

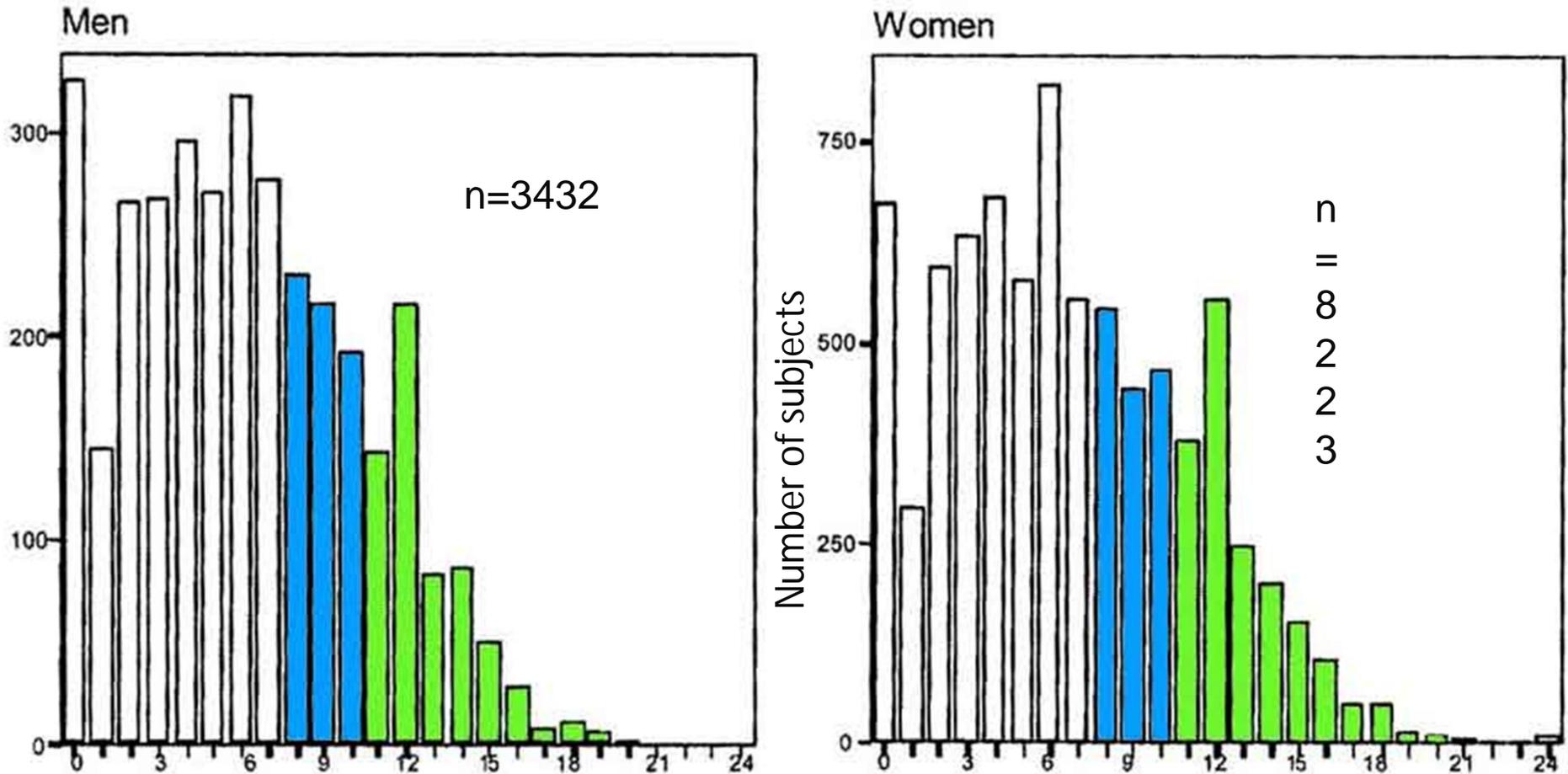
Seasonal Sleep Patterns in Migratory Birds: A model for bipolar disorder

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- Seasonal patterns in sleep, mood and other behaviors in normal humans
- Seasonality in patients with mood disorders
- Animal model for seasonal changes in behavior: Migratory sparrow

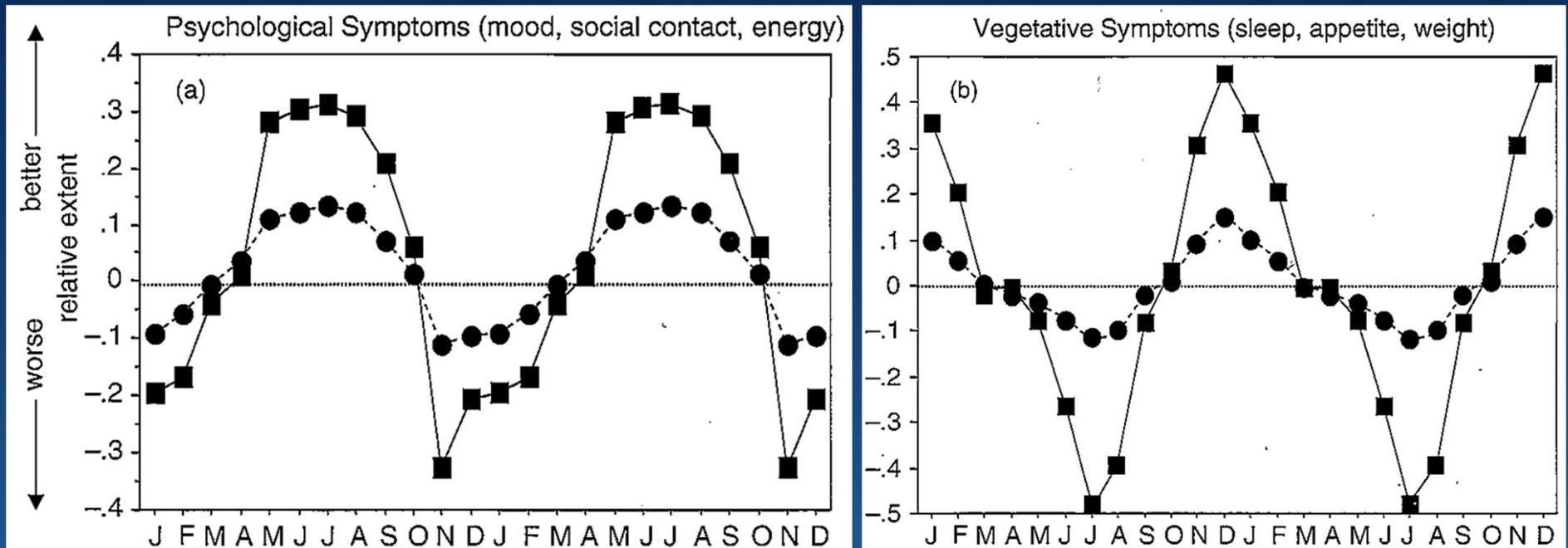
Seasonality in the general population: Global Seasonality Score (GSS) frequency distribution in Norway



