

# HITCHHIKER'S GUIDE TO FORECASTING SALMON WITH OCEAN CONDITIONS

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&  
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# The “art” of forecasting salmon at DFO

<b>Return Year</b>	<b>Forecast</b>	<b>Return</b>
<b>2009</b>	<b>10 million</b>	<b>1.7 million</b>
<b>2010</b>	<b>10 million</b>	<b>29 million</b>
<b>2011</b>	<b>3.2 million</b>	<b>5.1 million</b>

**=> Forecast Range in 2011: 1-10 million**

# The Trilogy in Five Volumes:

Tome 1: Linear regressions

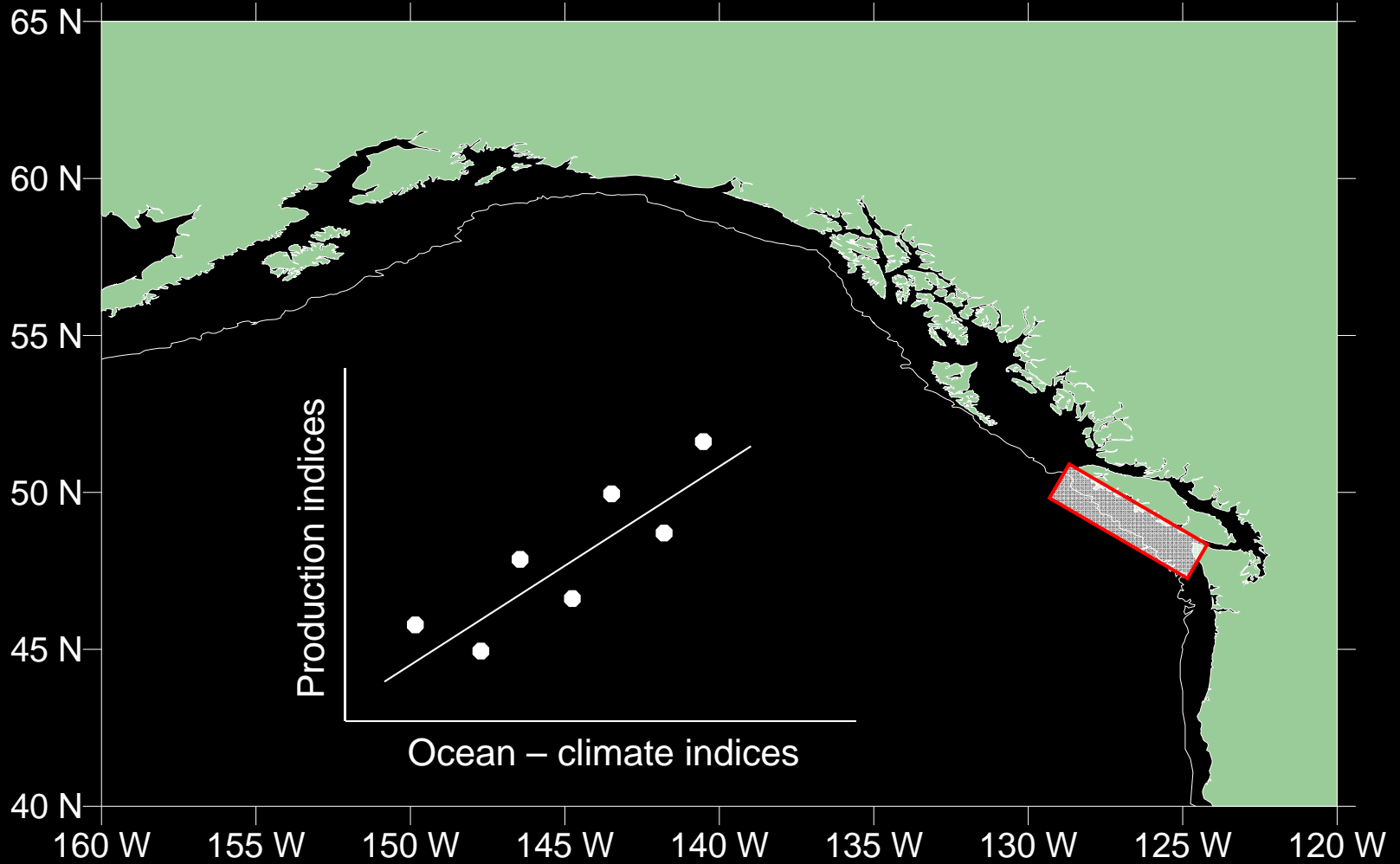
Tome 2: Stoplight chart

Tome 3: Multivariate statistics

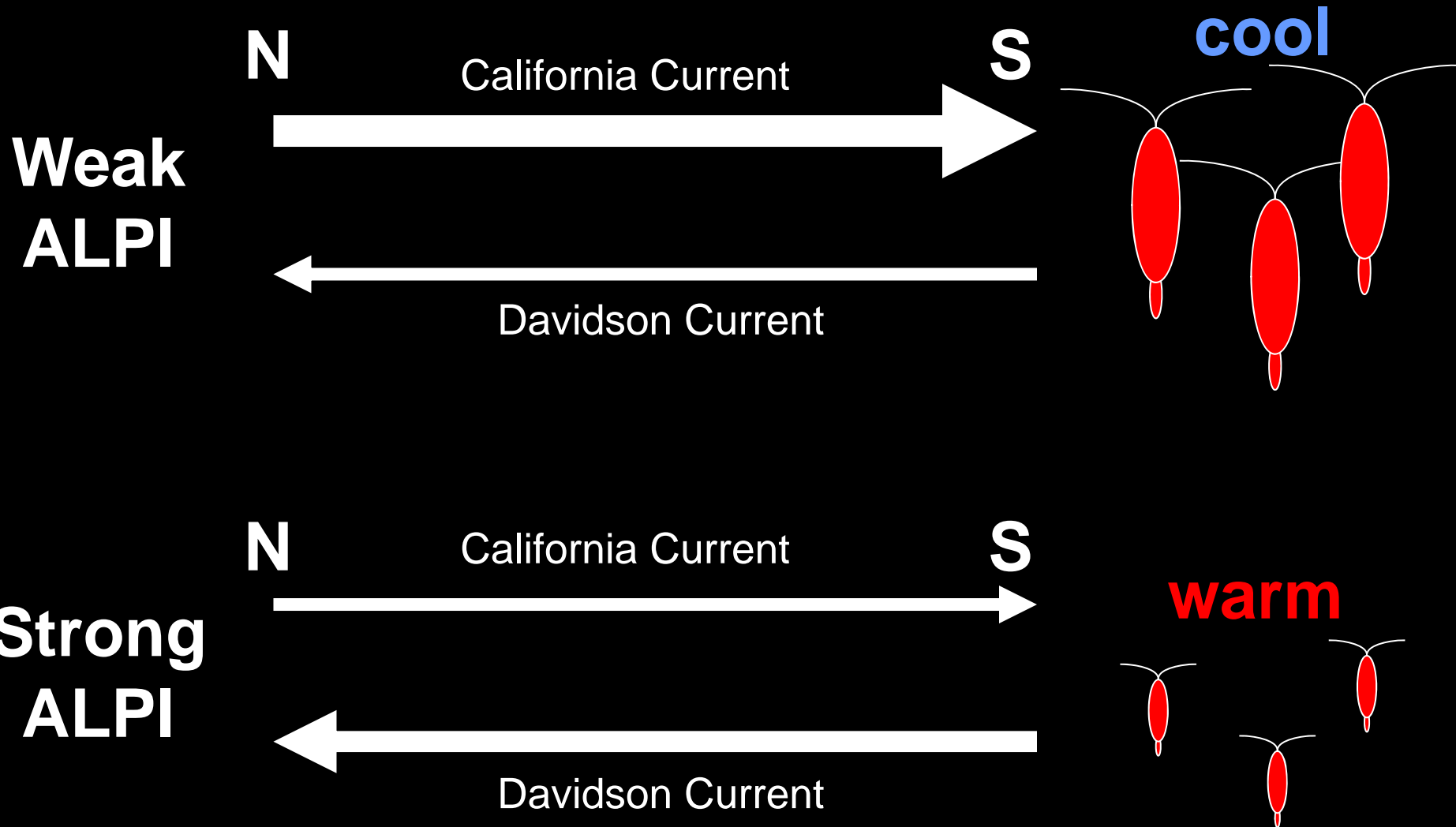
Tome 4: Bayesian Beliefs Network

Tome 5: The Life, the Universe, & the Everything

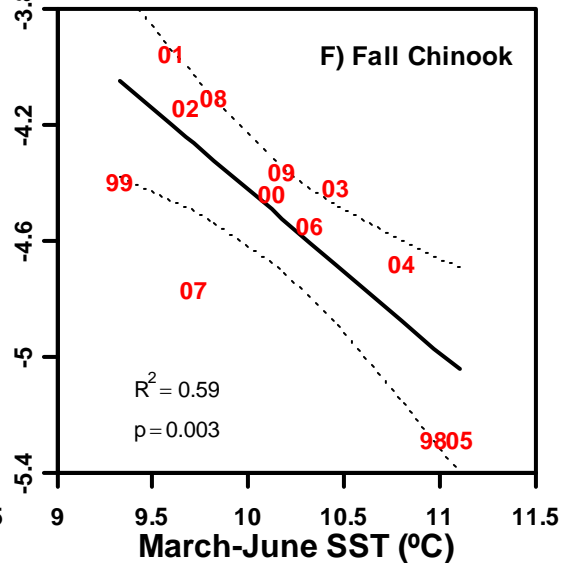
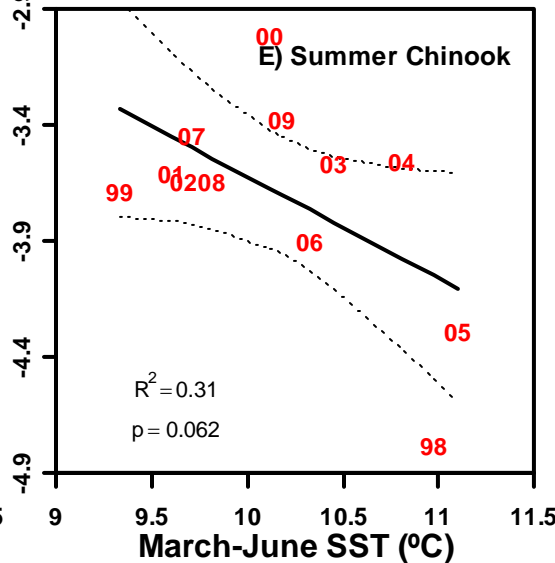
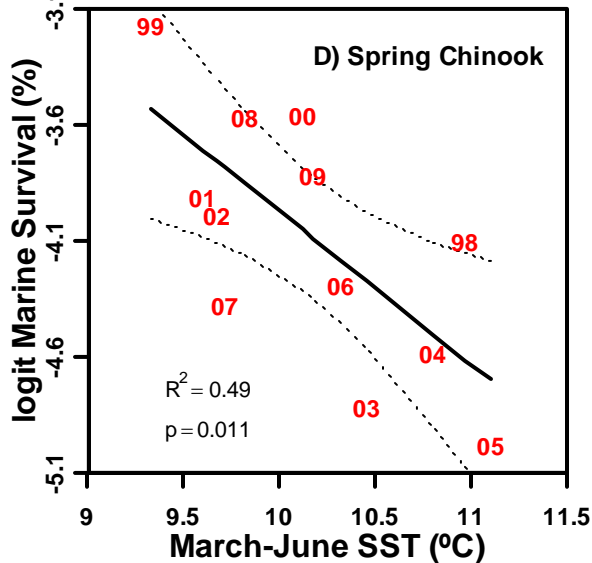
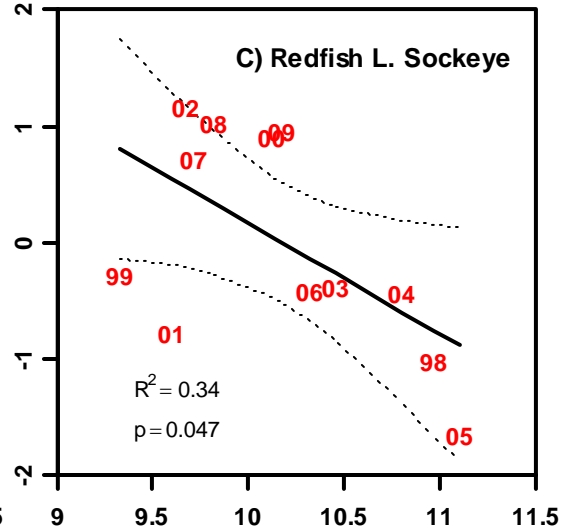
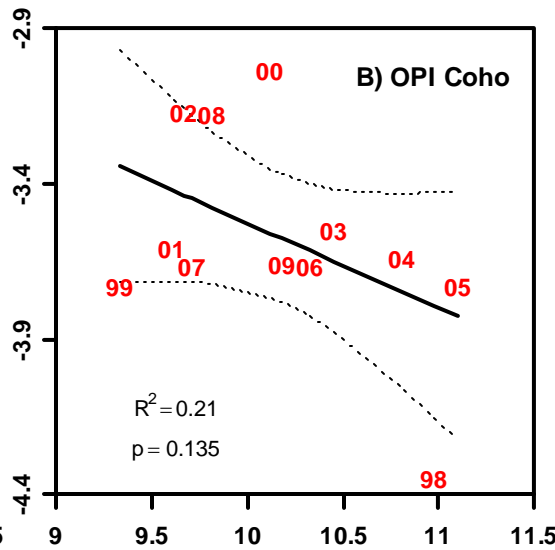
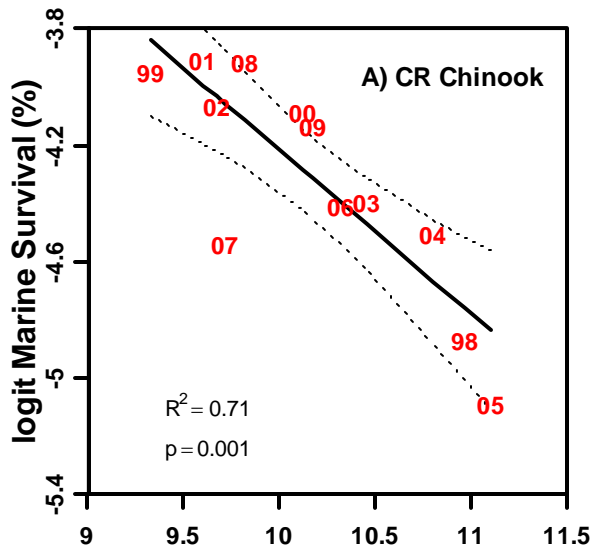
# Tome 1: Linear Regression



