Carbon isotope turnover as a measure of arrival time in migratory birds

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USGS science for a changing world

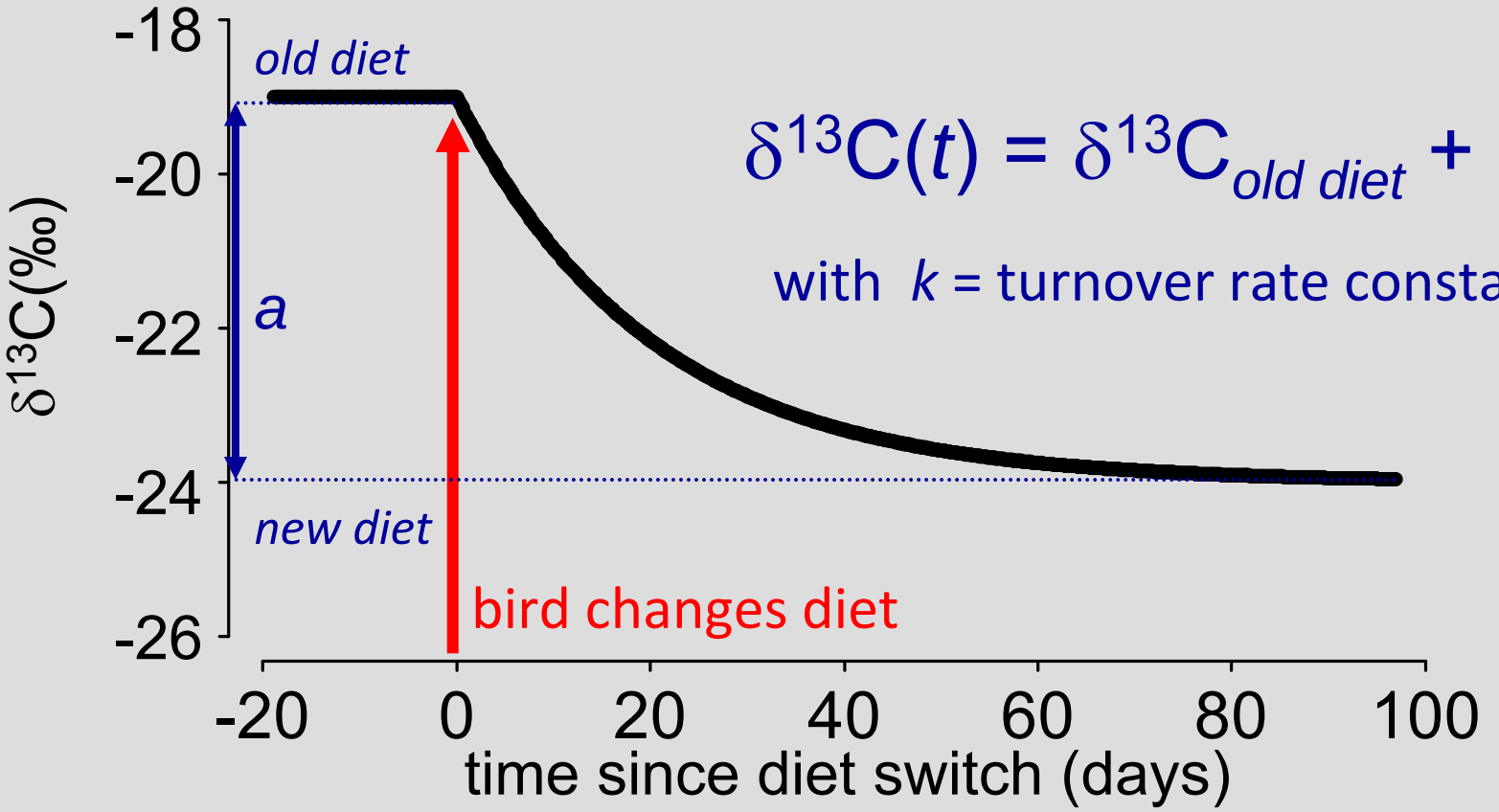
Arrival time matters

- arrival time important fitness metric
- early arrival = high fitness
- difficult to assess in the field

→ new approach needed

Stable Carbon Isotopes ($\delta^{13}C$) in blood

- $\delta^{13}C$ in blood reflects $\delta^{13}C$ in diet
- if diet changes, $\delta^{13}C$ in blood changes (turnover)