GSS score < 8 (low)
 GSS score 8-10 (moderate)
 GSS score > 11 (high)

Oyane et al. *Eur J Epidemiol* 2005; 105: 147-155.

Seasonal symptoms in a Swiss population



—■— 'Seasonals', N = 109

--●-- 'Non-seasonals', N = 871

Wirz-Justice et al. *Acta Psychiatr Scand.* 2003, 108(Suppl 418): 92-95.

Seasonal Affective Disorder

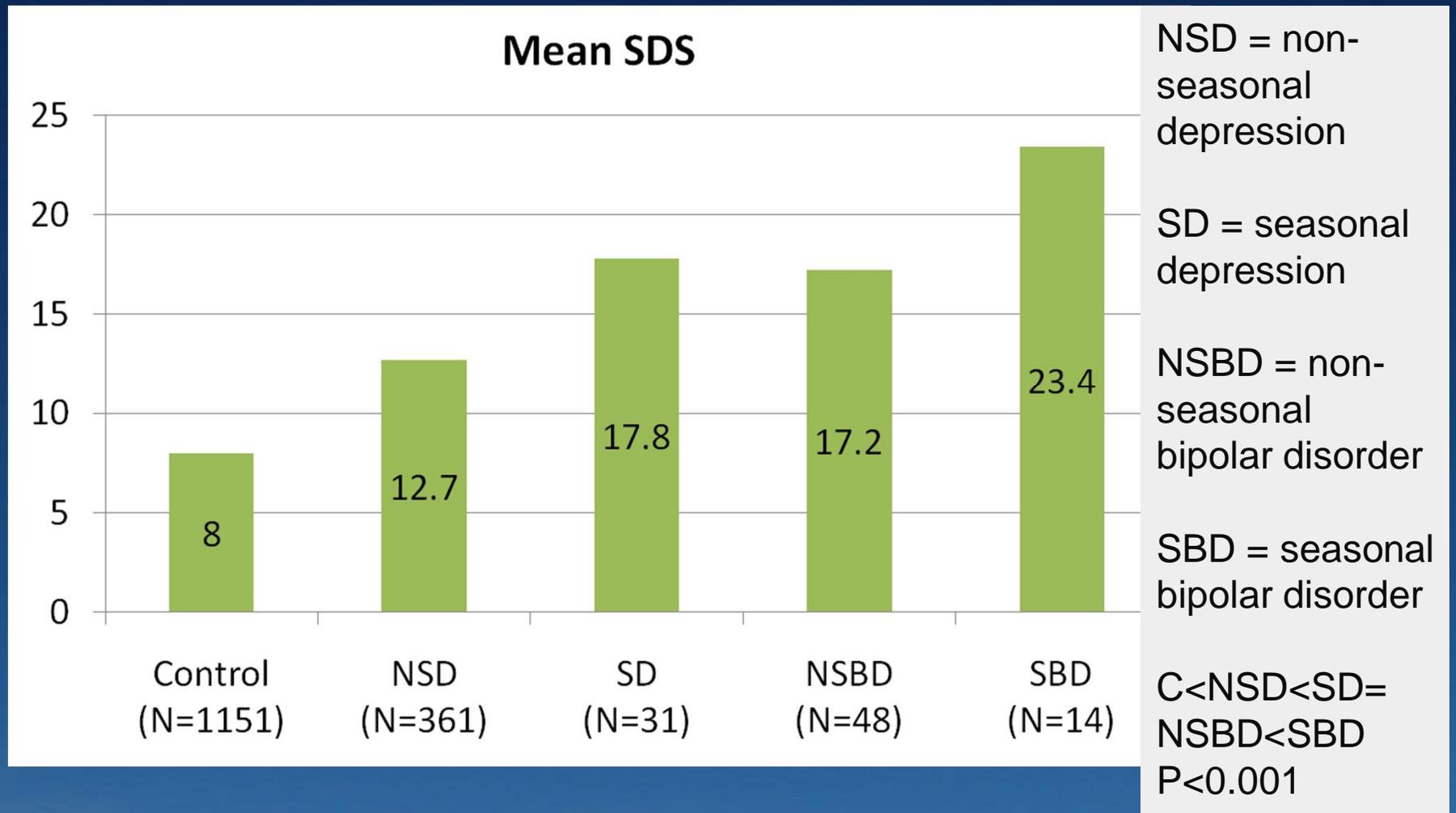
- Refers to Major Depressive Episodes recurring in the fall/winter, with remission in spring/summer
- Applies to Major Depressive Disorder and Bipolar Disorder
- Symptoms atypical (increased sleep and appetite)
- Light-responsive
- Prevalence about 0.8-2.8% in North America
- Subsyndromal SAD may affect up to 25% of population

Seasonality in bipolar disorder

- Bipolar patients show greater seasonal changes in sleep length and mood in comparison to unaffected twins^{1,2}
- Bipolar patients experience greater seasonality than those with depression or healthy controls³

1. Hakkarainen et al. *BMC Psychiatry*. 2003; 3(1): 6.
2. Wehr et al. *Arch Gen Psychiatry*. 2001; 58: 1115-6.
3. Shin et al. *J Affect Disord*. 2005; 86(1): 19-25.

