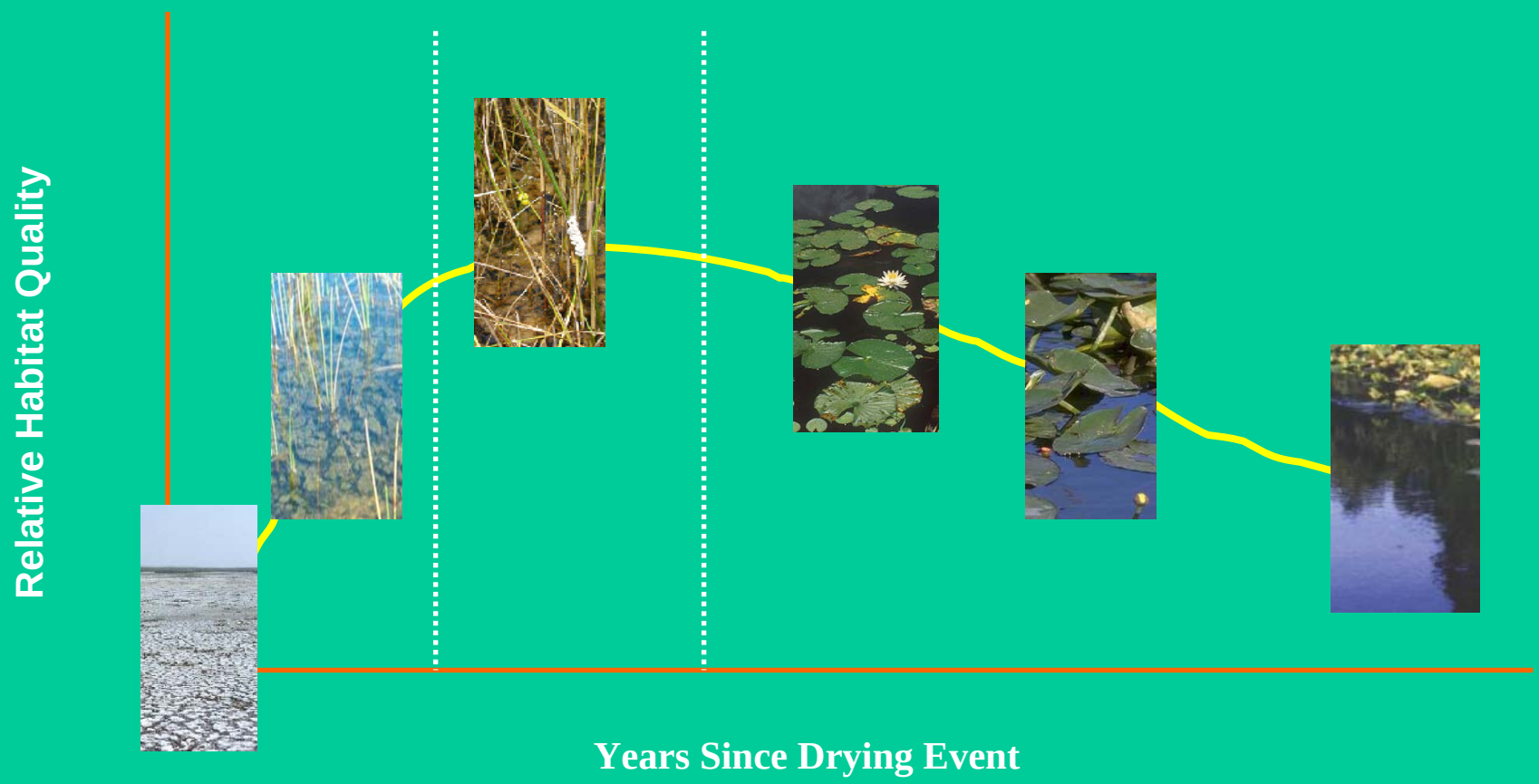
EMERGENT STRUCTURE IS CRITICAL



If you want prairie…….

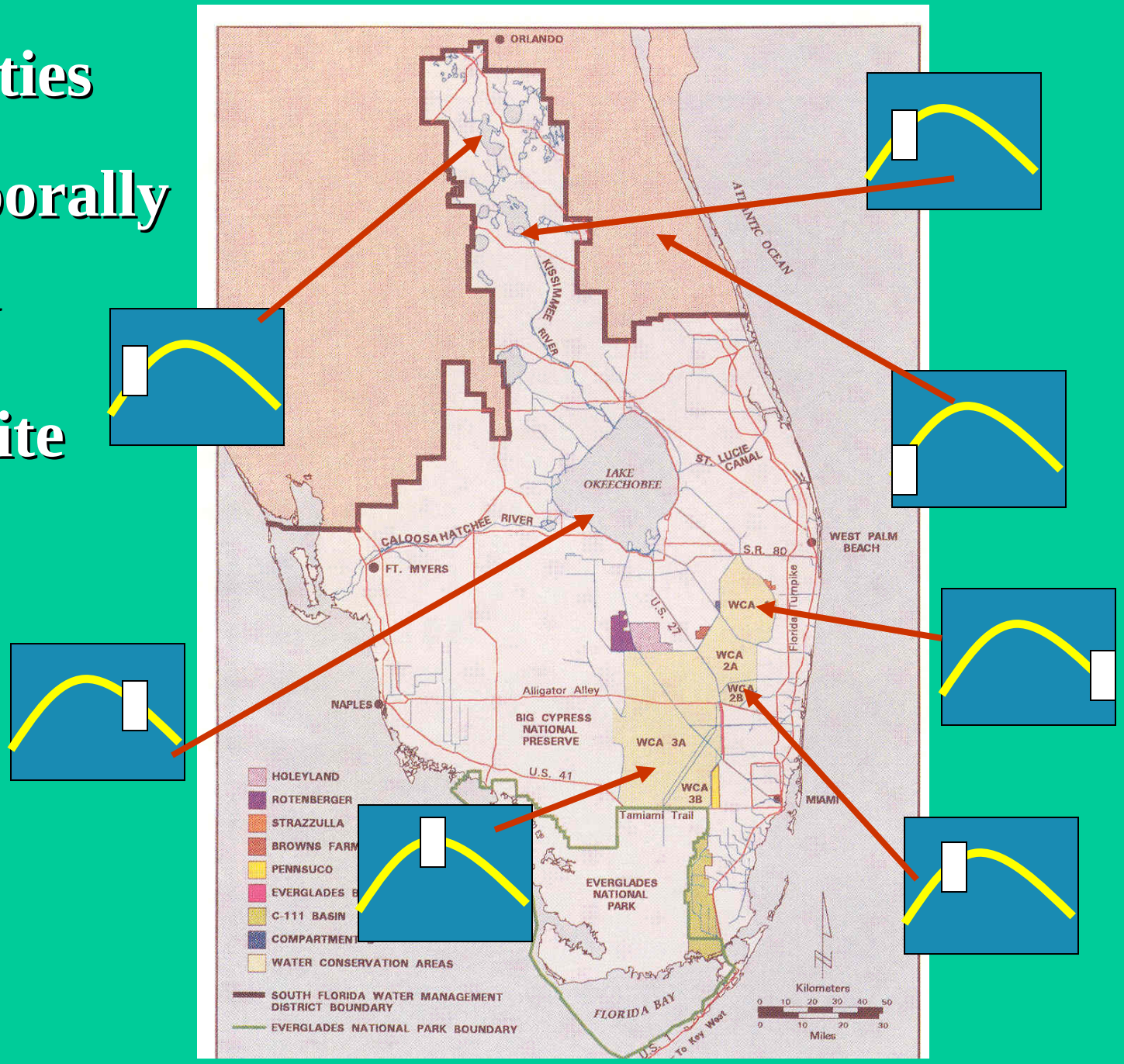
Dry Downs are Good for Snail Habitat

‘Dynamic Landscape Hypothesis’*: Snails Perspective

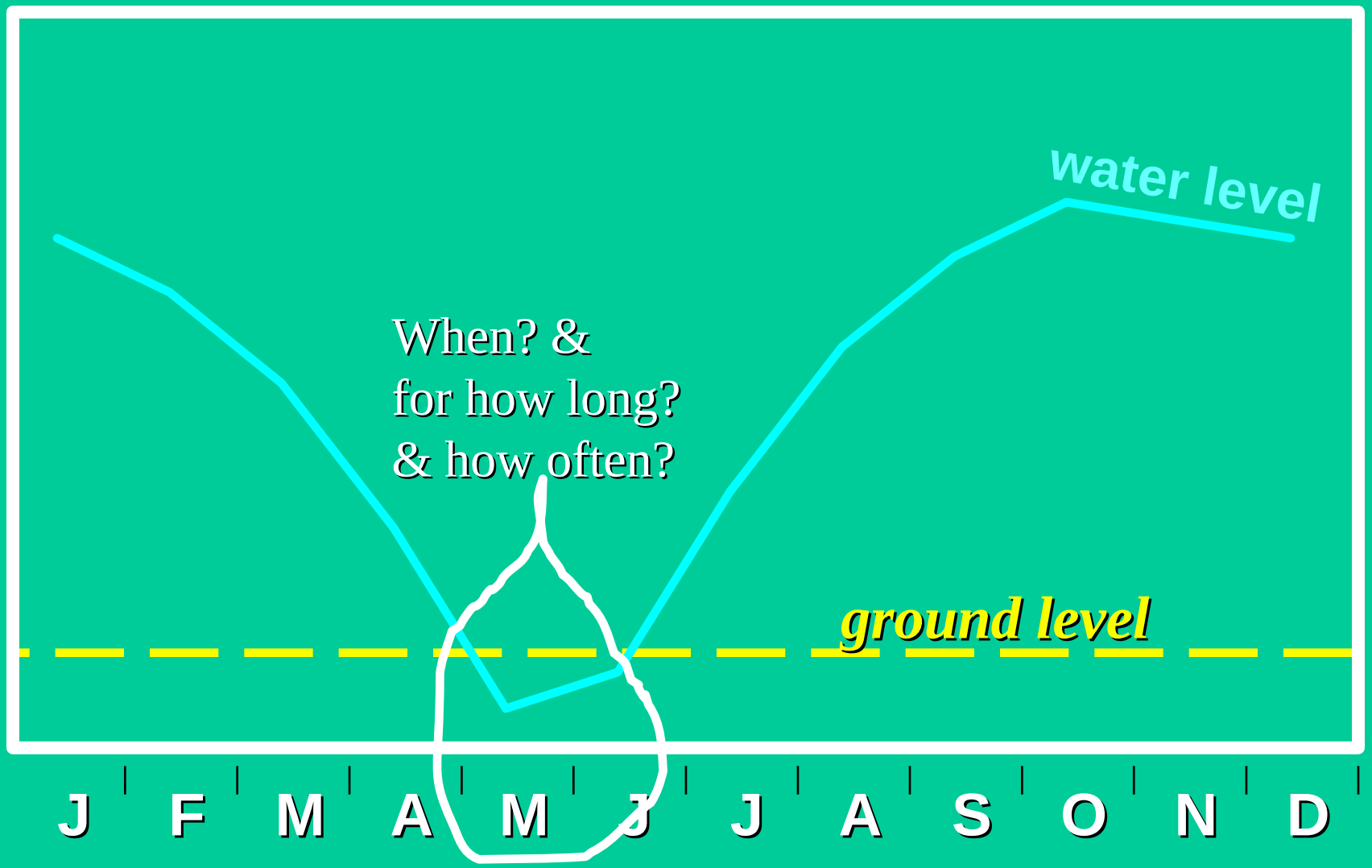


*Bennetts et al. 1998

Snail Densities Vary Temporally & Spatially Over the Kite Network

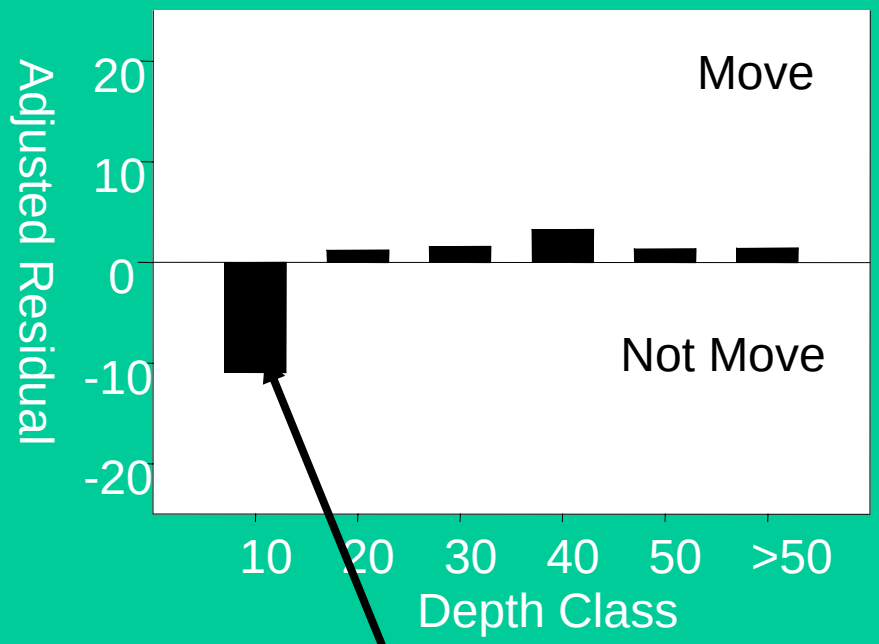


Hydrology Effects On Snails



Dry Down Impacts on Snails

No Movement*



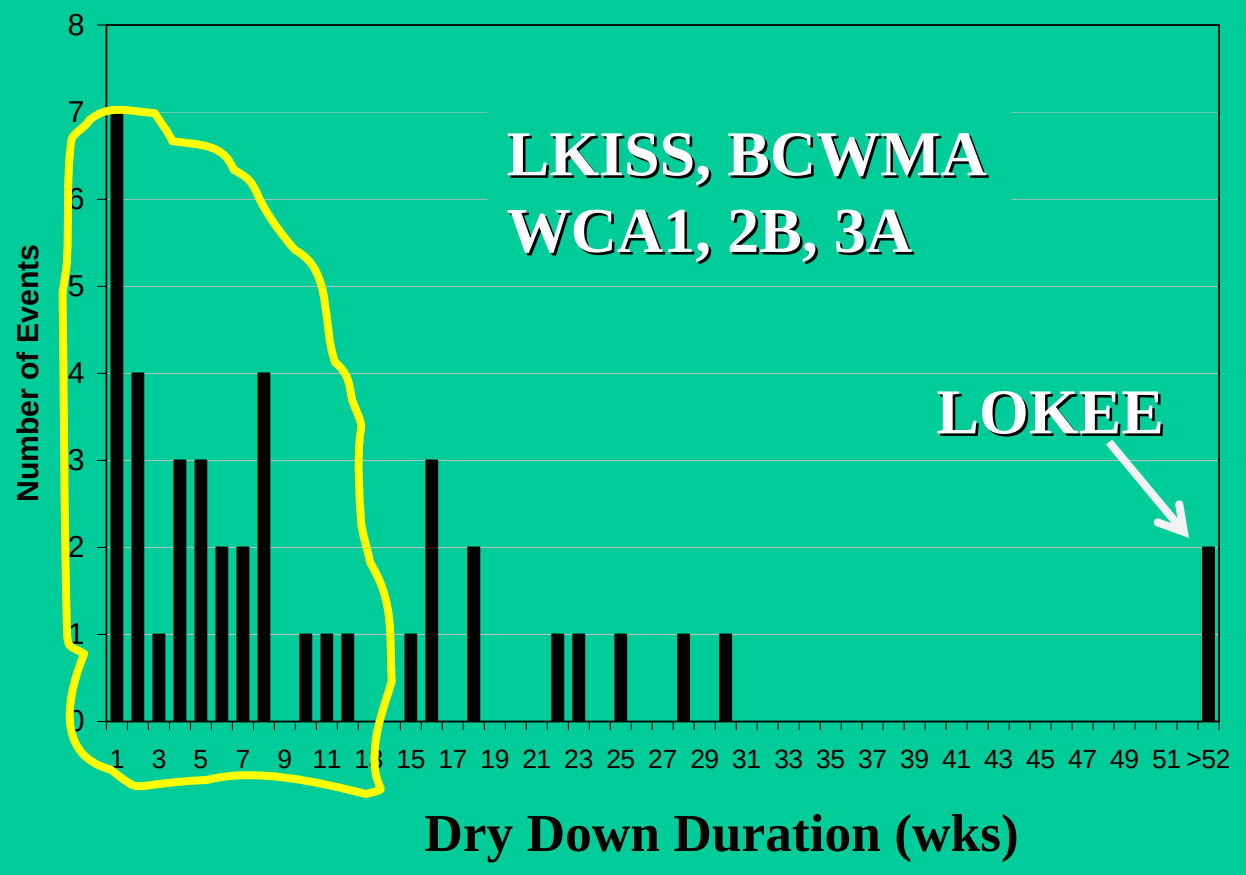
They get stranded

**Darby et al. 2002*

Adult-Sizes in Dry Down

79% Survive 3 months
47% Survive 4 months
37% Survive 4.5 months

1985-2004: Most Dry Downs Did Not Kill Most Adult Snails



70% of Events < 12 weeks

Dry Downs Impact Recruitment

Recruitment

4-5 mo.

2-4 mo.

3-5 mo.

overwinter 3-4 mo.

Dry Downs Impact Recruitment

especially….

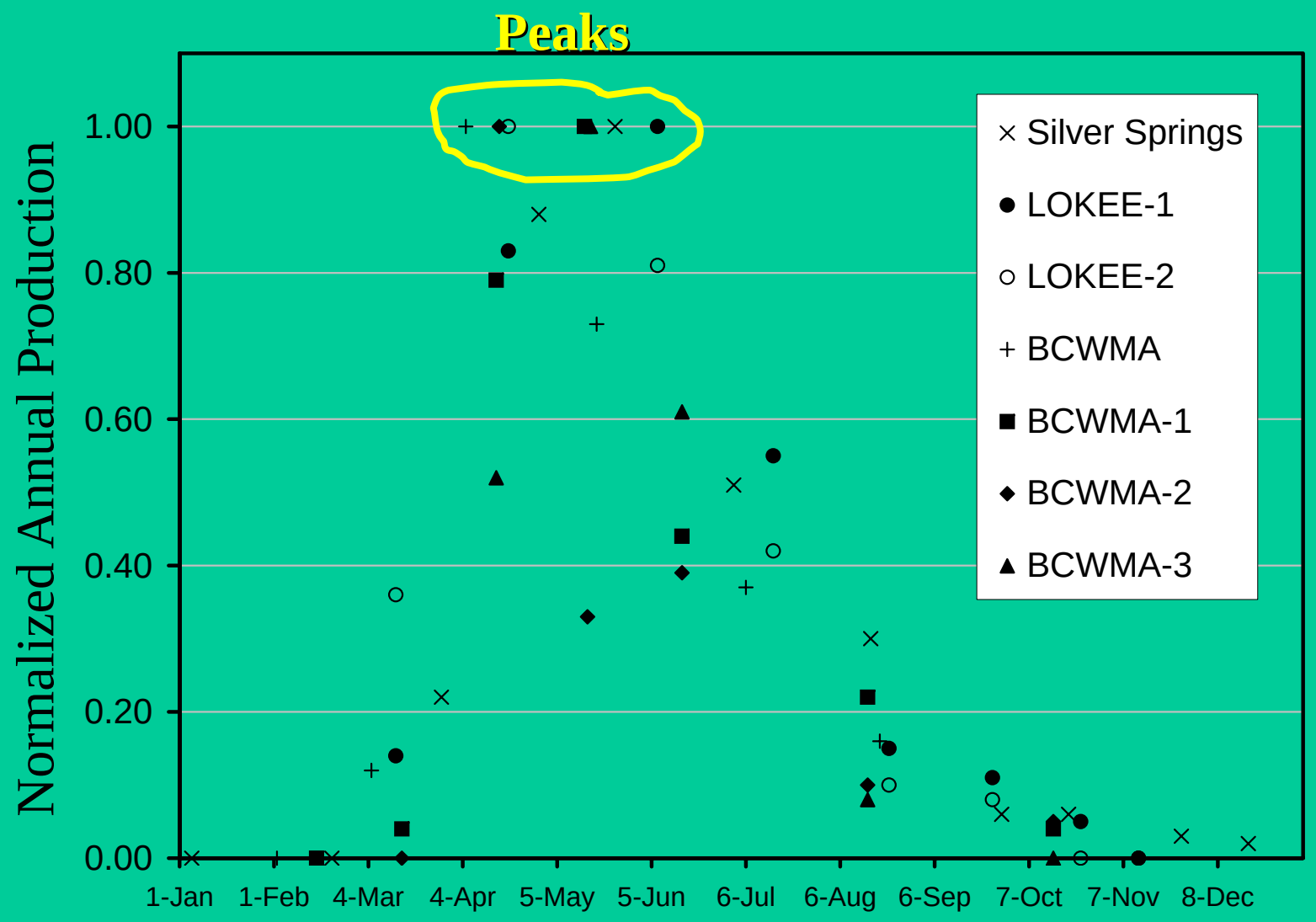
3-4 mo. peak

2-4 wks

overwinter 3-4 mo.

