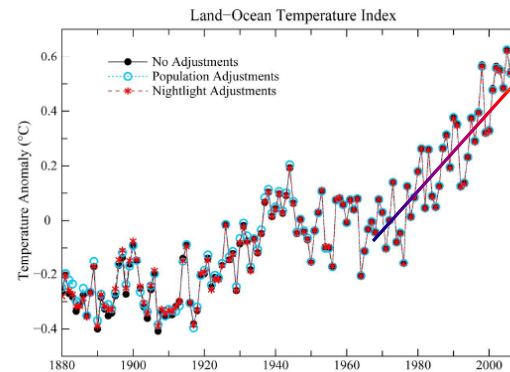




# Influence of High-Latitude Warming on Fall Migration Timing of Eastern Golden Eagles (*Aquila chrysaetos*)



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# Global temperature trends

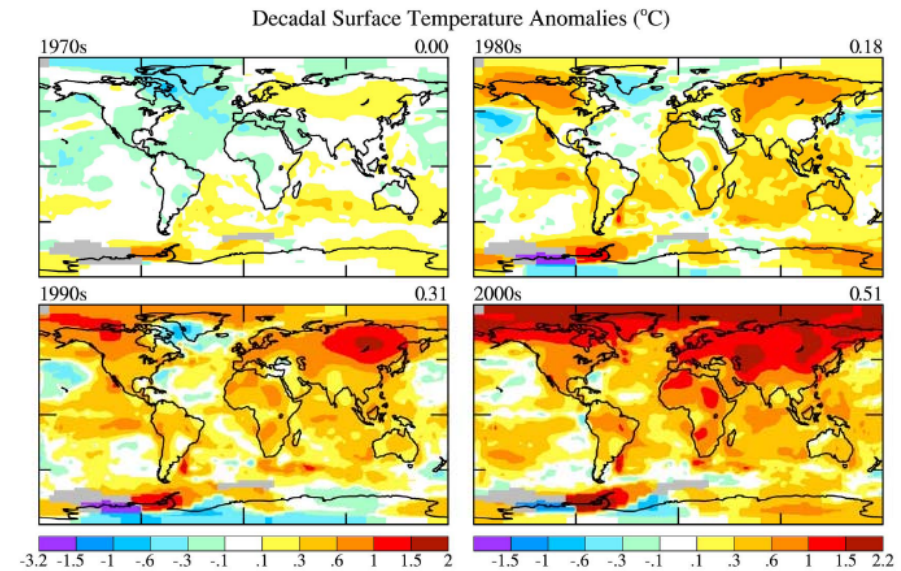
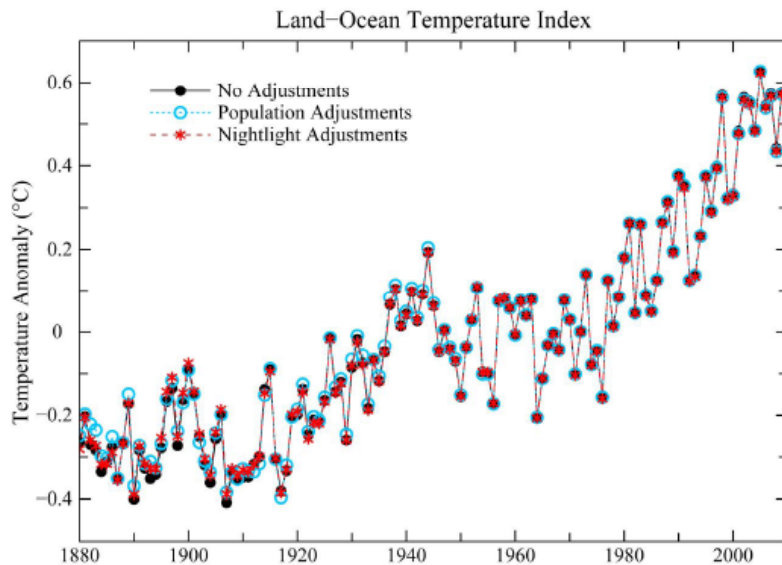


Figure 8. Decadal surface temperature anomalies relative to 1951–1980 base period.

- ▶ Global temp index (Hansen et al 2010)
- ▶ **Steady upward trend since 1970**
- ▶ Distribution of temp anomalies (Hansen et al 2010)
- ▶ **More warming at high latitudes**

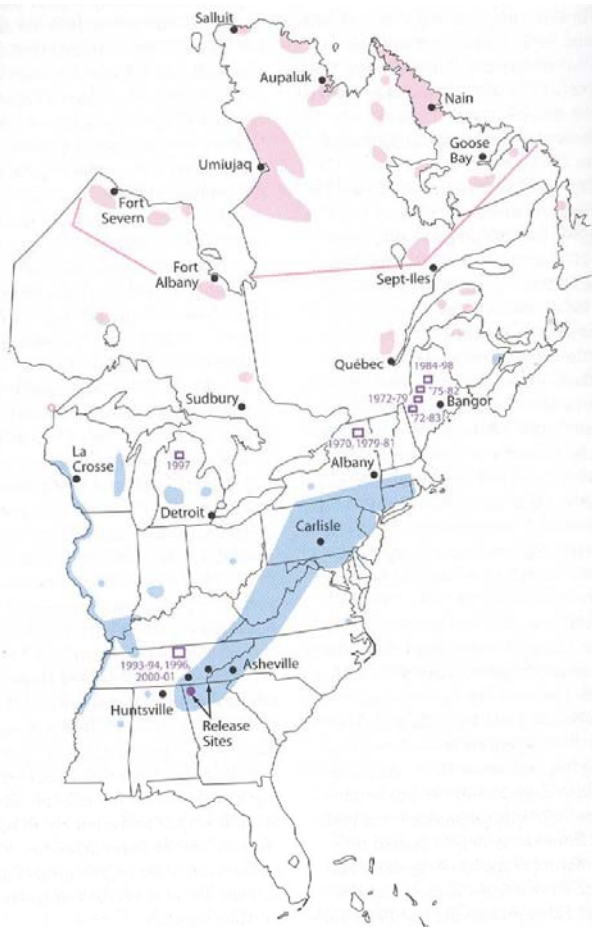
# Known impacts of climate change on some migratory bird species

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- ▶ Shifts in migration timing (esp arrival dates of passerines)
- ▶ Shifts in wintering ranges (e.g. white stork in Europe)
- ▶ Disruption of synchrony between predator and prey
- ▶ Changes in migratory behavior/strategies
  - ▶ Possibly happening now with RTHA in eastern N Am.
  
