

NORTH DAKOTA GAME AND FISH DEPARTMENT

Final Report

**Relationships among landscape composition, nesting density, chick condition,  
adult condition and reproductive success in Franklin's gull**

Project T2-4-R

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## State Wildlife Grant Proposal – Final Report

**Project Title:** Relationships among landscape composition, nesting density, chick condition, adult condition and reproductive success in Franklin's gull

**Species of Conservation Priority:** Franklin's gull (*Leucophaeus pipixcan*)

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**Activity Period:** April 1, 2009 – June 30, 2012

**Location:** Burke County (Beaver Lake Waterfowl Production Area), McHenry County (J. Clark Salyer National Wildlife Refuge), Nelson County (McHugh Slough), Pierce County (Rush Lake Waterfowl Production Area), Towner and Ramsey County (Lake Alice National Wildlife Refuge).

**Need:** Franklin's gull (*Leucophaeus pipixcan*) is a long distance migrant that nests over water in large marshes of the prairie regions of North America. Franklin's gull is a *Level I Species of Concern* in North Dakota and a *high priority species* for the Prairie Pothole Joint Venture Waterbird Plan. Information needs include identifying priority landscapes for nesting and staging, assessing human impacts on these priority areas, and understanding colony distribution and recruitment trends (including the effects of other gulls and predators on reproductive success of Franklin's gull).

**Summary:** We completed three field seasons for this study. We identified five active breeding colonies in North Dakota. Reproductive success is variable among sites and years. The timing of nesting affects egg and chick characteristics, and later nesting adults exhibit lower condition than early nesting adults. Analysis of historical records also indicates Franklin's gull is arriving to North Dakota colony sites earlier in spring.

### Findings:

*Active colonies:* We have identified five colonies currently breeding in North Dakota. These colonies are located at Beaver Lake Waterfowl Production Area (WPA) in Burke County, J. Clark Salyer National Wildlife Refuge (NWR) in McHenry County, Lake Alice NWR in Ramsey County, McHugh Slough in Nelson County and Rush Lake WPA in Pierce County. The Beaver Lake colony was active in all years and is currently active in 2012. The J. Clark Salyer NWR colony abandoned after laying in 2010 due to a planned water level drawdown, and flooding of the Souris river raised water levels

above emergent vegetation which prevented nesting in 2011. Another planned drawdown in 2012 has prevented nesting on the refuge this year. High water levels in 2011 at Lake Alice likely prevented nesting, but this colony was active in all other years and is currently active. Nesting appears to have taken place at McHugh Slough for several years, including currently in 2012 however we did not visit nests in this colony to confirm breeding because the colony is located on privately owned lands. The Rush Lake colony was active in all years and is currently active in 2012. The Rush Lake WPA is less than 50 km from J. Clark Salyer NWR and may serve as an alternative site for birds unable to nest at J. Clark Salyer NWR when water levels preclude nesting on the refuge. We consider these colonies to constitute the majority of Franklin's gull breeding for North Dakota.

*Site and Temporal Variation in Nest Success:* Nest success varied by colony and year. Nest daily survival rate (DSR) varied from 0.957 (Rush Lake WPA, 2011) to 0.988 (Beaver Lake WPA, 2011) (Table 1). Evidence from nests monitored in 2009 and in previous years at J. Clark Salyer NWR indicates nest bowl height is positively related to nest success and nest density is negatively related to nest success (Berg 2009).

Table 1: Nest daily survival rate (DSR) ( $\pm$  SE) by colony and year. Approximate % nest success and sample size are shown in parentheses.

Year	Colony and DSR			
	Beaver Lake	J. Clark Salyer	Lake Alice	Rush Lake
2009		0.980 $\pm$ 003 (61%, n = 119)	0.962 $\pm$ 007 (38%, n = 42)	
2010	0.982 $\pm$ 004 (63%, n = 37)			0.977 $\pm$ 005 (57%, n = 67)
2011	0.995 $\pm$ 003 (89%, n = 21)			0.957 $\pm$ 013 (34%, n = 27)

*Seasonal Variation in Egg and Chick Characteristics:* Egg size declines with laying date in Franklin's gull. Eggs laid early in the season are significantly larger than eggs laid late (Figure 1 a), and egg size declines linearly within the nesting season (Figure 1 b). Finally, egg size declines not only within the season with laying date, but also declines with absolute Julian date when data from all years and sites are examined (Figure 1 c). For example, an egg laid on May 25 in a particular year (or at a particular site) is more likely to be smaller than eggs laid before May 25 in that particular year (or that particular site) but is more likely to be larger than eggs laid after May 25 in another year (or at another site) even if those eggs are laid before most of the eggs in the other year (or at the other site).

Other egg constituents appear to vary seasonally based on stable isotope data. We compared Nitrogen isotope signals from the yolks of freshly-laid eggs in the Rush Lake colony in 2011 with marine invertebrate samples collected from Chile (where Franklin's gull adults overwinter). Isotopic ratios for Nitrogen indicate that eggs laid early in the season have an enriched Nitrogen ratio similar to the ratio seen in the marine invertebrate *Emerita analoga* (Figure 2), a common prey item of wintering Franklin's gull

(Burger and Gochfield 2009), but not in eggs laid later in the season. This suggests some proteins are enriched with Nitrogen derived from marine resources in early-laid eggs, but not in eggs laid later in the season.