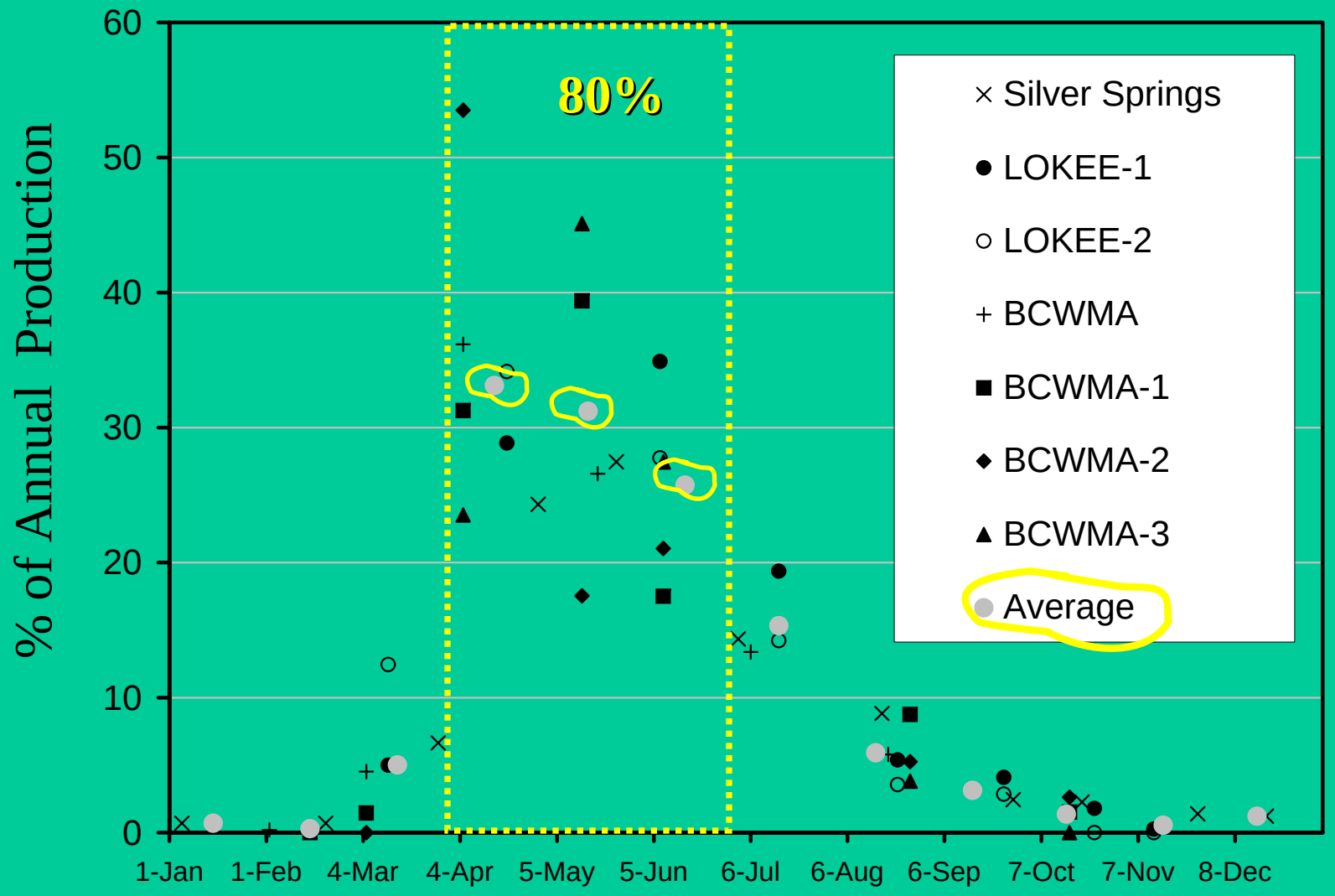
Seasonality of Reproduction

based on published data

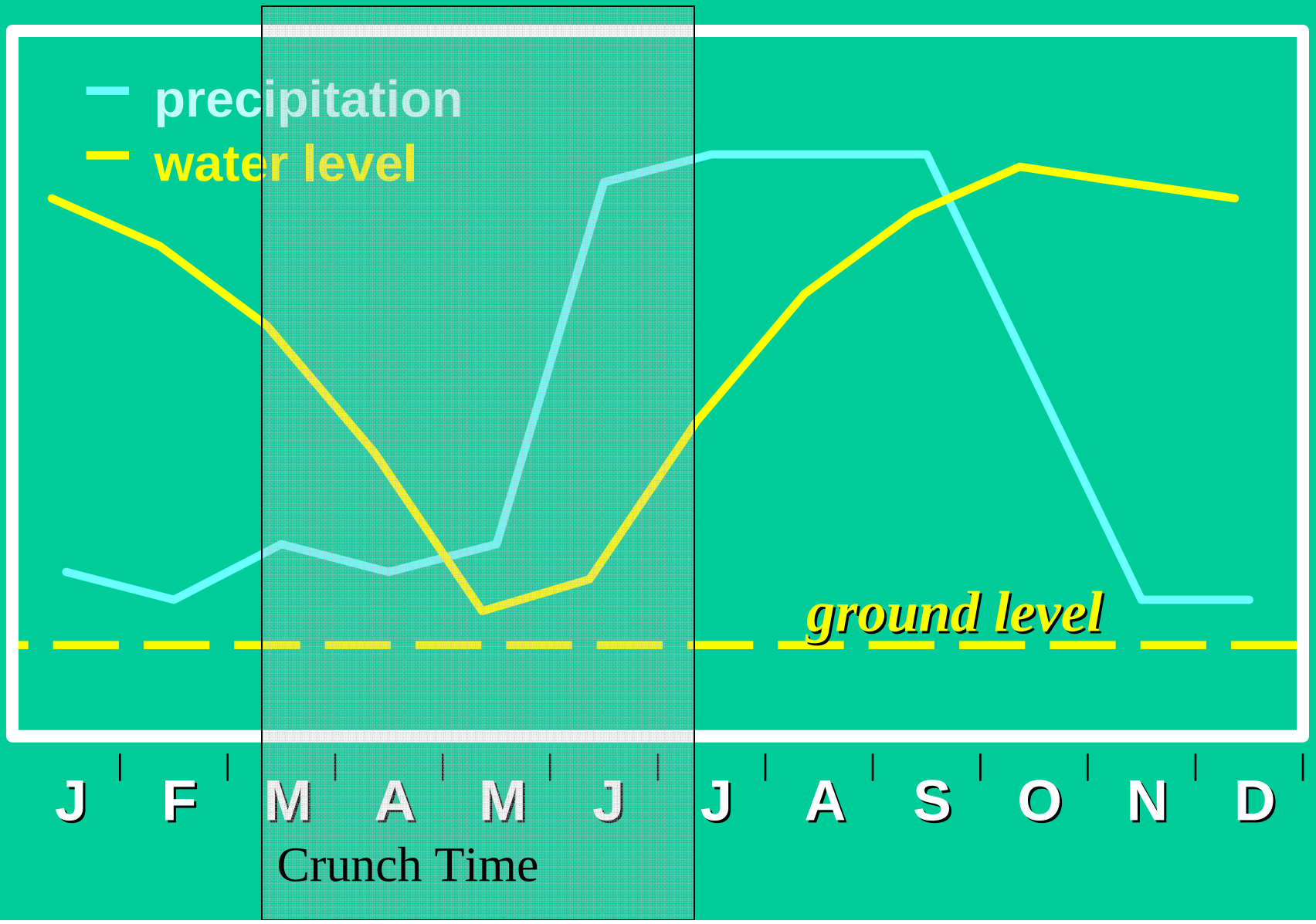


Seasonality of Reproduction

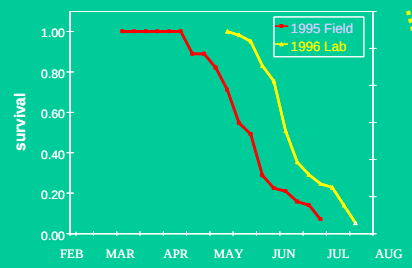
Darby et al. 2008

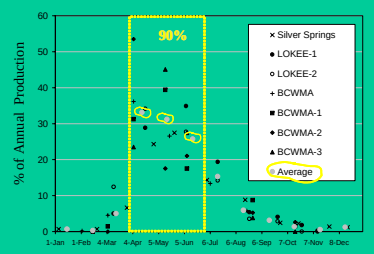


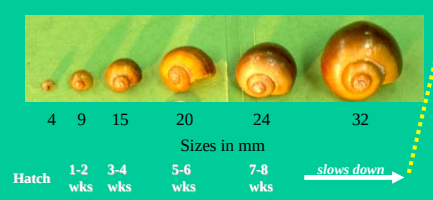
Peak Egg Laying is Mid-Late Dry Season



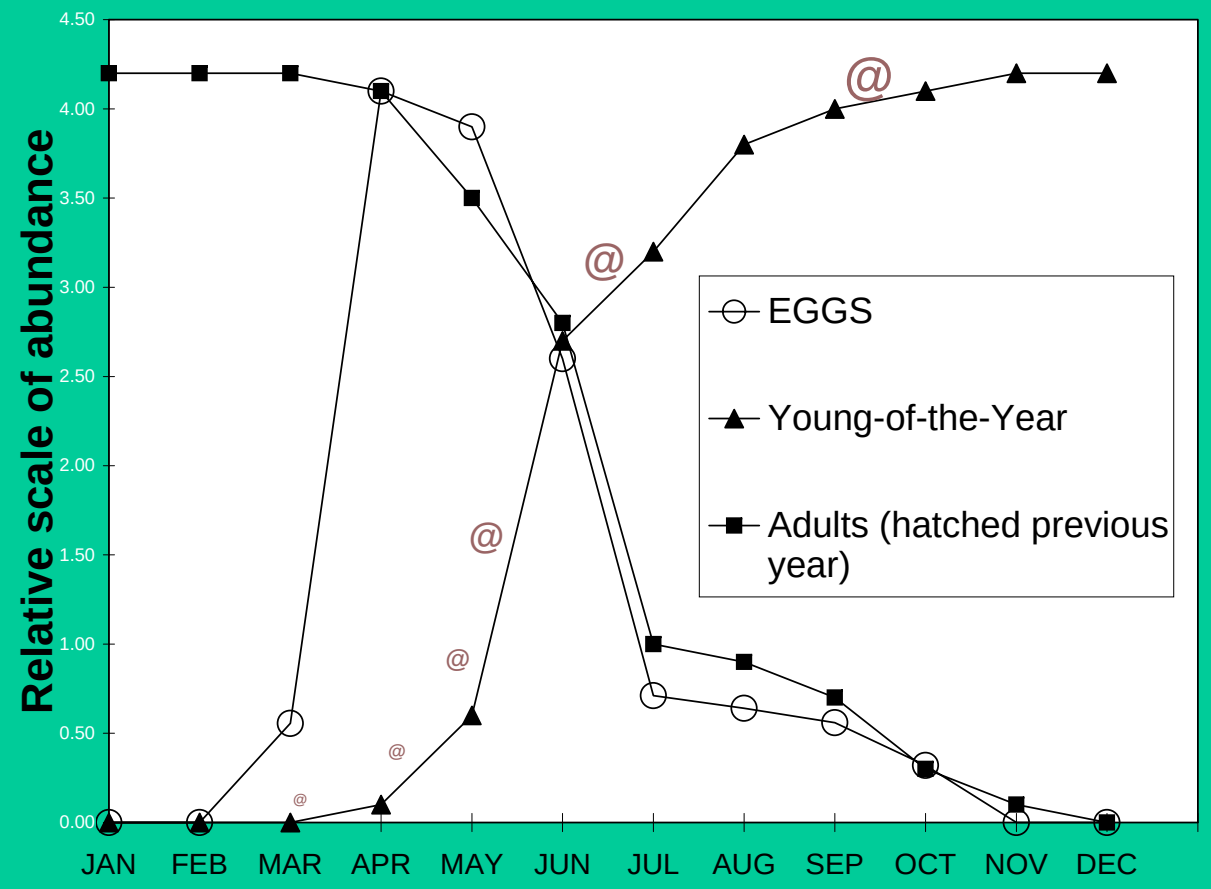
with one season per lifetime per female





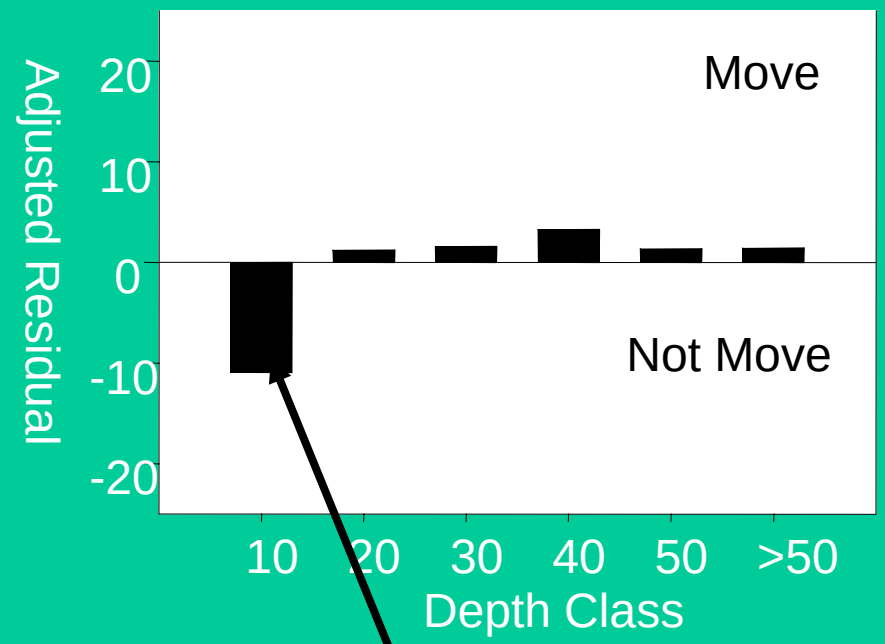


& Literature



….12-18 months life span

Dry Downs: *No Mating or Egg Laying***



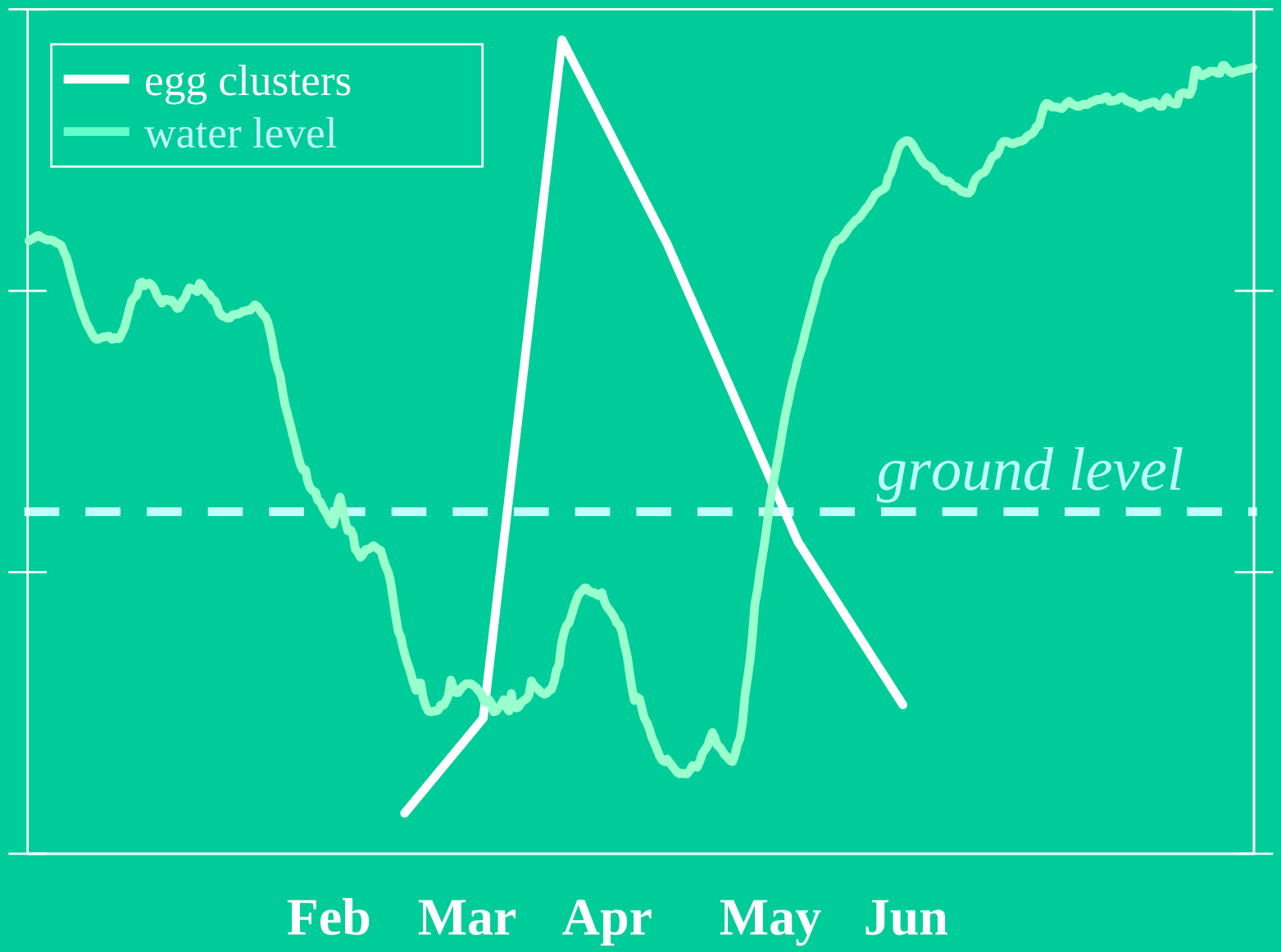
They get stranded

**Darby et al. 2002*

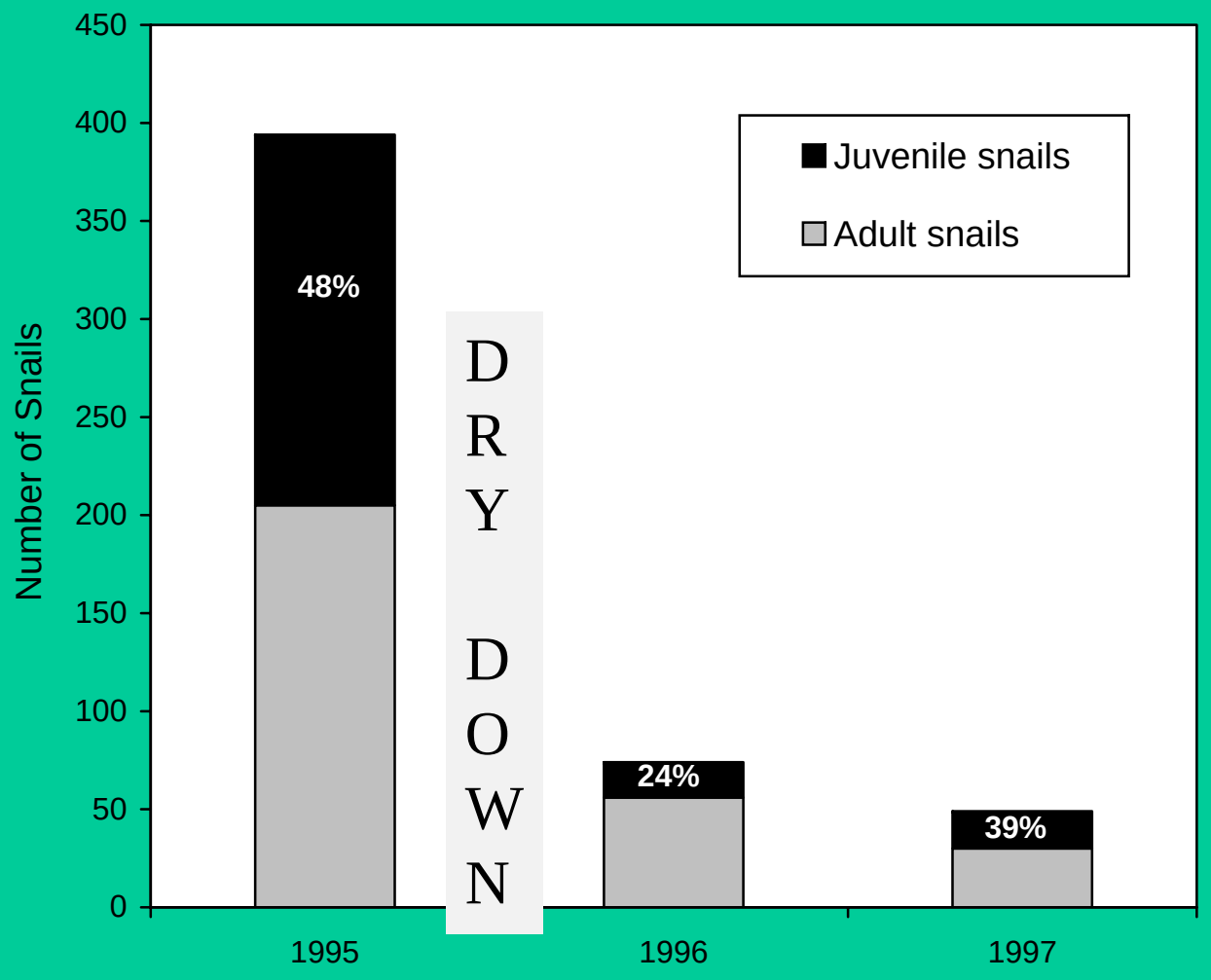
***Darby et al. 2004*

***Darby et al. 2008*

Dry Downs During Peak Egg Laying



Result in Low Recruitment / Density



Darby et al. 2004

Juveniles are most sensitive to dry downs

- <20% survive 8 week dry downs
- Smaller sizes most abundant following egg peak (Apr-Jun)

Darby et al. 2008

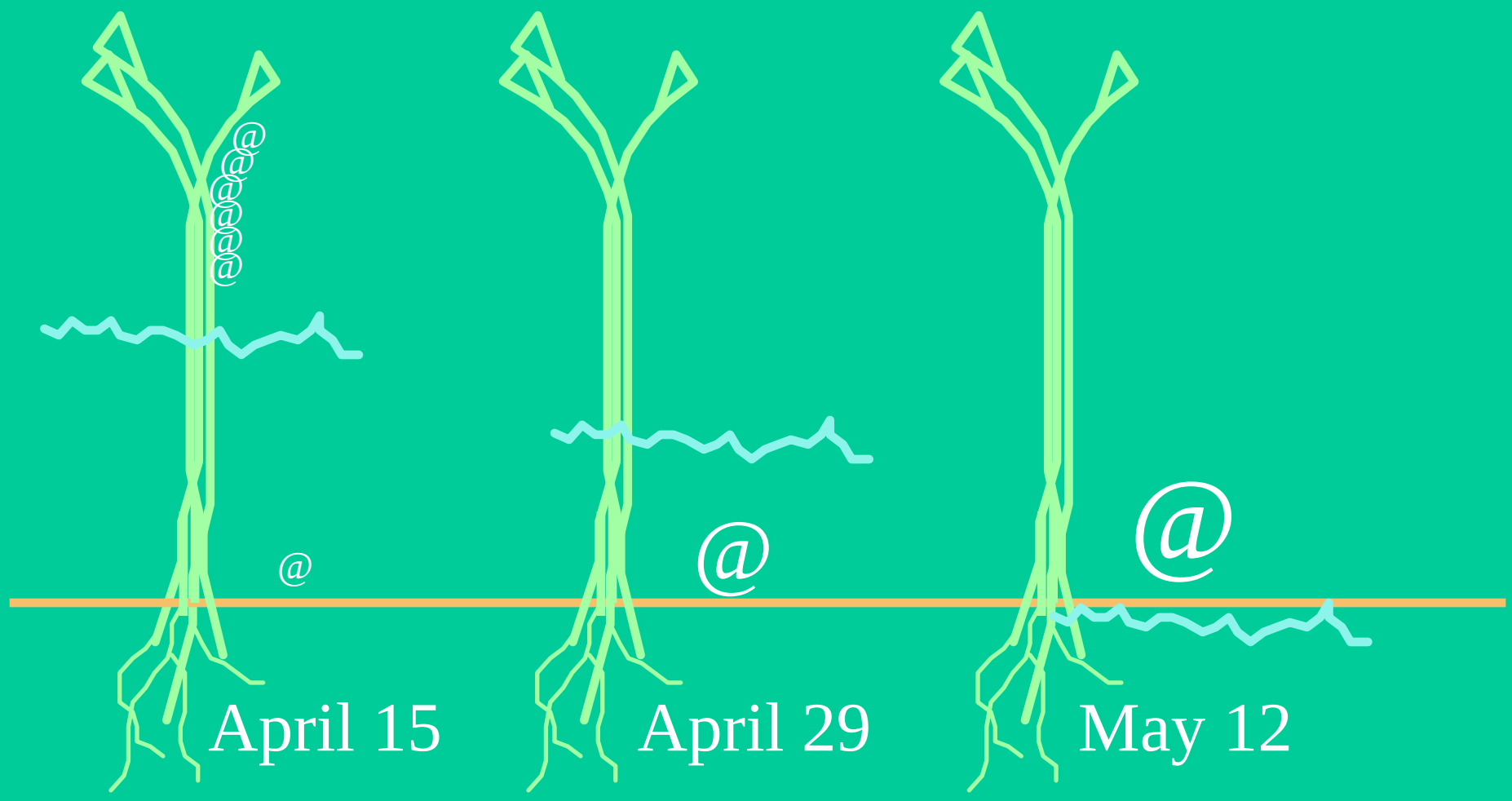
Survival Depends on Size Depends on Growth...