- ▶ Only one study focusing on timing of migrating raptors - based on 30 yrs of fall counts at Organbidexka Pass, western Pyrenees (Filippi-Codaccioni et al 2010)
  - ▶ *Long-distance migrants advanced mean passage date (earlier migration)*
  - ▶ *Short-distance migrants delayed mean passage date (later migration)*
    - ▶ *Exception: Sparrowhawk advanced passage date – following passerine prey base?*

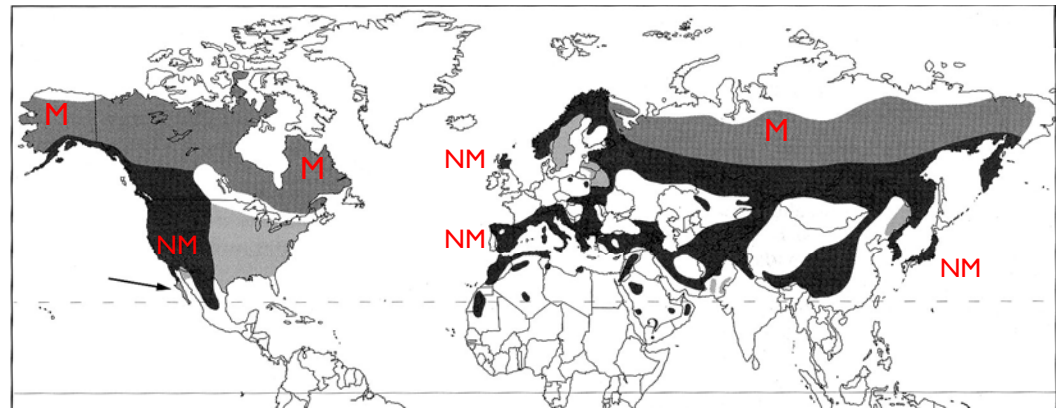


# Could we see some of these impacts/ adaptations in eastern Golden Eagles?



Range map from Wheeler, 2008

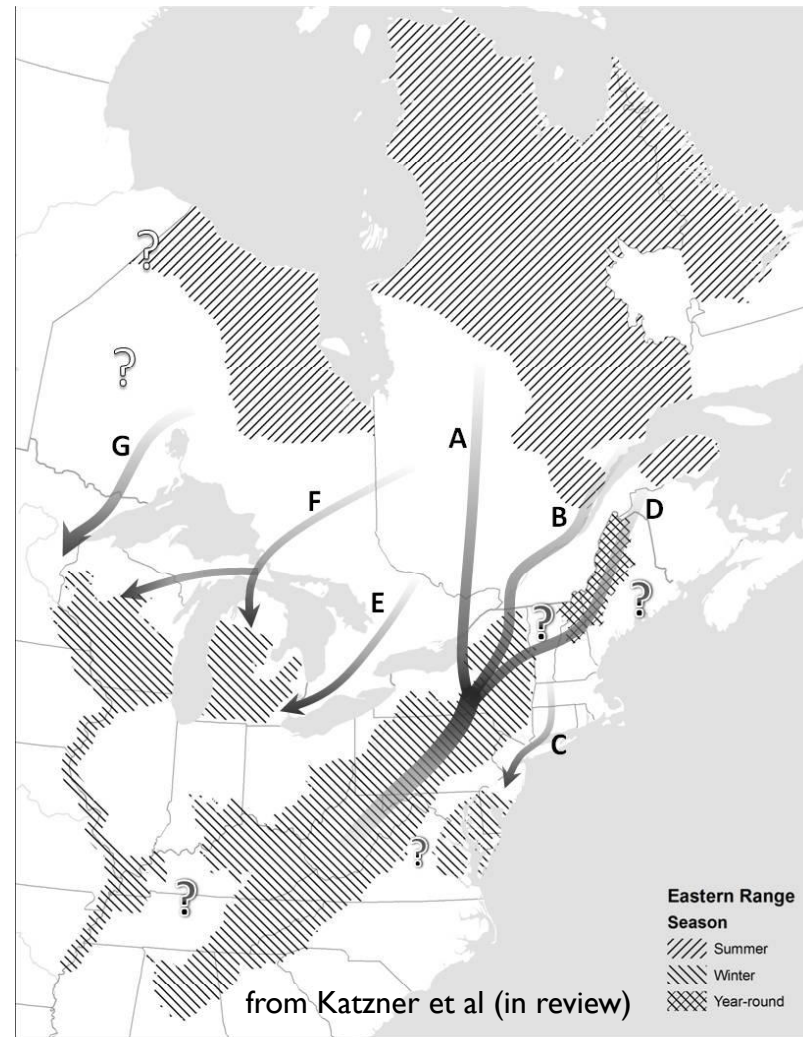
Worldwide distribution (Ferguson-Lees & Christie, 2001)



- ▶ Much variation in migratory behavior in these sub-populations
- ▶ Medium distance migrant
- ▶ GOEA likely to adapt its migratory behavior as conditions change?

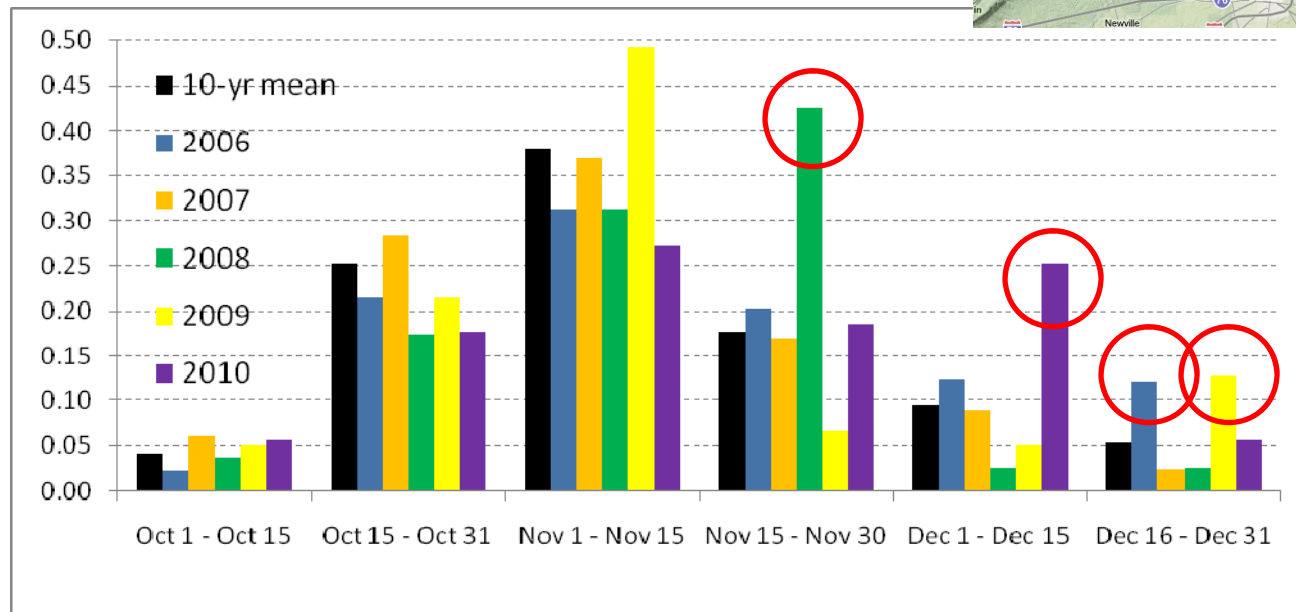
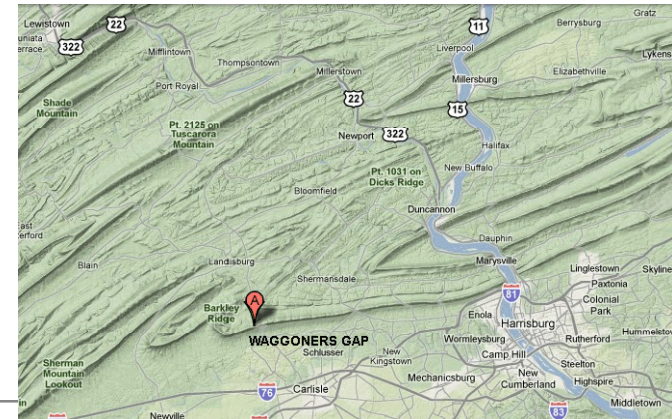
# GOEA fall migration patterns