Seasonality of depression symptoms greatest in bipolar subjects



Shin et al. *J Affective Disorders*. 2005; 86:19-25.

Sleep and bipolar disorder

- Unique association between sleep and bipolar illness
- During depressed phase, sleep indistinguishable from MDD
 - short REML
 - decreased SWS
 - decreased sleep continuity
 - sleep amounts may be increased (EDS) in some cases
- During manic phase,
 - Sleep continuity more disrupted than in depressed phase
 - REM sleep abnormalities same as in MDD

Hudson JI et al. *Arch Gen Psychiatry*. 1988 ;45: 267-273. Hudson JI et al. *Arch Gen Psychiatry*. 1992; 49: 378-383.
Riemann et al. *Neuropsychobiology*. 2002; 45(suppl 1): 7-12. Benca RM et al. *Arch Gen Psychiatry*. 1992; 49: 651-668

Seasonality in migratory sparrows



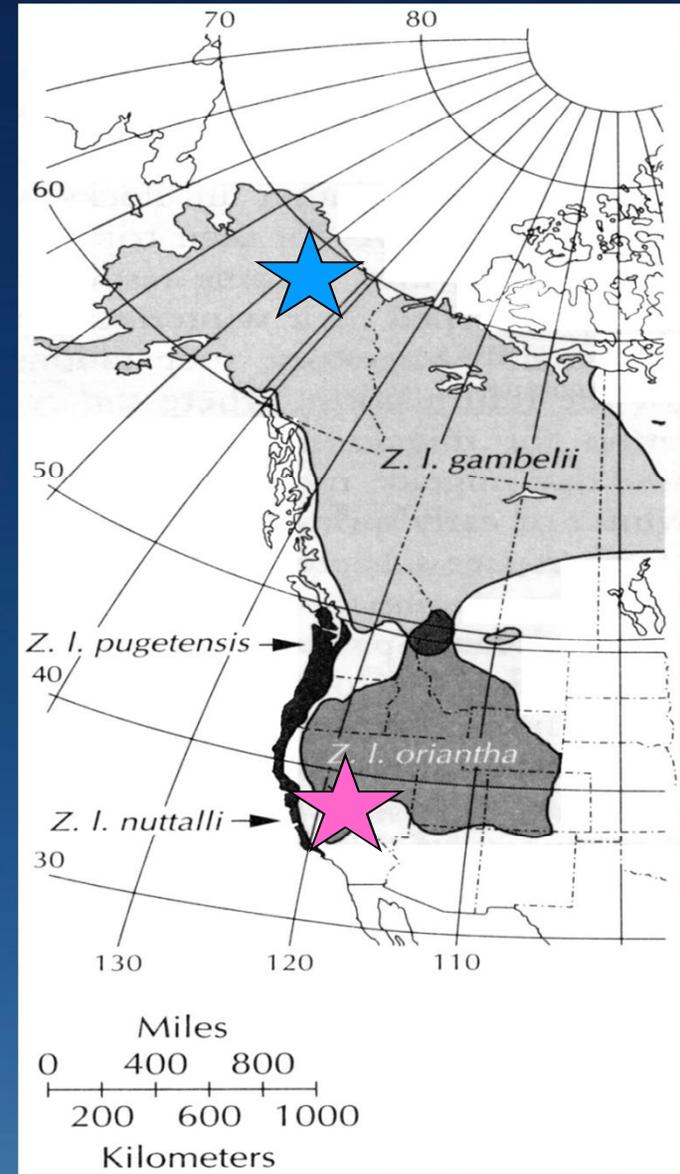


Migration pattern

White-crowned Sparrows *Zonotrichia leucophrys gambelii* show profound seasonal changes in behavior, including sleep