4 9 15 20 24 32

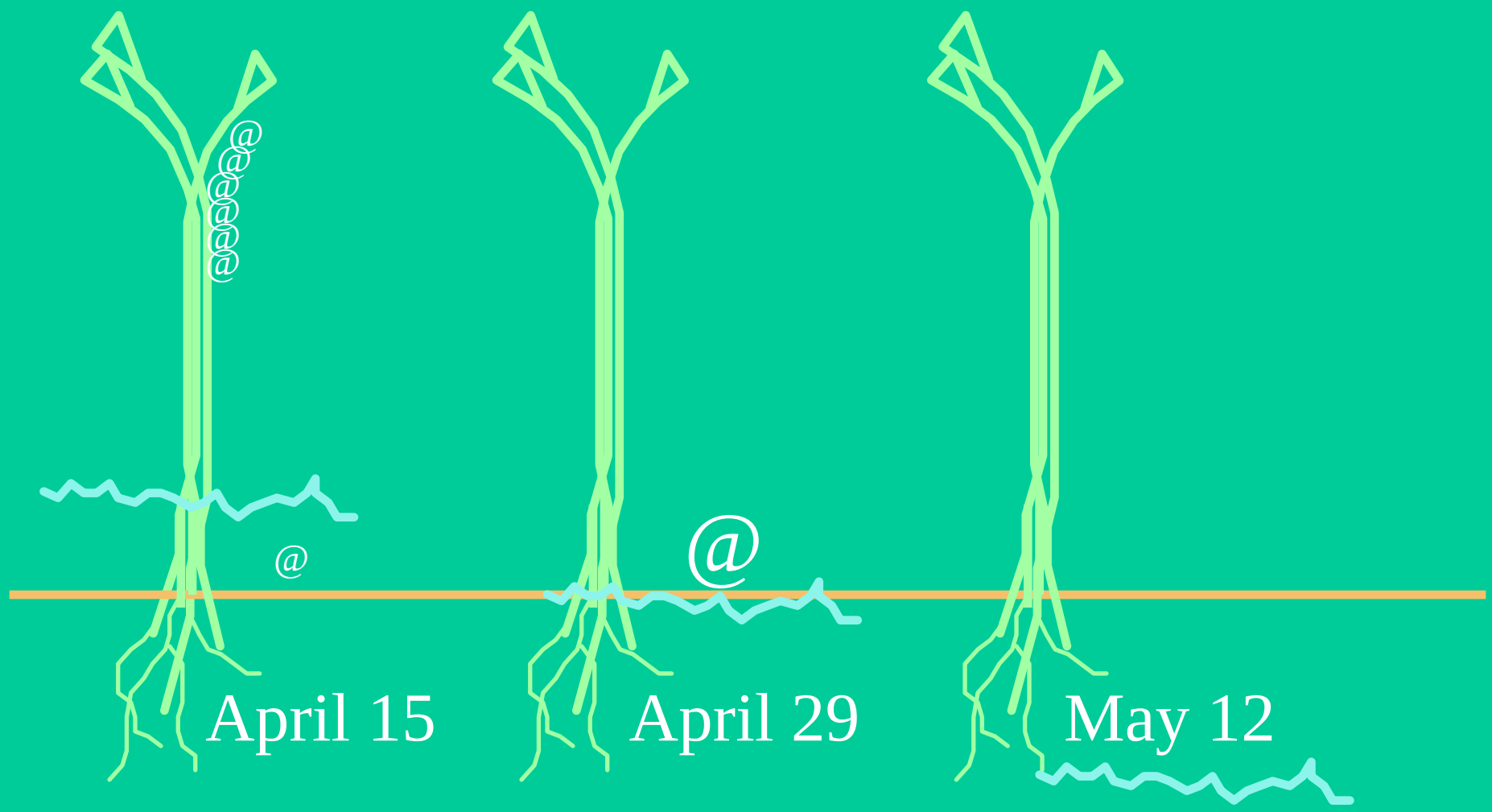
Sizes in mm

Hatch **1-2 wks** **3-4 wks** **5-6 wks** **7-8 wks** ***slows down*** →

Dry Down Timing Defines the Window for Growth

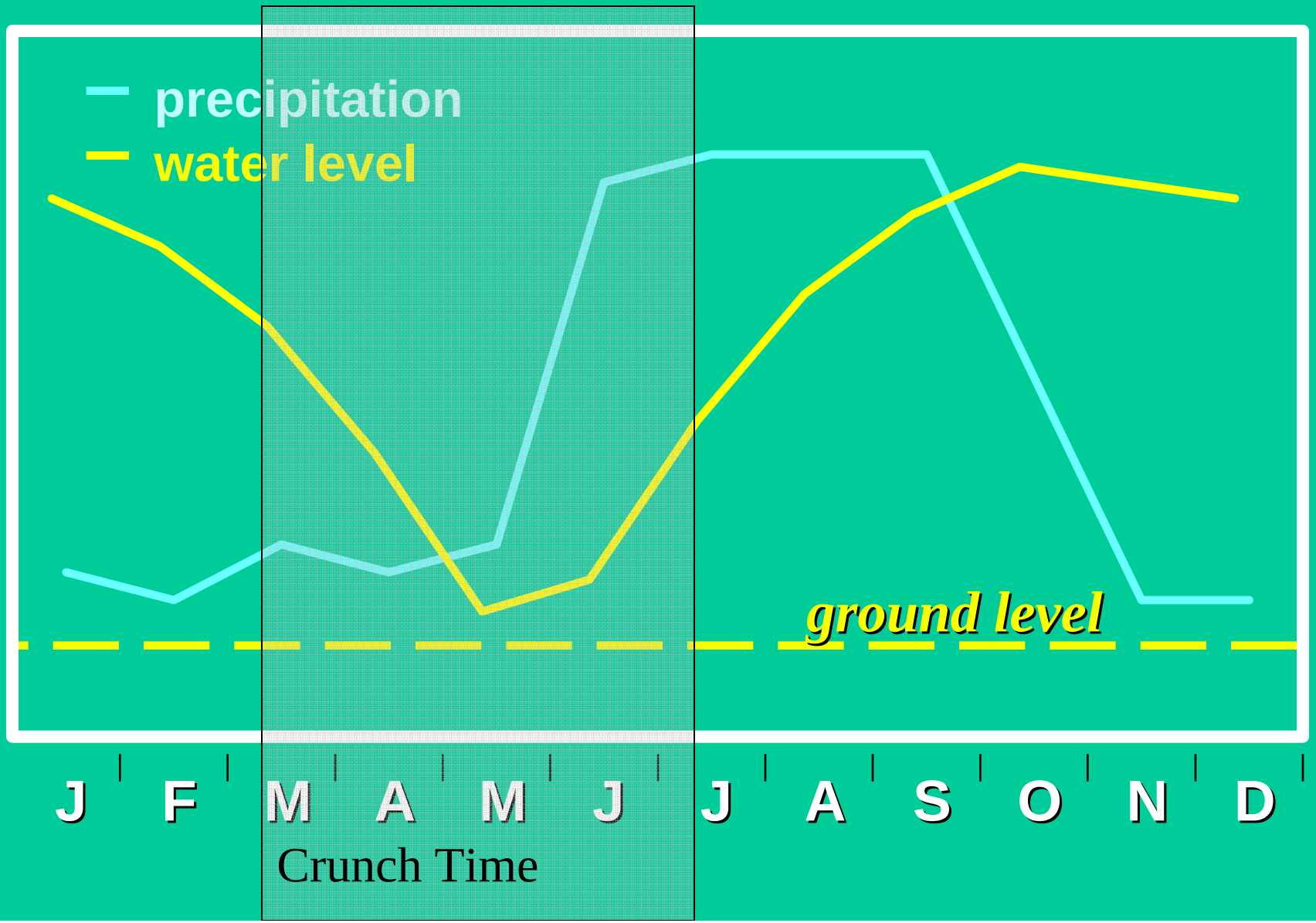


Less Time to Grow = Lower Dry Survival

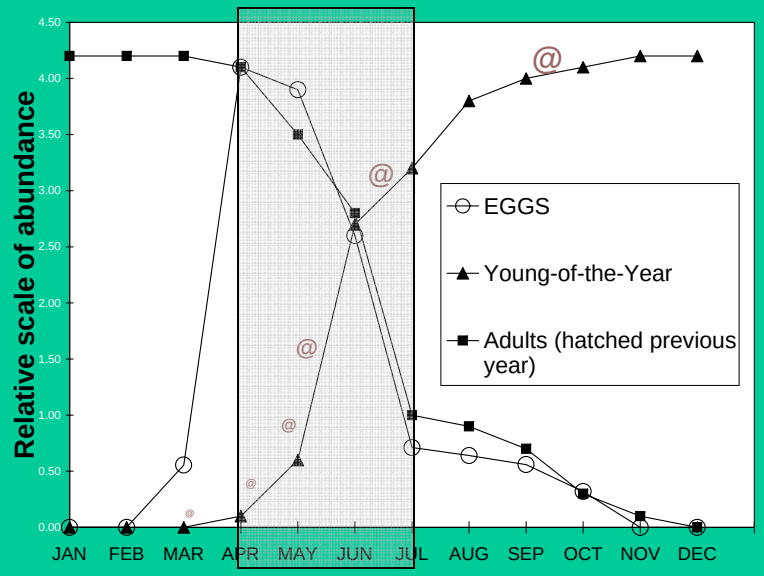


**Darby et al. 2008*

Peak *Recruitment* is Mid-Late Dry Season



Snails Life History= *f* (periodic dry downs)



Snails Survive Dry Downs

<4 weeks: *little impact*

4-16 weeks: *depends on timing*

>16 weeks: *expect >50% losses*

Dry DownTiming

Dry season conditions (receding waters) favor egg production*

Rapid early growth enhances dry down survival

Dry Downs are good for snail habitat

Sawgrass for oviposition

Wet prairies support more snails than *Nymphaea*-sloughs

Dry downs likely decrease predation pressure (*in progress*)

*Turner; Hanning; others

Hydrology Effects On Snails

Can Rising Water Cause Problems?

Turner (1998):
submersed eggs
fail to hatch*

**affected by egg age + flood duration*

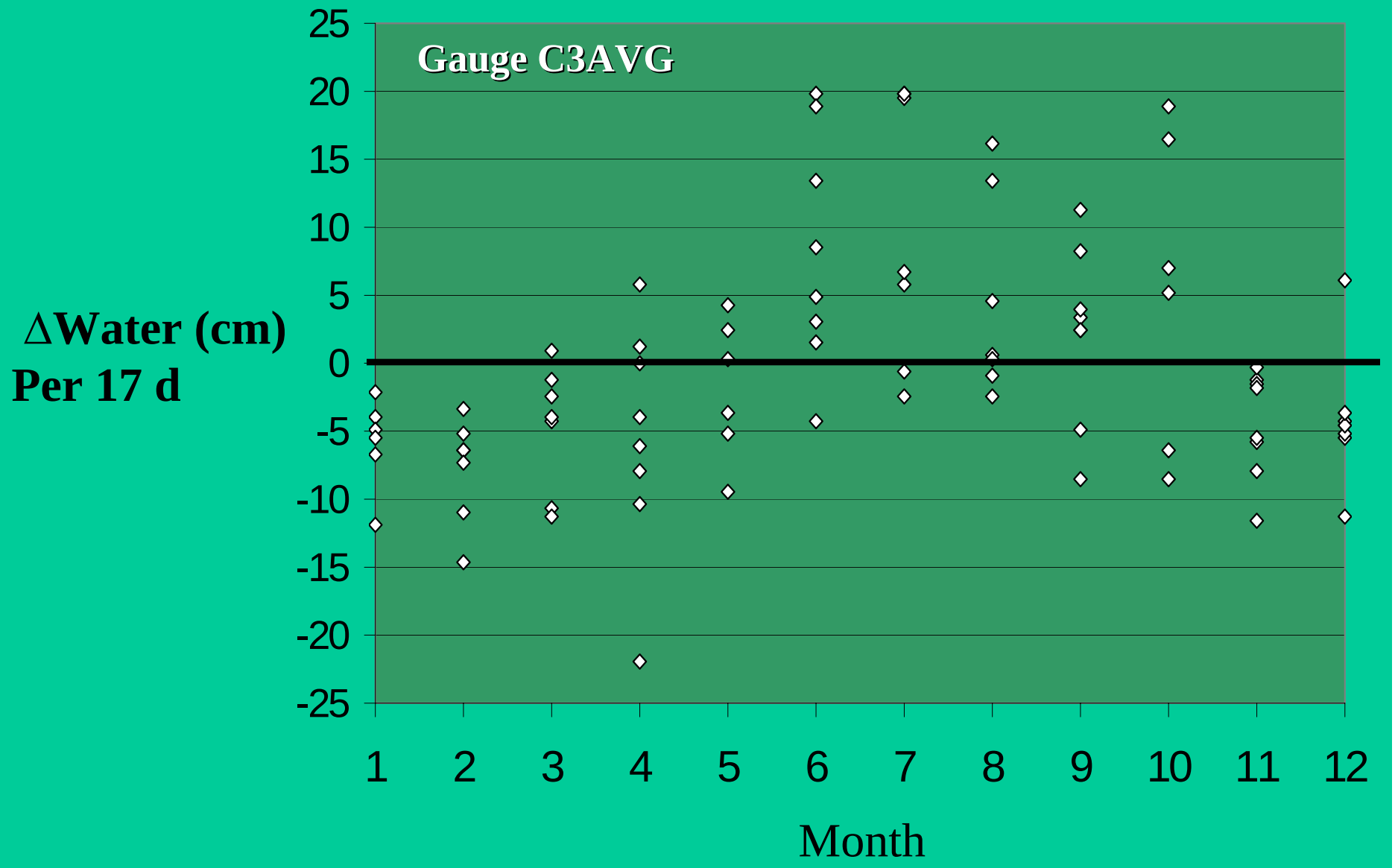
Getting the Hatch Before the Rise

- **14-21 d Incubation (~17 d)***
- **Eggs laid above water line**
  15 ± 28 cm (Hanning 1979)
  17 ± 7 cm (Turner 1996)
  22 ± 8 cm (Darby, *Crinum* only)*

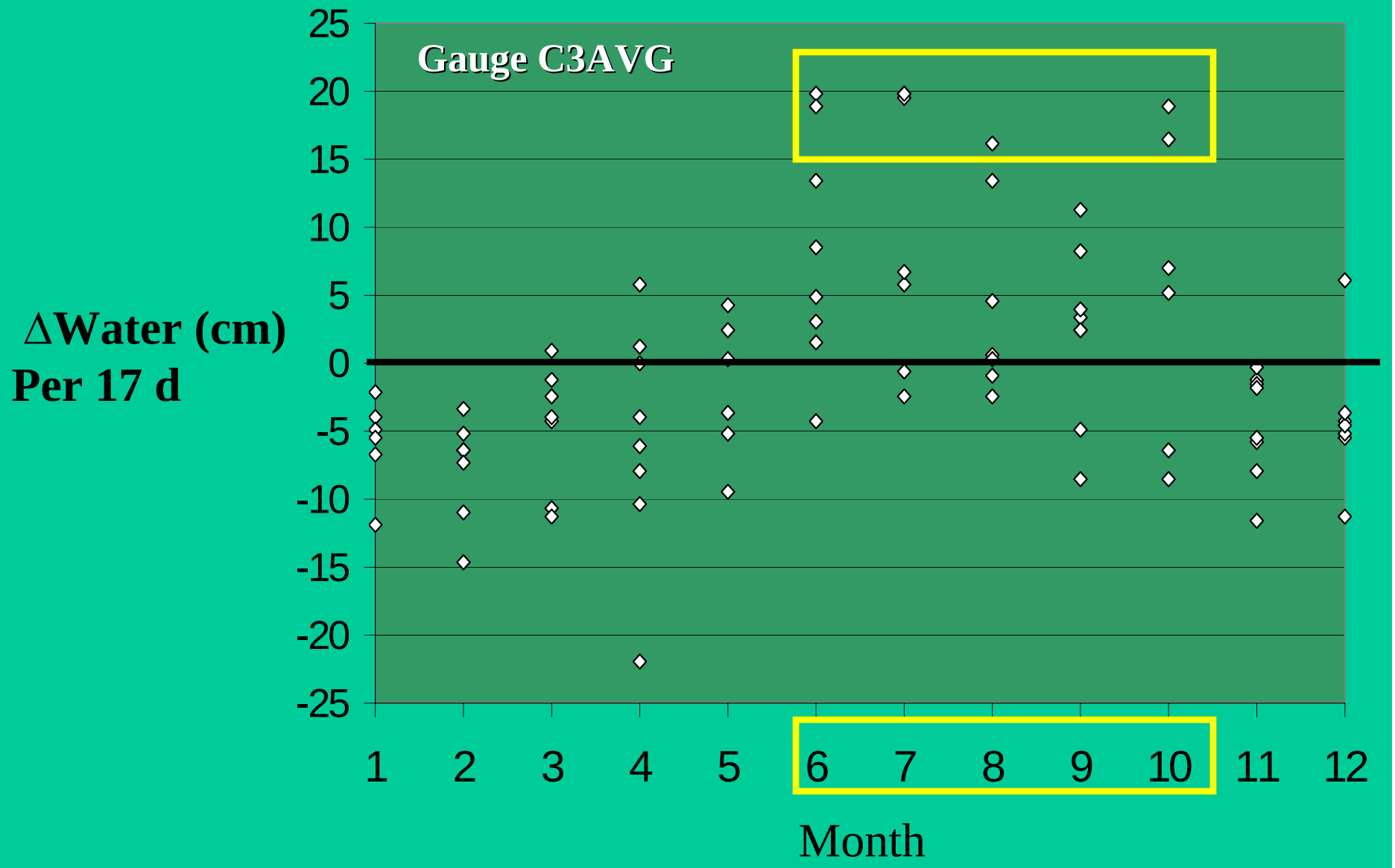
  ~18 cm (=7 inches)*
- **18 cm in 17 days?**