- ▶ Multiple flightpaths between breeding and wintering areas
- ▶ Extent of mixing of flightpaths not clear
- ▶ Age appears to affect timing, and location of flightpaths and wintering areas
- ▶ Some apparent leap-frogging

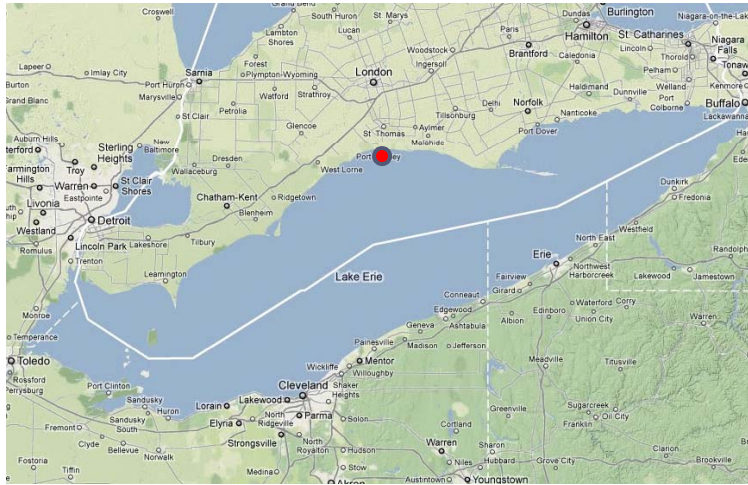


# Three recent anecdotal observations

- ▶ Count data from Waggoners Gap, PA
  - ▶ Highest annual fall GOEA counts in the east (~10% of total population?), and consistent season-long coverage
  - ▶ Late movements in recent years



# Hawk Cliff, Ontario

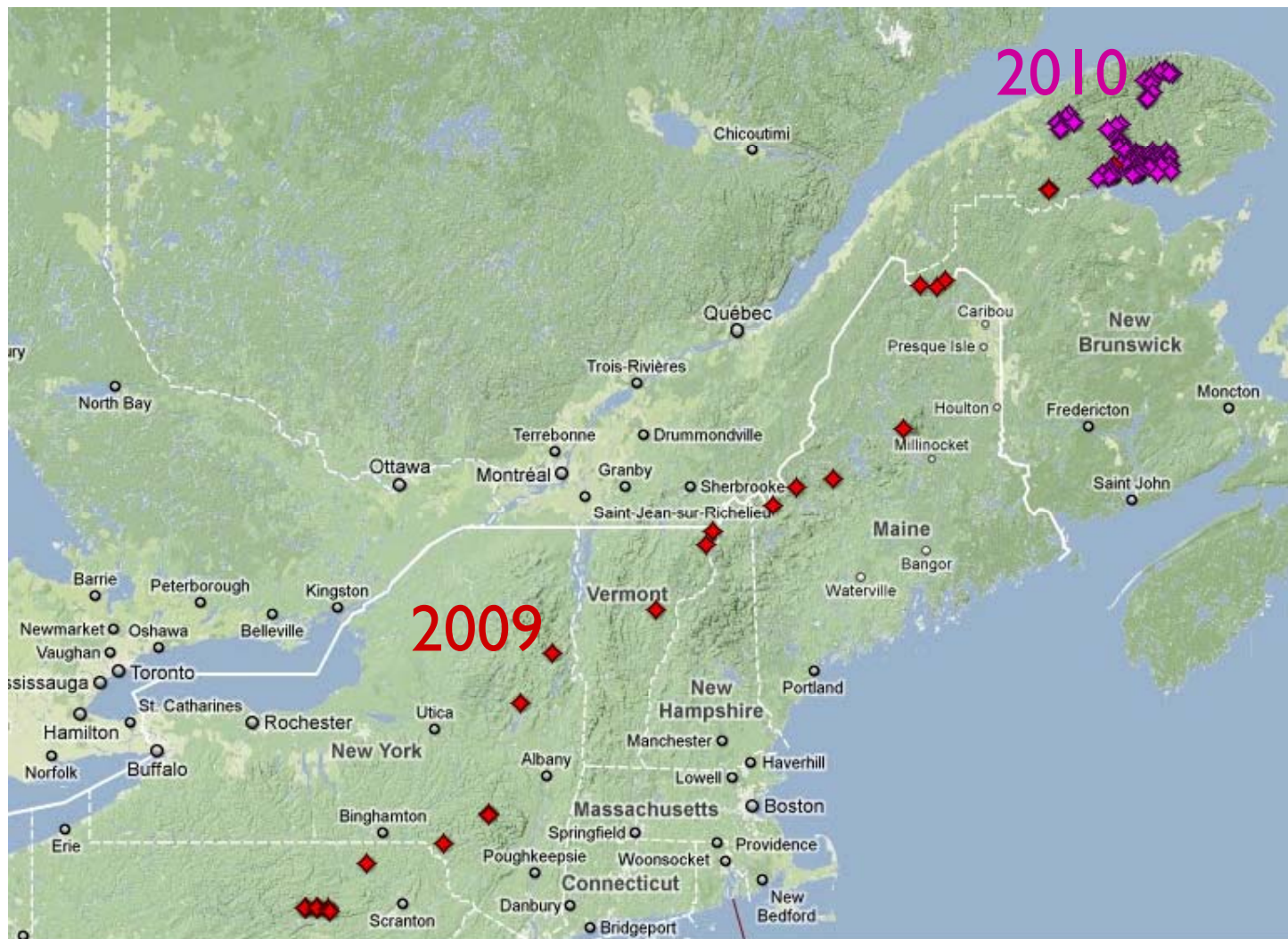


From hawkcount.org

- ▶ Second-highest count ever of **43 GOEAs on Dec 21, 2010**, and **10** more on **Dec 26th** – previous high counts at this site have typically occurred ~ first week of Nov
- ▶ In past years, no December monitoring
  - ▶ true of many sites in the monitoring network