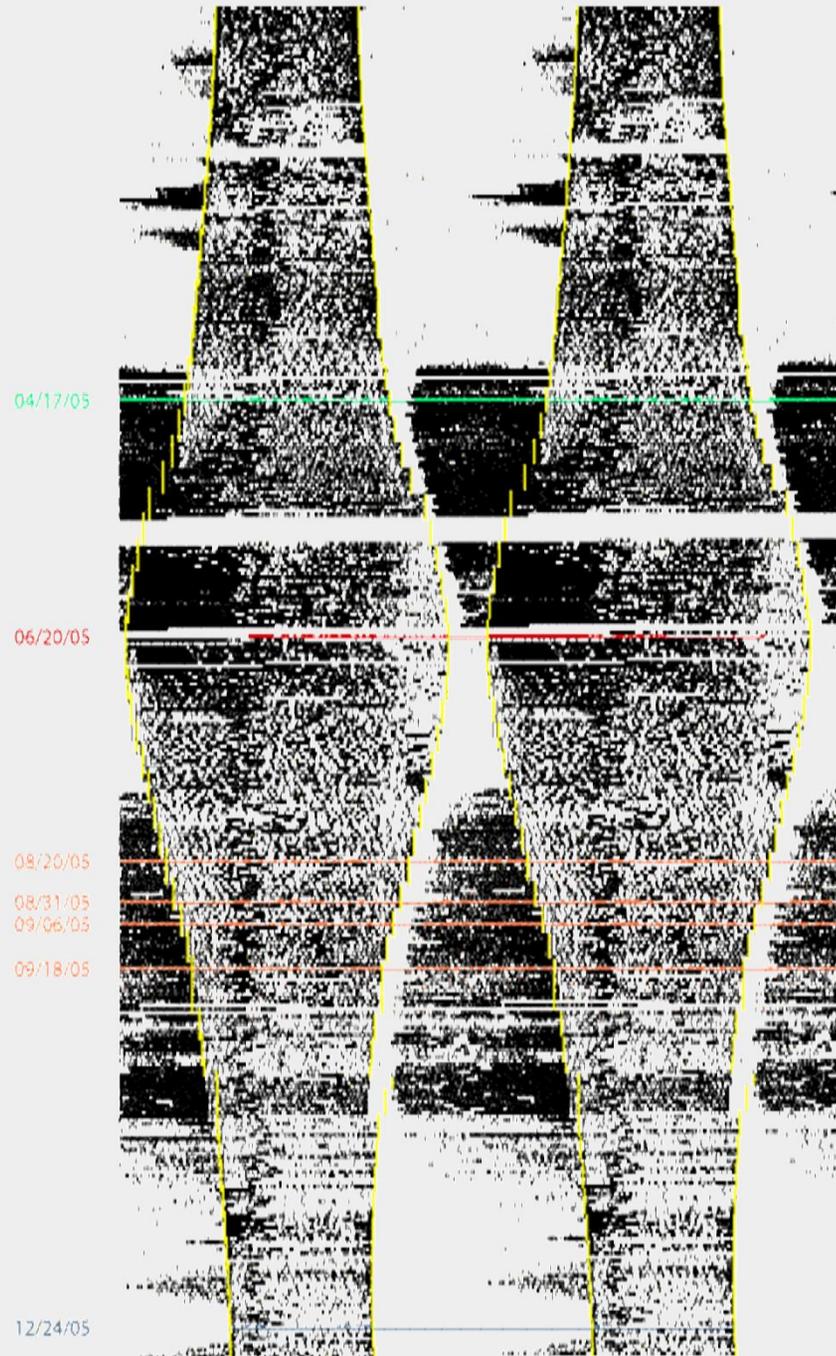
- Summer

- Winter

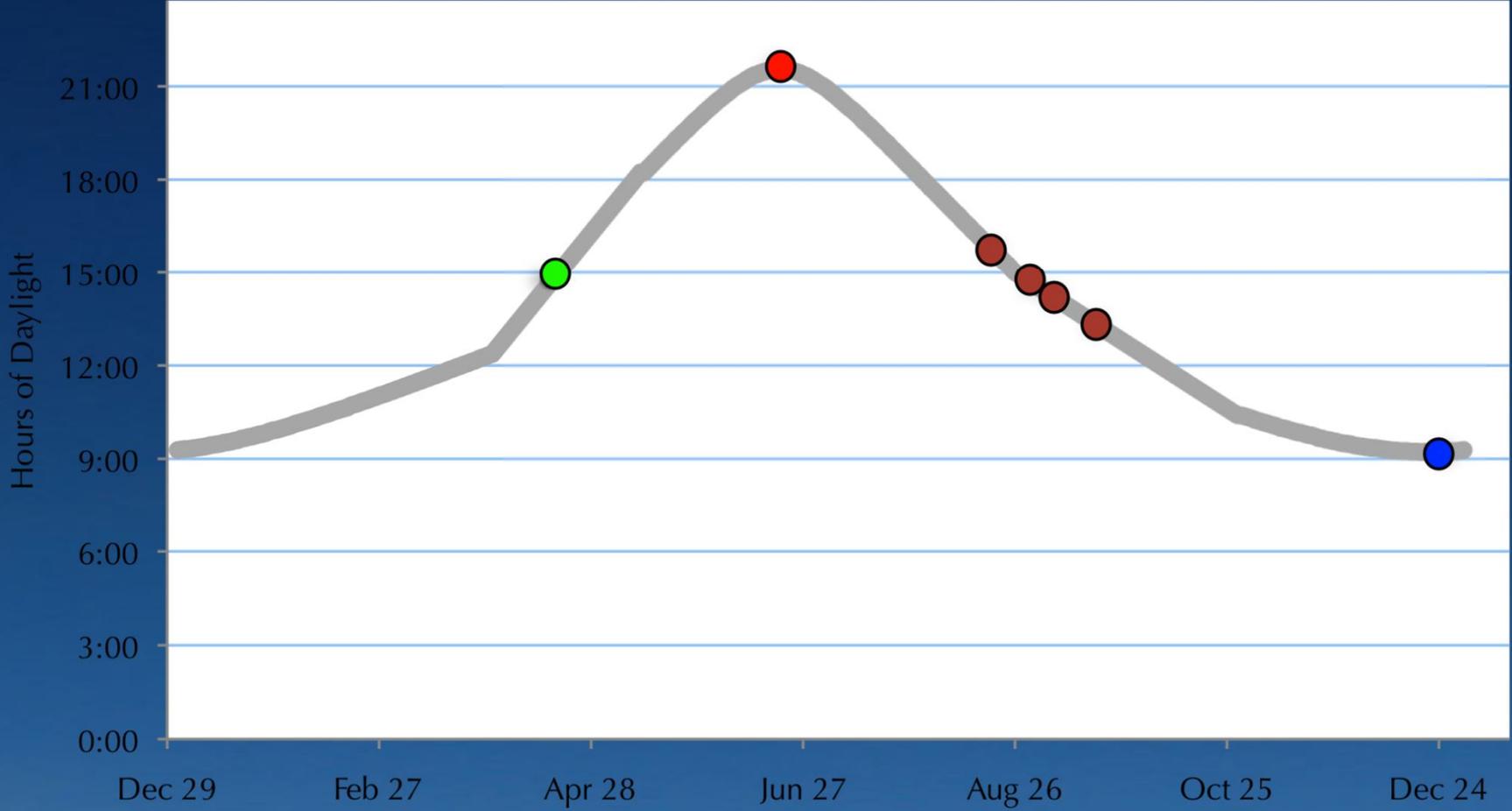




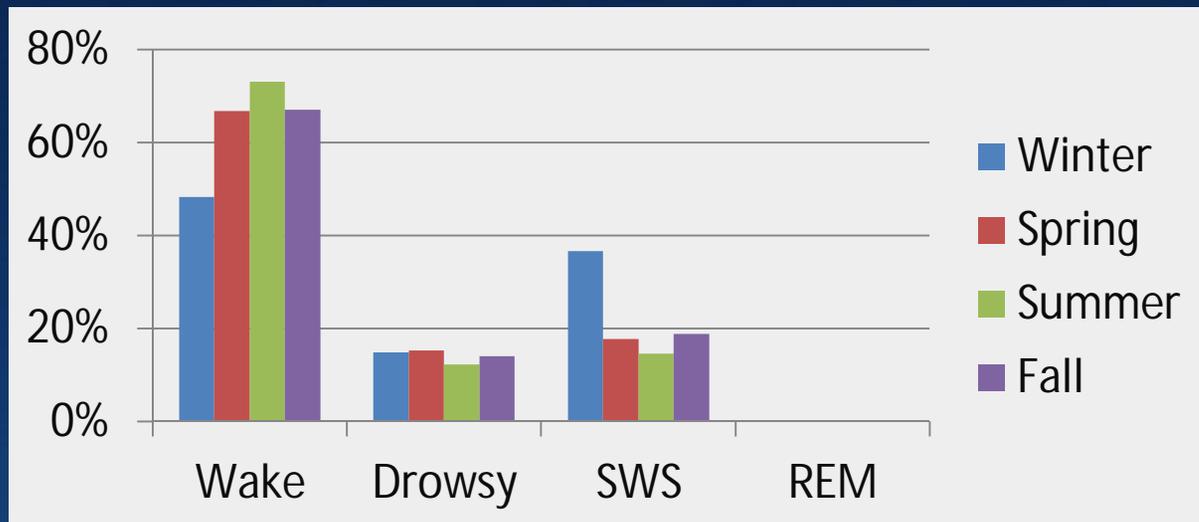
Migratory Restlessness under a seasonally changing photoperiod



Seasonal pattern: Hours of daylight

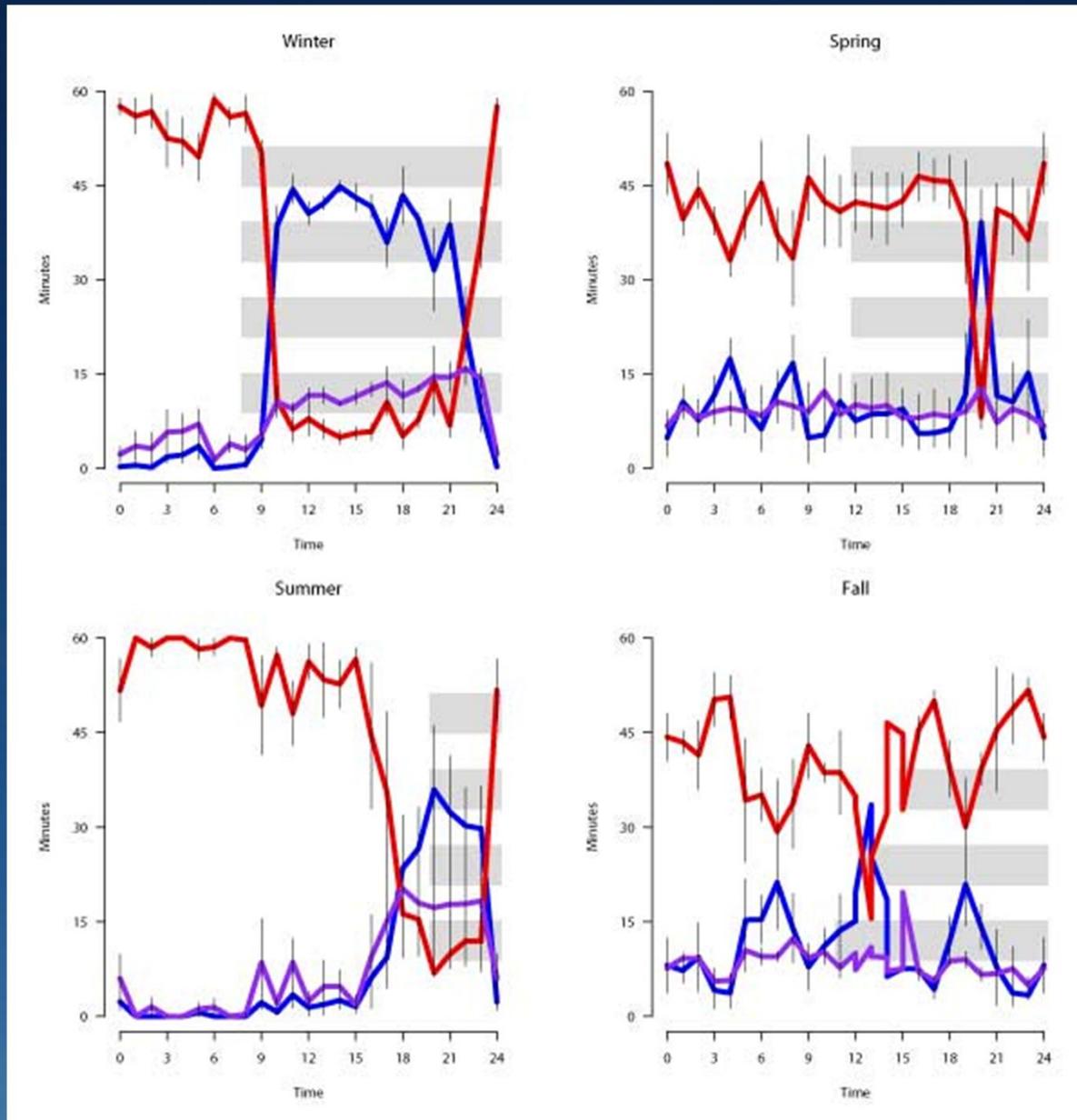


Vigilance states by season



Season	Wake	Drowsy	SWS	REM
Winter	48.3% ±2.2%	14.9% ±0.6%	36.6% ±2.2%	0.168% ±0.020%
Spring	66.8% ±4.5%	15.3% ±5.6%	17.8% ±3.3%	0.108% ±0.029%
Summer	73.1% ±4.4%	12.3% ±6.0%	14.6% ±2.3%	0.068% ±0.035%
Fall	67.1% ±5.6%	14.0% ±0.5%	18.8% ±5.1%	0.147% ±0.047%