***more data & calcs in progress**

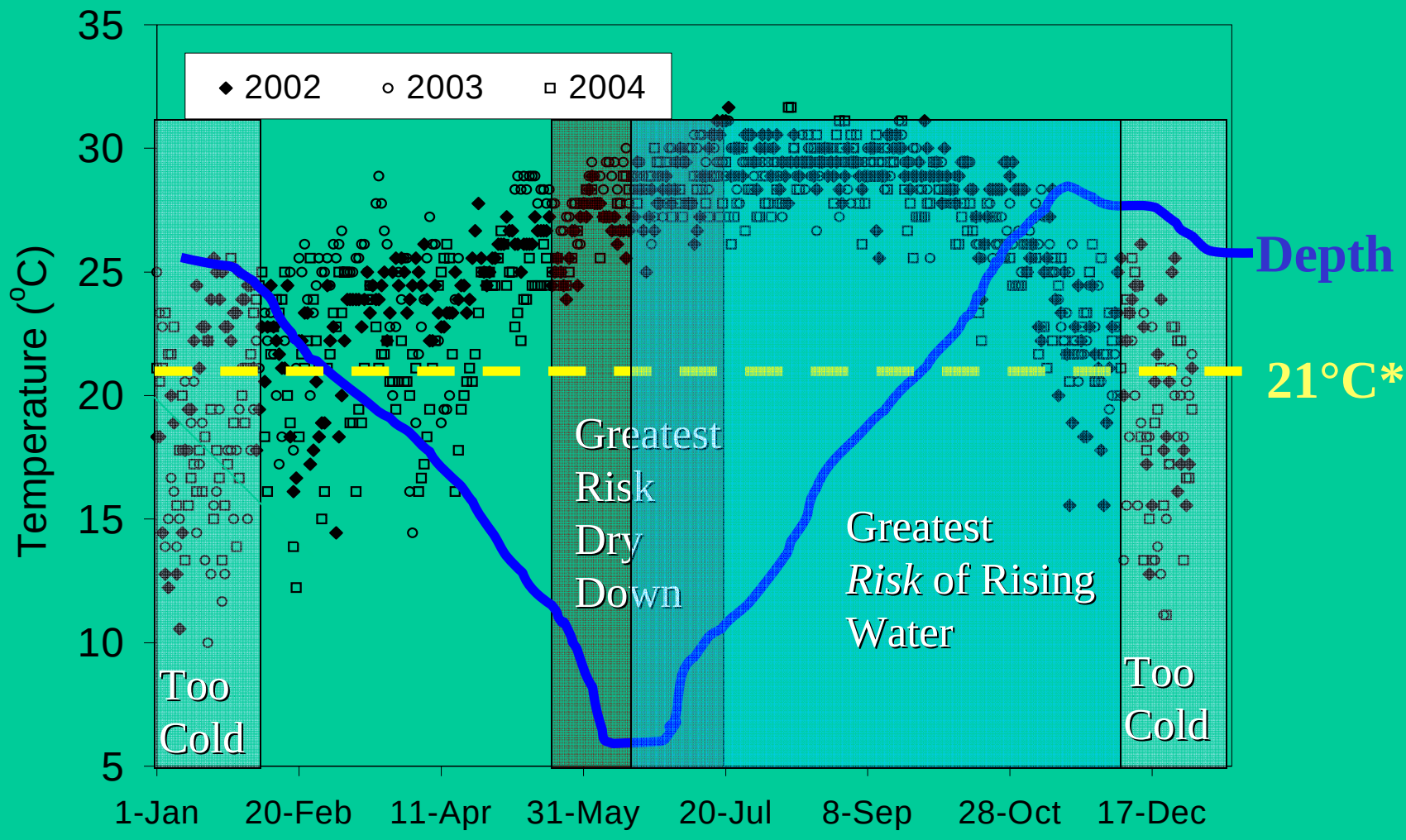
WCA3A Changes in Water Level: 2000-2003



Risk of Flooding: June - October

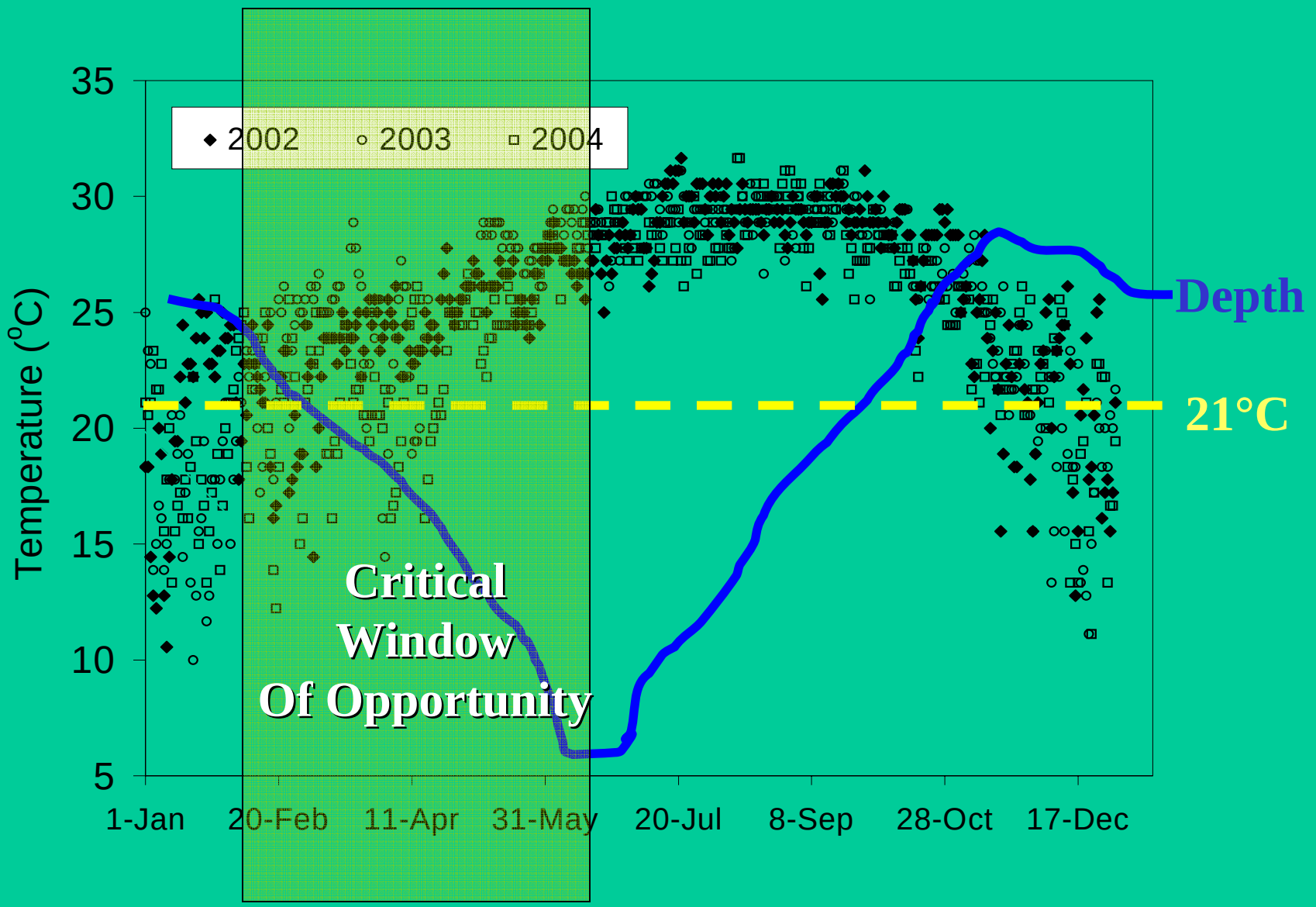


CONSTRAINTS ON RECRUITMENT

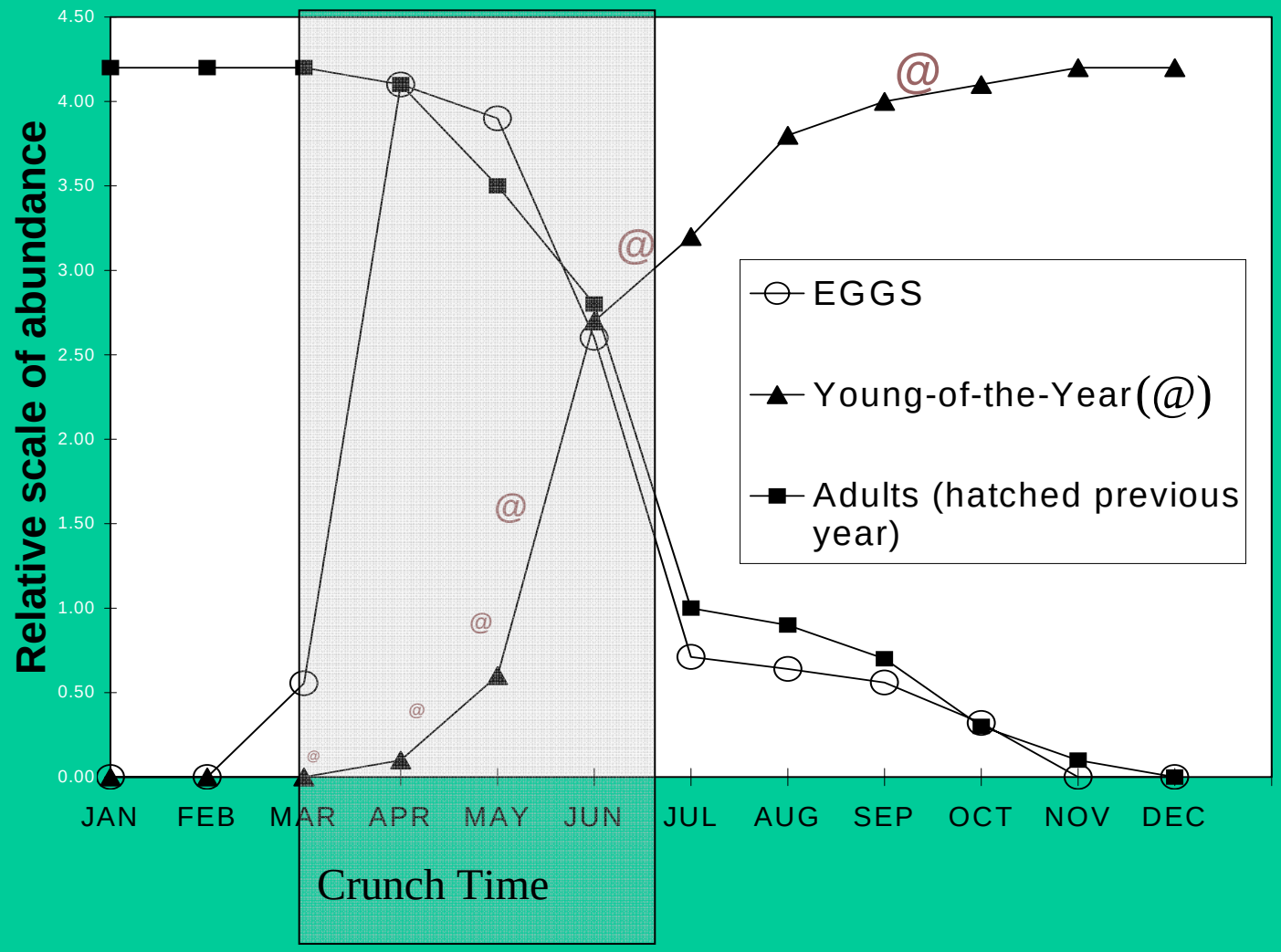


**Stevens et al. 2002*

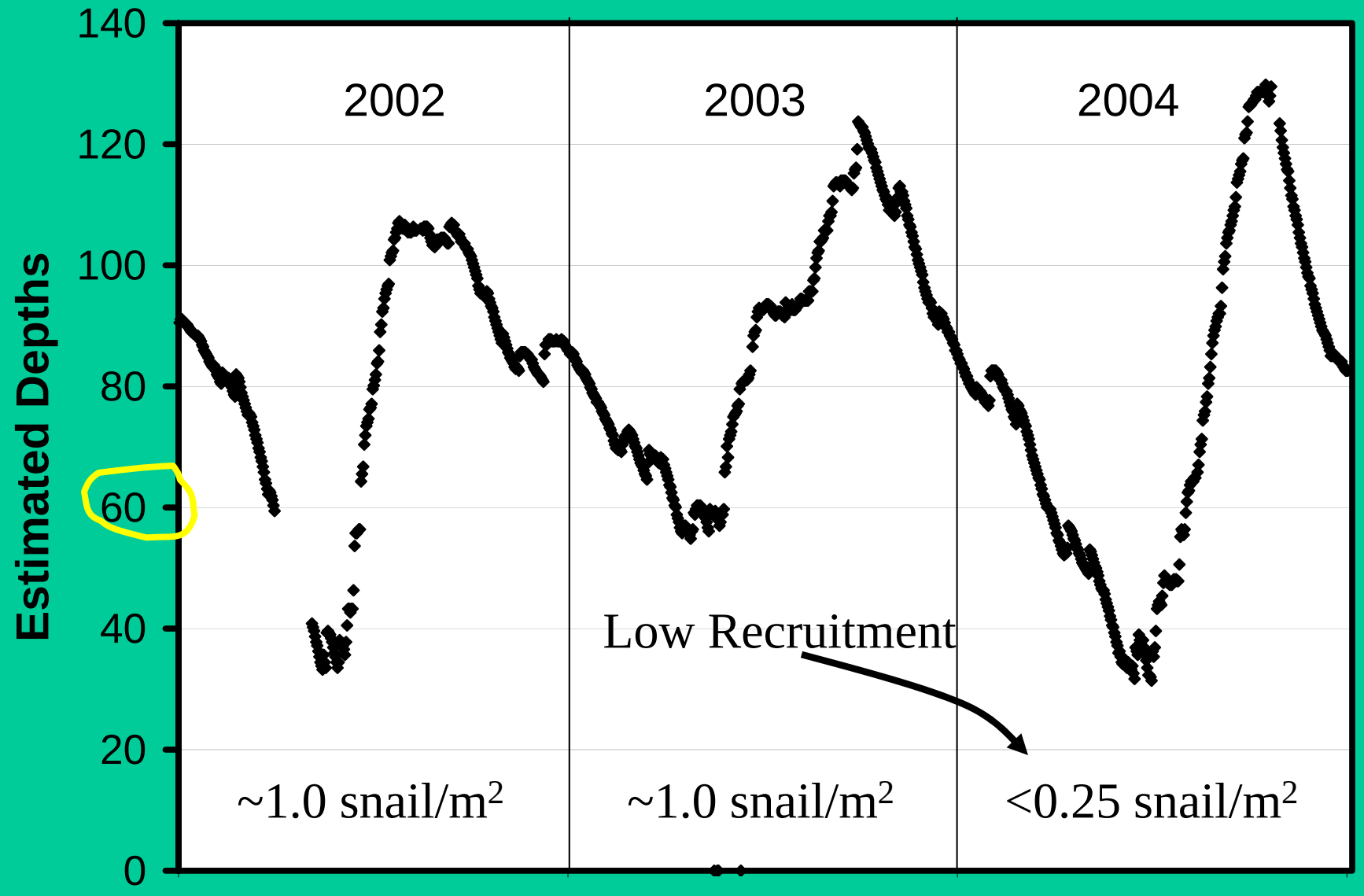
Most Reproduction Falls Within What Remains……..



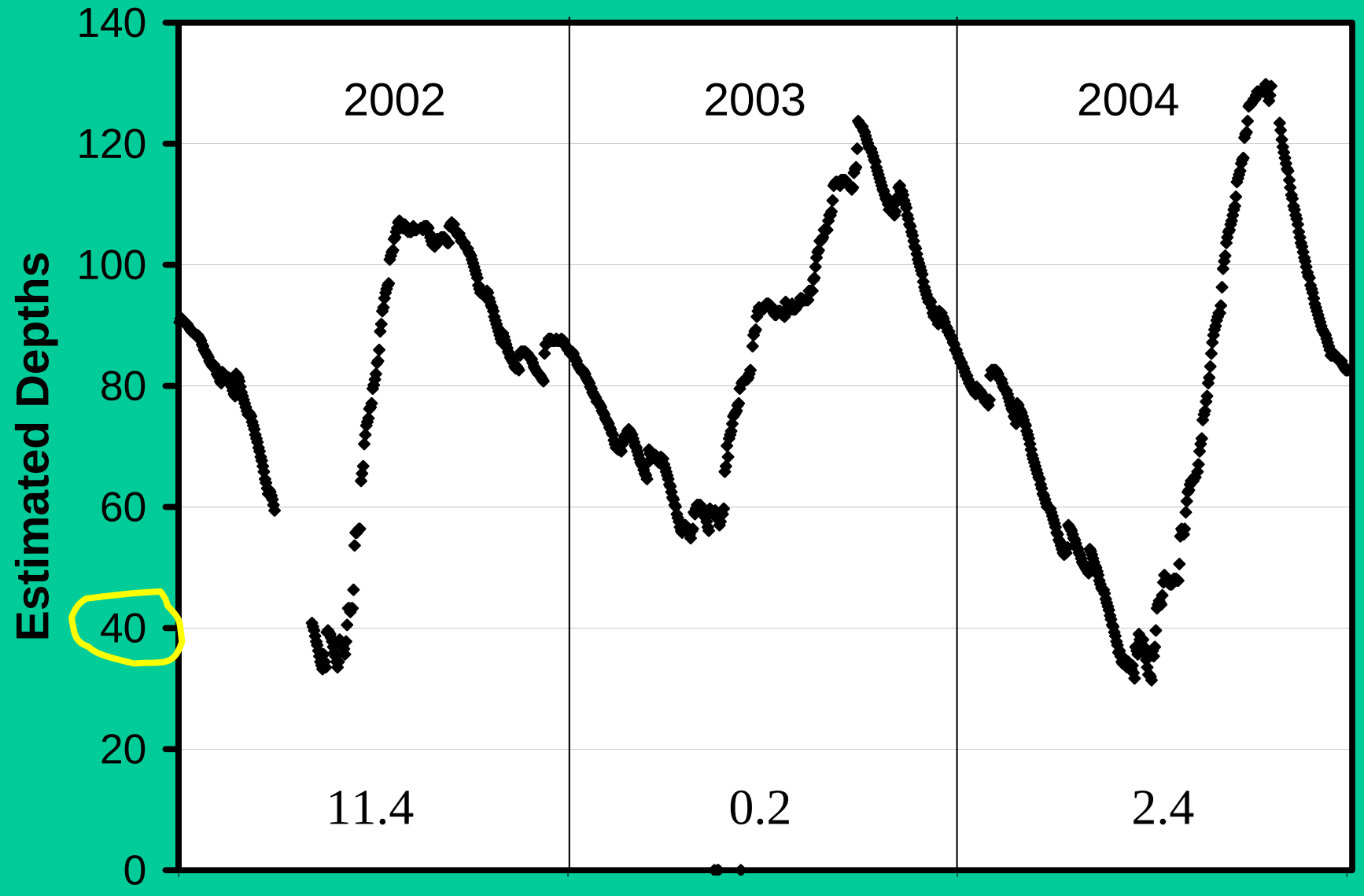
Depth During Dry Season Affects Recruitment...



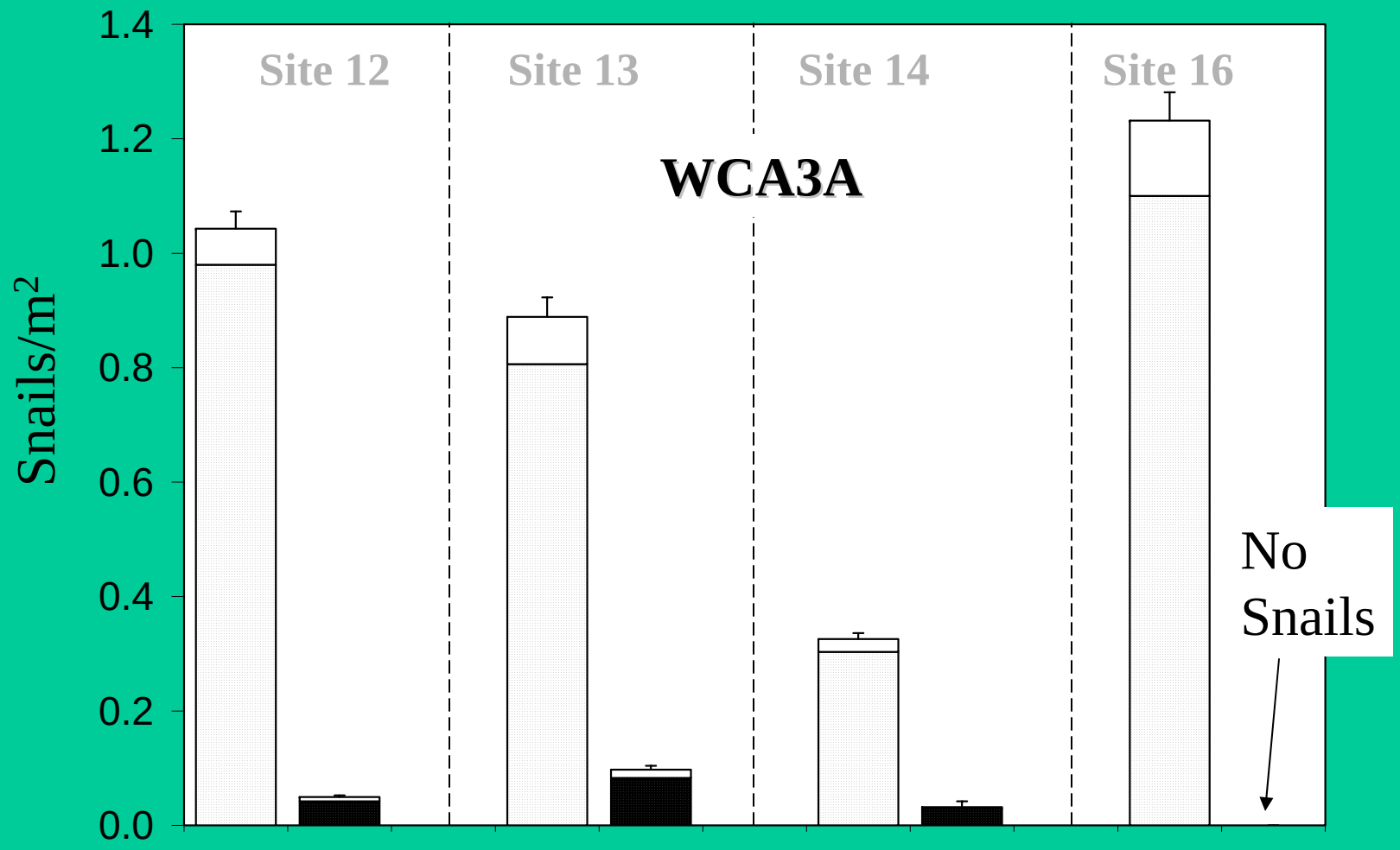
…initially based on observations in WCA3A



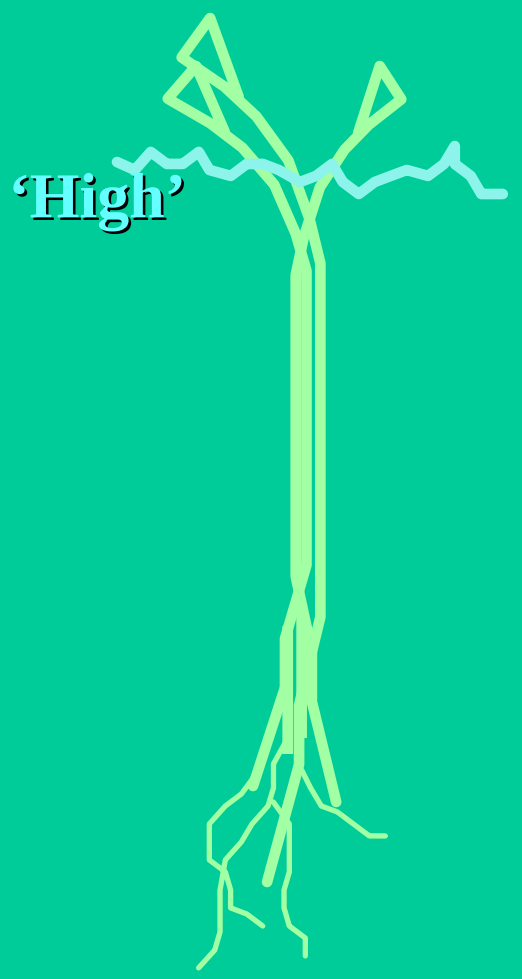
EGG INDEX IS HIGH(ER) WHEN DEPTHS DROP <40 CM