# GOEA #27 (Adult Male) – fall/winter 2010



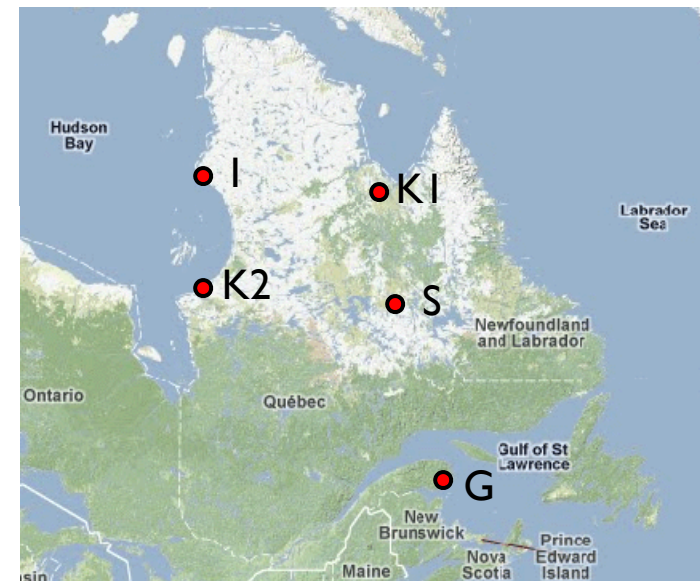
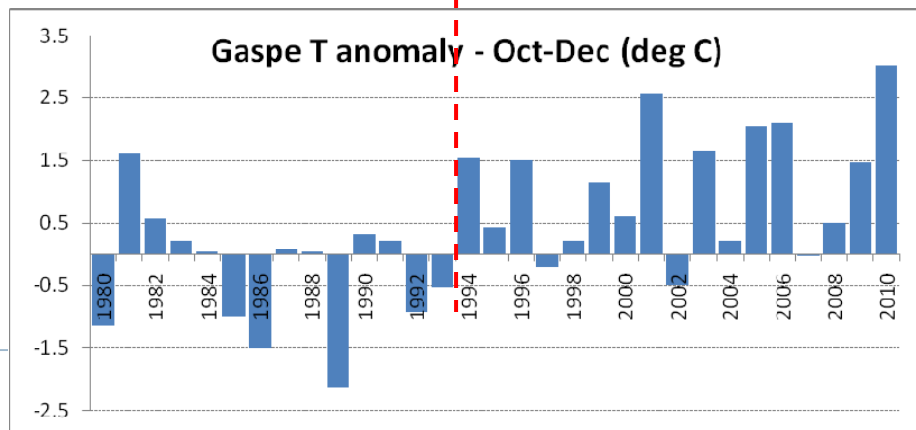
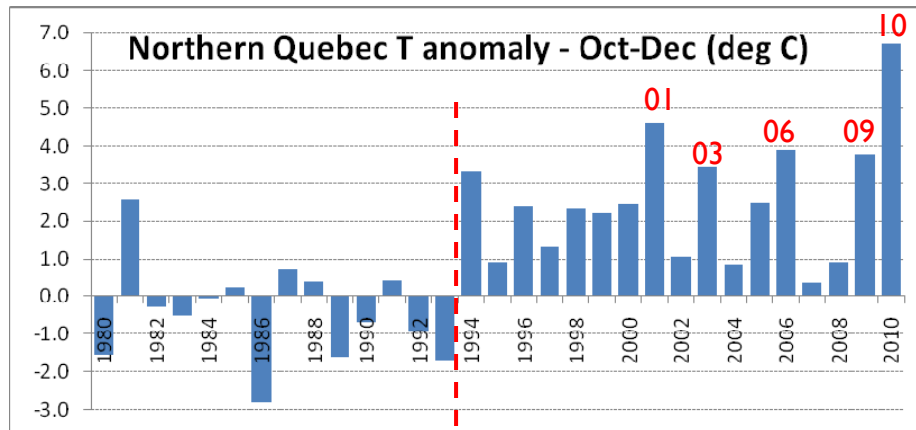
- ▶ Q1: How is temperature changing in northern Quebec?
- ▶ Q2: Is there evidence that timing of eastern GOEA migration is shifting?



- ▶ Q3: If so, what might be the implications?

# Temperature data from the breeding range

- ▶ “Northern QC climate underwent an abrupt warming in 1993 and the past two years have seen anomalously warm winter conditions over northern Labrador and QC in response to persistent blocking patterns over the NW Atlantic”  
- Ross Brown, Env. Canada

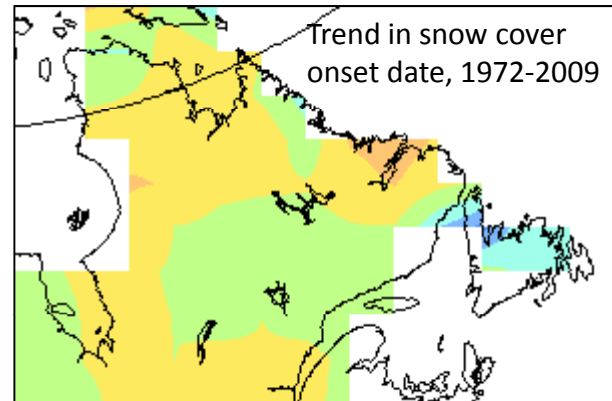


All data from Environment Canada National Climate Data and Information Archive

# Trends in snow cover onset and snow-off dates (*Brown et al., 2010*)

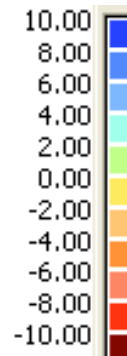
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- ▶ Not much change in snow cover onset date