Seasonal patterns of sleep and wakefulness



- Sleep
- Waking
- Drowsy

Light-dark cycle length regulates sleep amount in non-migratory periods

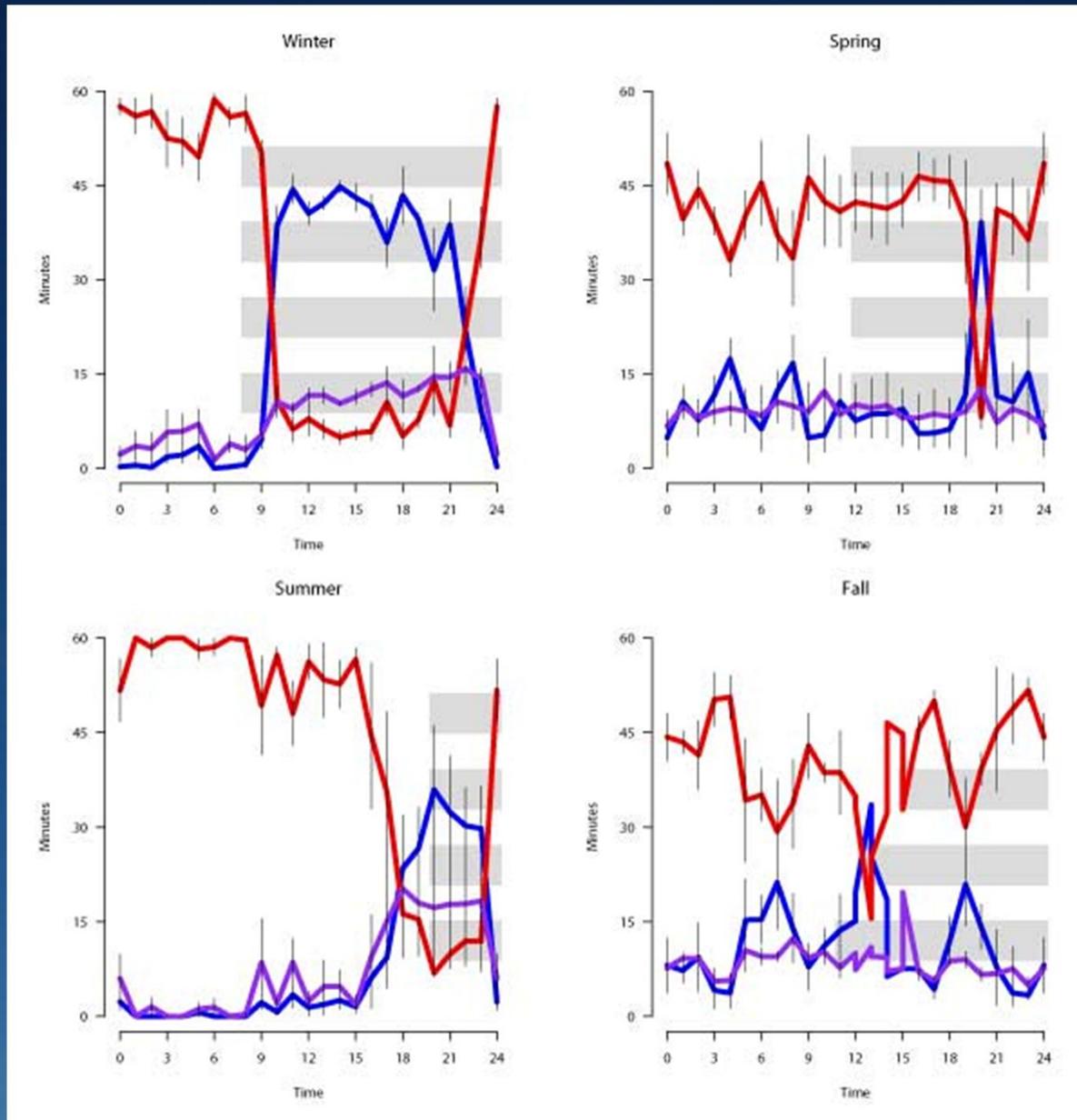
Summer sleep (% time) under different LD conditions

	12:12 LD*	21.5:2.5 LD
Wakefulness	48.2 ± 3.6 %	73.1 ± 4.4 %
Drowsy	17.9 ± 2.2 %	12.3 ± 6.0 %
Total Sleep	33.8 ± 3.7 %	14.6 ± 2.3 %