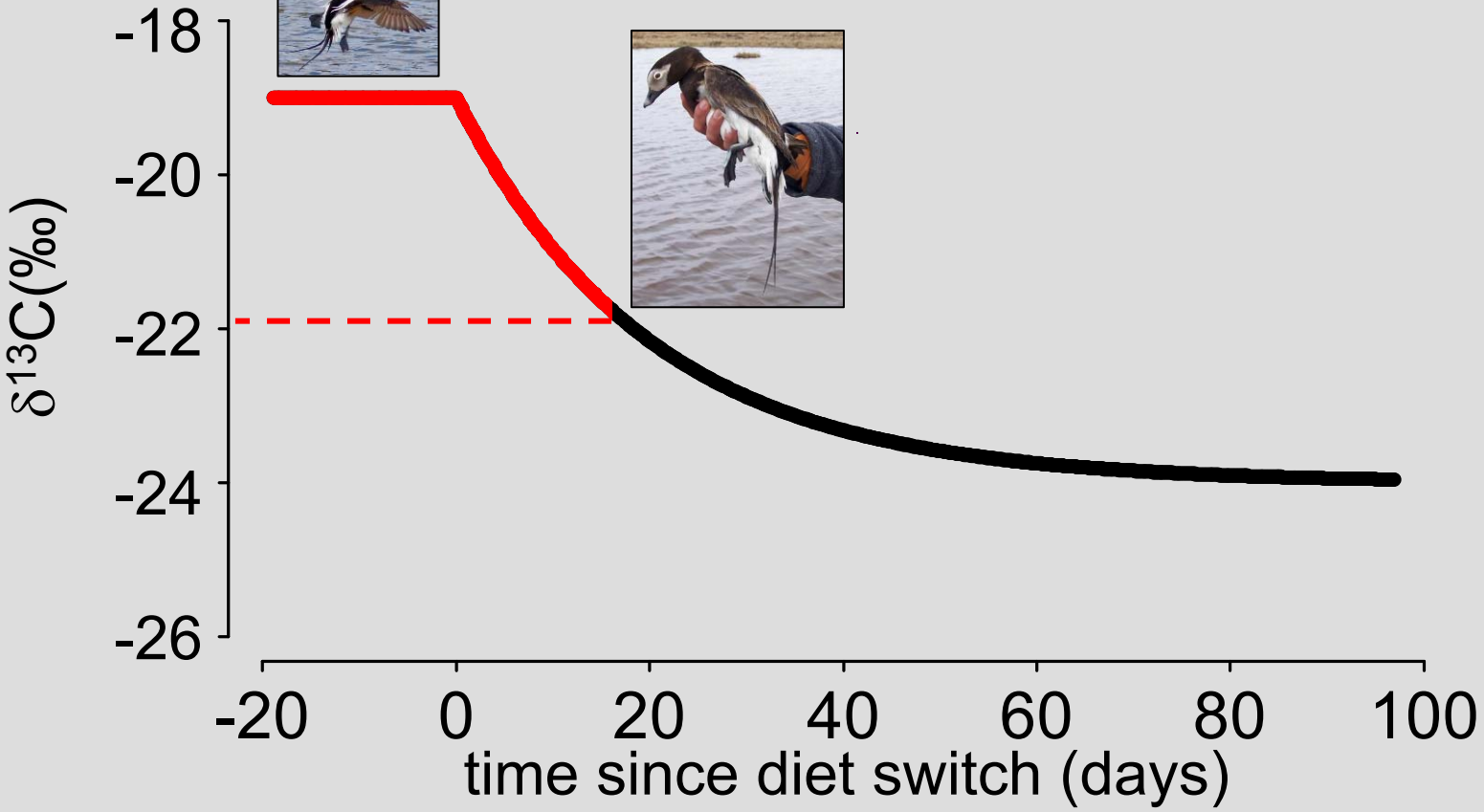


$$\delta^{13}C(t) = \delta^{13}C_{old\ diet} + a^{*}e^{-kt}$$

with k = turnover rate constant

Arrival time estimation

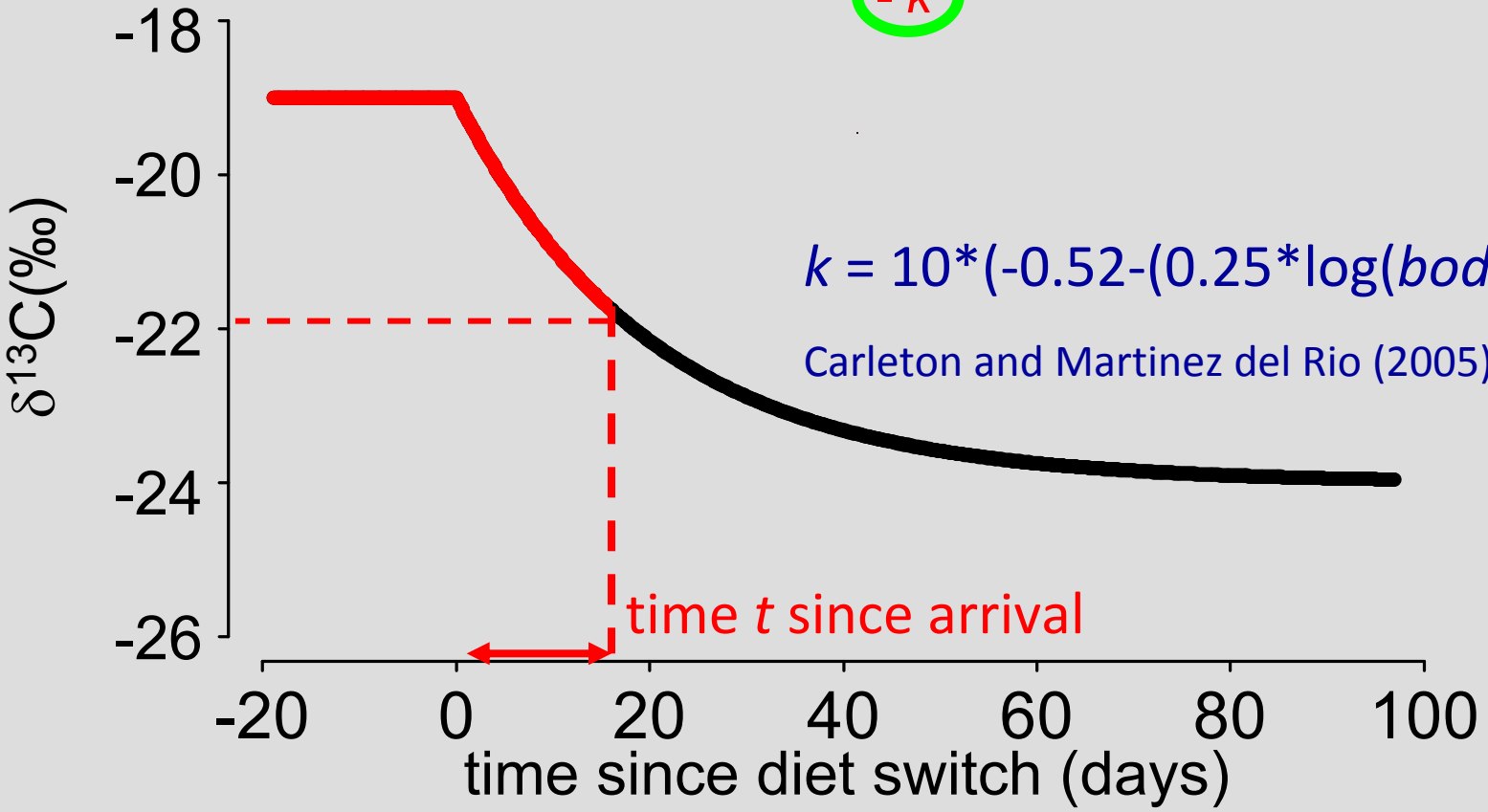
- if birds arrive at new habitat → diet changes
- use change in blood $\delta^{13}C$ to estimate arrival time



Arrival time estimation

- if birds arrive at new habitat → diet changes
- use change in blood $\delta^{13}C$ to estimate arrival time

$$t = \frac{(\ln(\delta^{13}C(t) - \delta^{13}C_{new\ diet}) - \ln(\delta^{13}C(t) - \delta^{13}C_{old\ diet})}{-k}$$



$k = 10*(-0.52-(0.25*\log(body\ mass)))$

Carleton and Martinez del Rio (2005)

Question

Does the theoretical turnover model provide reliable estimates of *t*:

1. in controlled captive experiments?