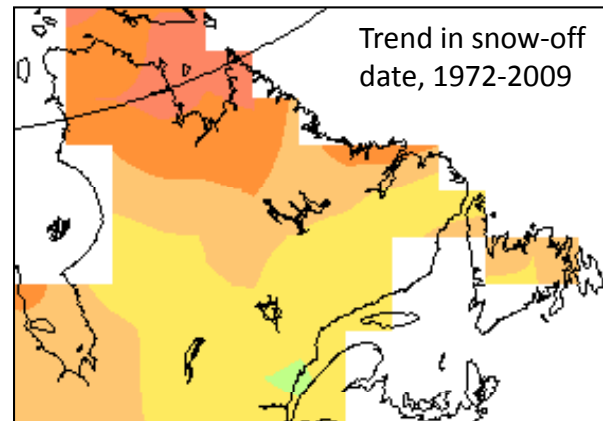


**Earlier onset  
or Later melt**

**days/ 10y**



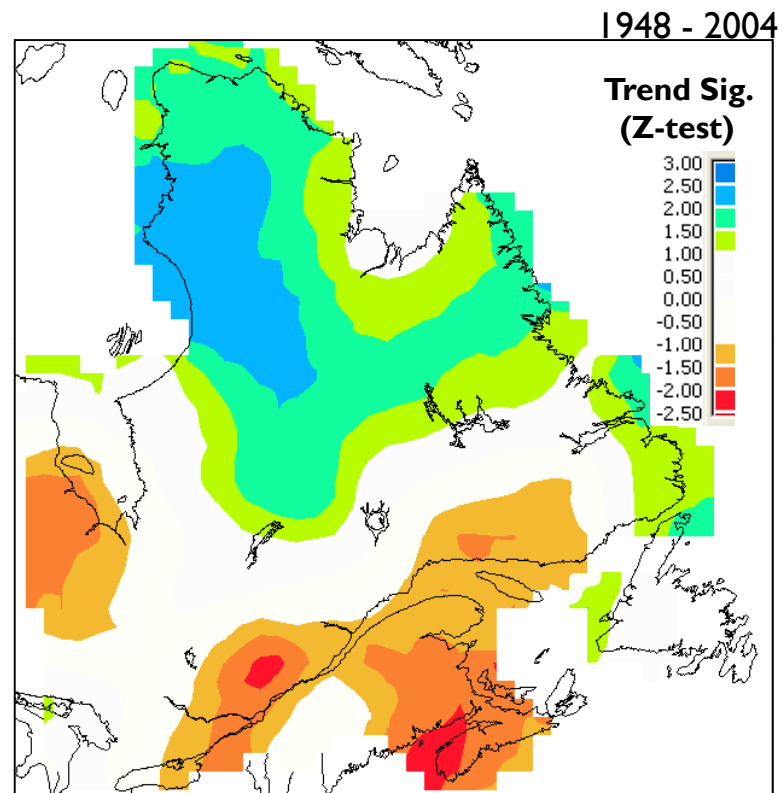
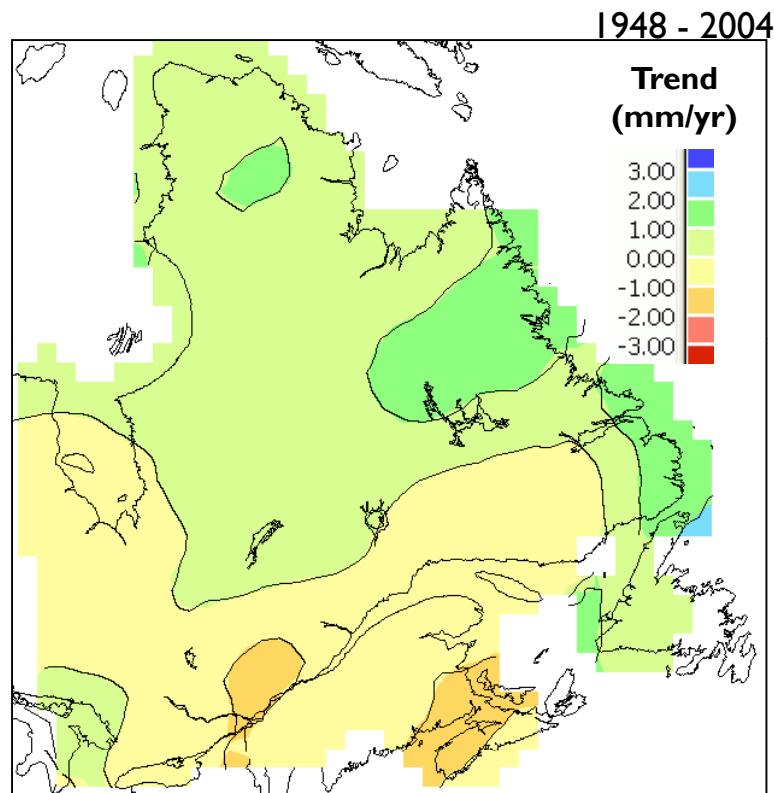
- ▶ Earlier spring snow-off dates, esp in northern QC



**Later onset or  
Earlier melt**



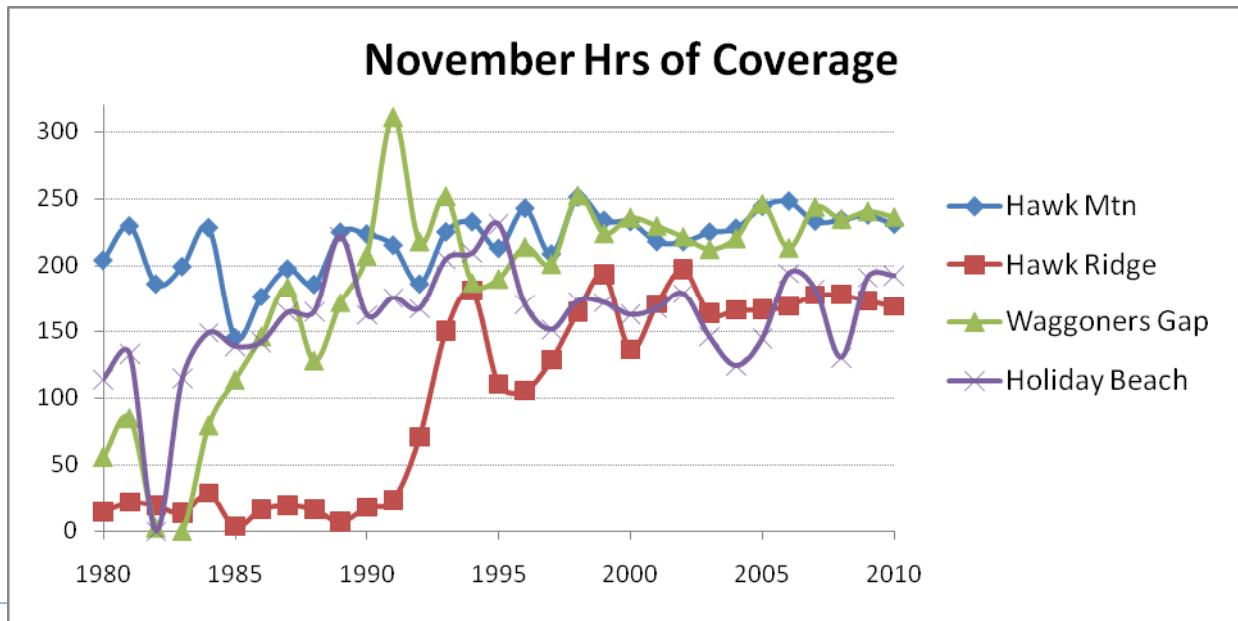
# Trends in maximum snow water equivalent (Brown, 2010)