In addition to egg size, chick growth also varies seasonally. In a study of chicks hatched from artificially-incubated eggs obtained from Rush Lake in 2010 and fed *ad libitum*, we found that chicks produced from eggs laid early in the season grew similarly to chicks produced from eggs laid late in the season (Figure 3 a). However, eggs laid early produced chicks that grew faster and reached a larger peak mass than chicks produced from eggs laid late in the season (Figure 3 b). Moreover, allometric relationships among mass, tarsus and wing length of chicks in the study were similar to observations for free-living chicks in the Beaver Lake, Rush Lake and Lake Alice colonies in 2010. Based on the allometric comparisons, we consider the growth observed in the laboratory to be comparable to characteristics of growth in free-living birds.

In a separate laboratory study we also found seasonal effects and photoperiod effects on embryonic development. Eggs laid early and late in the season that were artificially incubated under alternative photoperiod regimes (14:10 light:dark cycle simulating an early season photoperiod and 18:6 light:dark cycle simulating a late season photoperiod) produce chicks with differential tarsus lengths (Figure 4 a) and residual yolk sac masses (Figure 4 b) at hatching (Clark and Reed 2012).

*Chick Survival and Growth:* We estimated chick survival and growth at the Rush Lake colony in 2010 using mark-recapture methods. We individually-marked chicks at hatching, measured tarsus length and monitored and recaptured chicks every other day until chicks were older than eight days. We estimated chick survival rates using individual recaptures following Lebreton et al. (1992) using Program MARK (White and Burnham 1999). We compared models of chick survival using information theoretic methods (Burnham and Anderson 2002). The most parsimonious model for chick survival assumed chick survival varied as a function of the initial instantaneous growth rate of the chick (Figure 5). In this model, chick survival to age eight days is approximately 25% for individuals with tarsus growth rates greater than about 0.02 mm/mm/d. Instantaneous growth rates of the tarsus exceeded 0.02 mm/mm/d for 60% of the 1-2 day-old chicks in the lab study in which chicks were fed *ad libitum*. Assuming chicks fed *ad libitum* were growing at maximal rates, this indicates that only chicks achieving maximal growth rates are likely to survive one week post hatching in the Rush Lake colony.

*Seasonal Variation in Adult Condition:* In 2010 we captured nesting adults in the first week of incubation to compare variation in adult condition across the nesting period at the Rush Lake colony. We collected serial blood samples to determine stress response based on plasma corticosterone concentrations (Wingfield et al. 1982), and measured mass, tarsus length and keel depth of captured birds to assess body condition (Schulte-Hostedde et al. 2005, Schmidt-Wellenburg et al. 2008). Peak corticosterone concentrations were significantly higher in individuals that initiated nests later in the season (Figure 6), indicating later nesting birds are more physiologically sensitive to stress (Wingfield et al. 1982). In addition, later nesting birds exhibit significantly lower

residual body mass (i.e., mass corrected for skeletal size) (Figure 7 a) and greater keel bone exposure (Figure 7 b), indicating later nesting birds have reduced body condition compared to birds nesting earlier in the season. Preliminary evidence also suggests immune function is reduced in later nesting adults (Weissenfluh 2012).

*Variation in Adult Arrival Dates:* We analyzed data on first arrival dates of Franklin's gull maintained at J. Clark Salyer NWR from 1934 to 2007. Observed first arrival dates have declined significantly since the refuge was established in the 1930s (Figure 8).

## **Synopsis**

Franklin's gull colonies in North Dakota exhibit temporal and spatial variation in reproductive success. Colony site fidelity appears robust from 2006-2012, but colony abandonment can result from variation in water levels. Currently several colonies are broadly distributed across the northern portion of the state, which may buffer localized effects of water level variation. Recharge of large wetlands following drought conditions in the late 1980s have provided suitable nesting habitat for several colonies. Managed water levels at J. Clark Salyer NWR likely provide refugia for nesting birds during low water periods.

In addition to spatial and annual variation in production, Franklin's gull exhibits considerable within season variation in reproductive output. Generally, characteristics of eggs, offspring and adults decline across the nesting period. Nesting is highly synchronous in Franklin's gull, with nest initiation typically occurring over a 3-4 week period (Burger and Gochfield 2009). Hence, factors that delay nesting even by 1-2 weeks are accompanied by significant declines in egg, chick or adult quality. Moreover, embryonic development is affected by photoperiod, so changes in quality associated with delays in nesting may be compounded by affects on embryonic development due to lengthening photoperiods that occur with the delays.

Chick survival is also related to early growth, and therefore potentially related to the timing of nesting. Moreover, mark-recapture analysis linked with lab studies of growth indicates only chicks achieving maximum growth rates are likely to survive. In order to understand the relationship to recruitment and population stability, information on adult survival is needed.

Many migratory birds are exhibiting earlier arrival dates at breeding areas compared to historical dates, and so are Franklin's gulls nesting in North Dakota. It is hypothesized that the shifts in arrival dates in migratory birds is driven by climatic changes, but the effects of the shifts on population viability are not known (Visser 2008). Our findings are among the first to indicate that shifts in arrival will affect embryonic development if the timing of nesting is related to arrival date. It is not known if the timing of nesting is related to arrival date in Franklin's gull, and this is a critical question for managers to evaluate effects of climate change on population persistence and develop management plans for maintaining viable colonies in the northern Great Plains.