2. in a field application?

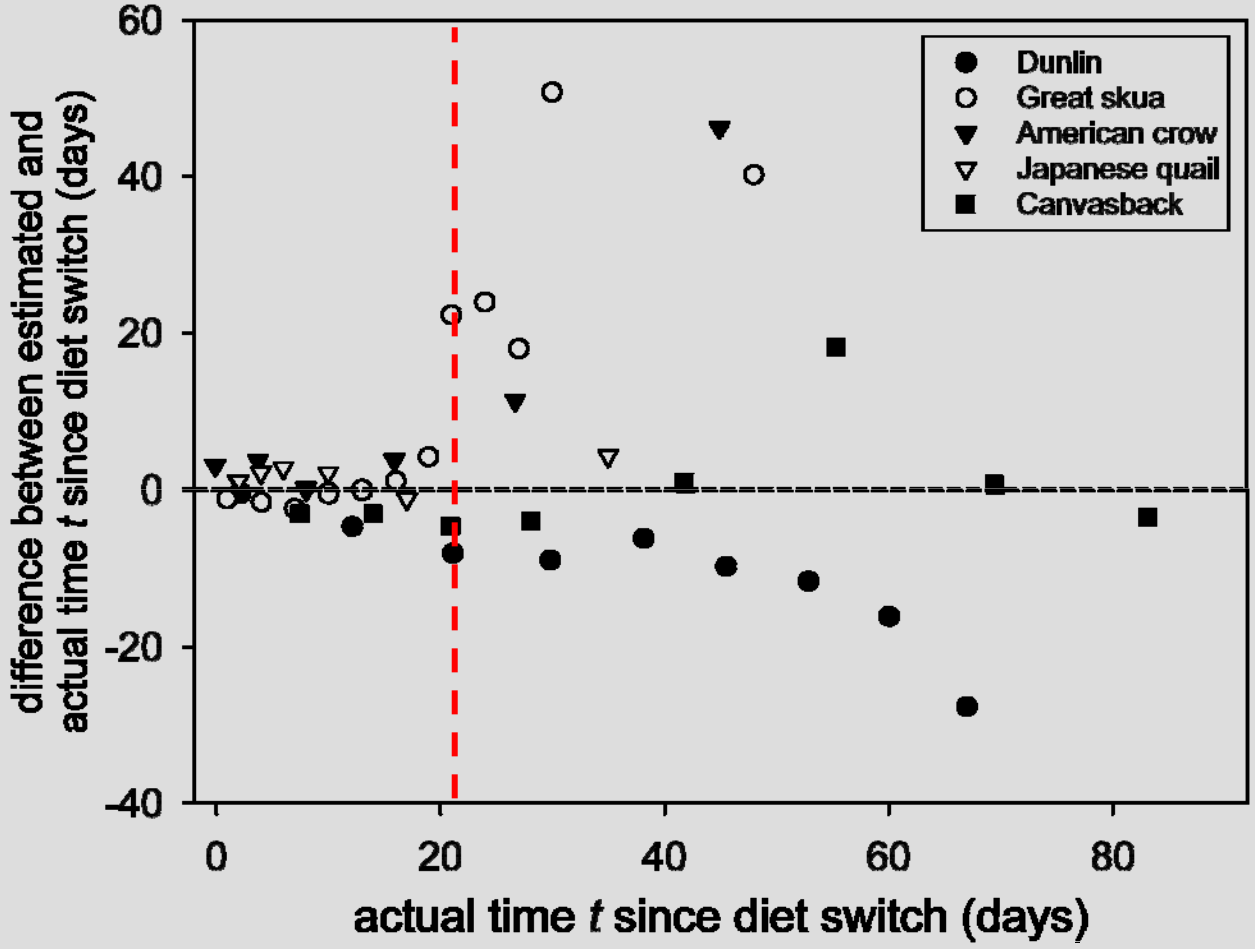
Captive experiments - methods

- data from 5 published studies of isotope turnover
- estimated *k* from body mass of birds
- estimated time since diet switch (*t*) as:

$$t = \frac{(\ln(\delta^{13}C(t) - \delta^{13}C_{new\ diet}) - \ln(\delta^{13}C(t) - \delta^{13}C_{old\ diet})}{-k}$$