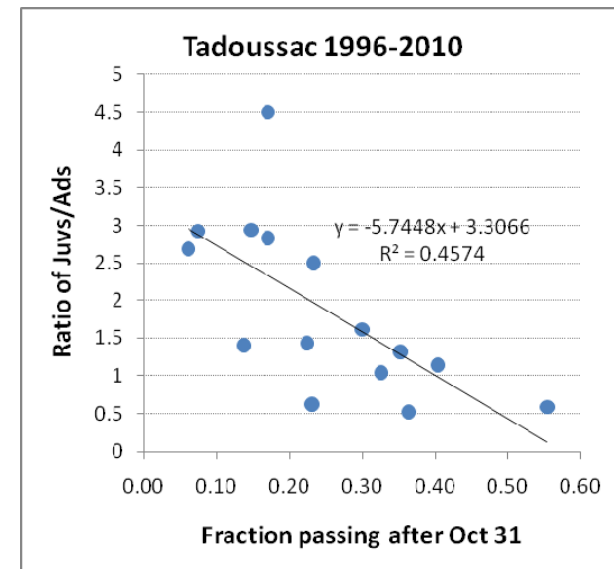
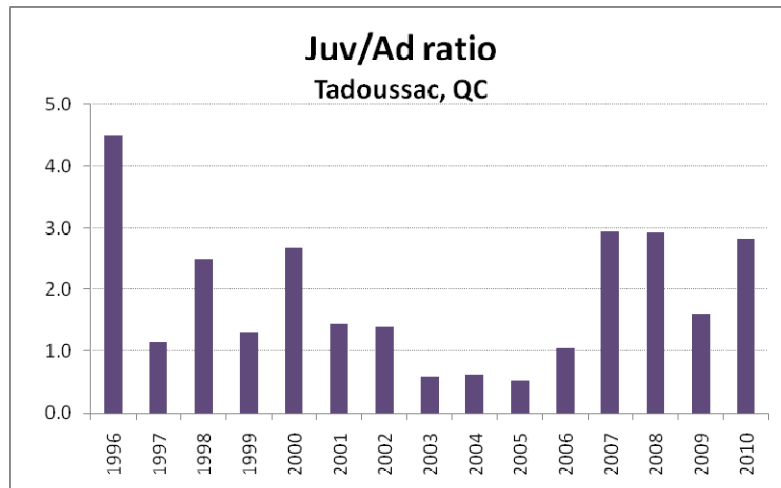
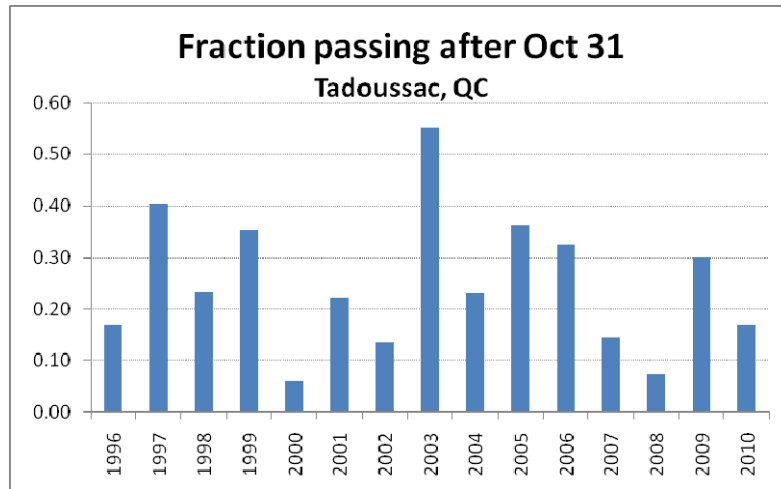
- ▶ Max SWE is increasing in the northern QC (due to reduction in Hudson Bay ice) and decreasing in the St Lawrence region

# Timing shifts? – best available data to assess this are migration counts

- ▶ Problem: GOEA is a late-season migrant, w/ some of the passage after most counts have ended (esp true 15+ yrs ago)
- ▶ Fortunately, some sites have increased late-season monitoring in the last several decades
- ▶ *Unfortunately*, there are few sites with consistent coverage effort spanning the mid-90s temperature shift

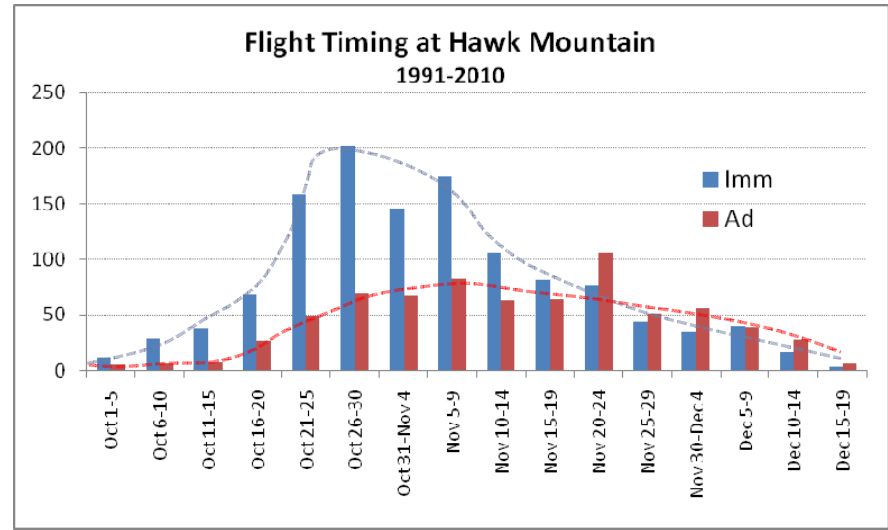
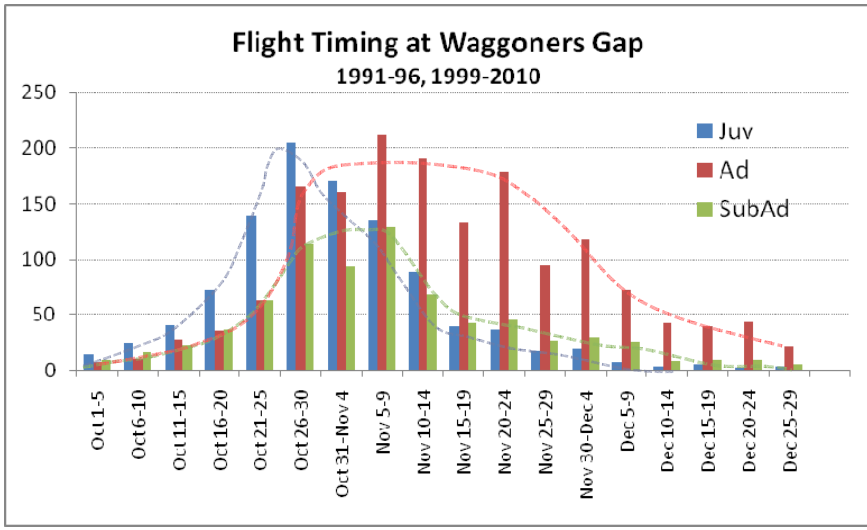
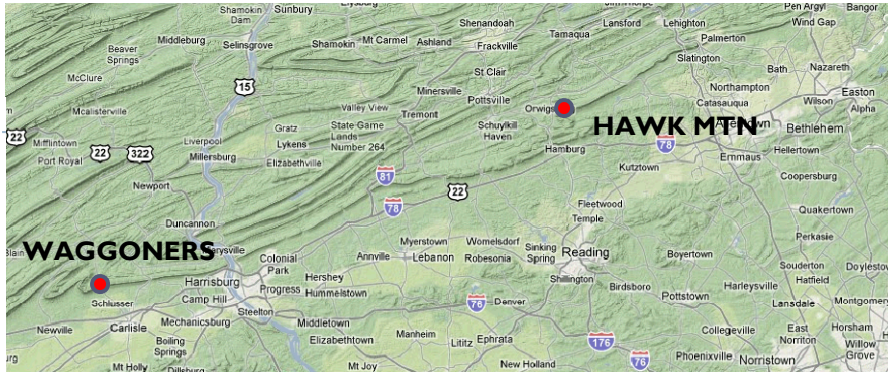