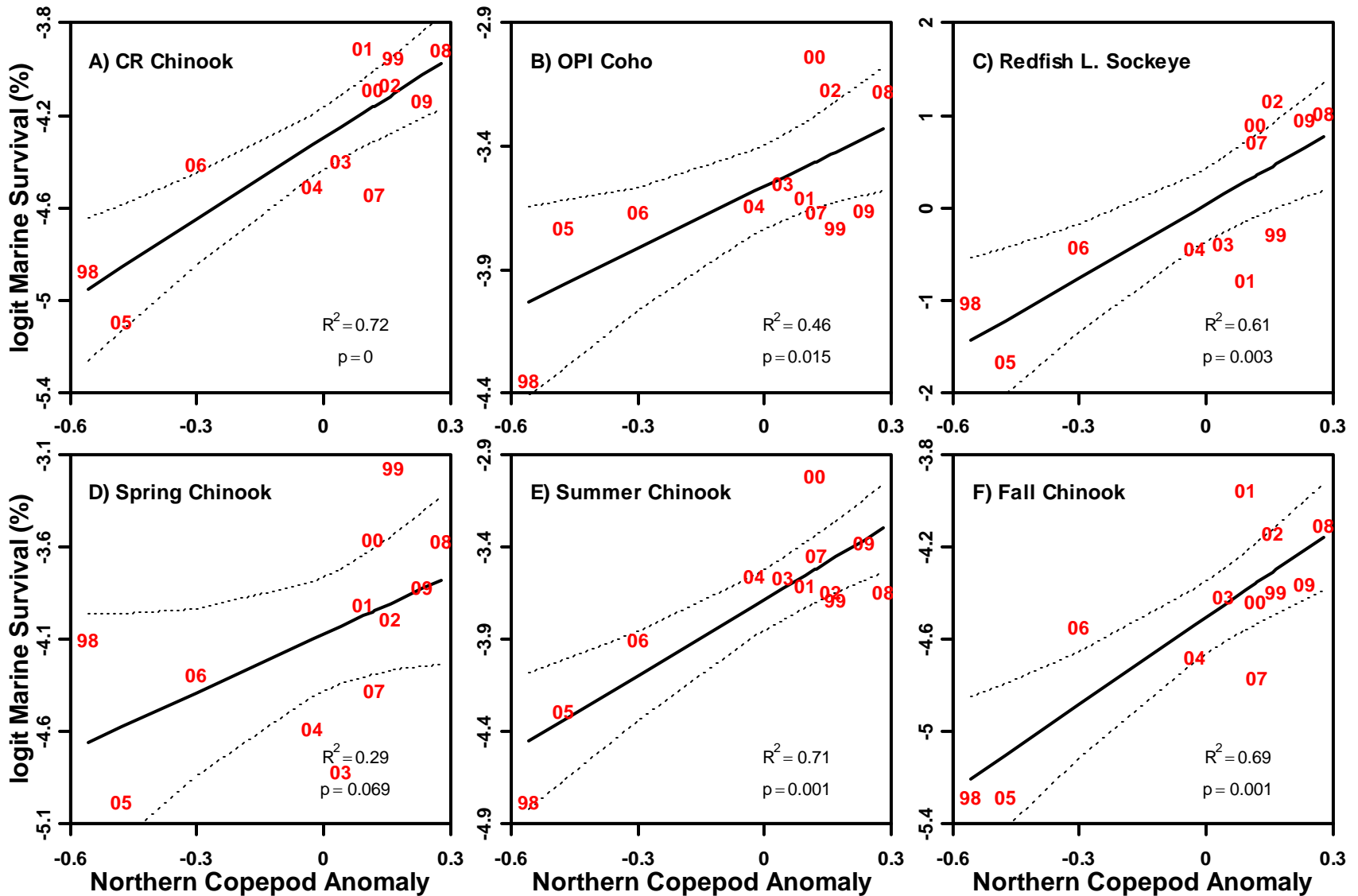
# Have a conceptual model in mind



# Survival & Sea Surface Temperature



# Survival & Northern Copepods



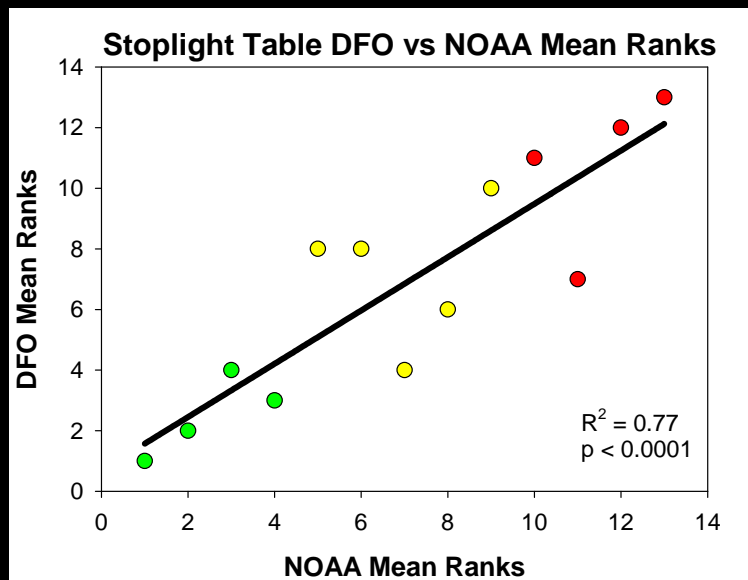
# Tome 2a: NOAA Stoplight

<i>Ecosystem Indicators</i>	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
PDO (December-March)	13	5	2	9	6	14	8	12	10	7	4	1	11	3
PDO (May-September)	8	3	5	4	9	13	12	14	10	11	1	7	6	2
ONI Jan-June	14	1	1	5	10	11	9	12	6	8	3	7	13	4
SST at 46050 (May-Sept)	12	8	3	4	1	7	14	11	5	13	2	9	6	10
SST at NH 05 (May-Sept)	8	4	1	6	2	5	14	11	7	13	3	12	10	9
SST winter before (Nov-Mar)	14	11	3	5	7	10	12	9	8	2	1	4	13	5
Physical Spring Trans (UI Based)	3	6	13	12	4	9	11	14	9	1	5	2	7	8
Upwelling Anomaly (Apr-May)	7	1	12	3	6	10	9	14	7	2	4	5	11	12
Length of upwelling season (UI Based)	6	2	13	9	1	10	8	14	5	3	7	3	11	12
Deep Temperature at NH 05	14	4	6	3	1	9	10	11	12	5	2	8	7	13
