Temporal Stability of Fatty Acids in Herring Hearts

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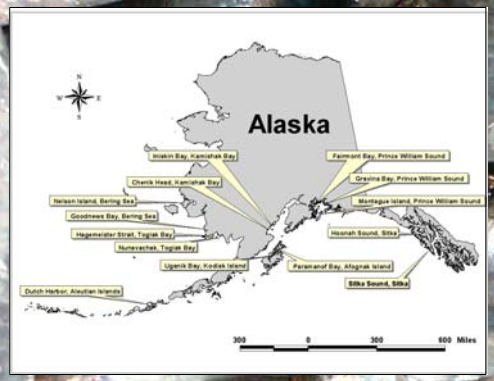


Herring in Alaska are managed as discrete stocks, but managers lack tools for accurately discriminating them.

Objective

We assessed the utility of fatty acids as a tool for discriminating herring stocks.

In 2001 we determined that heart fatty acids could be used to discriminate putative stocks on fine spatial scales.

In this study we tested the hypothesis that these differences are conserved over time by comparing the fatty acid compositions of hearts collected from different spawning aggregations in 2001, 2005 and 2006.

Spawning aggregates and the number of samples processed in each year

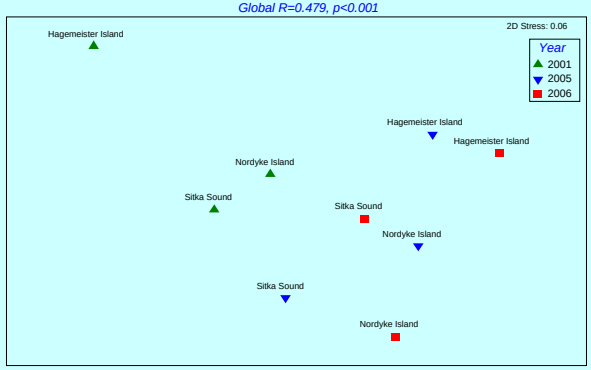
General Area	Location / Year	2001	2005	2006	Total
Southeast Alaska	Sitka Sound	18	20	30	**68**
	Hoonah Sound		20	30	**50**
Prince William Sound	Fairmont Bay	36			**36**
	Gravina Bay		24		**24**
	Montague Island	38			**38**
Kamishak Bay	Nordyke Island	33	27	30	**90**
	Iniskin Bay		27		**27**
	Oil Bay			30	**30**
Kodiak Island	Uganik Bay		27	30	**57**
	Paramanof Bay	27			**27**
	Kiliuda Bay		27	30	**57**
Dutch Harbor	Illiulink Bay			30	**30**
Togiak Bay	Nunavachak		20	29	**49**
	Hagemeister Strait	18	21	30	**69**
Bering Sea	Goodnews Bay		27		**27**
	Nelson Island			30	**30**
	Toksook Bay		28		**28**
	Total	170	268	299	**737**

17 spawning aggregations within 7 putatitive herring stocks were discriminated using log transformed concentrations of 16 fatty acid isolated from their hearts.

The fatty acid compositions were analyzed by analysis of similarity (ANOSIM) and non-metric multi-dimensional scaling (MDS) to determine if the differences in composition between stocks are conserved over time. These analyses were based on a euclidean distance matrix.

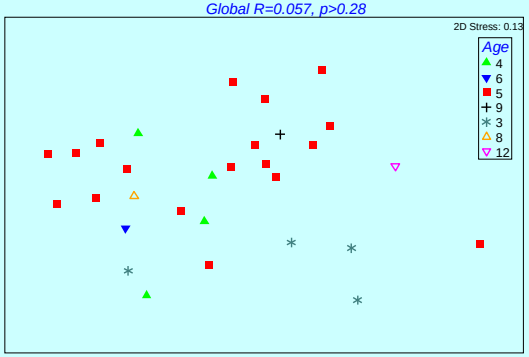
Choosing MDS over discriminant function analysis allowed us to avoid assumptions about the linearity of fatty acid data. ANOSIM allows for non-parametric multi-variate hypothesis testing.

MDS plot of ANOSIM R dissimilarity coefficients.
Global R=0.479, p<0.001



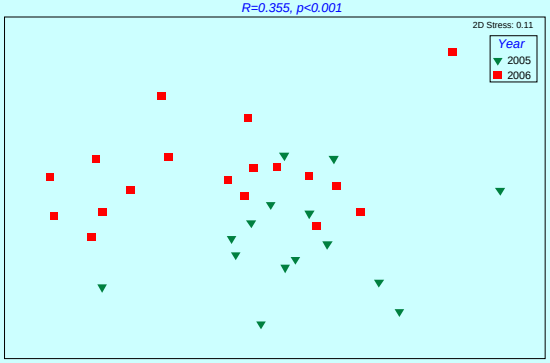
Variation among stocks and years:
MDS plot of stock centroids (R) indicates spatial and temporal differences (all p<0.05) in fatty acid signatures for herring collected at three common locations in 2001, 2005 and 2006. Note how compositional differences for a given stock increase with time even though there are significant differences between stocks.

MDS plot of Herring ages sampled at Kiliuda bay in 2006
Global R=0.057, p>0.28



Intra-annual variation among year classes:
This MDS plot of individuals indicates that in 2006 the fatty acid compositions of the different age classes in Kiliuda Bay were indistinguishable.

2001 year class herring collected at Kiliuda bay in 2005 and 2006.
R=0.355, p<0.001



Inter-annual variation within a year class:
This MDS plot of individuals sampled from Kiliuda Bay indicates that the fatty acid composition of the 2001 age class changed between 2005 and 2006.

Conclusions

- We confirmed that within a given year stocks can be discriminated using heart fatty acids.
- However, the FA compositions of some stocks are more temporally stable than others.
- For a given year class, FA compositions can differ among years, but in a given year and location different age classes do not differ.
- These data suggest the use stock-specific baseline FA for identifying stock of origin in mixed stock samples is limited to short time scales.