# Complication: effect of breeding success on measures of timing



- ▶ Need to focus on adult birds to assess possible shifts in timing

# Hawk Mountain & Waggoners Gap, PA

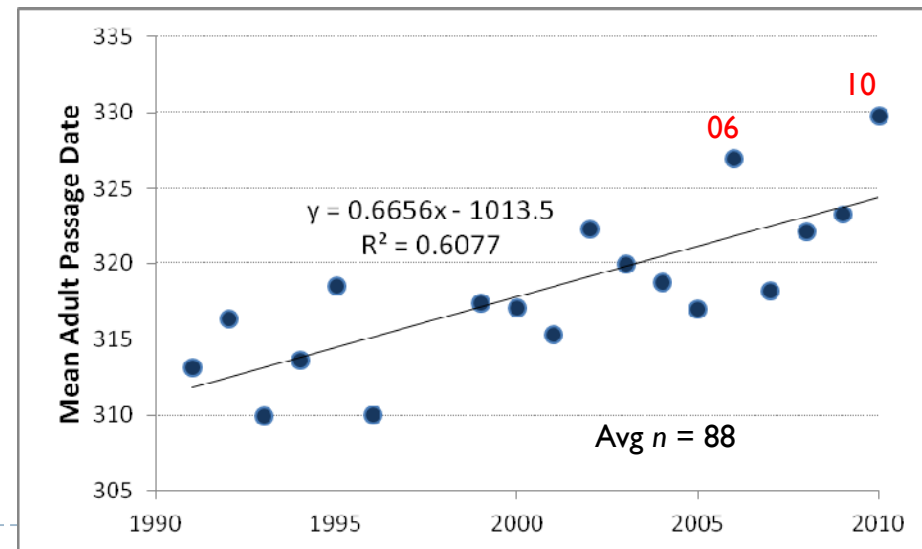
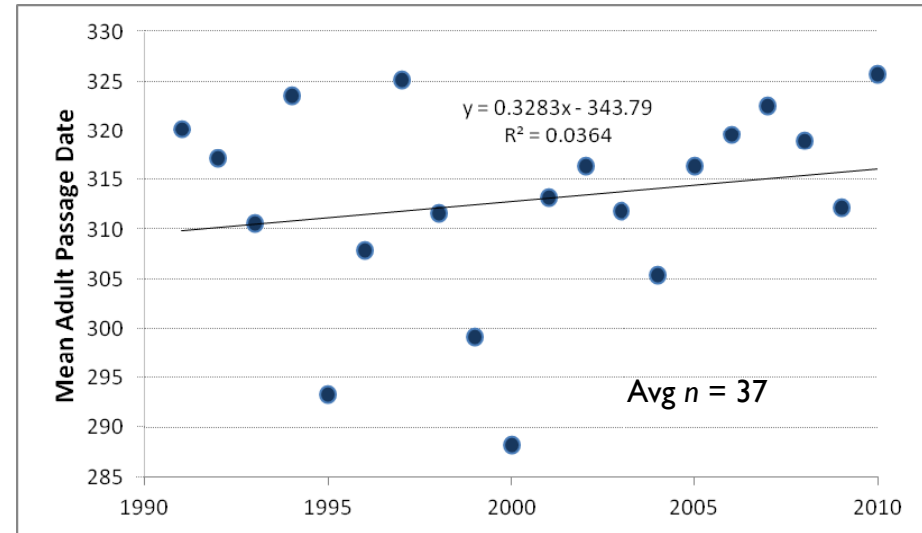


- ▶ Only two sites with consistent December coverage
- ▶ Adults migrate later, and over a long time period (through Dec)

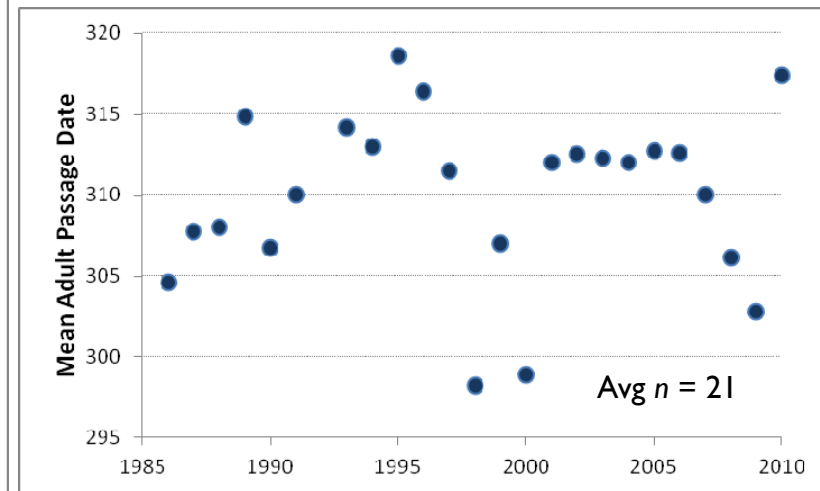
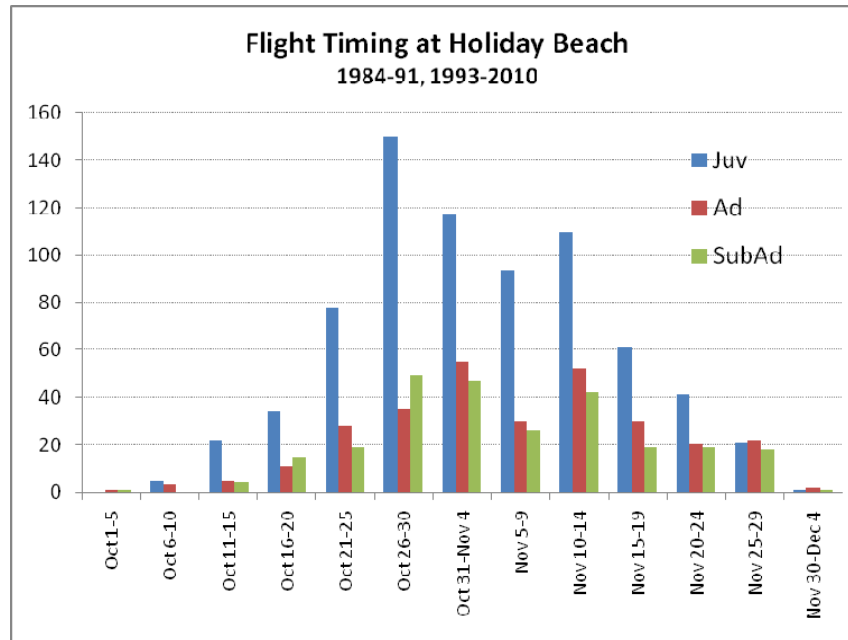
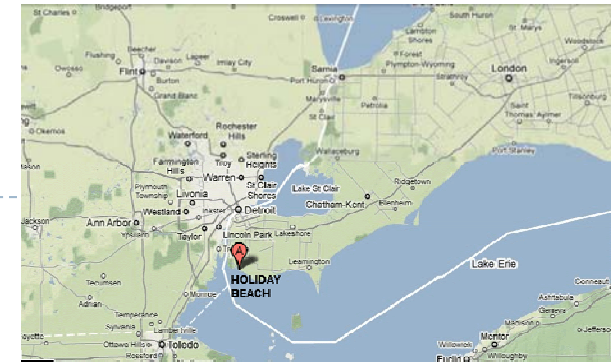


# Mean passage dates at Hawk Mountain & Waggoners Gap, PA

- ▶ At Hawk Mountain, there is a very weak (insignificant) trend in mean passage date
- ▶ At Waggoners Gap, a site with more adult birds, there is a highly significant trend toward later mean passage date
  - ▶ But limited correspondence with temp data (2001?, 2009?)