## **Tasks Completed**

- Comprehensive list of active colonies in North Dakota

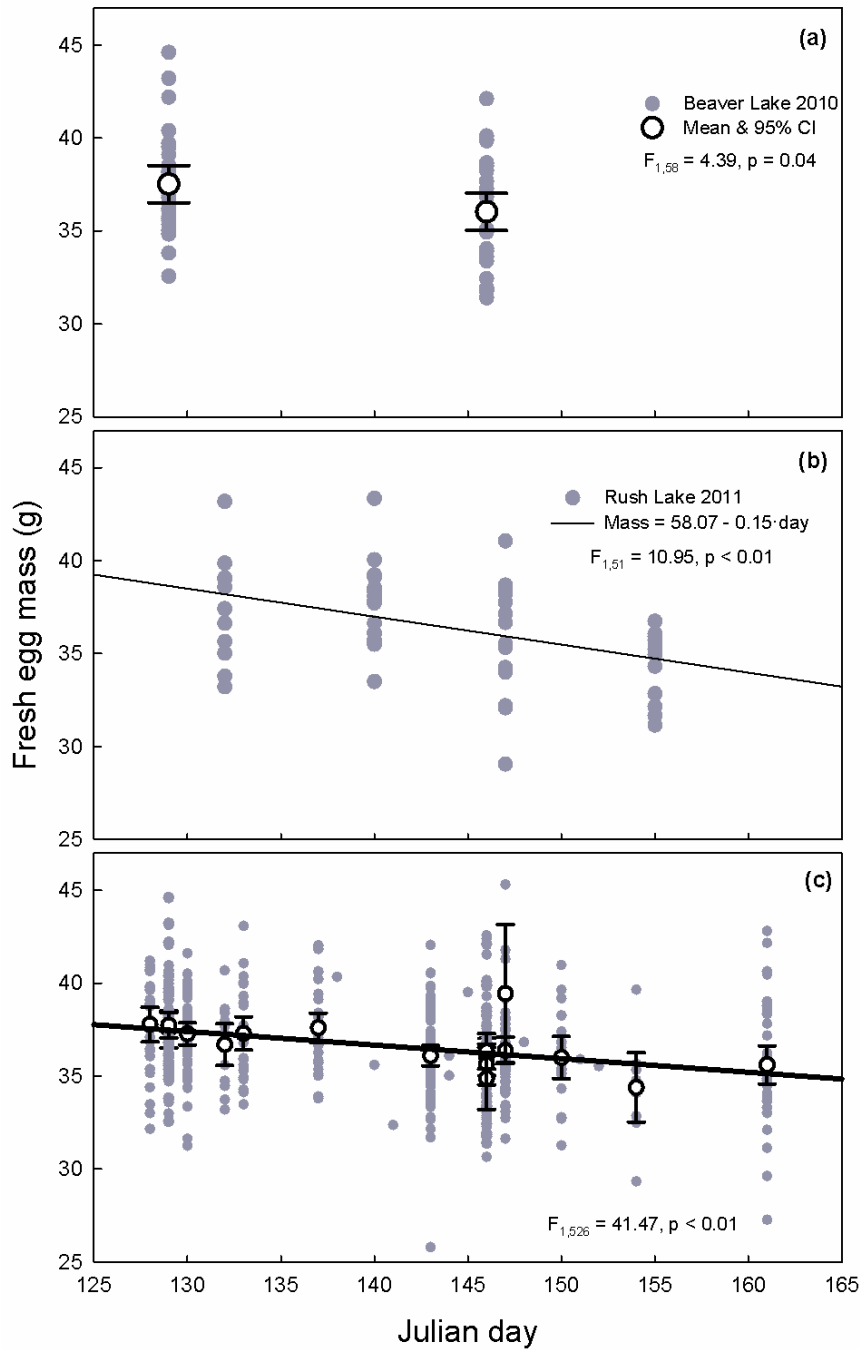
- Nest survival estimates for four (Beaver Lake, J. Clark Salyer, Lake Alice and Rush Lake colonies) of the five North Dakota colonies
- Evidence of seasonal declines in egg size and hatchling characteristics
- Evidence of Nitrogen enrichment consistent with marine Nitrogen sources in eggs laid early in the season
- Estimated chick survival to approximately one week is 25%, but only for chicks achieving maximum growth rates
- Evidence of seasonal differences in chick growth
- Evidence of photoperiod effects on embryonic development
- Evidence of seasonal declines in adult condition
- Evidence of shifts in arrival dates of Franklin's gull