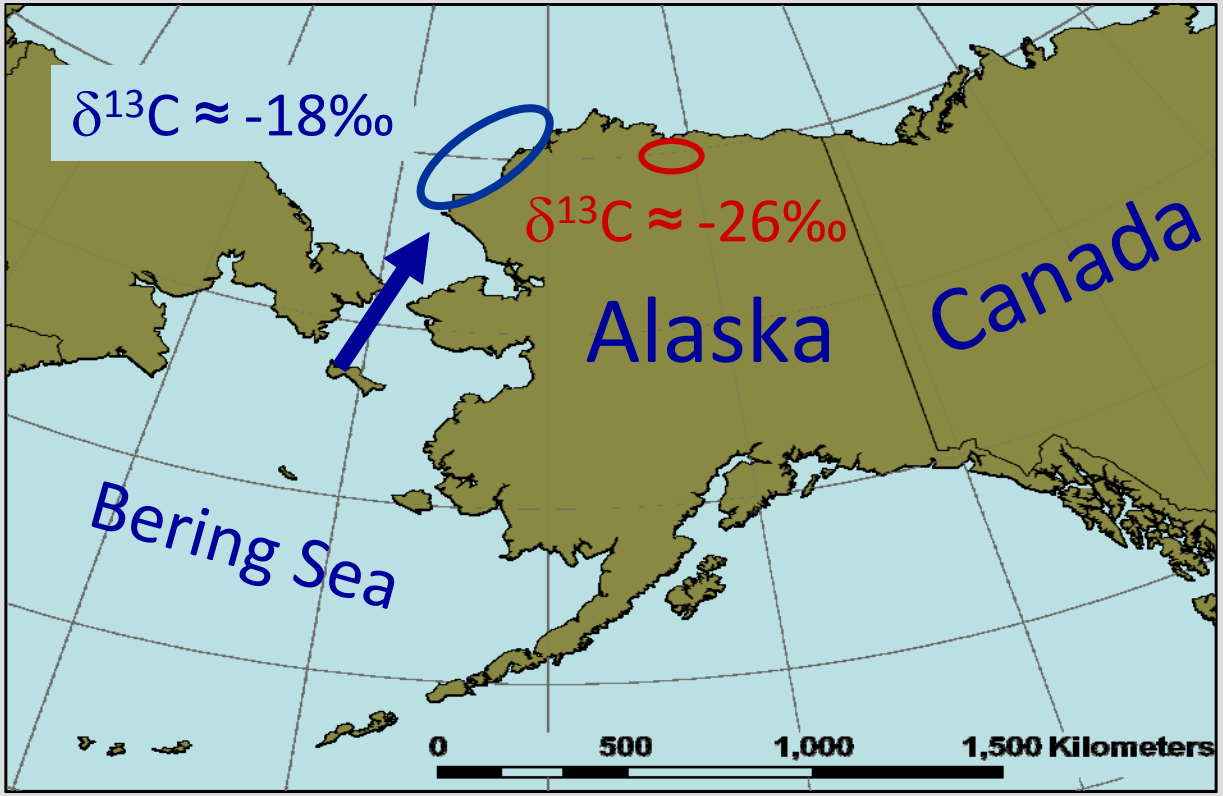
Captive experiments - results

- very good prediction for first 3 weeks
- potentially large error after > 3 weeks



Field application - background

- King Eiders migrate at sea and breed on tundra
- marine and tundra diet differ in $\delta^{13}C$