Suppressed Recruitment in 2003 resulted in Low Density in 2004



‘High’ Water (Depths) Causes Low Recruitment: Hypotheses

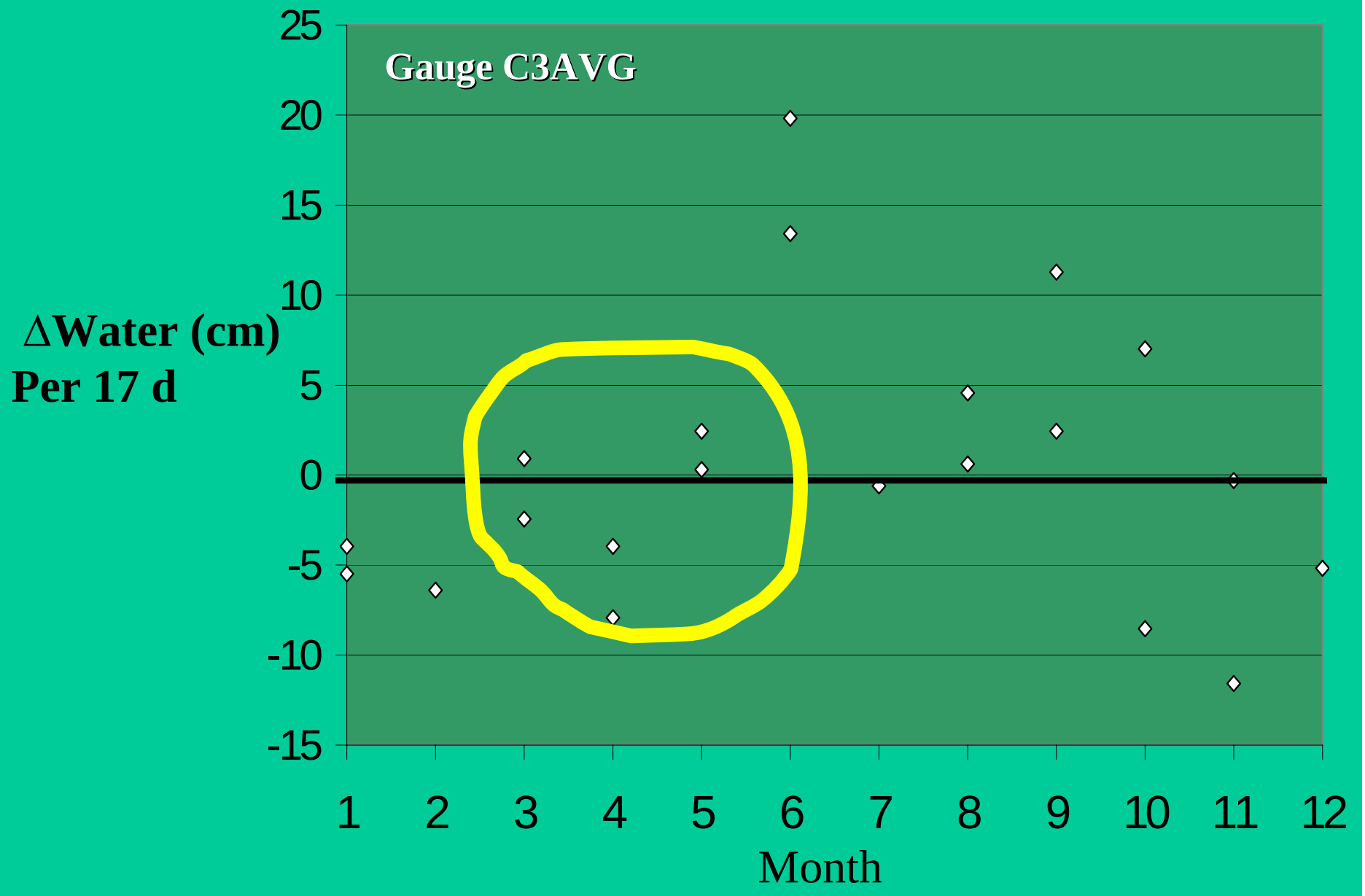


*Flood Low Profile Emergent Stems

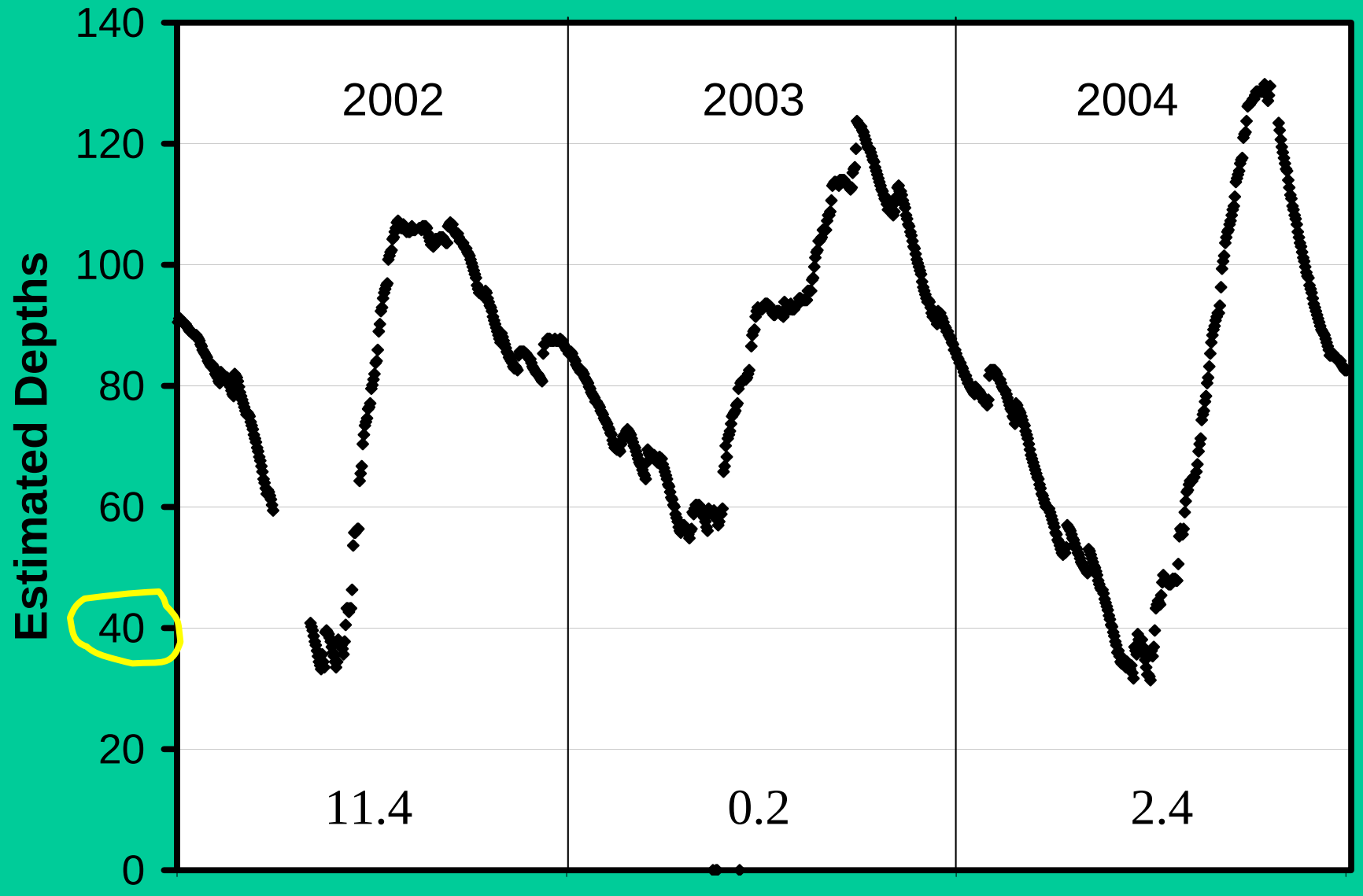
*Force ♀ Higher up Tapered Stems

*Deeper Water is Cooler Water
(which affects snail ecophysiology)

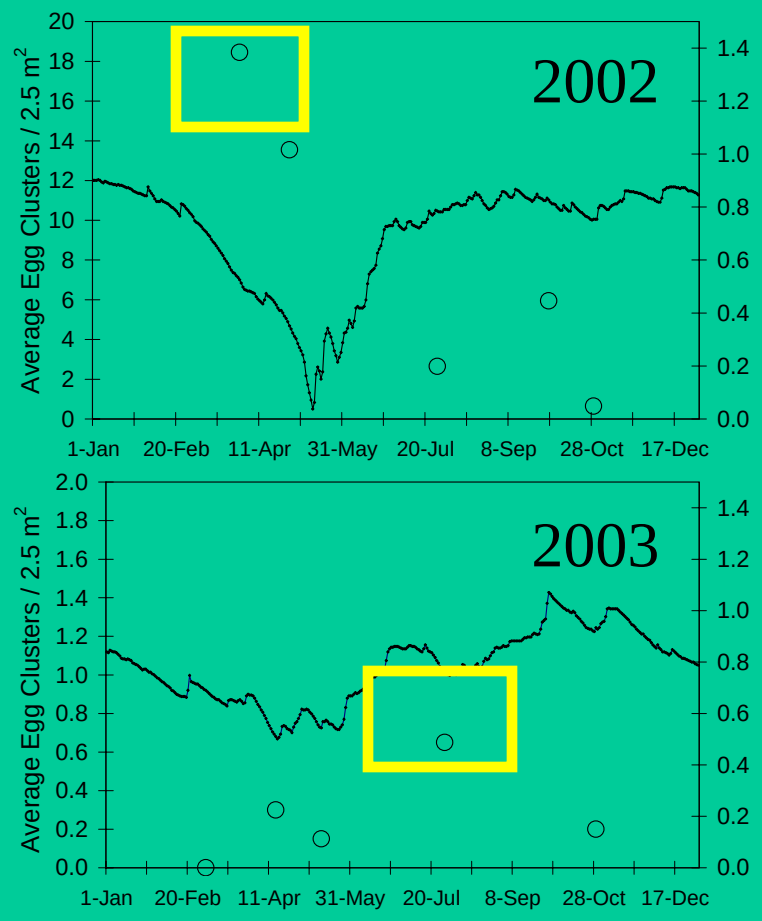
Rising Water was NOT the Issue in 3A in 2003



IT APPEARS TO BE DEPTH (also 2005-2008 data, and LKISS)



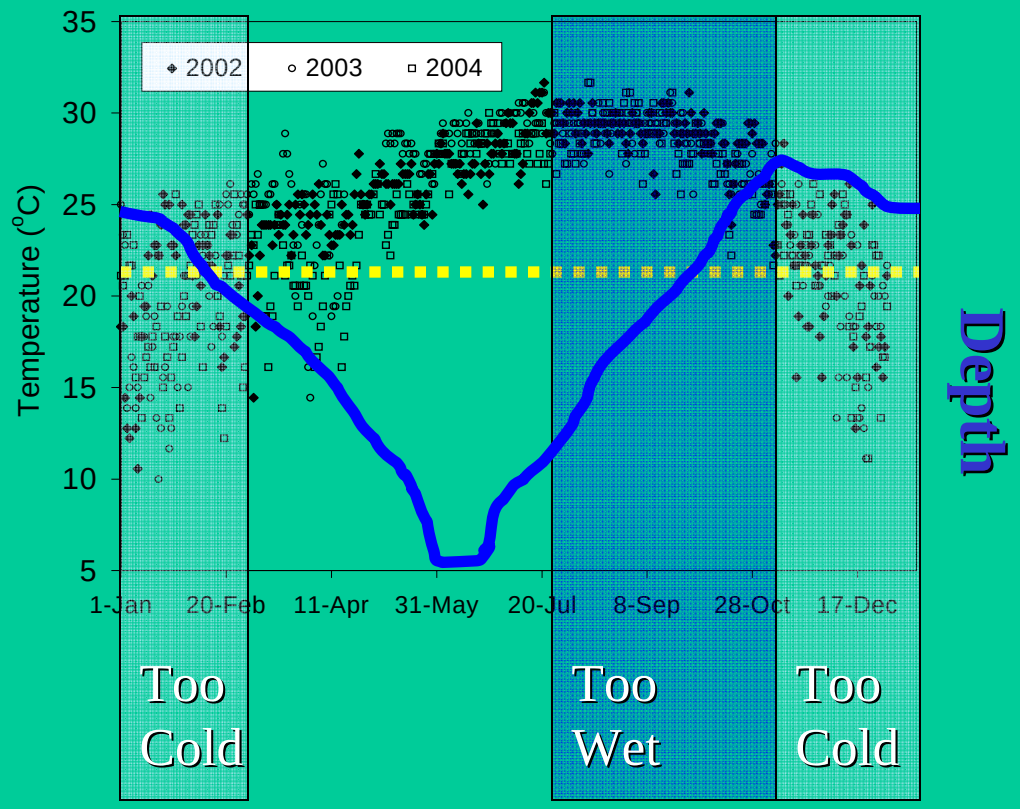
‘High” Dry Season Water *Delays* Egg Production



WCA3A 2002 to 2003

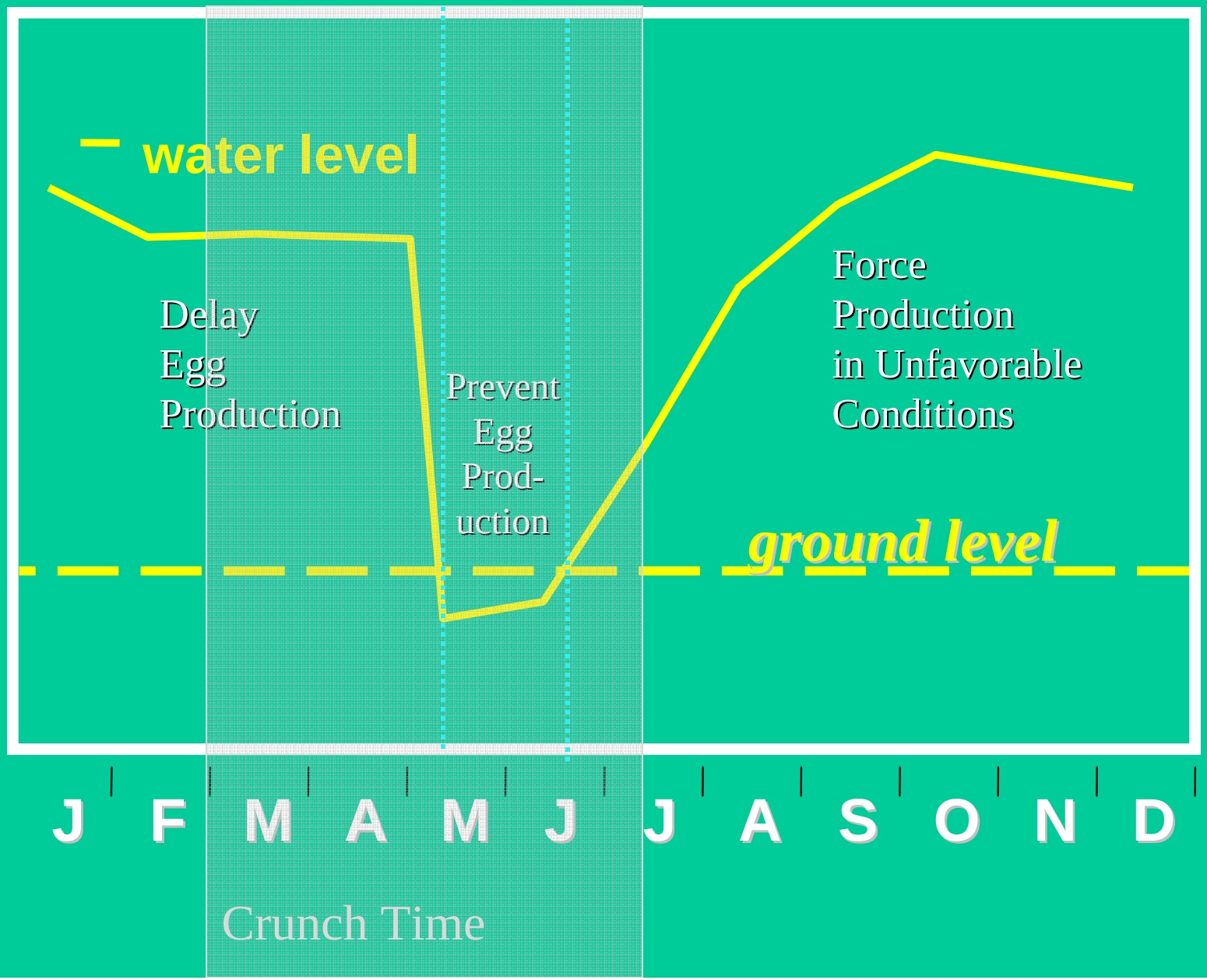
Depth and ° C:
Synergistic Effect?

Delay Forces Production to Unfavorable Conditions*

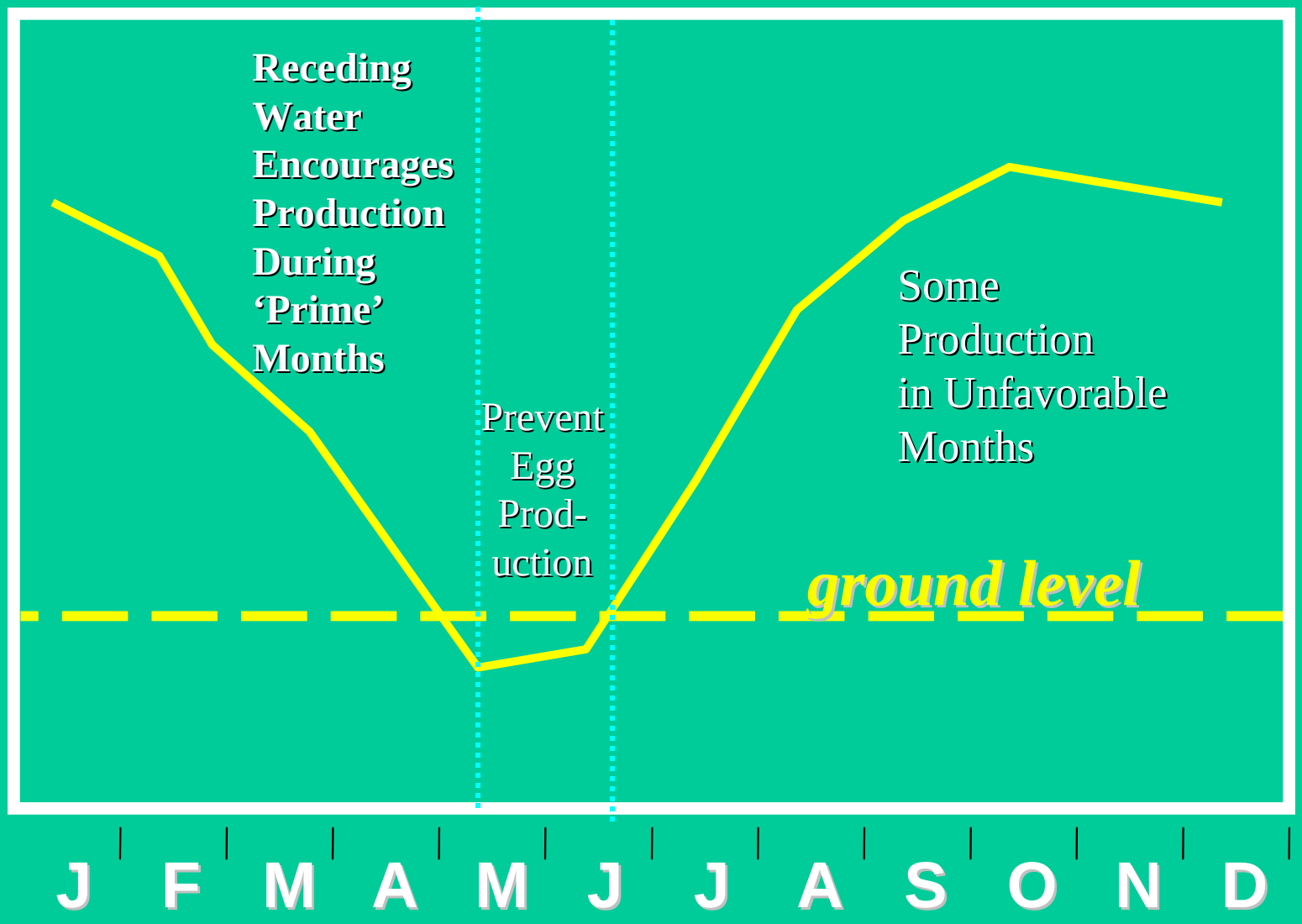


*applies to any delay
(too high, too dry, too cold)

WORST CASE SCENARIO

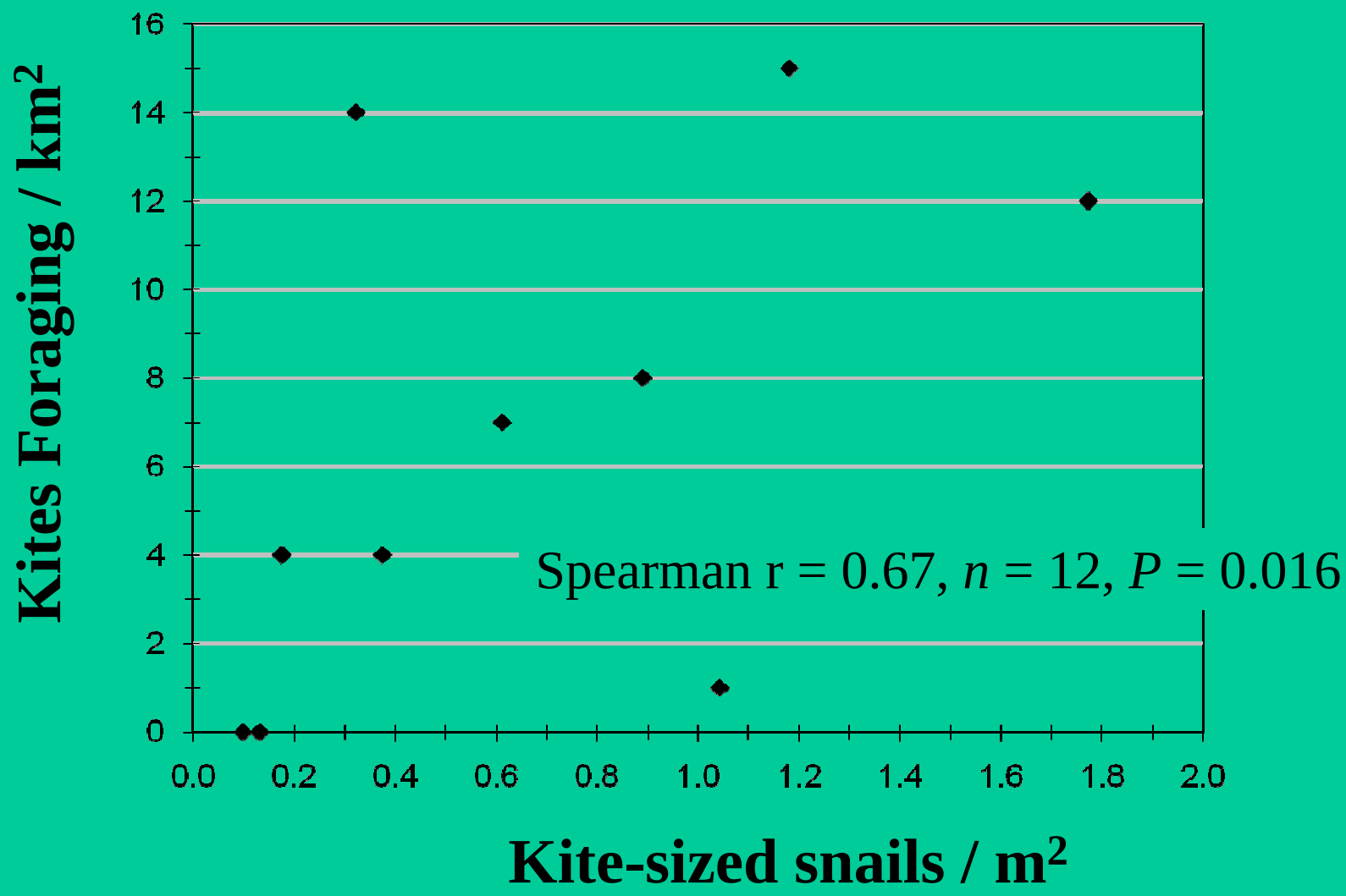


BETTER CASE SCENARIO



How Many Snails Does It Take?