### **Tasks in Progress**

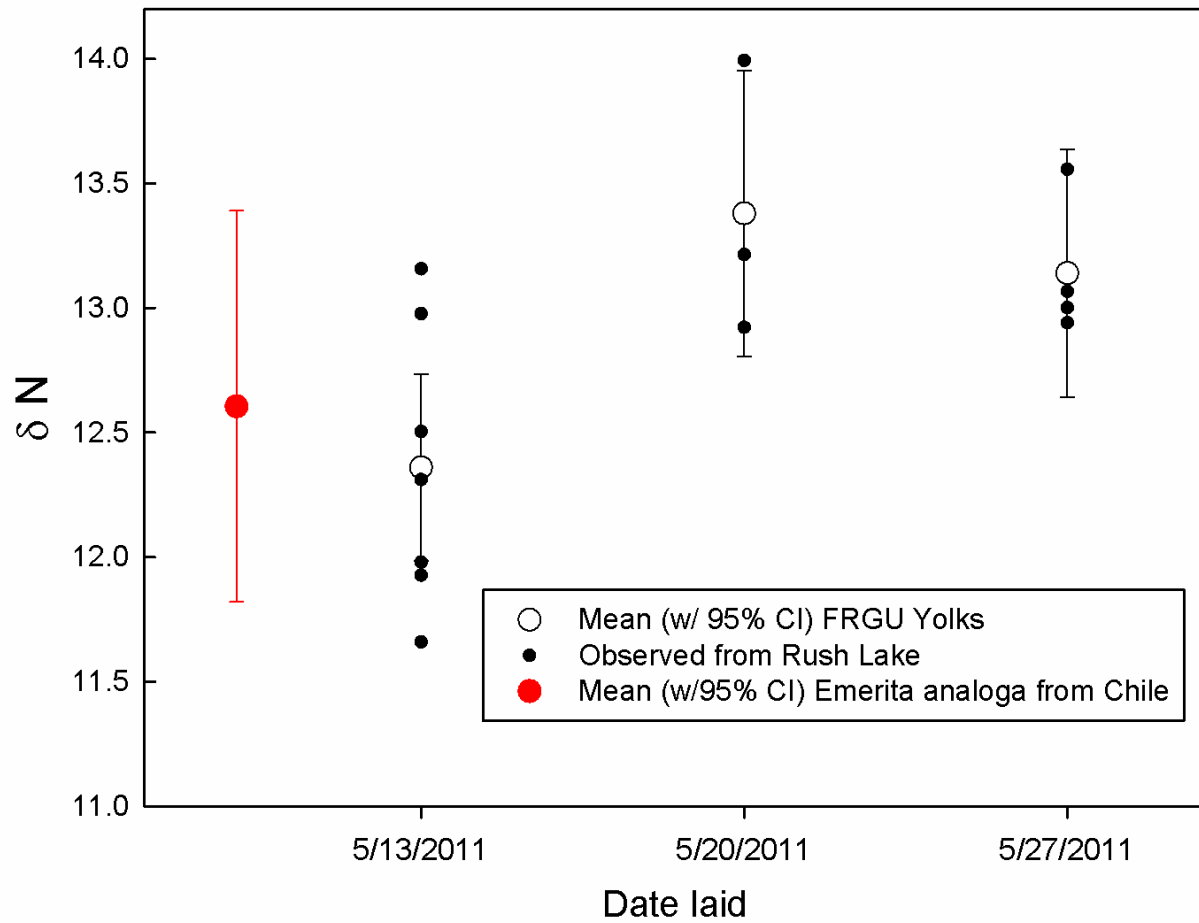
- Analysis of yolk carotenoid and hormone constituents in eggs
- Complete & submit manuscript on laboratory study of chick growth
- Complete & submit manuscript on seasonal variation in condition of nesting adults

### **Other Activities Associated with this Project**

- Shawn Weissenfluh (graduate student at NDSU) graduated and thesis completed
- Seven undergraduate field and lab assistants have been trained through this project
- Presentation of results at several scientific meetings (e.g., North Dakota Chapter of The Wildlife Society Annual Meeting, Society of Integrative & Comparative Biology Annual Meeting, Association of Field Ornithologists Annual Meeting)
- Publication of two peer-reviewed scientific papers (Reed and Clark 2011, Clark and Reed 2012)

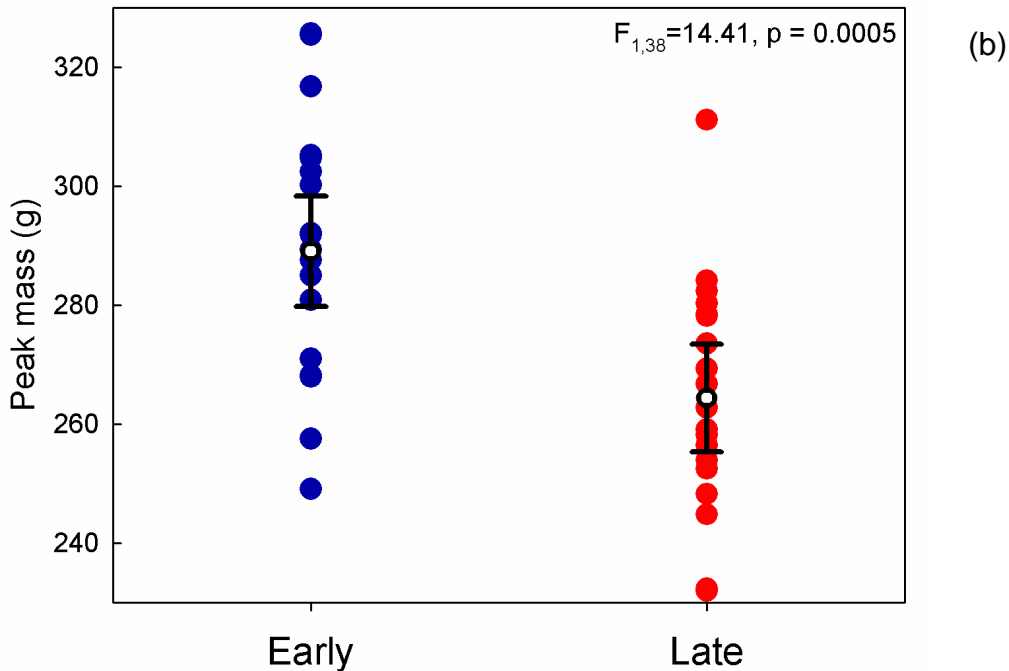
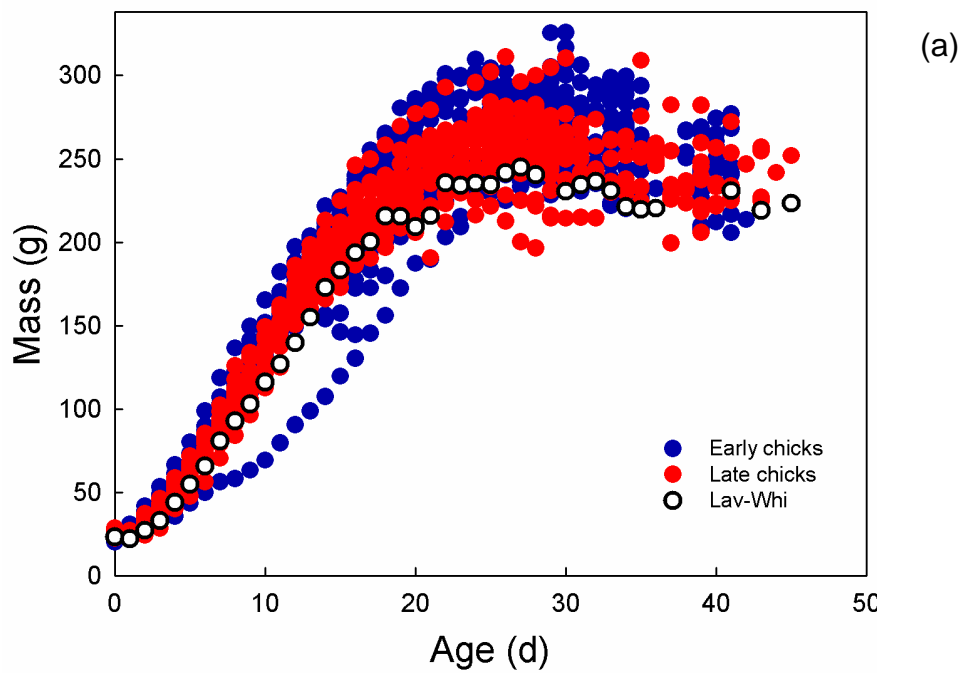