Deep Salinity at NH05	14	3	6	2	5	12	13	8	7	1	4	10	11	9
Copepod Richness Anomaly	14	2	1	5	4	10	9	13	11	8	6	7	12	3
N.Copepod Anomaly	13	9	5	6	3	12	11	14	10	8	2	7	4	1
Biological Transition	13	9	6	5	7	12	8	14	11	2	1	4	10	3
Copepod Community structure	14	4	3	6	1	10	11	13	12	8	2	5	9	7
Winter Ichthyoplankton	14	6	2	4	5	13	12	8	11	10	1	7	3	9
Catches of salmon in surveys														
June-Chinook Catches	13	2	3	11	7	9	12	14	8	6	1	4	5	10
Sept-Coho Catches	10	2	1	4	3	6	11	13	8	9	7	14	12	5
Mean of Ranks	11.3	4.6	4.8	5.7	4.6	10.1	10.8	12.2	8.7	6.5	3.1	6.4	8.9	6.9
RANK of the mean rank	13	2	4	5	2	11	12	14	9	7	1	6	10	8

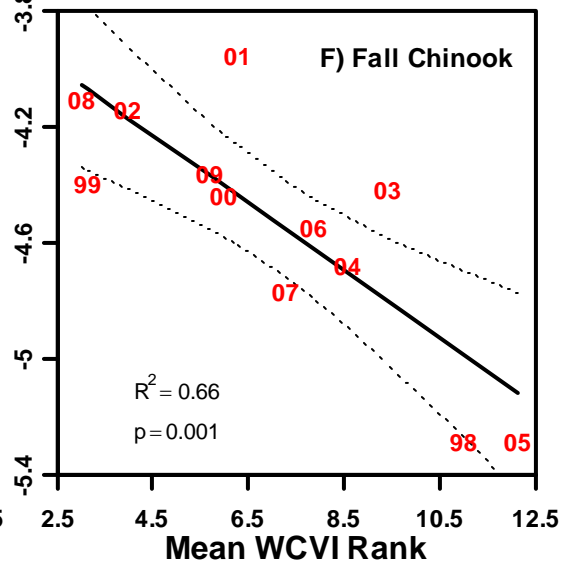
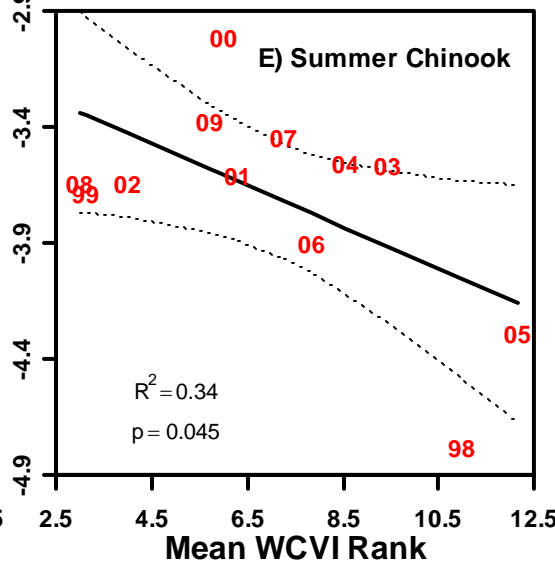
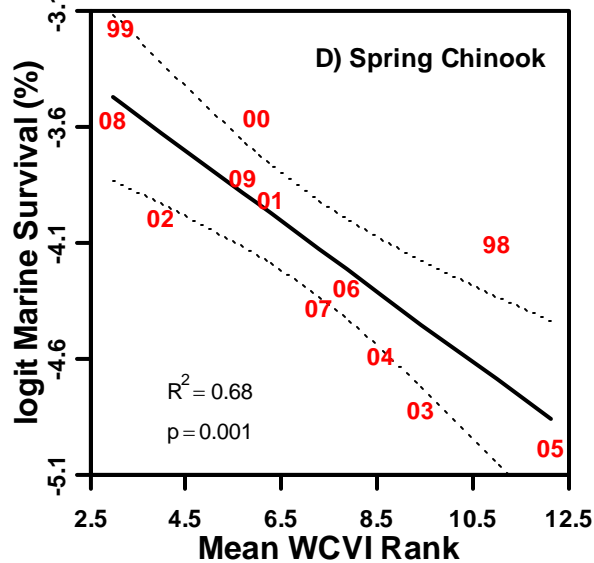
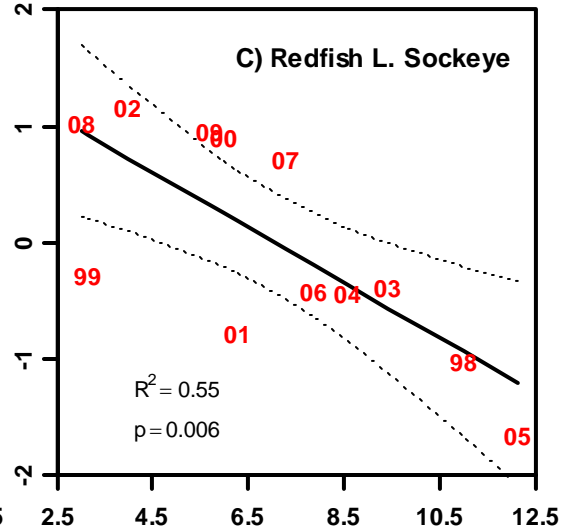
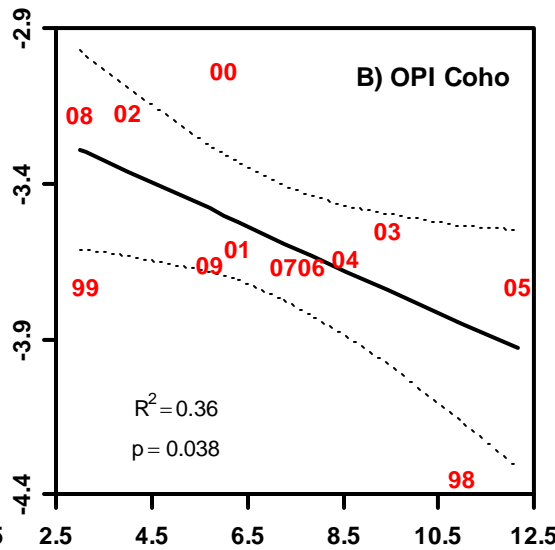
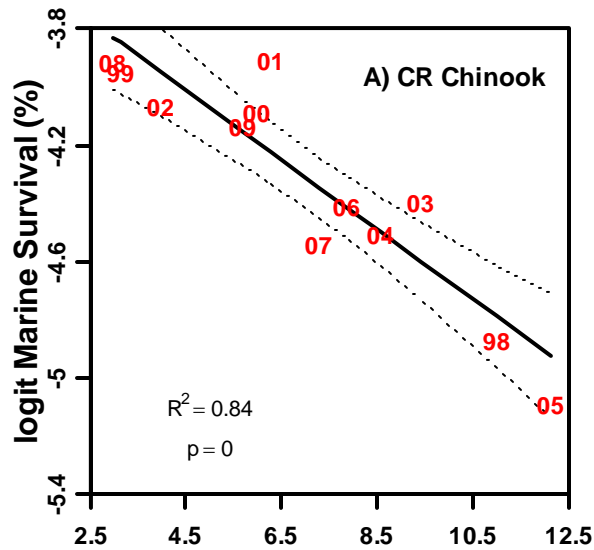