E. Odum: "The Painful Elaboration of the Obvious"



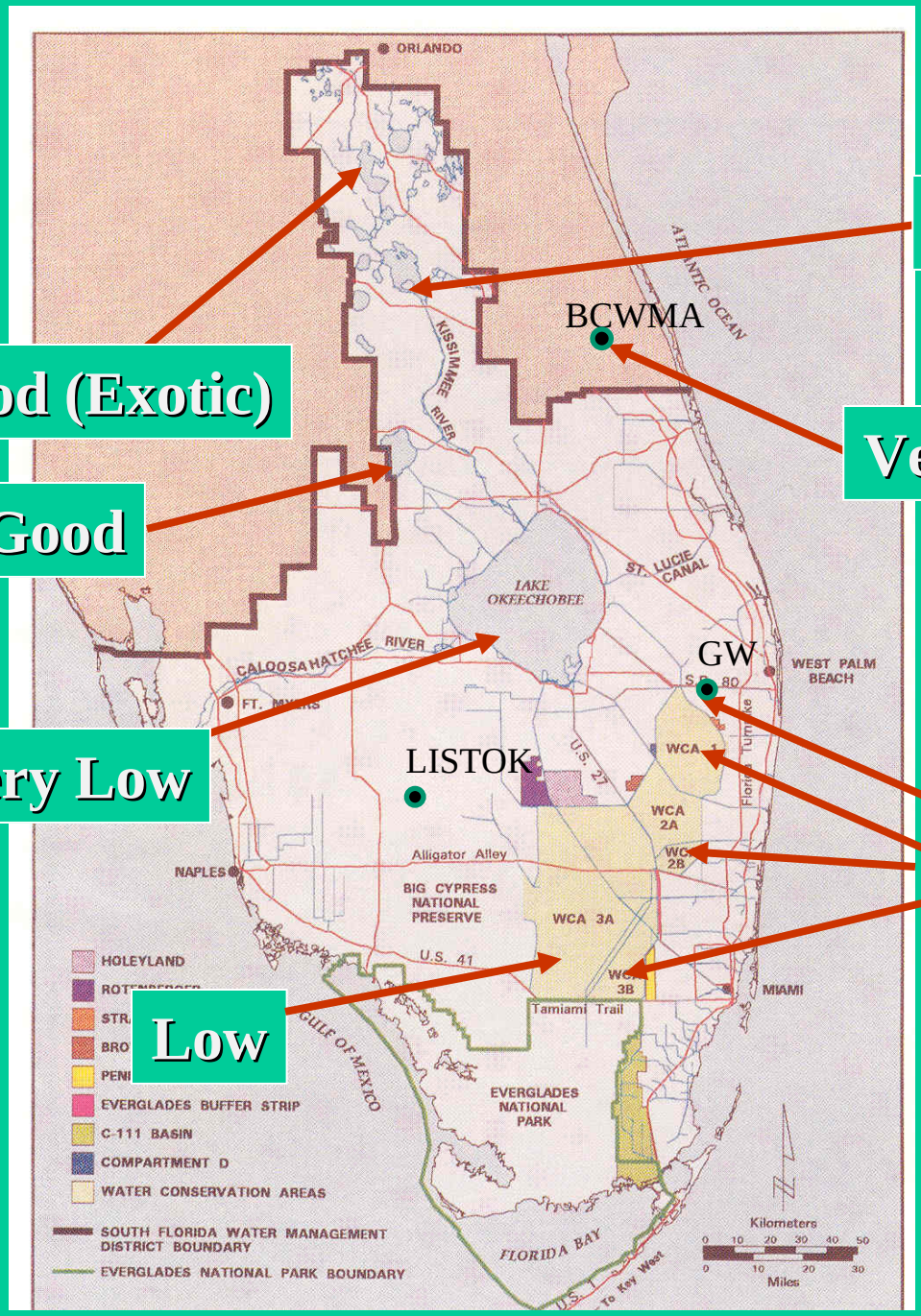
Darby et al. 2006

and after only 1600 throw traps

			Foraging Kites/km^2	Snail Density Mean ± SE
WCA1	A	2002	0	0.00 ± 0.00
WCA1	F	2003	0	0.01 ± 0.01
WCA1	D	2003	0	0.01 ± 0.01
WCA1	E	2003	0	0.03 ± 0.01
WCA3A	11	2003	0	0.10 ± 0.01
WCA3A	3	2002	0	0.13 ± 0.02
WCA1	B	2002	0	0.14 ± 0.01
WCA3A	2	2002	2	0.20 ± 0.04
WCA1	C	2002	2	0.22 ± 0.01
WCA3A	1	2002	2	0.25 ± 0.04
WCA3A	14	2003	14	0.32 ± 0.01
WCA3A	15	2003	7	0.61 ± 0.03
WCA3A	13	2003	8	0.89 ± 0.03
WCA3A	12	2003	1	1.04 ± 0.03
WCA3A	16	2003	15	1.18 ± 0.04
WCA3A	10	2002	12	1.77 ± 0.25

Darby et al. 2006

Kite-Sized Snail Status 2005-2008

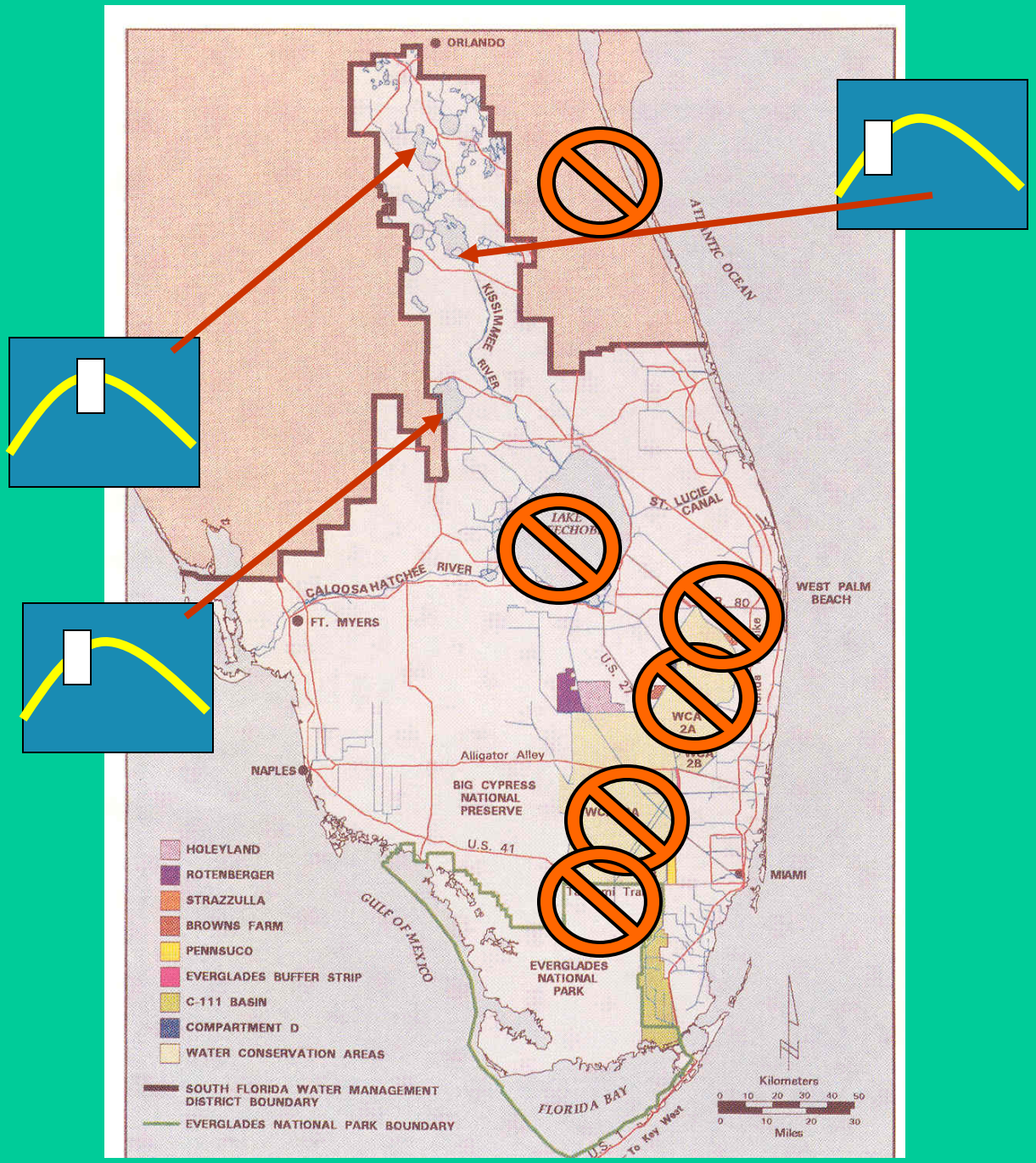


At Present:

critical

areas support

too few snails



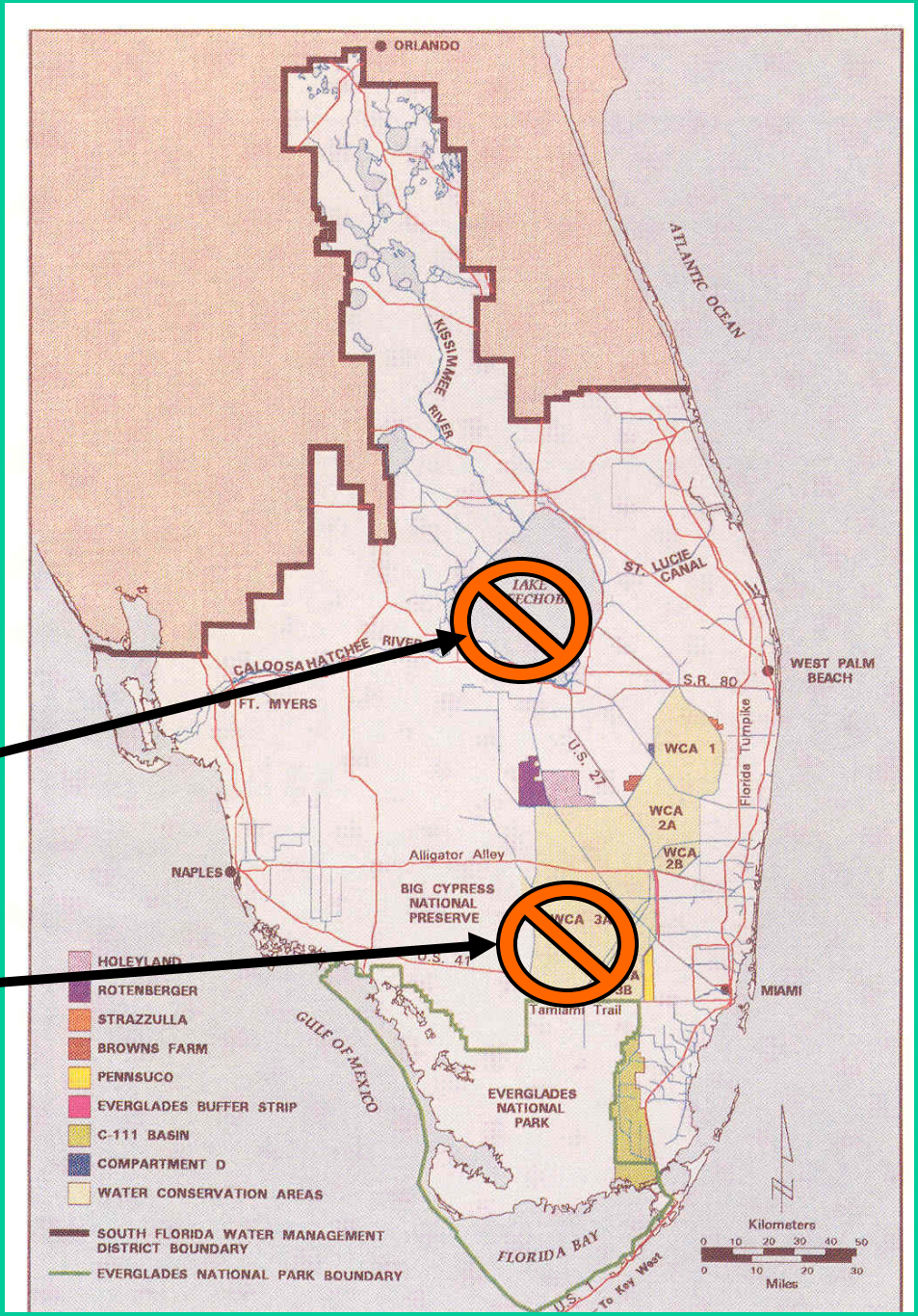
‘HUBS’:

LOKEE

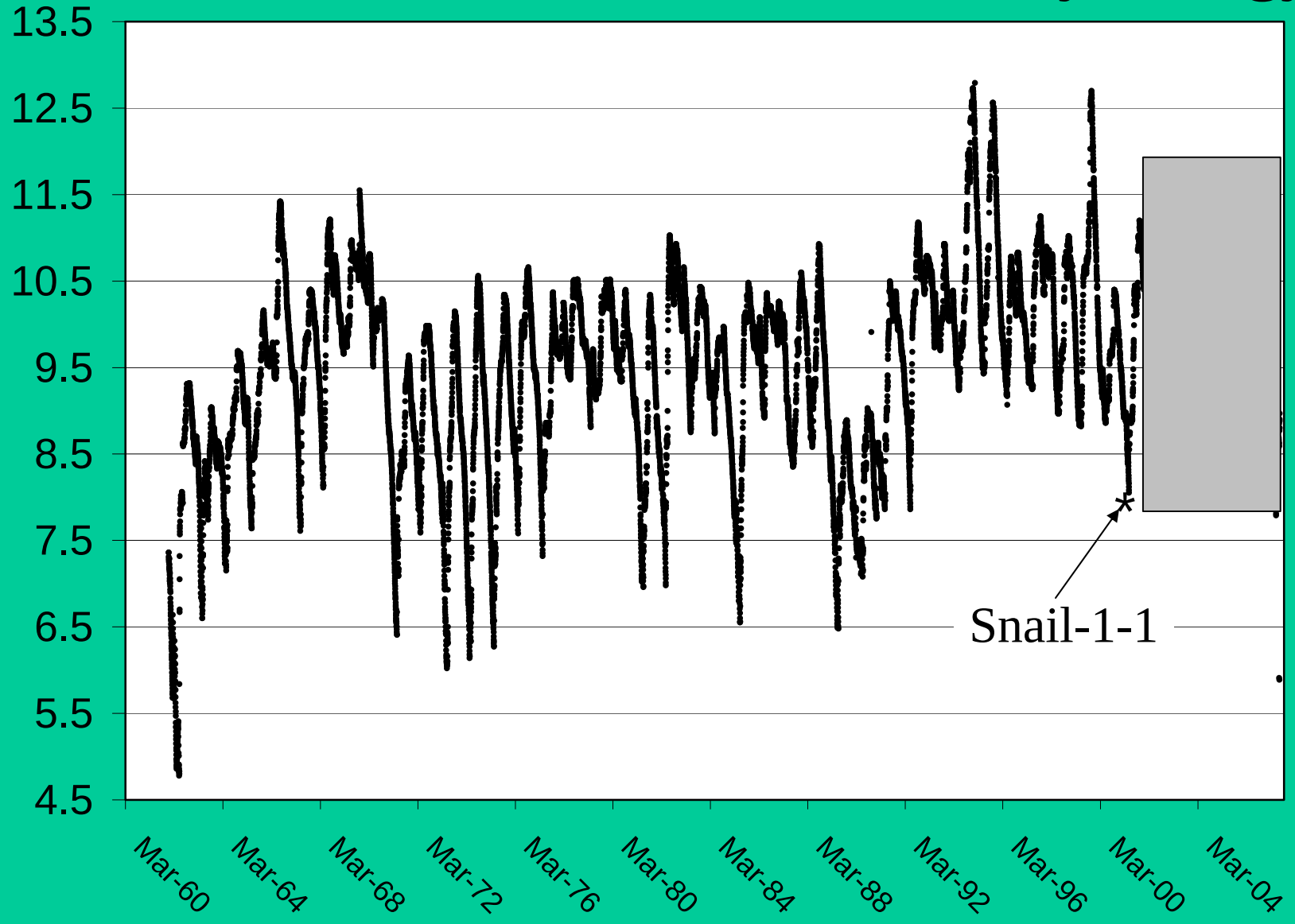
WCA3A

TOO DRY

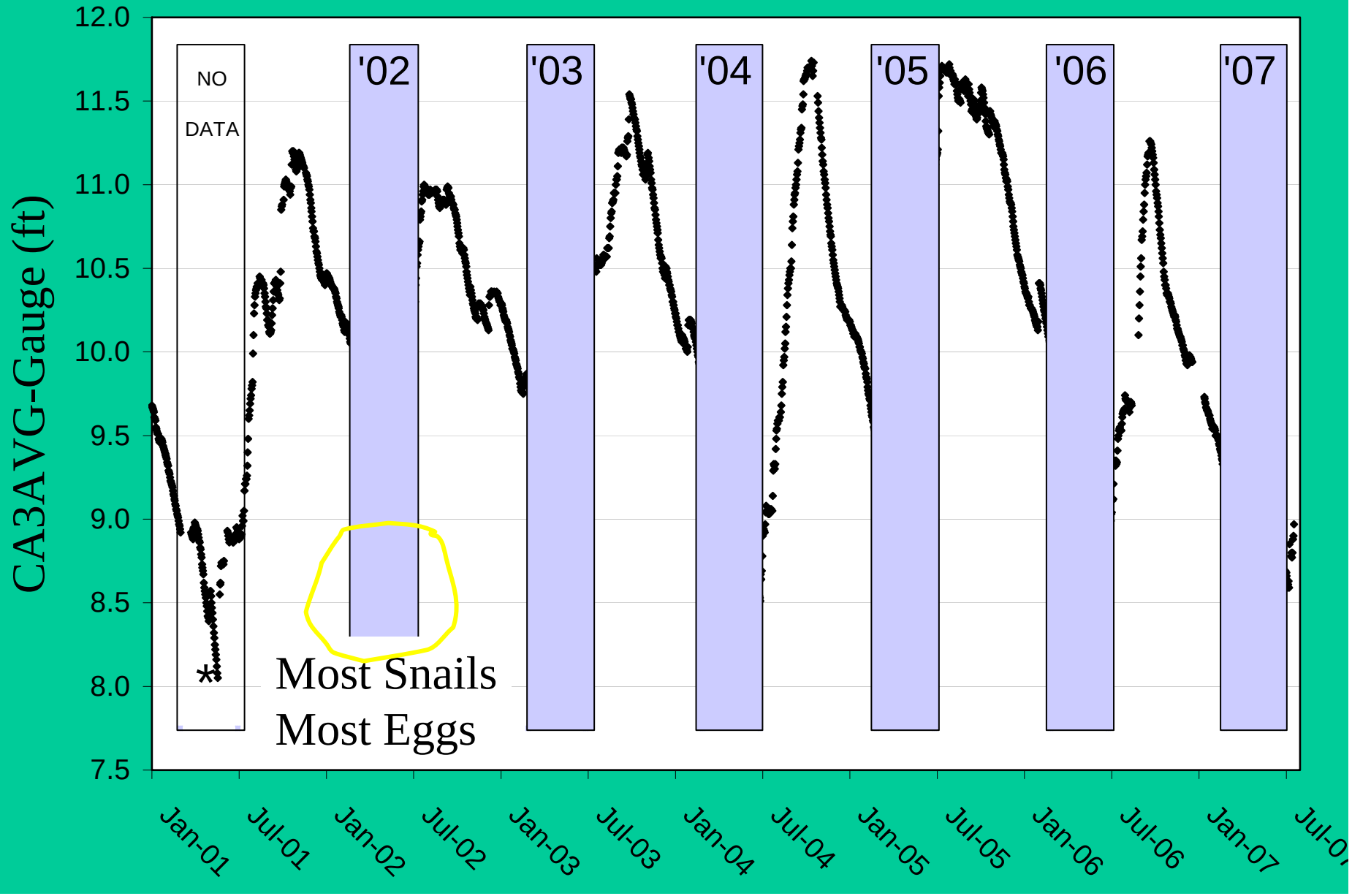
TOO WET
(southern 3A)



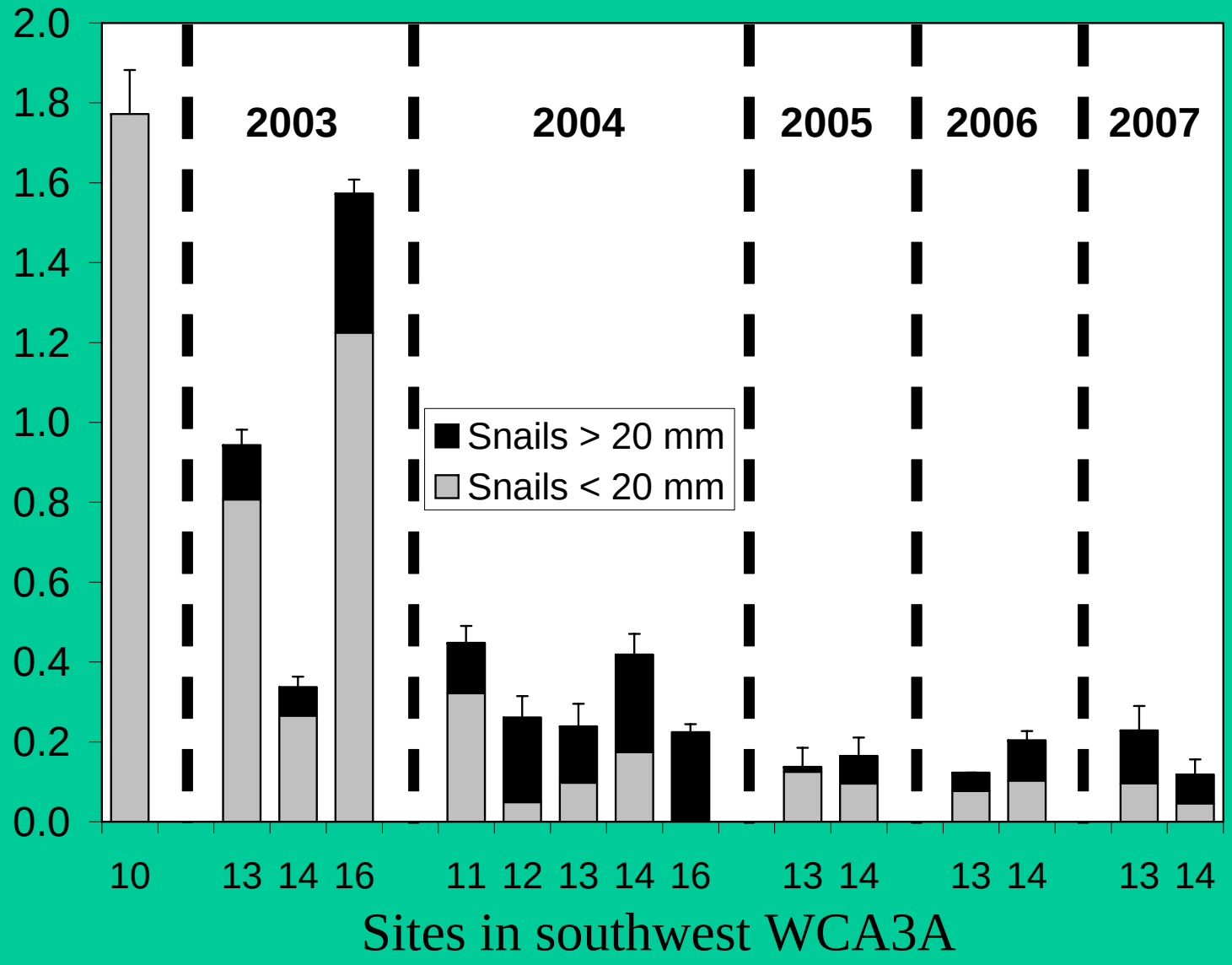
WCA3A Studies Reflect 2001-2007 Hydrology