**Figure 1:** Seasonal variation in egg size in Franklin's gull colonies located in North Dakota from 2006-2011. (a) Eggs laid early in a nesting season are larger than eggs laid later, and (b) egg size declines with laying date within a colony. (c) Egg size also declines with absolute laying date when observations from all sites and years are combined (gray circles show data from Beaver Lake 2009, J. Clark Salyer 2006-2009, Lake Alice 2009-2010 and Rush Lake 2010, with mean and SE by Julian date shown as open circles with bars).

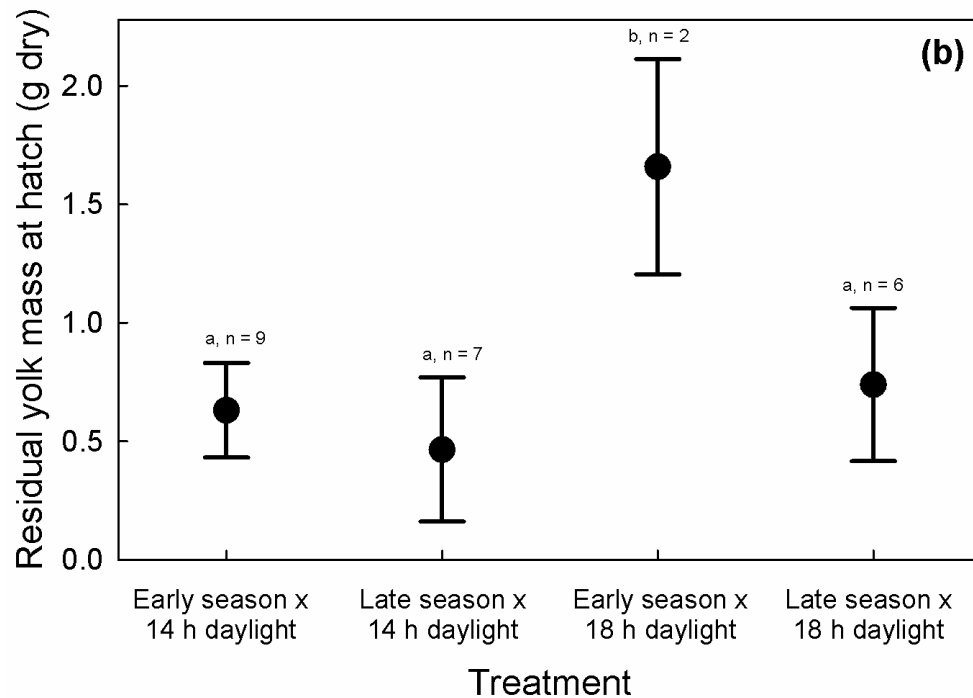
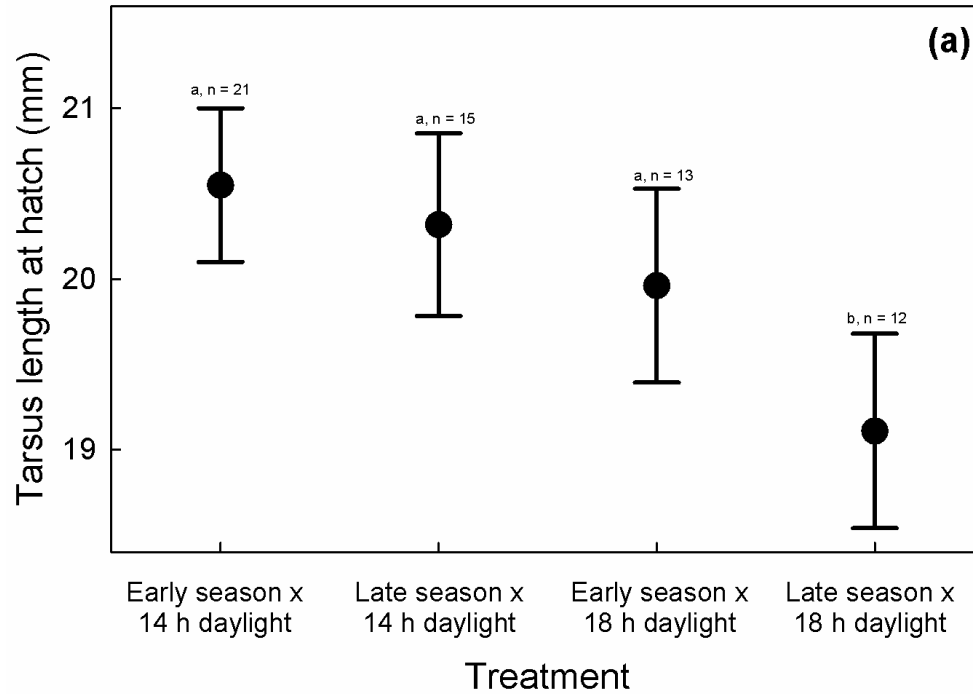


**Figure 2:** Nitrogen isotope ratios from yolks of eggs (white circles with bars) laid early in the season overlap with ratios from marine invertebrates (red circle and bars) collected along the coast in Chile, but ratios from yolks of eggs laid later in the season show less overlap.