Winter sleep in 9:16 LD is about 37%

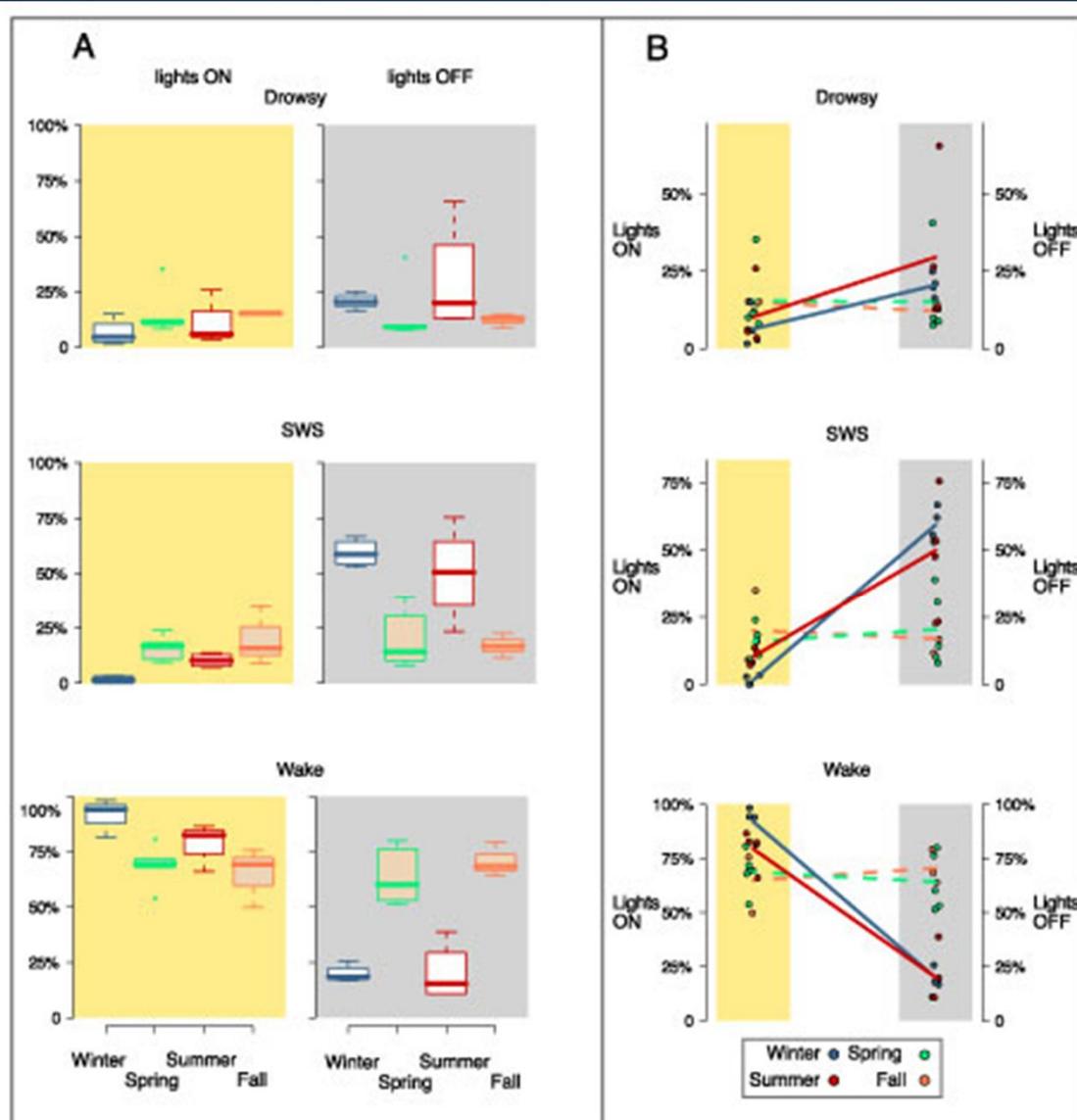
*Rattenborg et al. *PLoS Biology*. 2004;2:924-936.