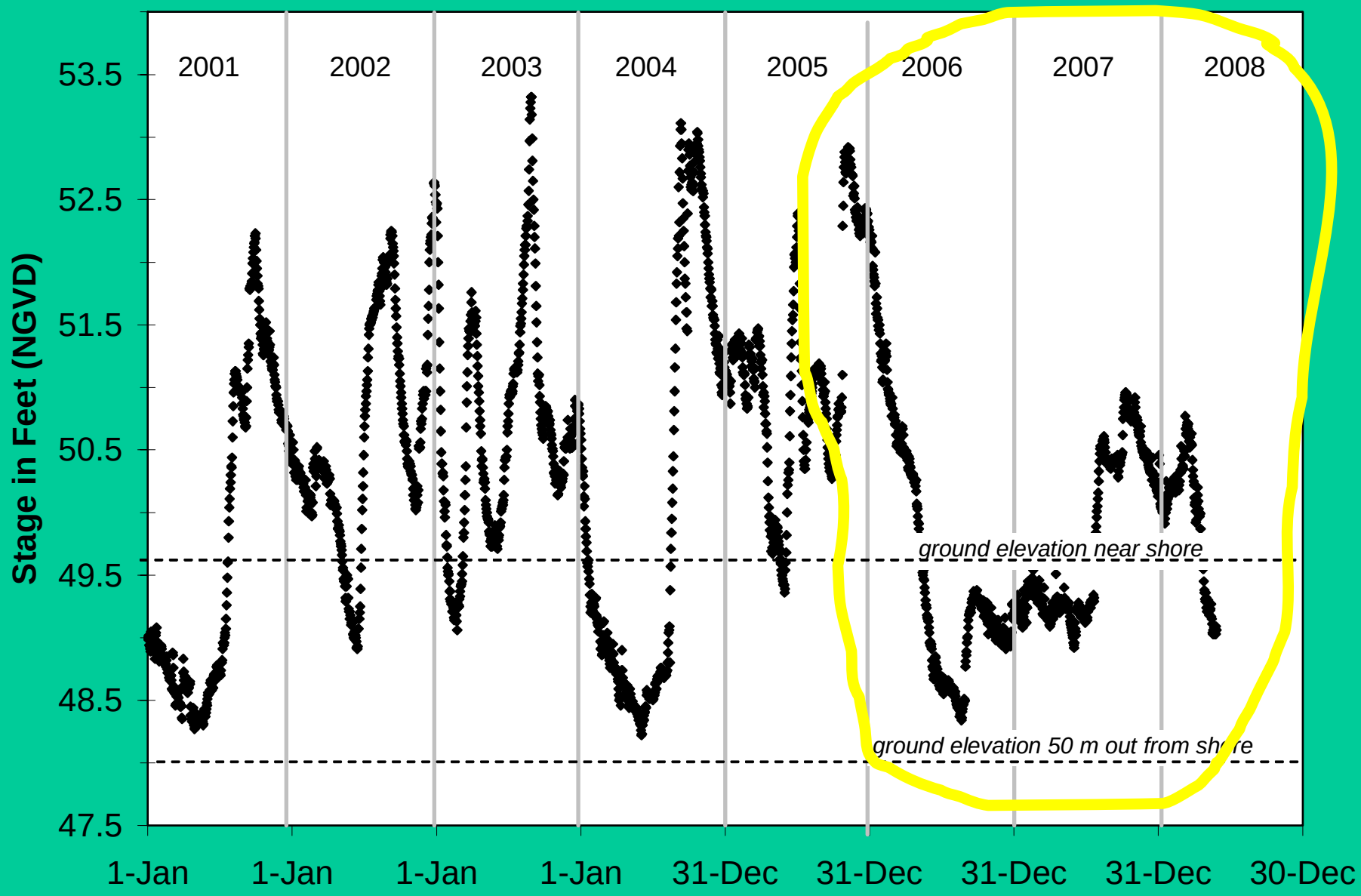
WCA3A: Crunch Times 2002-2007



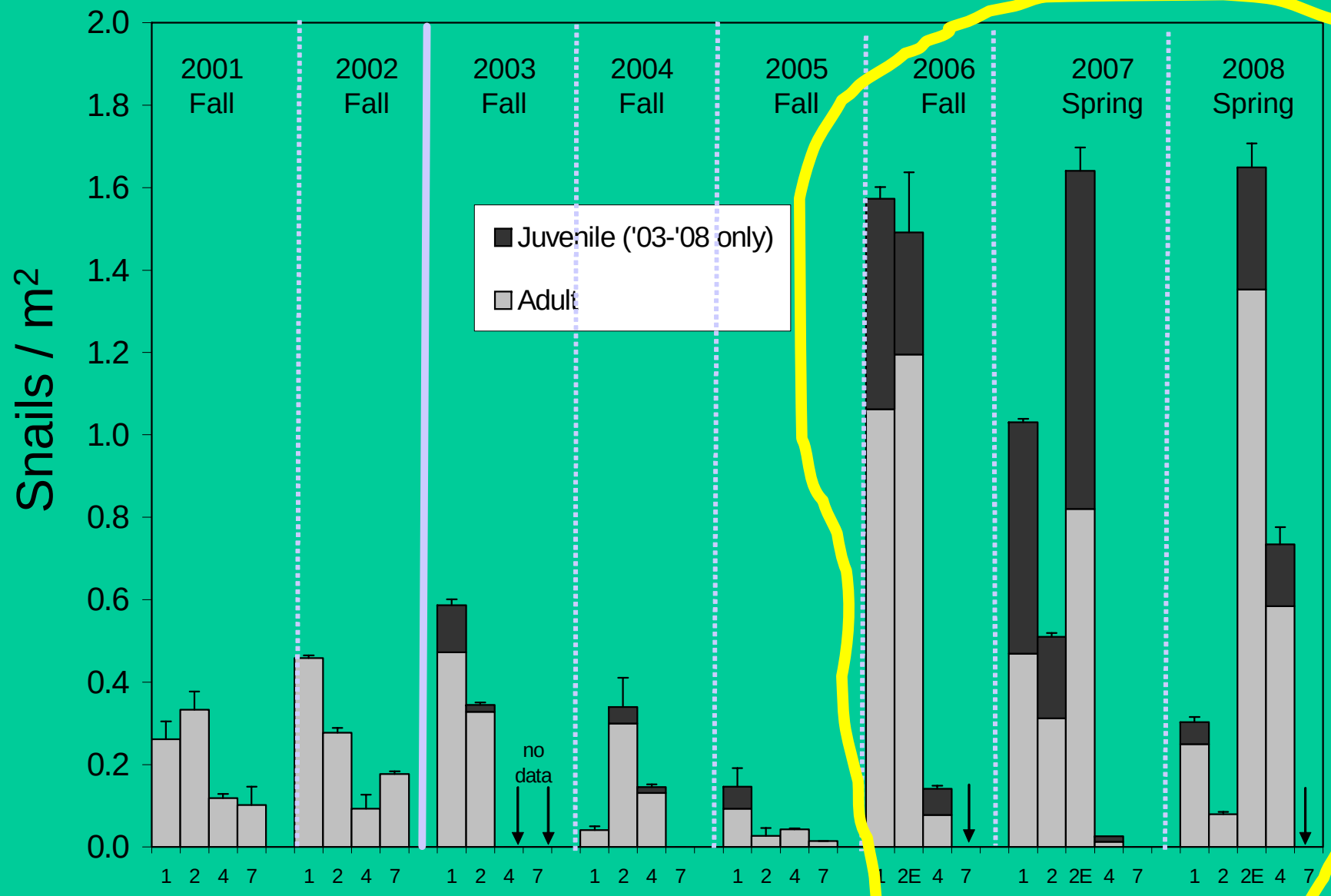
Snail Densities Southwest 3A*



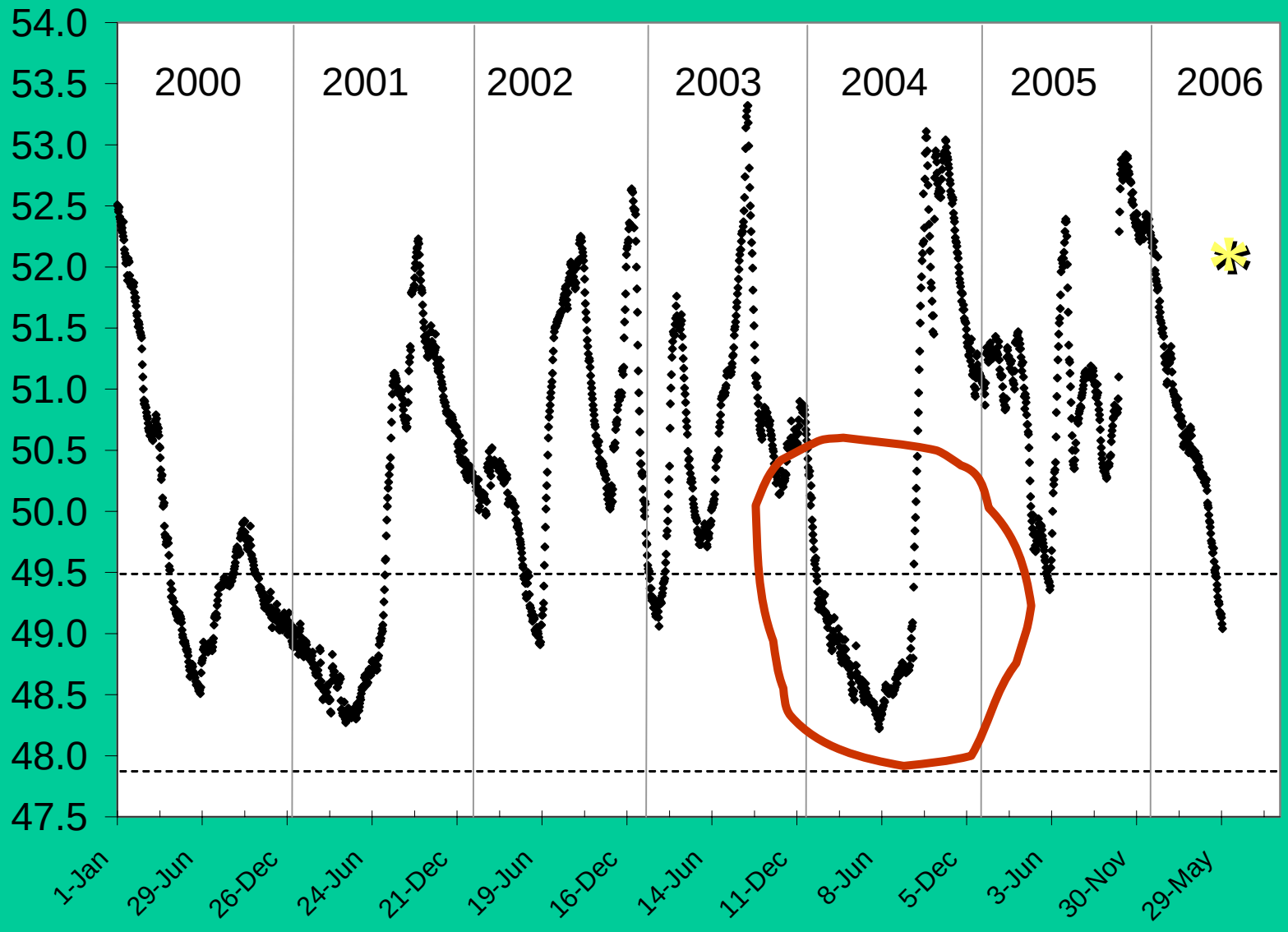
Meanwhile: overall decline in LKISS Depths



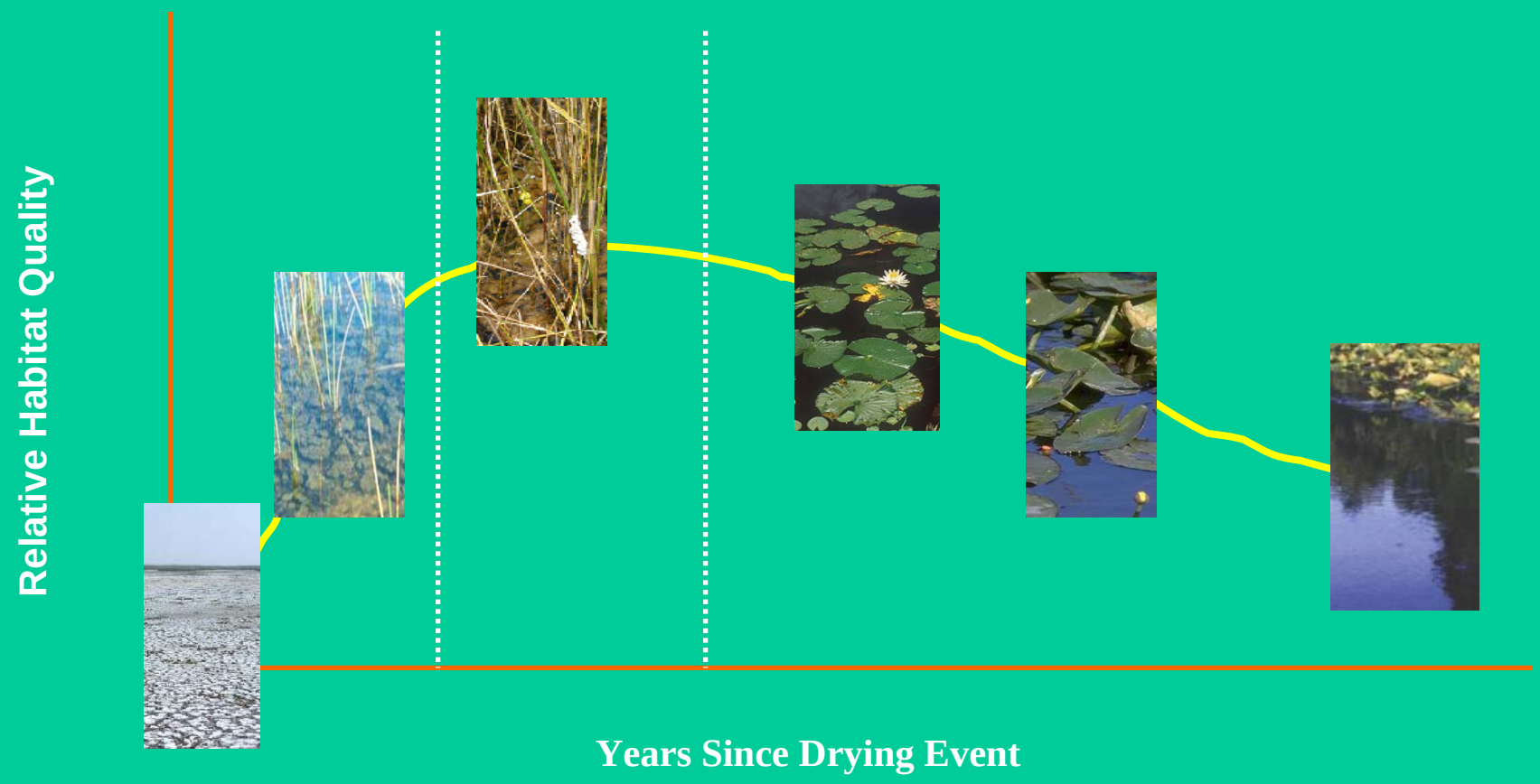
….corresponds to overall *increase* in snail density



Within 2 yrs of 'Drought'

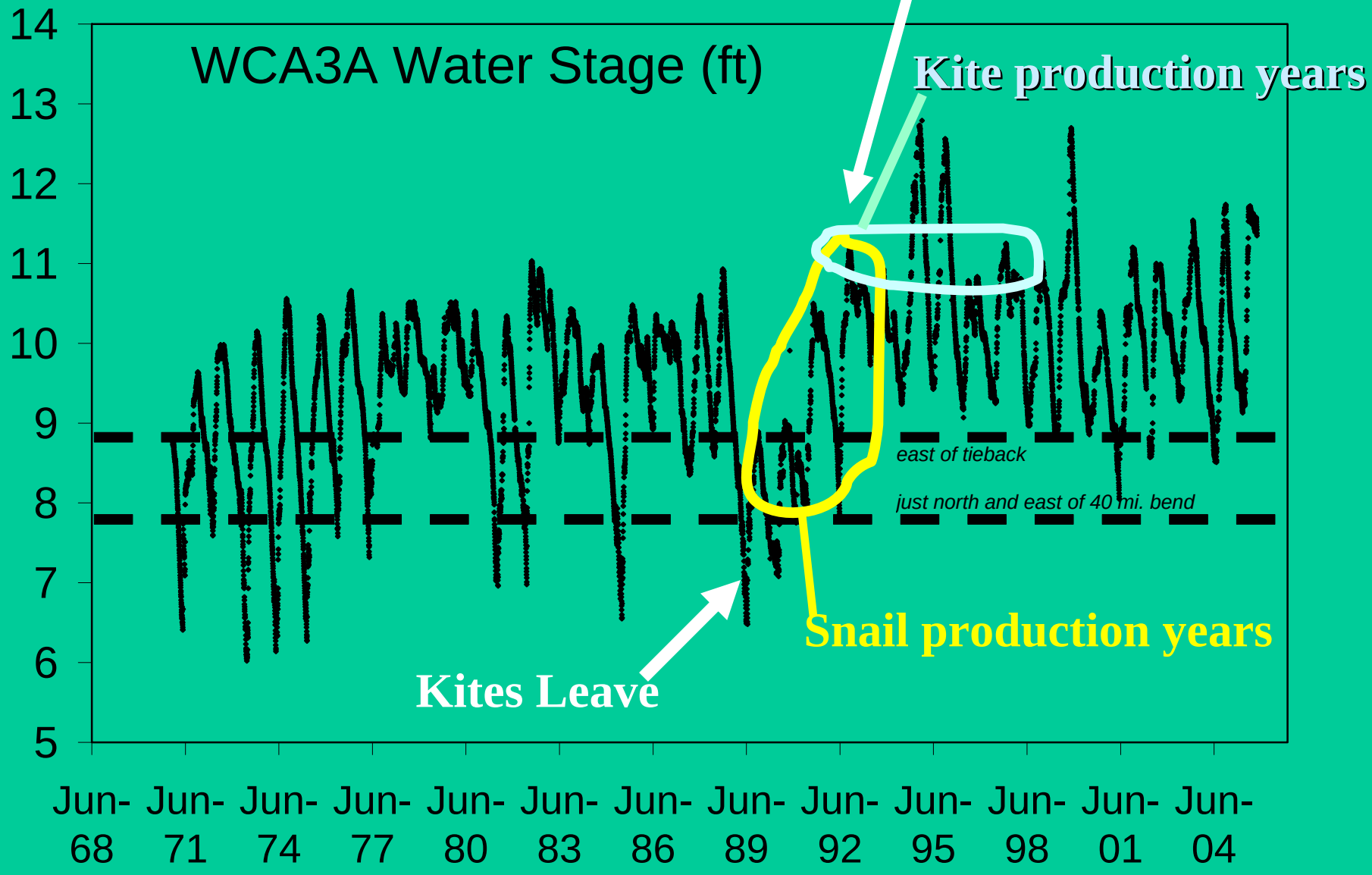


‘Dynamic Landscape Hypothesis’*: Snails Perspective

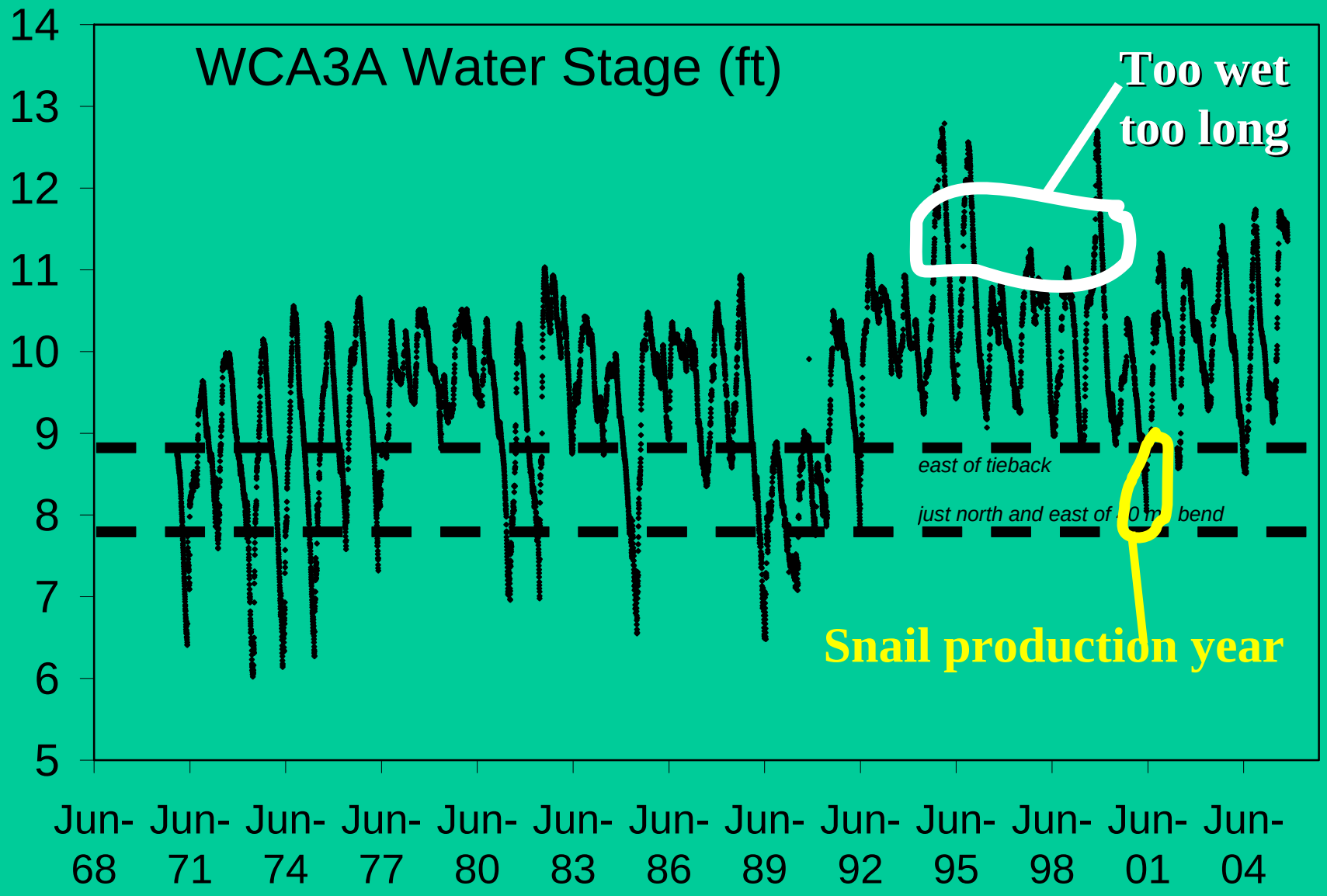


*Bennetts et al. 1998

It NEEDS TO BE DYNAMIC…



It NEEDS TO BE DYNAMIC…



WHAT IS THE GOAL?