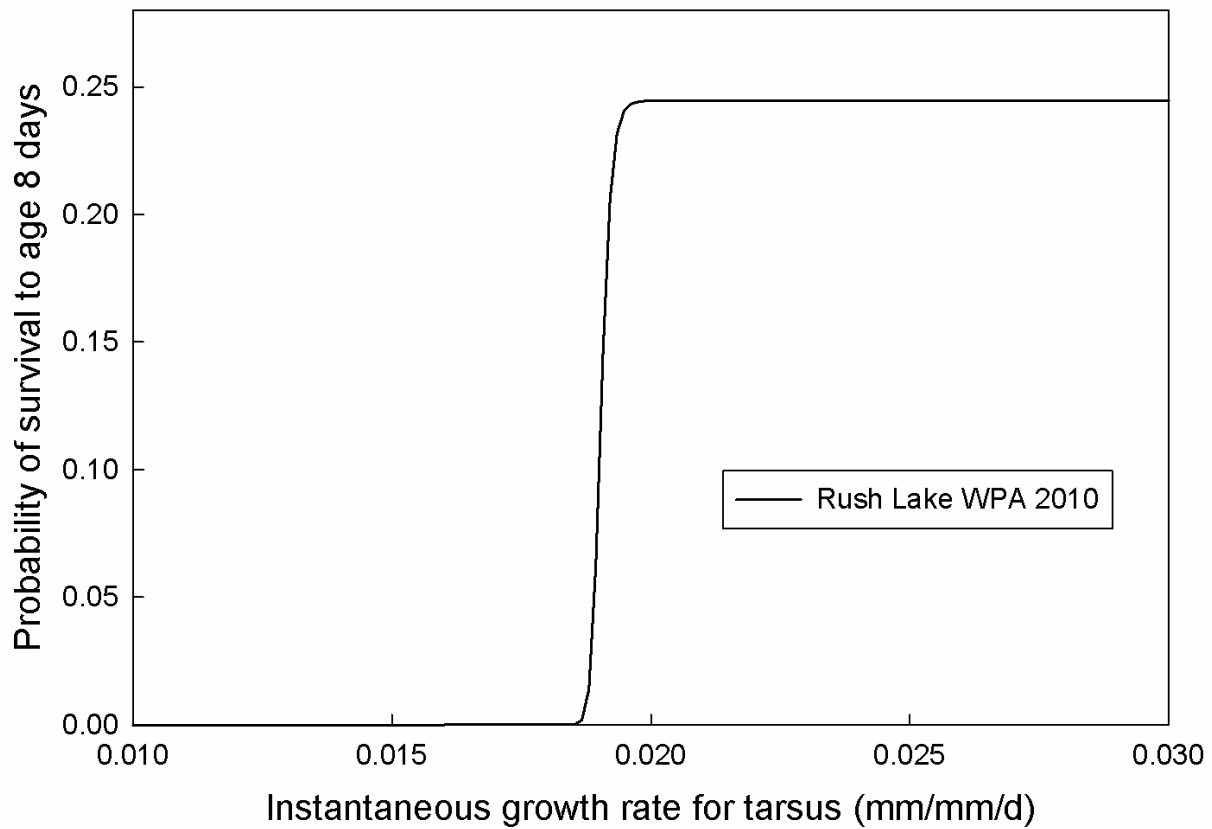


**Figure 3:** (a) Chicks hatched from eggs laid early in the season (blue circles) grew to similar asymptotic mass as chicks hatched from eggs laid late in the season (red circles) in a laboratory study of growth. (b) However, early chicks achieved a larger peak mass than late chicks (and also grew at a significantly faster rate).