# Tome 2b: DFO Stoplight

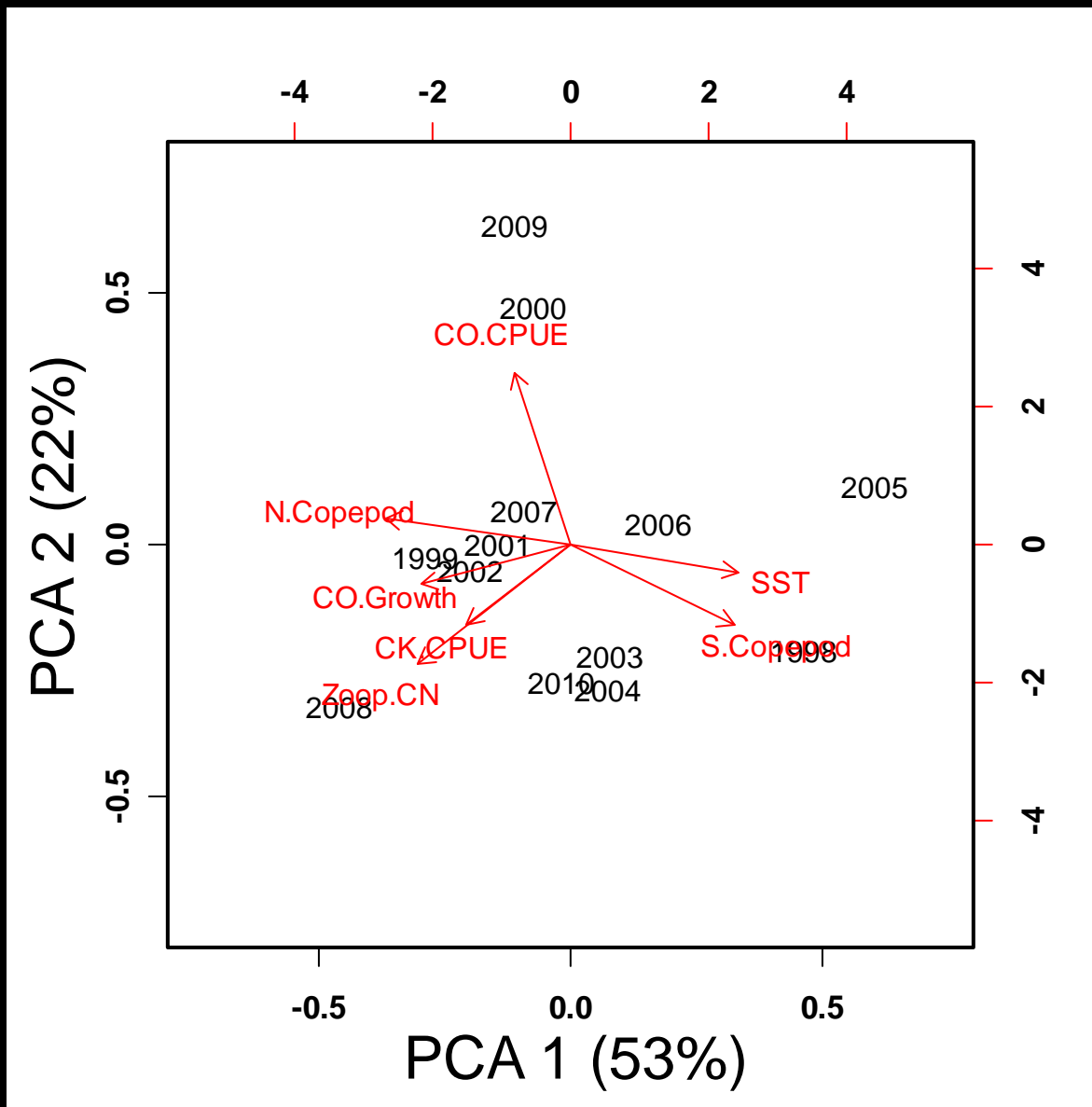
RANK SCORES													
Environmental Variables	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
<b>Online data</b>													
Mean SST - WCVI (Amphitrite) - Mar-Jun	12	1	6	2	3	9	11	13	8	4	5	7	10
<b>Survey data - Zooplankton</b>													
C:N Zooplankton Ratio (WCVI)	12	5	11	6	4	7	2	13	9	8	1	10	3
Northern (Boreal) Copepods	13	3	6	8	4	9	10	12	11	5	1	2	7
Southern Copepods	13	6	7	5	4	12	9	11	10	3	2	1	8
<b>Survey data - Fish</b>													
Coho Growth	12	1	3	7	2	8	4	13	9	10	6	11	5
WCVI CR CK CPUE - Jun-Jul	4	2	7	10	5	9	11	12	6	13	1	8	3
WCVI sockeye CPUE - Jun-Jul	8	5	4	11	13	2	3	12	9	6	1	7	10
WCVI coho CPUE - Jun-Jul	9	4	2	6	7	12	13	11	3	8	5	1	10
<b>Summary Statistics</b>													
Mean Rank	10.1	3.7	5.7	7.6	5.6	8.4	7.4	12.0	8.1	7.6	2.4	5.7	6.6
Rank of Mean Ranks	12	2	4	8	3	11	7	13	10	8	1	4	6