Seasonal patterns of sleep and wakefulness



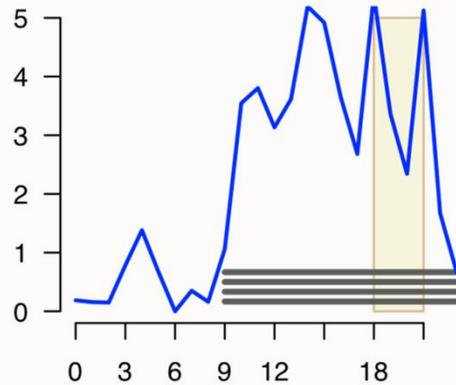
- Sleep
- Waking
- Drowsy

Vigilance states in light and dark periods across seasons

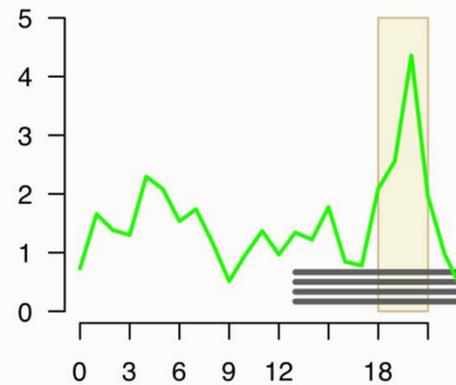


Average sleep bout length by season

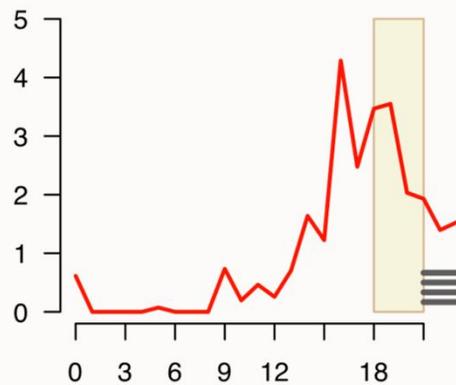
Winter Sleep Bout Length



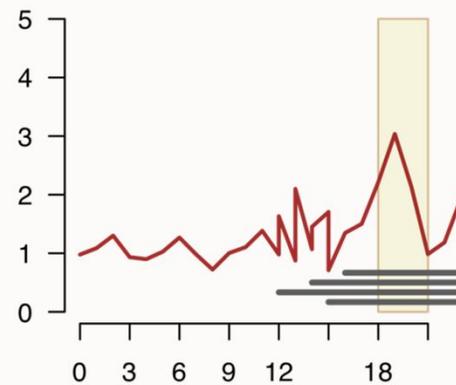
Spring Sleep Bout Length



Summer Sleep Bout Length

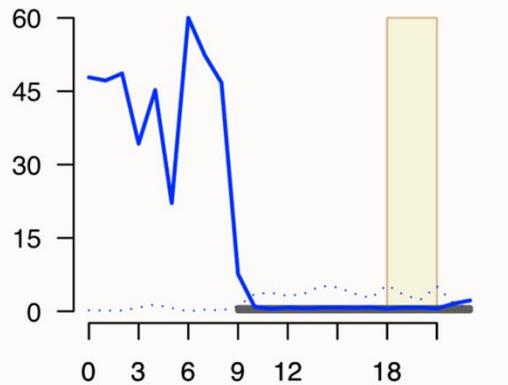


Fall Sleep Bout Length

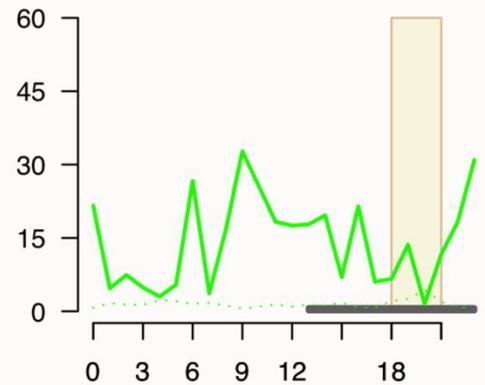


Average Waking Bout Length by Season

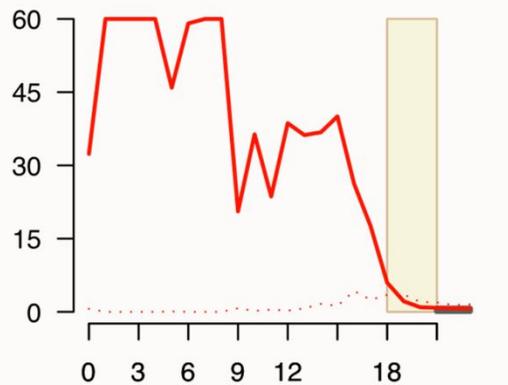
Winter Waking Bout Length



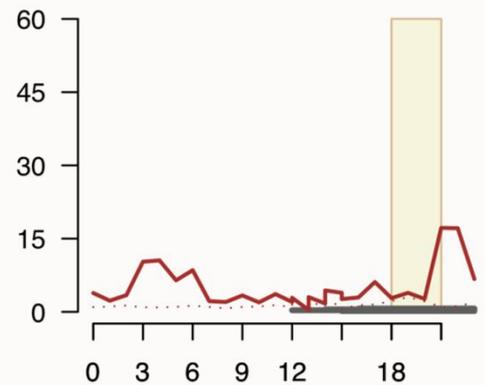
Spring Waking Bout Length



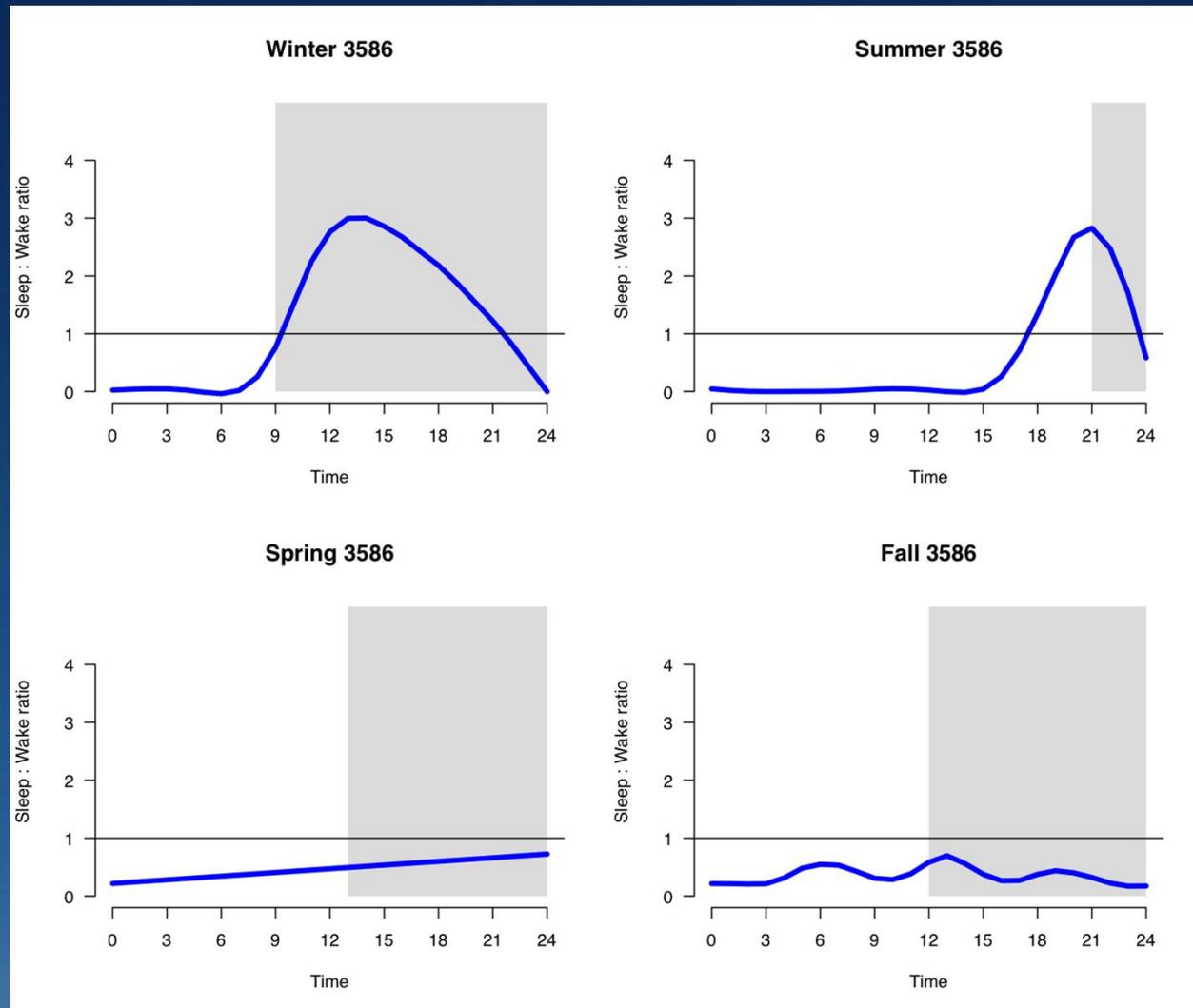
Summer Waking Bout Length



Fall Waking Bout Length



Sleep to waking bout length ratio: Lack of identifiable sleep period during migratory seasons



Seasonal sleep patterns in migratory sparrows

- Sleep amounts increase by over 2-fold in winter compared to other seasons; differences related to LD cycle, migratory status
- Diurnal pattern of sleep seen in summer and winter, disappears during spring/fall migration
- Sleep maintenance decreased during spring and fall migratory periods, with increased daytime fatigue/sleepiness

Questions:

- Do seasonal factors play a role in nocturnal sleep organization?
- Is nocturnal sleep fragmentation associated with qualitative changes in daytime wakefulness?
- Is the temporal pattern of arousals across the night related to daytime sequelae?