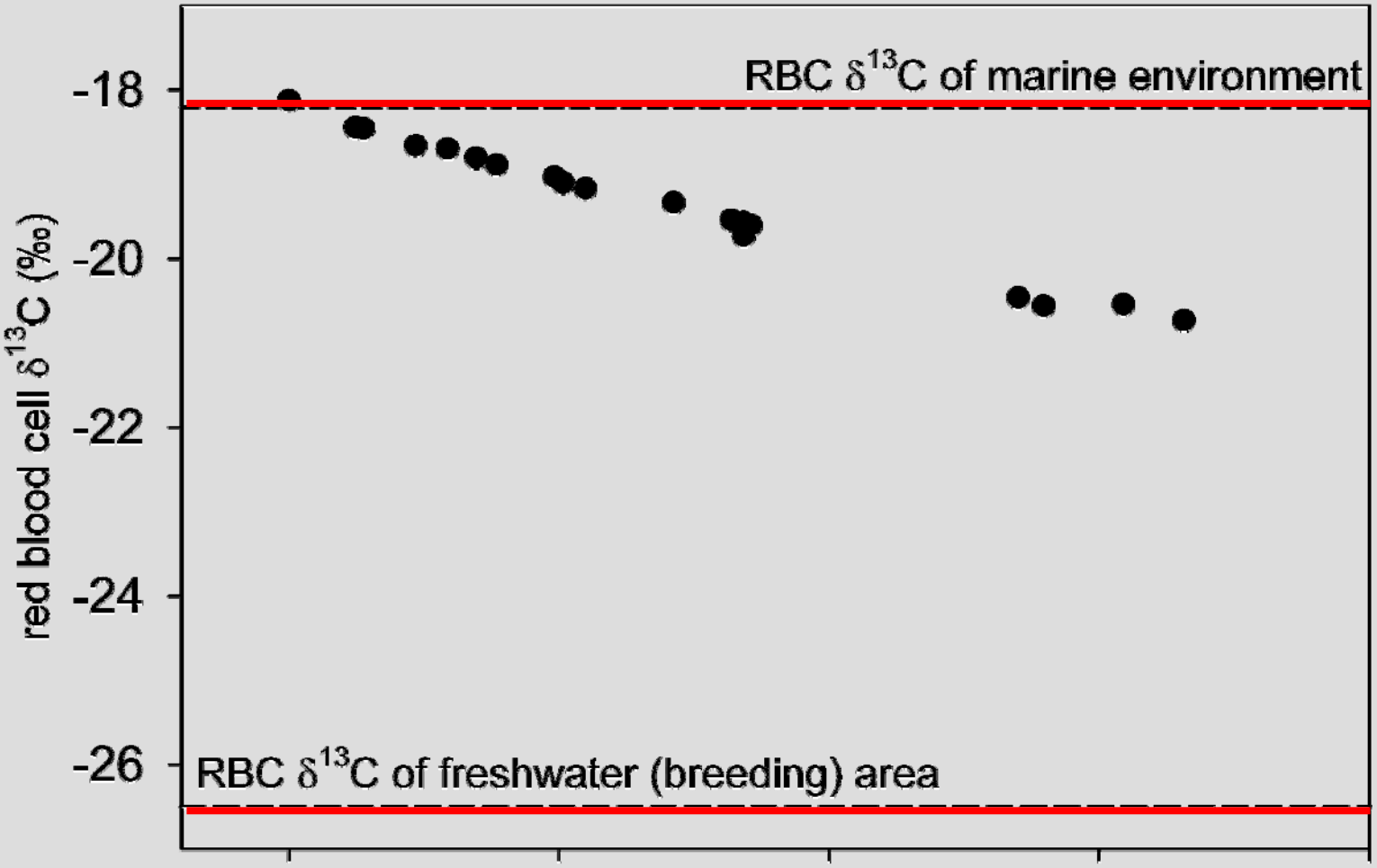
breeding site

spring staging area

Field application - methods

- captured birds in June
- sampled blood
- measured $\delta^{13}C$ in RBC

Field application - results



Field application - results

arrival dates of
satellite-tracked birds

estimated arrival dates

capture dates

26 31 5 10 15 20 25

May June

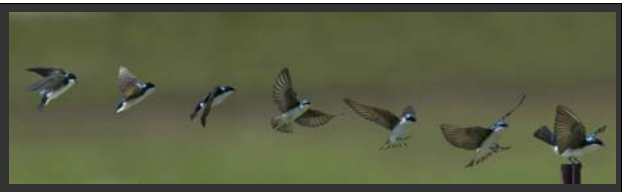
Conclusions

- isotope turnover in blood can be used to estimate arrival time
- reliable for ~3 weeks after arrival

Limitations and caveats

- habitats must be isotopically distinct
- diets from both habitats must be sampled
- birds must forage upon arrival in new habitat

Acknowledgements



- U. S. Fish and Wildlife Service
- ConocoPhillips Alaska Inc.
- Polar Continental Shelf Project
- Minerals Management Service
- Coastal Marine Institute

- North Slope Borough
- U. S. Geological Survey
- ABR, Inc.
- Troy Ecological Research Associates, Inc.
- Alaska Cooperative Fish and Wildlife Research Unit

Questions?

Photo credits: Anupam Pal, Steve Baraff, Chao Rospech, Steve Axford, Ted Swem