		Year	Foraging Kites/km^2	Snail Density Mean ± SE
WCA1	A	2002	0	0.00 ± 0.00
WCA1	F	2003	0	0.01 ± 0.01
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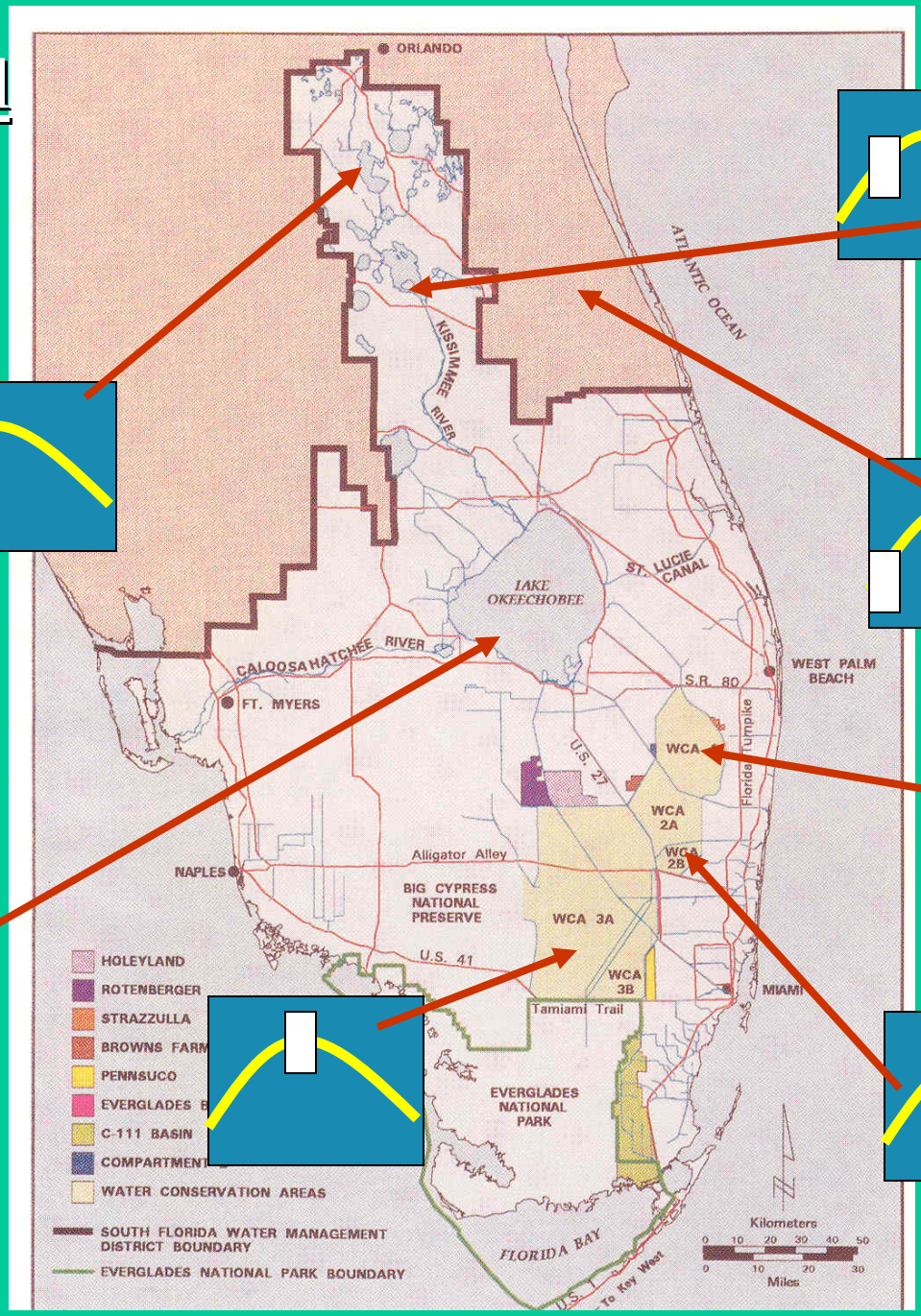
WCA3A	16	2003	15	1.18 ± 0.04
WCA3A	10	2002	12	1.77 ± 0.25

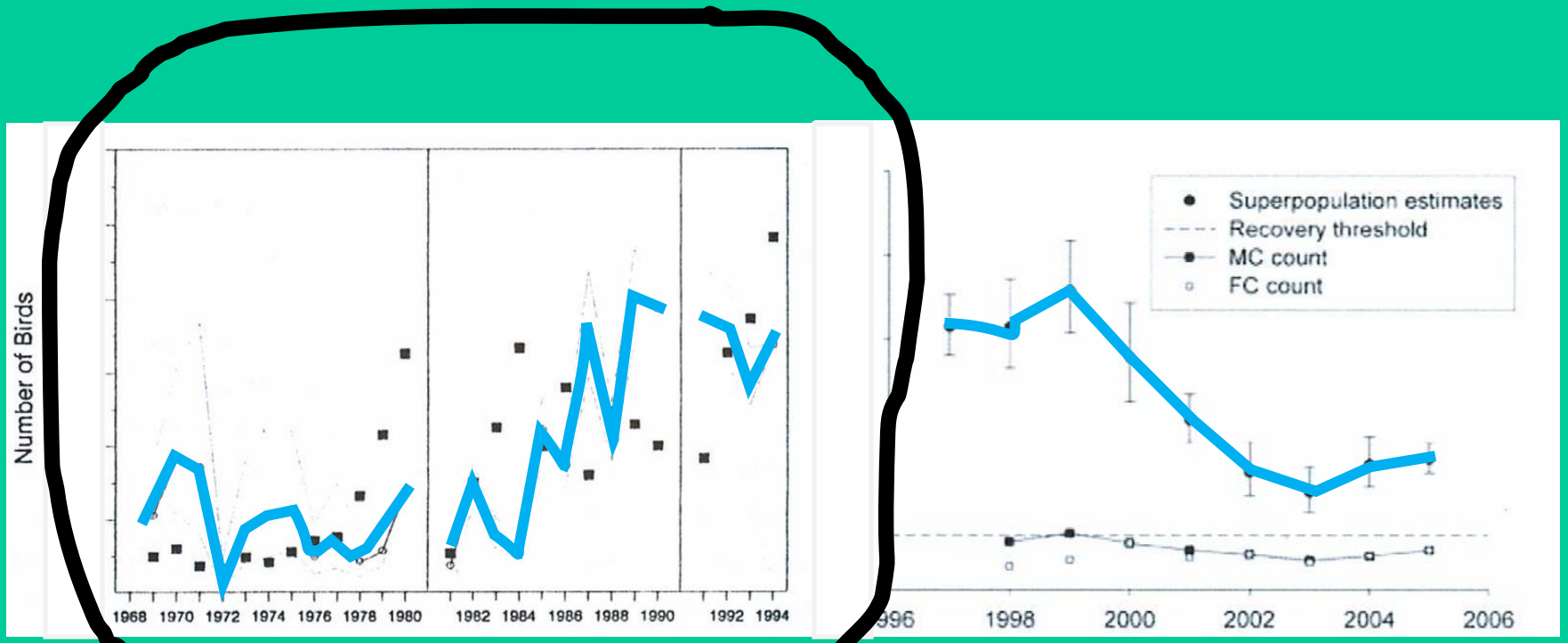
Darby et al. 2006

And over what areal extent?

(Kites *historically* had options)



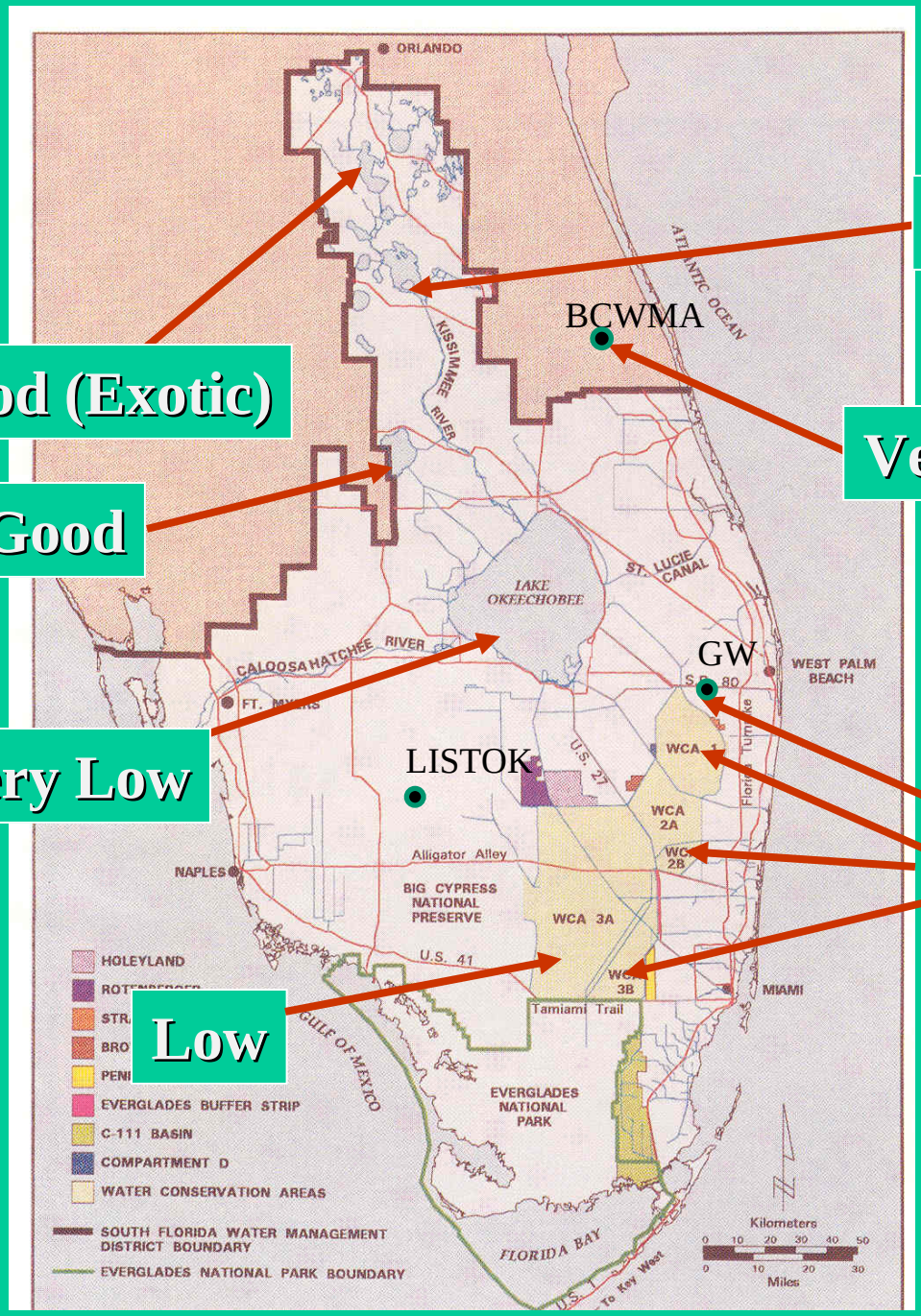
Historically: No Snail Density Estimates



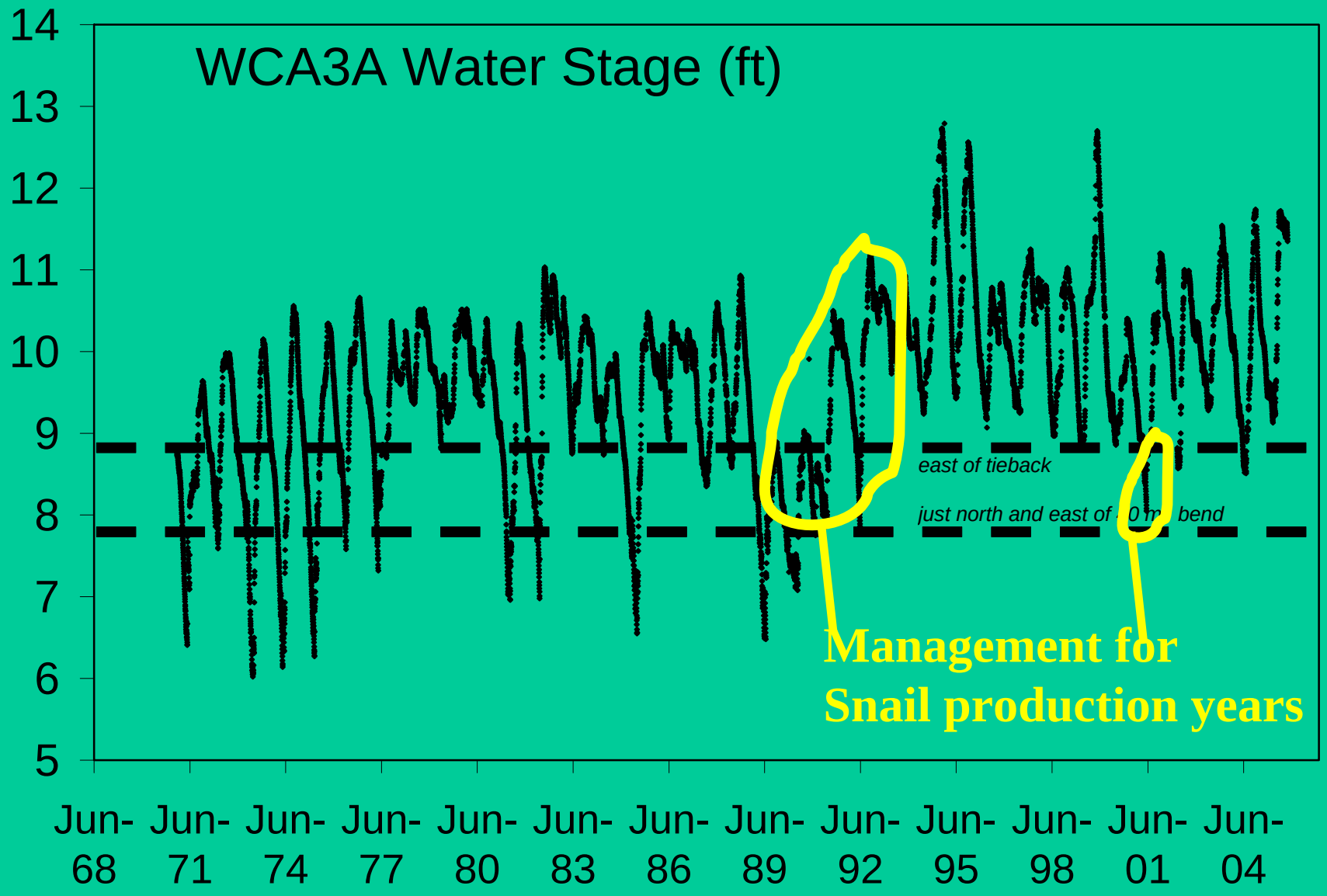
It’s Possible Many Wetlands had >2 snails/m^2

Kites can tell us something about snails

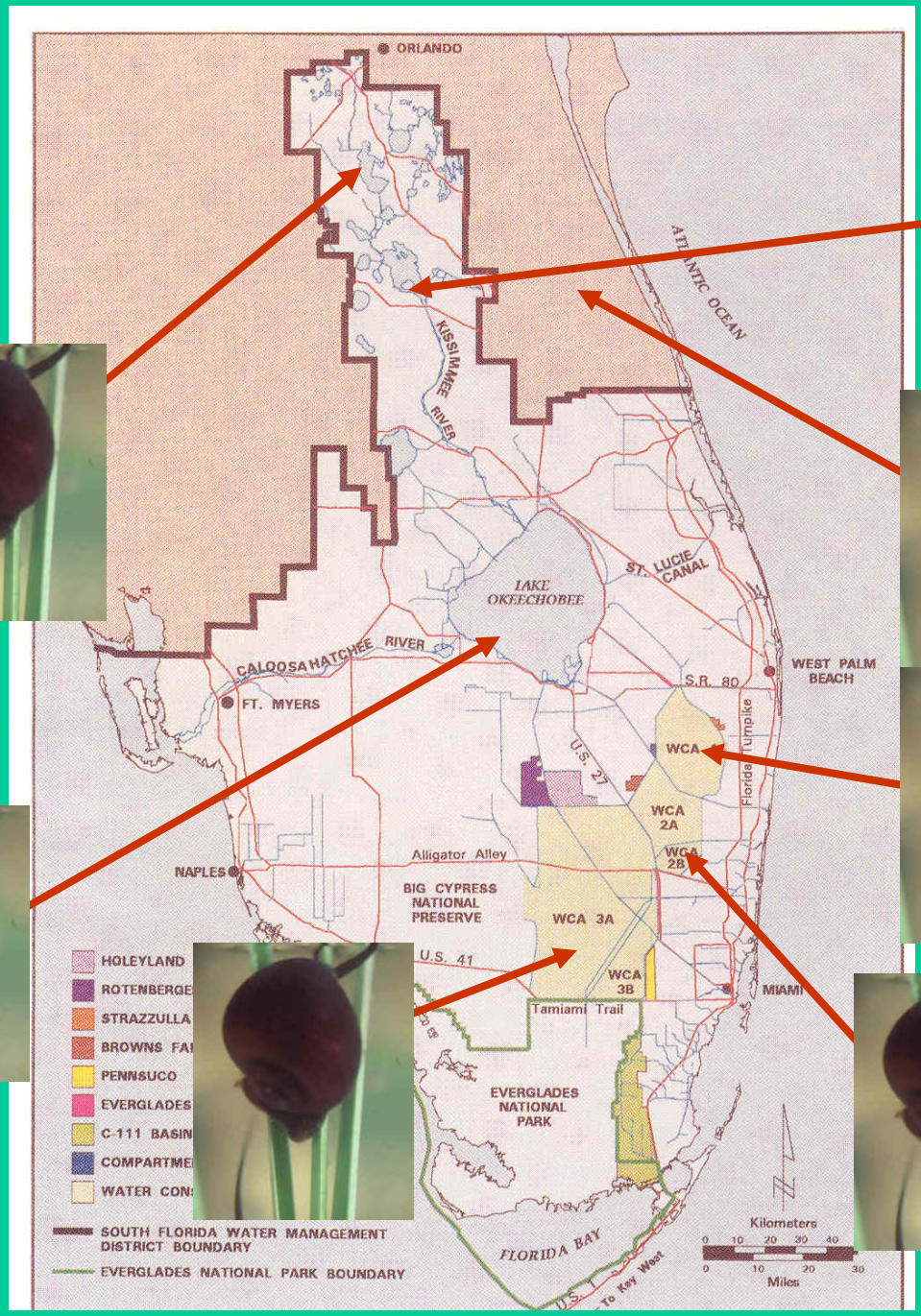
But not Snail Status & Trends In Abandoned Areas



Monitoring Supports Adaptive Management



monitoring *snails* to support kites* need to be considered at the right scale



**and other predators*

CONCLUSIONS

- snail are products (via natural selection) of their environment

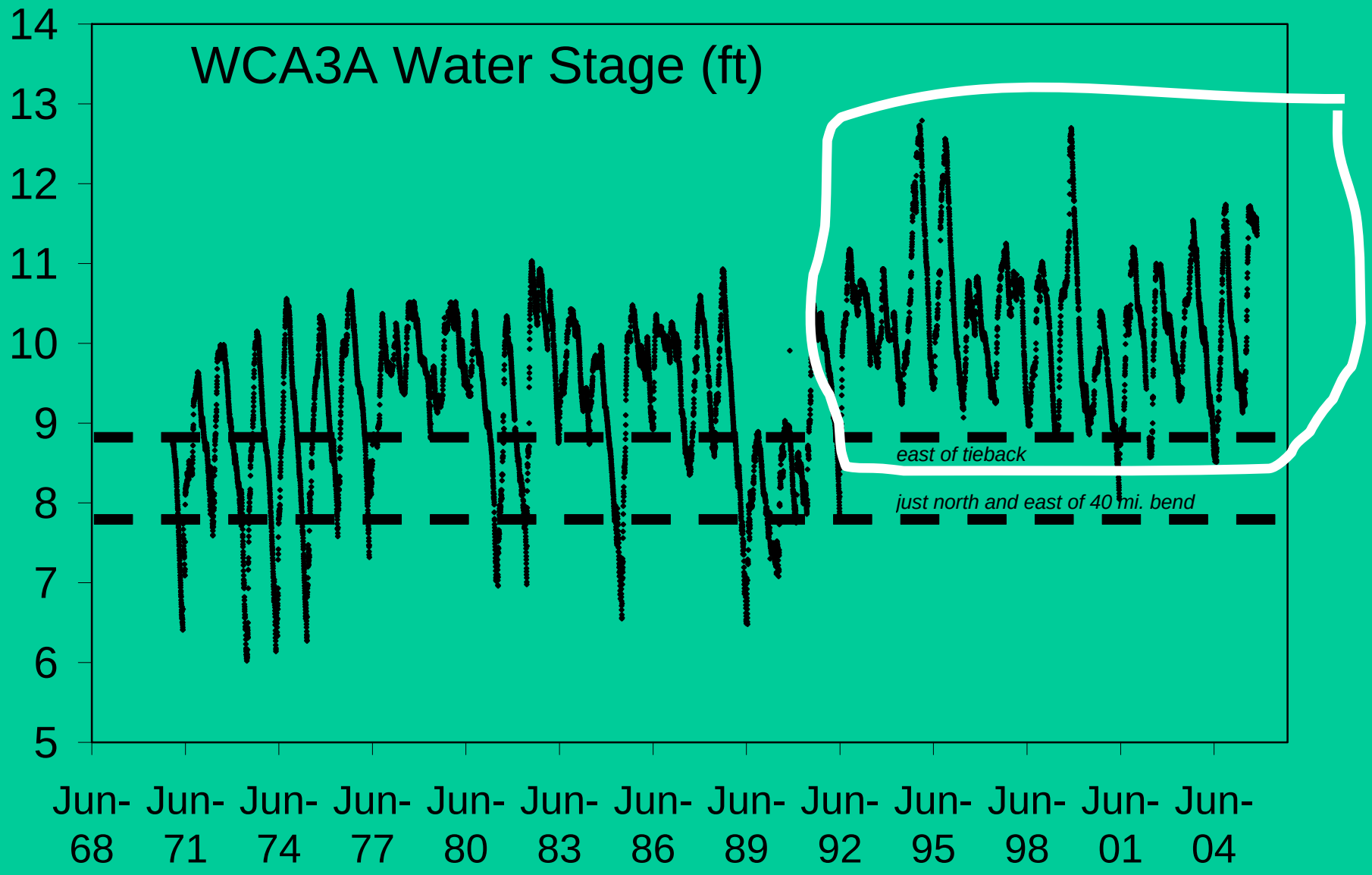
- Demographic metrics (survival, reproduction, abundance) reflect the quality of snail habitat

- snails have adaptations sensitive to environmental attributes that are targeted by restoration and management:

"Get the water right"

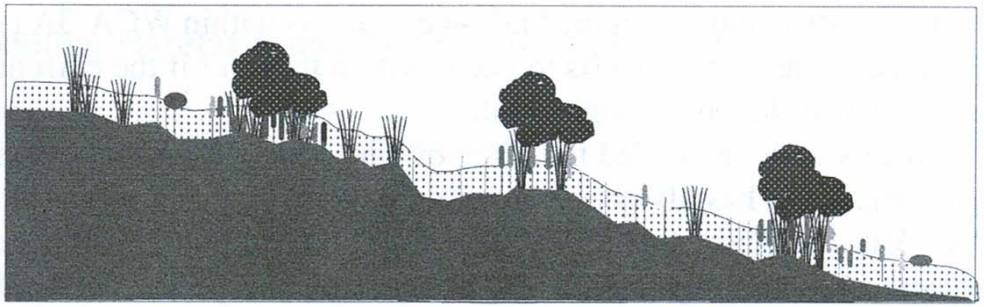
Snails are adapted to dry down conditions….

trends of low recruitment and decreasing densities…

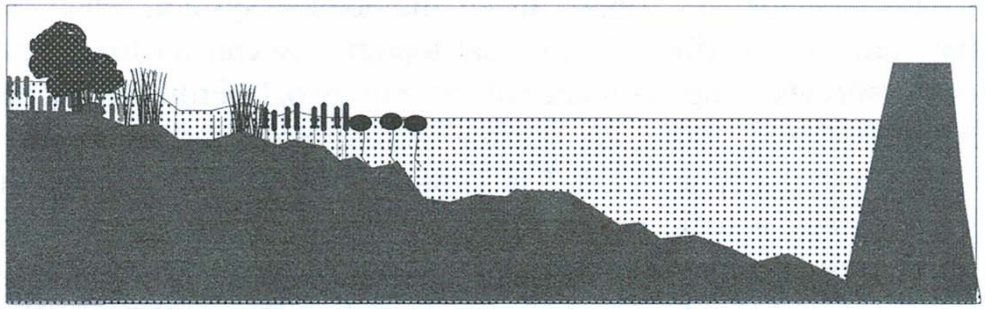


suggest another incentive for DECOMP

Natural System



Impounded System



A
S
A
P

From Kitchens et al. 2002

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Steven Slack (*Tennessee*)

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Amy Busch (*California*)

Jennifer DuPree (*Florida*)

Jason Liddle (*Florida*)

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US Fish and Wildlife Service

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St. Johns River Water Management District

South Florida Water Management District

Florida Cooperative Fish & Wildlife Research Unit

University of West Florida