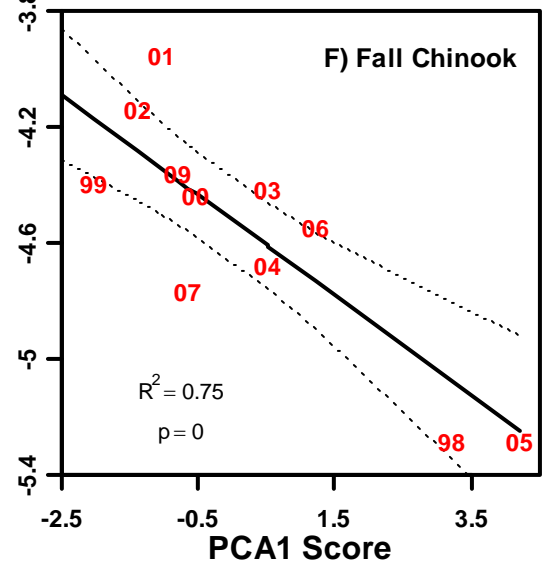
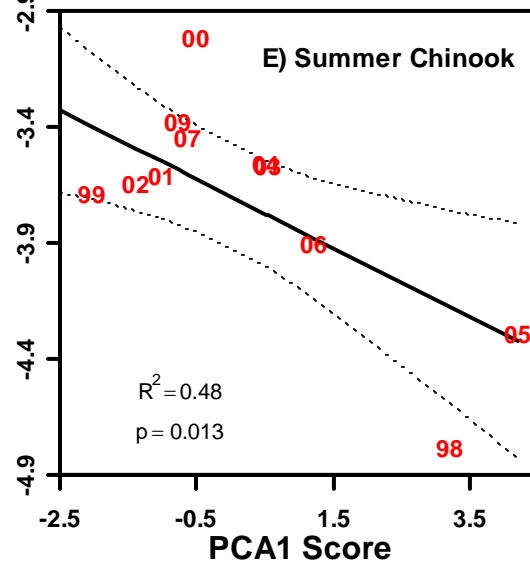
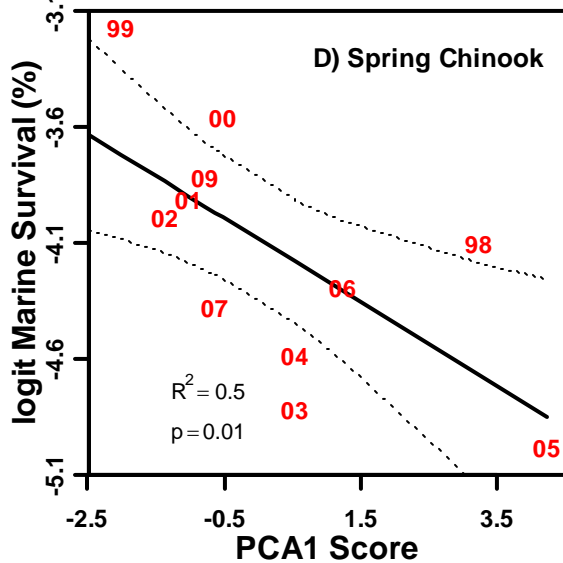
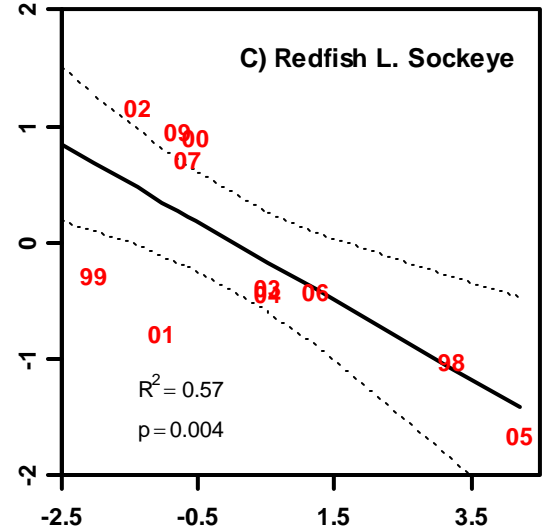
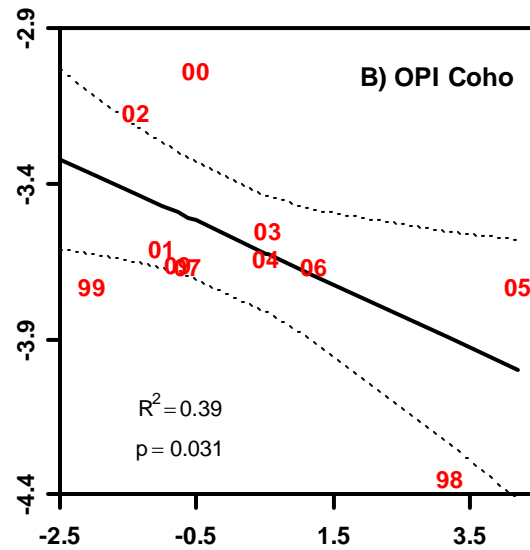
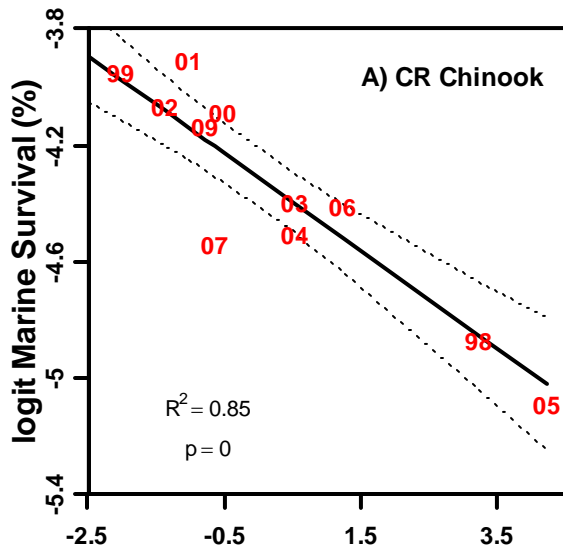
# Survival & Mean Rank