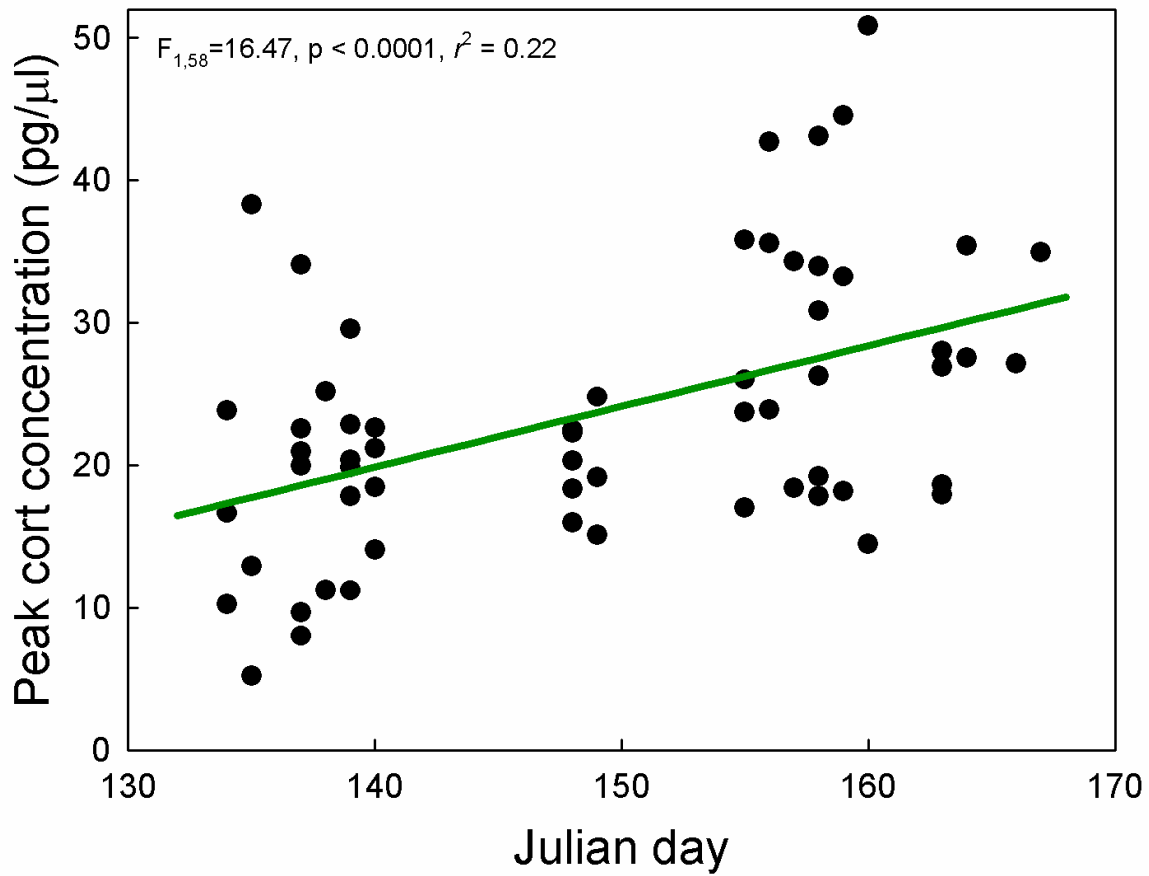


**Figure 4:** Least square means with standard errors for (a) tarsus length and (b) residual yolk sac mass at hatching from an experiment on artificially incubated eggs collected from North Dakota colonies. Both tarsus length and residual yolk sac mass at hatching are significantly affected by season (i.e., laying date) and photoperiod. Letters above error bars indicate different means and numbers indicate sample size of the respective treatment group.

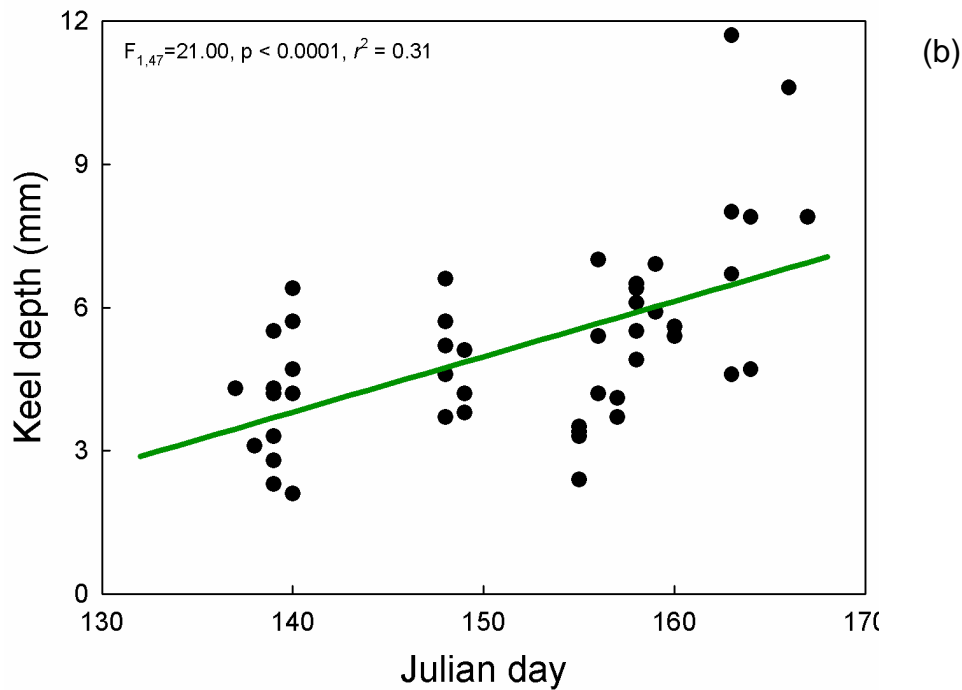
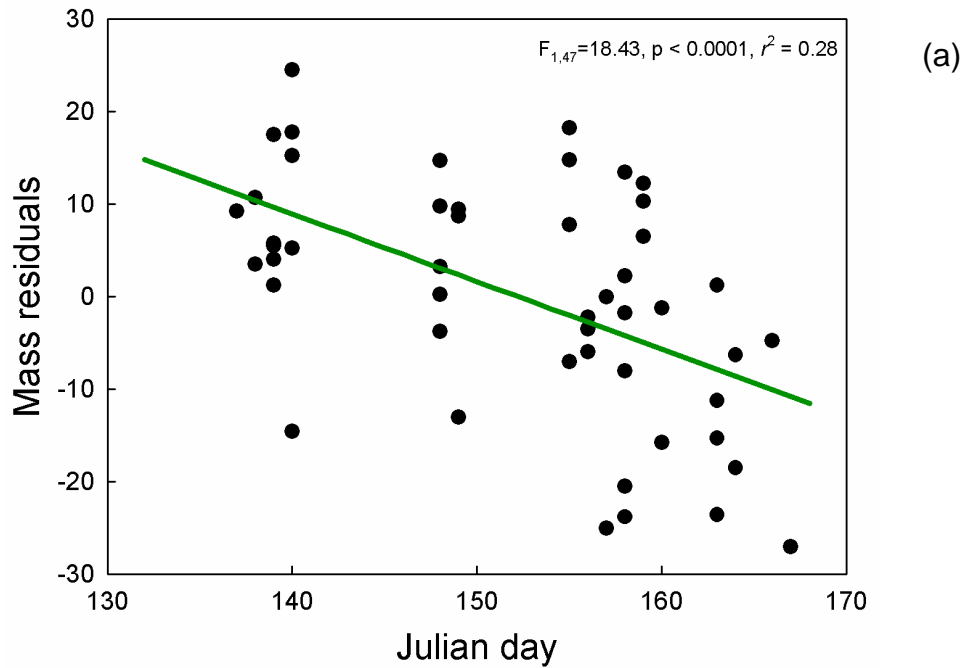




