LAB 6 Supplement:
Akaike's Information Criterion (AIC)

1. Akaike's Information Criterion (AIC)

- Metric used for model selection
  - Gives best model (of those examined) based on a trade-off between fit and number of parameters
  - Based on distances (Kullback-Leibler information) from some "true" model that we don't know
- **Lower AIC indicates better model**
- Go-to-book on AIC and information theory: Burnham and Anderson 2002

AIC calculation from regression

$$\mathrm{AIC} = n\log(\frac{RSS}{n}) + 2\mathrm{k} + \mathrm{constant}$$

- RSS = residual sum of squares (aka SSE)
- n = number of data points
- k = number of parameters (including the estimated error term, σ^2); 2k acts as a penalty for complexity
- Constant - can ignore this b/c identical for models

- Full equation for reference: $\mathrm{AIC} = n\left(1 + \log(2\pi\frac{RSS}{n})\right) + 2\mathrm{k}$
- To get AIC in R: > AIC(Model1, Model2,…)

Kimura 2008; Note difference from Burnham and Anderson 2002

AIC Differences (Δ or dAIC)

$$\Delta_i = AIC_i - AIC_{\min}$$

- Rules of thumb:

Δ_i	Level of empirical support for model i
0-2	Substantial
4-7	Considerably less
>10	Essentially none

- dAIC used to compare across models
  - → best model has Δ=0; other models have Δ_i >0
- Use table to evaluate relative support for each model

Burnham and Anderson 2002

Example

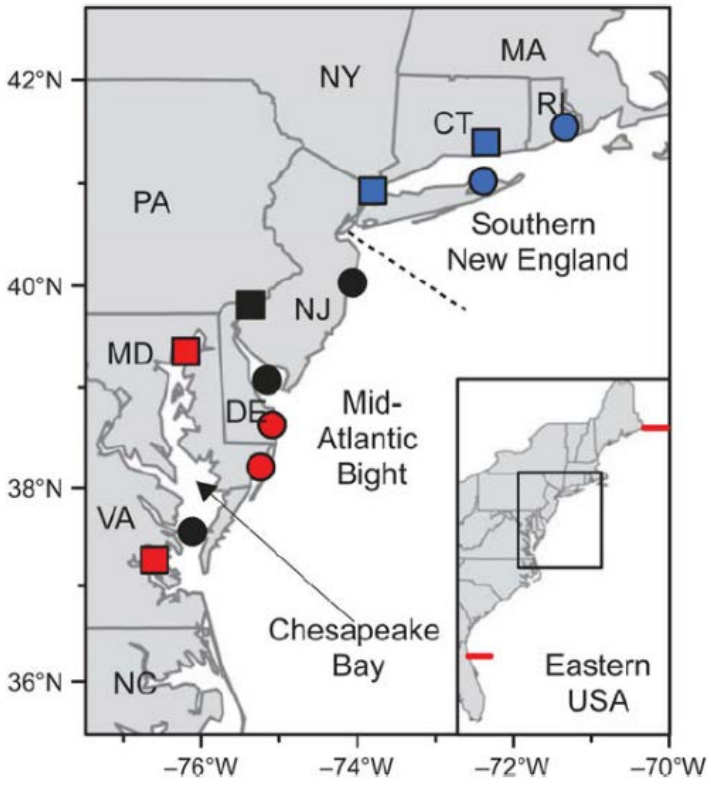

Table 3. Highest ranking DFA models of Atlantic menhaden recruitment using data spanning two different periods.

Period	Model rank	Covariate	*m*	ΔAIC
1959–2013	**1**	**AMO (lag 1)**	**2**	**0.0**
	2	**LAND (lag 1)**	**2**	**2.1**
	3	TEMP_SNE (lag 1)	2	8.1
	4	PCP_SNE	2	10.3
	5	LAND	2	11.0
1987–2013	**1**	**LAND (lag 1)**	**2**	**0.0**
	2	**AMO (lag 1)**	**2**	**1.6**
	3	PCP_SNE	2	5.3
	4	PRED_Ms	2	5.7
	5	PALM_SNE	2	6.2

Models with different covariates and different numbers of common trends (*m*) were ranked based on AIC differences (ΔAIC). Covariates include the Atlantic Multidecadal Oscillation (AMO), coast-wide menhaden landings (LAND), water temperature (TEMP), precipitation (PCP), predator biomass of striped bass *M. saxatilis* (PRED_Ms), and the Palmer drought index (PALM). Some models had covariates that were specific to the SNE region (_SNE) and some had covariates lagged by 1 year. Bolded models have substantial support for being the best model.

See more examples in lab…

Akaike weights (w_i)

- The relative likelihood of a model, given the data and the set of R models, can be expressed as "**Akaike weights**", w_i:

$$w_i = \frac{\exp(-\frac{1}{2}\Delta_i)}{\sum_{r=1}^{R}\exp(-\frac{1}{2}\Delta_i)}$$

- All w_i values will add to 1
- A given w_i is considered as the "***weight of evidence***" in favor of model i being the actual best model for the situation at hand given that one of the R models must be the best

Burnham and Anderson 2002

Sidenote: AIC corrected for small sample size (AICc)

$$\mathrm{AICc} = AIC + \frac{2k(k+1)}{n-k-1}$$

- n = number of data points
- k = number of parameters (including the estimated error term, σ^2)

- AICc adds a greater penalty for extra parameters to prevent overfitting (i.e., selecting overly complex models)
- Rule of thumb: Use AICc if n/k < 40

Kimura 2008; Note difference from Burnham and Anderson 2002

AIC summary

- **AIC (Akaike's Information Criterion)** = Model selection tool
  - Gives relative measure of model fit
  - **Lowest AIC indicates best model** (of those evaluated)
  - Model MUST use the same response data!
- **Δ** (i.e. $\Delta_i = AIC_i - \min(AIC)$) → Standardizes AIC values
  - best model has Δ=0; other models have $\Delta_i > 0$
- **Akaike weights** (w_i) -wgt of evidence that model i is the best
- **AIC corrected for small sample size (AICc)** – use if n/k<40

Δ_i	Level of empirical support for model i
0-2	Substantial
4-7	Considerably less
>10	Essentially none