# Tome 3: Multivariate Statistics



# Survival & Principal Component

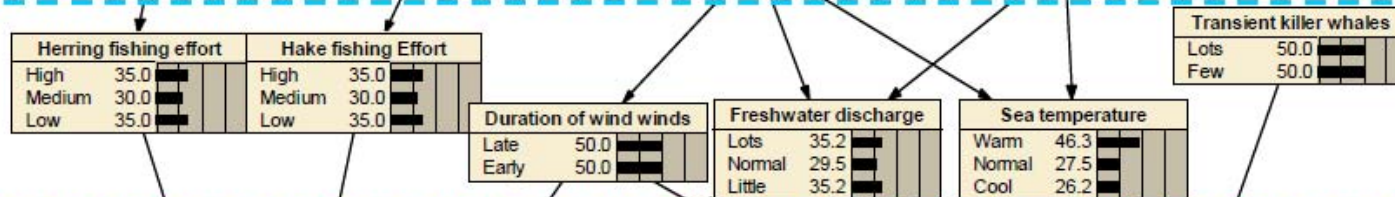


# Tome 4: Bayesian Beliefs Network

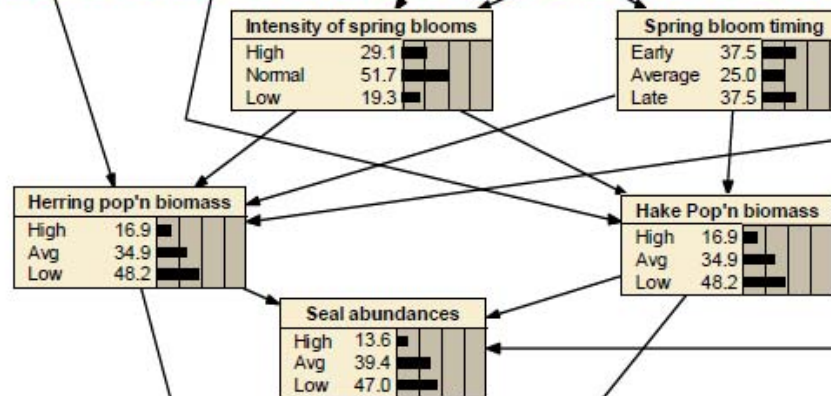
Drivers



Pressures



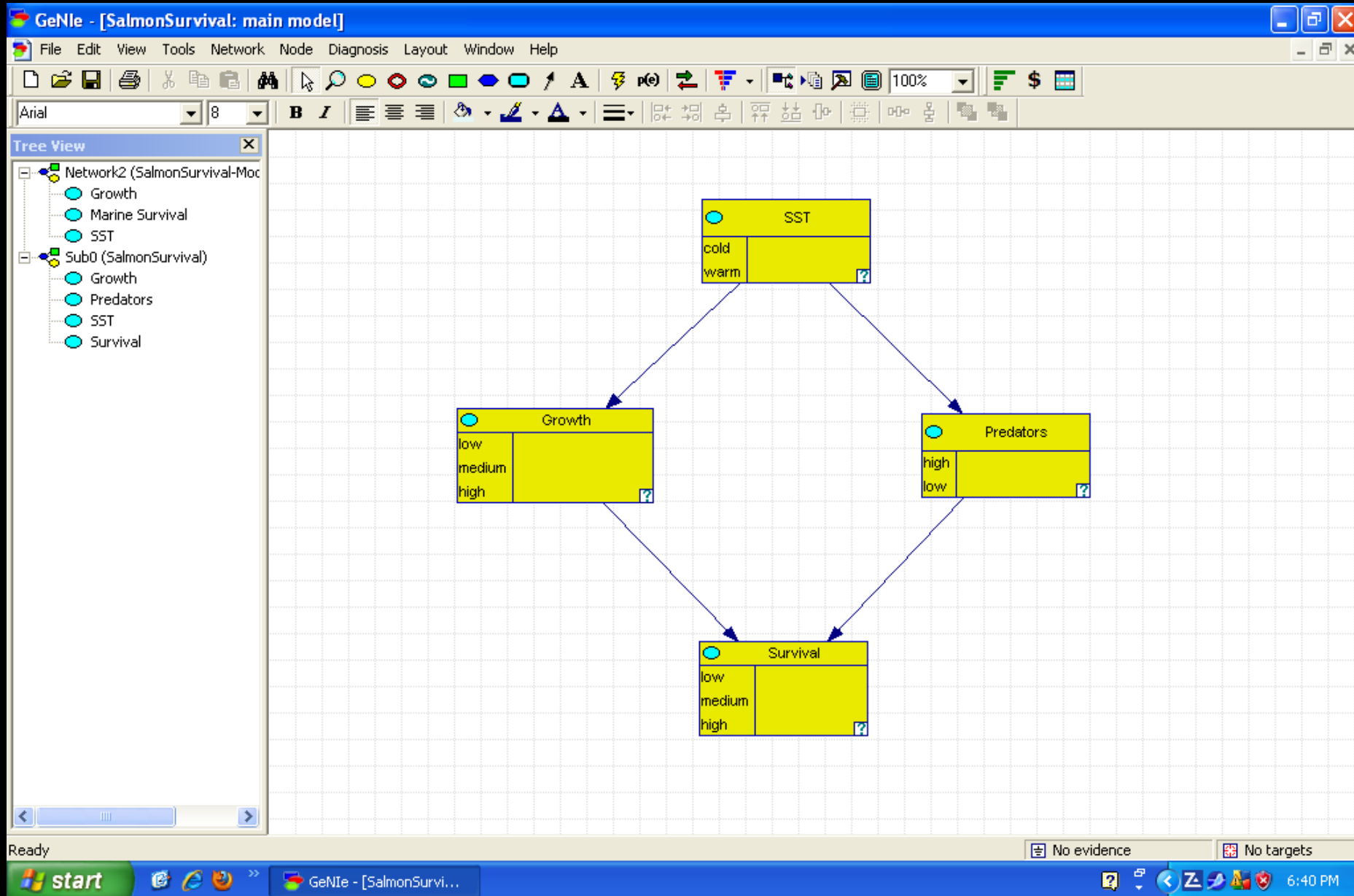
States



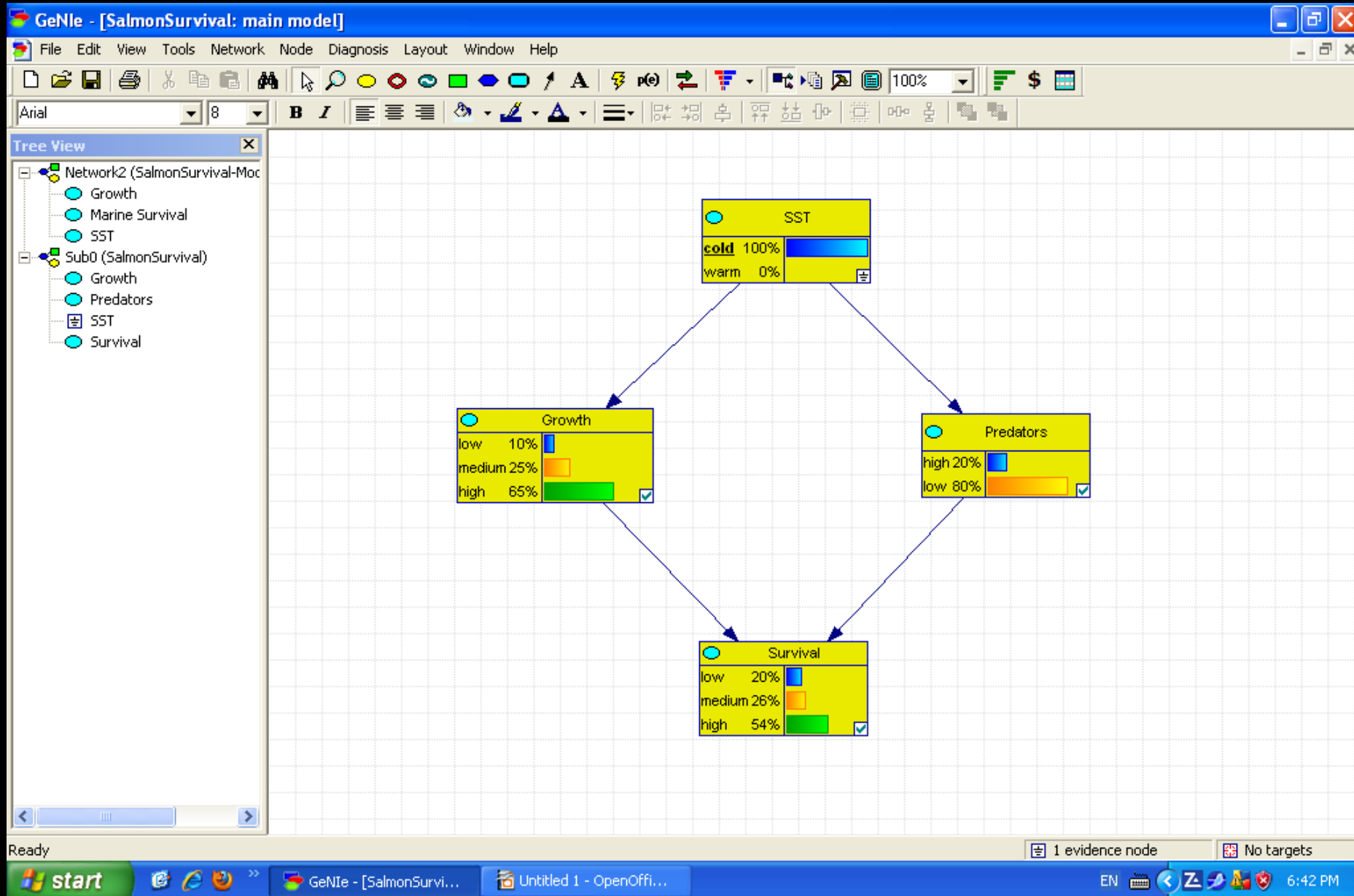
Impacts



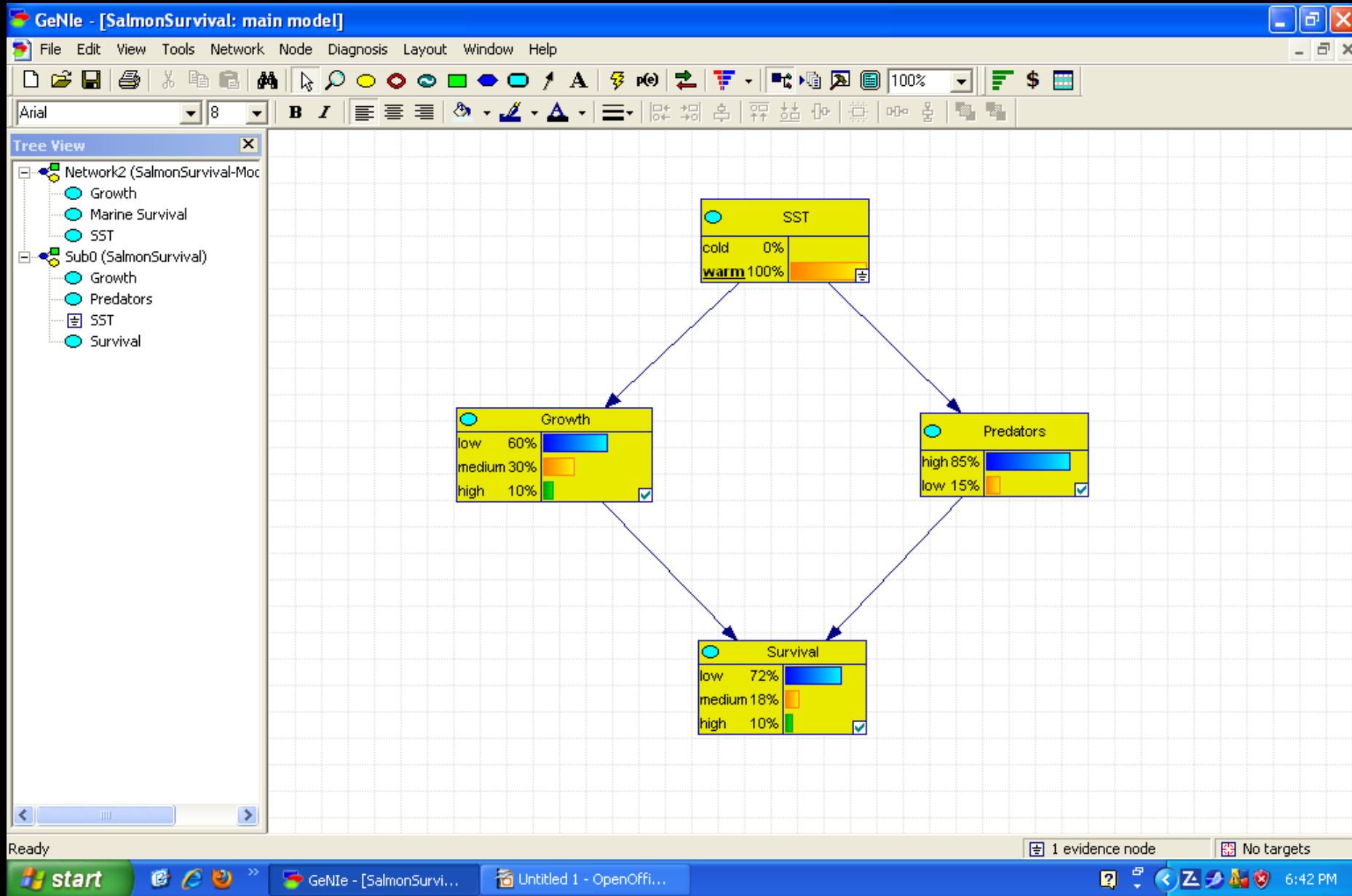
# A Simple Hypothetical BBN



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# A Simple Hypothetical BBN

The screenshot shows the GeNIe software interface for a Bayesian Network model titled "SalmonSurvival: main model". The "Node properties: Survival" dialog is open, showing the "Value" tab with a conditional probability table (CPT) for the Survival node. The CPT is defined by the states of the parent nodes: Growth and Predators.

	Growth low		Growth medium		Growth high	
	high	low	high	low	high	low
Predators low	0.9	0.6	0.7	0.25	0.2	0.05
Predators medium	0.1	0.25	0.2	0.5	0.35	0.15
Predators high	0	0.15	0.1	0.25	0.45	0.8

The software interface includes a "Tree View" on the left showing the network structure with nodes: Growth, Marine Survival, SST, Sub0 (SalmonSurvival), Growth, Predators, SST, and Survival. The bottom status bar indicates "1 evidence node" and "No targets".

# Tome 5: The Life, the Universe, & the Everything

1. Good smolt and adult data
2. Know where the fish go
3. Have some conceptual model in mind
4. Take advantage of online data
5. Be prepared: correlation breaks over time
6. Don't be married to a single approach



Fisheries and Oceans Canada  
Pêches et Océans Canada



**SO LONG, AND THANKS  
FOR ALL THE FISH**