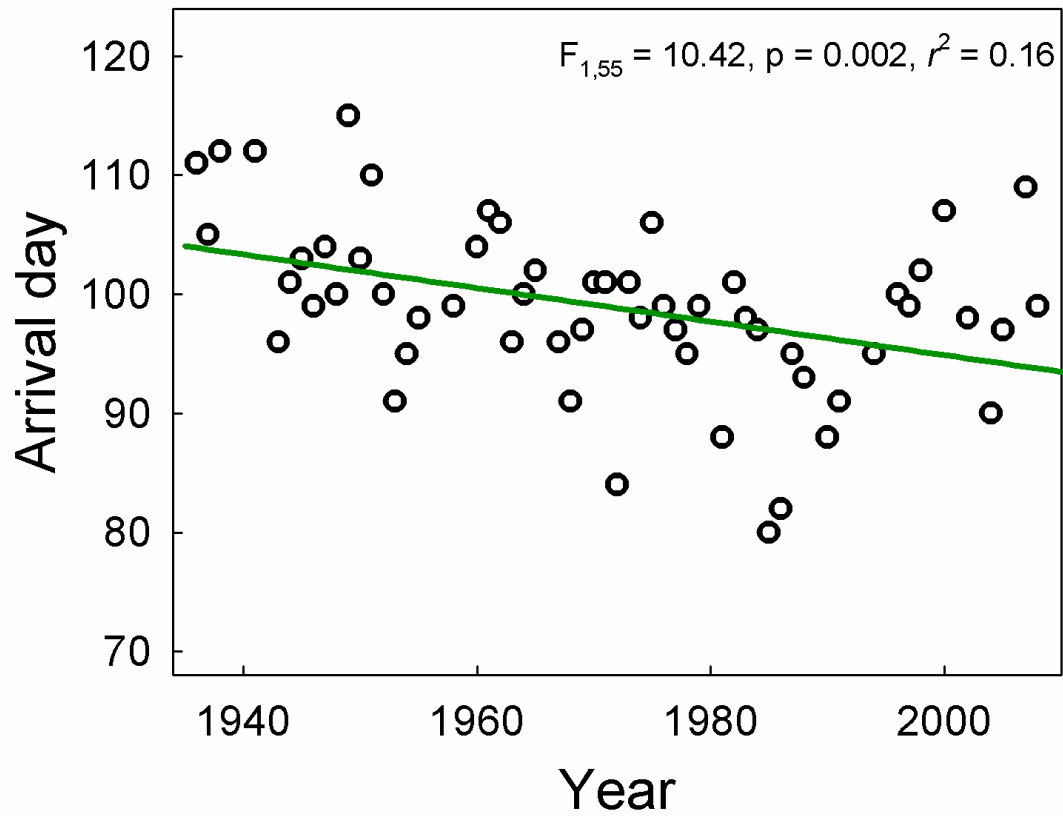
**Figure 5:** Chick survival to eight days increased with growth rate of the tarsus in the most parsimonious model for mark-recapture data of Franklin’s gull chicks at Rush Lake WPA in 2010. This model indicates that chick survival to age eight is approximately 25% if the instantaneous growth rate in the tarsus is 0.020 mm/mm/d or greater, but chicks with slower tarsal growth have less than 0.05% chance of surviving to age eight days.



**Figure 6:** Observed increase in peak plasma corticosterone concentration for adult Franklin's gull captured in the first week of incubation at different dates across the season at Rush Lake WPA. Measured concentrations are indicated by filled circles, and the regression line fitted to the data is indicated by the green line.



**Figure 7:** (a) Residual body mass declines, and (b) keel bone exposure increases for later nesting adult Franklin's gulls. Lower residual body mass indicates body mass is less than expected based on skeletal size (measured by tarsus length). Greater keel bone exposure indicates less pectoral (i.e., flight) muscle mass. Observed values indicated by filled circles and regression lines are shown in green.



**Figure 8:** First arrival dates of Franklin’s gull at J. Clark Salyer NWR in Upham, North Dakota indicate birds are arriving significantly earlier in the spring at the refuge. Observed dates are indicated by open circles, and the regression line fitted to the data is indicated by the green line.

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## Attachments

1. Clark, M. E. and W. L. Reed. 2012. Seasonal interactions between photoperiod and maternal effects determine offspring phenotype in Franklin's gull (*Leucophaeus pipixcan*). *Functional Ecology* 26:948-958.
2. Weissenfluh, S. E. 2012. Quantifying seasonal variation in physiological condition of adult Franklin's gull (*Leucophaeus pipixcan*) during nesting. North Dakota State University, Fargo, ND.