# Holiday Beach, Ontario

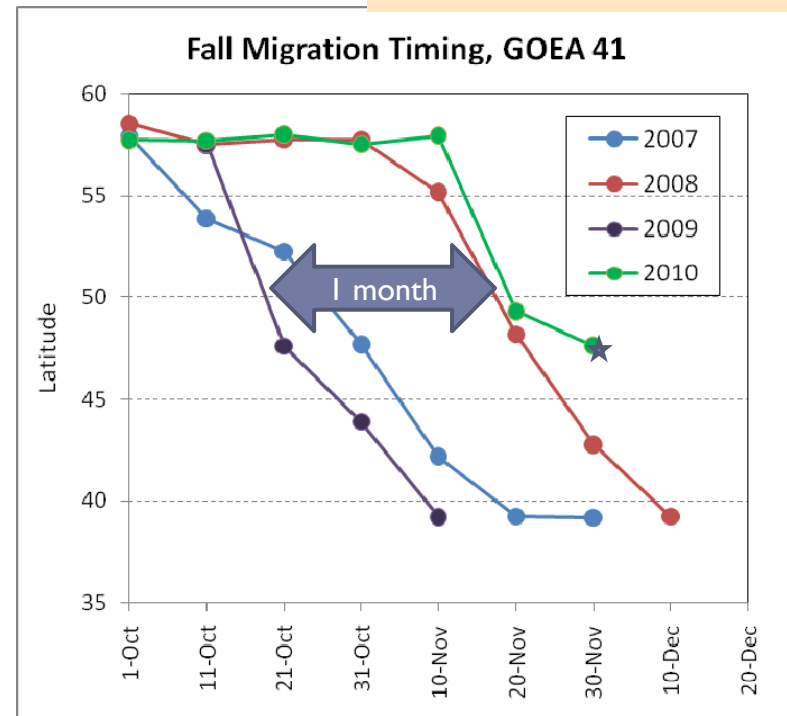
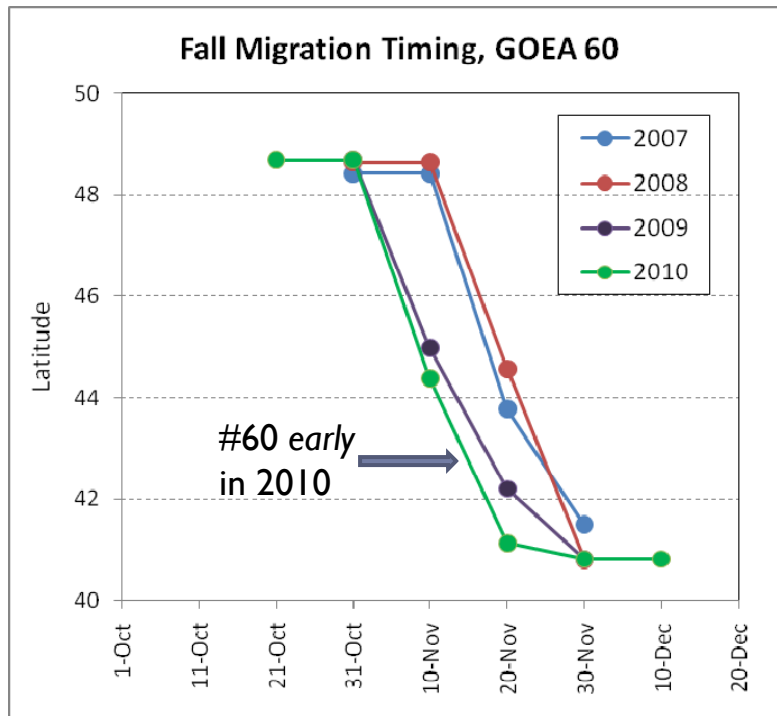


- ▶ Higher ratios of juvenile/adult birds than Appalachian sites
- ▶ No trend toward later adult flight (although no Dec coverage)

# Timing of tracked GOEAs w multiple fall migrations



- ▶ #27 did not migrate from Gaspé in 2010



- ▶ #60 = adult Male, Gaspé to northern PA (~3 weeks)
- ▶ #41 = TY-Ad male, northern Quebec to WV (~5-6 weeks)
- ▶ Timing highly variable, but not much correlation with Temp data



# Conclusions

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- ▶ It has become significantly warmer in the breeding range of eastern GOEAs since mid-1990s
- ▶ There are *suggestions* of later passage of eastern GOEAs, but no clear evidence (yet) of a widespread trend
  - ▶ Monitoring sites need to record ages to increase value of their data
  - ▶ Increased coverage in December highly recommended (brrr)
- ▶ Tracked bird movements show much variation in timing – likely more closely related to individual access to prey than to broad-scale climate/weather patterns
  - ▶ More tracking data needed

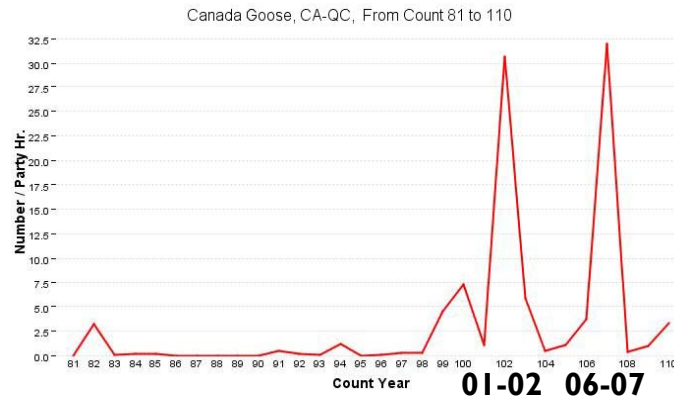


# Implications

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- ▶ Temp too simple a predictive variable to understand timing
  - need to incorporate data on prey abundance
  - ▶ E.g. rodent & ptarmigan cycles, deer herd, waterfowl wintering patterns

CBC data for  
Canada Goose  
in Quebec  
(1980-2010)



- ▶ Shifts in migratory timing/behavior may result in new/different threats for GOEAs
    - ▶ Increased exposure to trapping season in Quebec (starts ~ Oct 25)
    - ▶ More reliance on orographic lift if migration is delayed
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# Acknowledgments

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- ▶ Laurie Goodrich (HMS), Dave Grove (WG), Bob Petit (HB), Pascal Cote (TAD), Tom Dick (AF), and Tom Salo (FM) for graciously allowing use of their hard-earned migration monitoring data stored in HMANA's Hawkcount database
- ▶ Input from Ross Brown, Cryosphere Scientist, Climate Research Division, Environment Canada
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  - ▶ VA DGIF, WV DNR, PA DCNR, SWG
  - ▶ Various conservation organizations

