Paper Fish 101

A Primer on Salmon Planning Models

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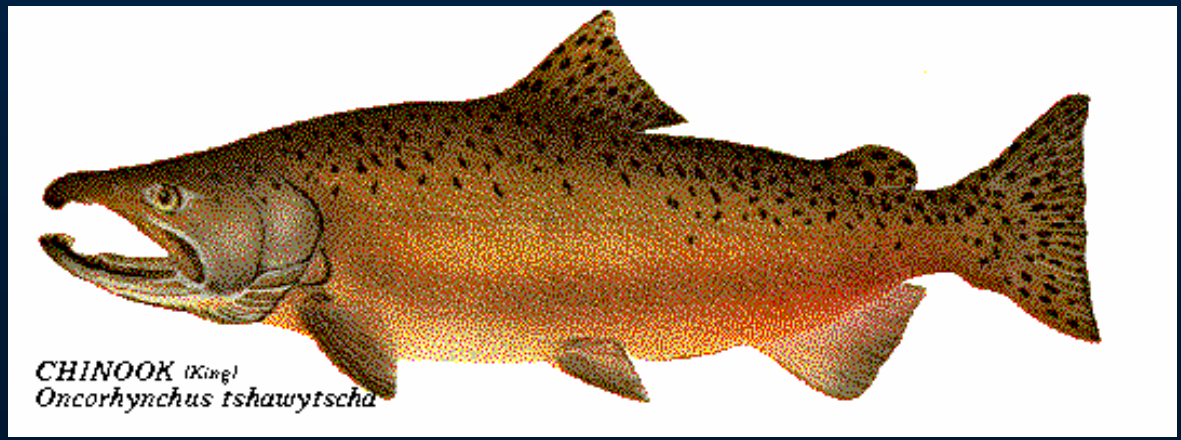
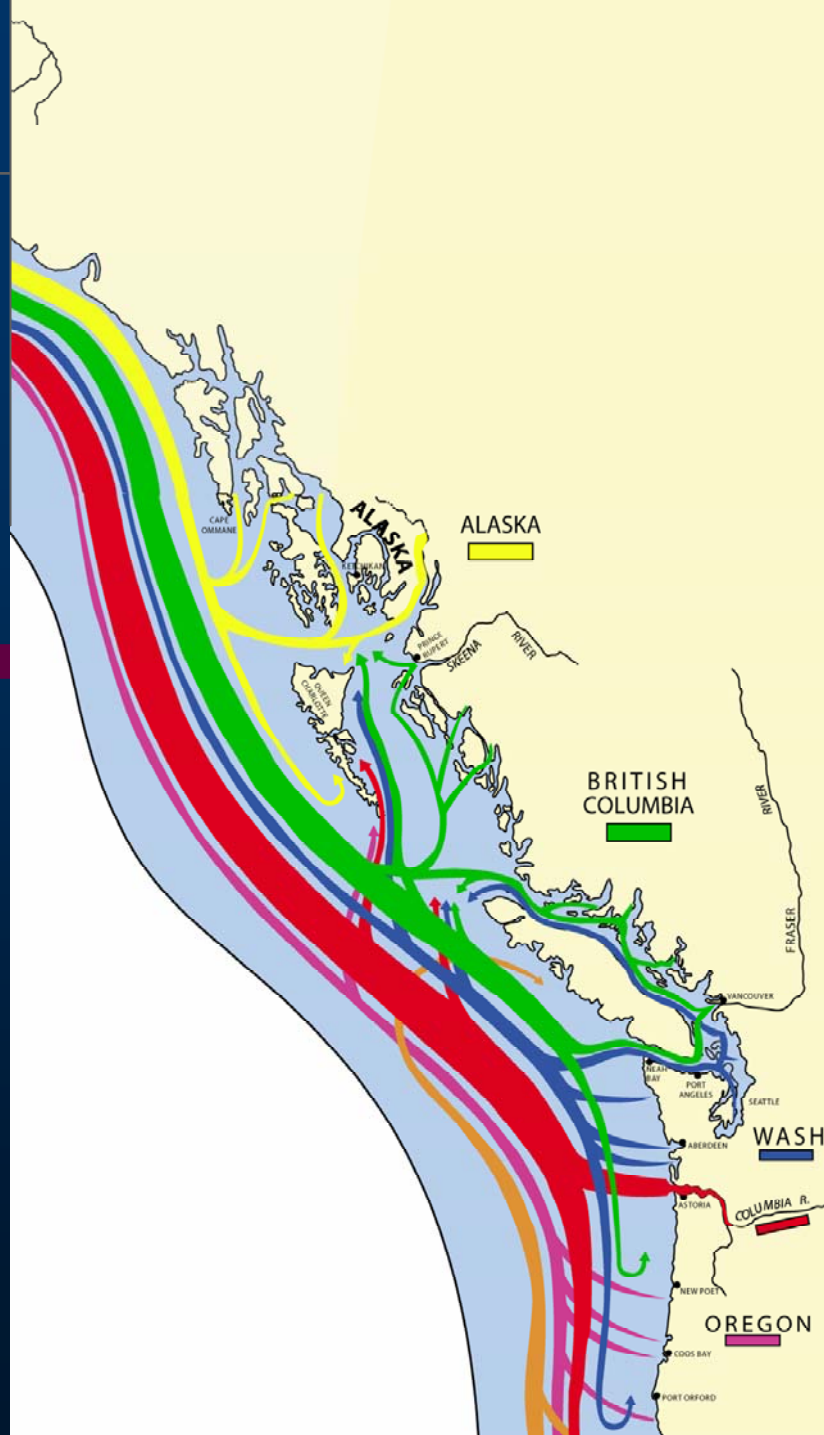
On the electronic transformation of hypothetical mathematical relationships representing processes involving the spatial and temporal removal of individual members of a heterogenous, polymorphic population, comprised of complex mixtures of artificially and naturally propagated, genetically and geographically distinct stocks of the genus Onchoryhnchus under highly uncertain conditions.



‘lectric Fish

Chinook Migration

- Broad marine distribution
  - California to Alaska;
  - Same places, at the same times;
  - Returning fish can range from two to six years old;
  - Subject to sport, commercial and tribal fisheries.



Multiple Jurisdictions – Columbia River Chinook

Constrain impacts throughout migratory range

NPFMC
- Alaska

Canada

PFMC
- Makah
- Quinault
- Quileute
- Hoh
- S'Klallam
- Washington

Columbia River Compact
- Washington
- Oregon

Treaty Indian
- Yakama
- Warm Springs
- Umatilla
- Nez Perce

States
- Washington
- Oregon
- Idaho

PFMC
- Oregon
- California

Sport & Troll — **Sport & Net** — **Net** — **Sport** — **Escapement**

Dependence on Exploitation Rates

Domestic & international obligations

Managers regulate fisheries to constrain exploitation rates for natural stocks of interest. Age-Time-Fishery ERs allocate both the conservation responsibility and harvest benefits.

Exploitation Rate

Landed or Total

$$ER_{s,a,f} = \frac{Mortality_{s,a,f}}{CohortSize_{s,a}}$$

Total Population prior to fishing in time period

Exploitation rates for a given fishery differ by stock and age

The Challenge

- Many Management Units
  - Highly variable abundance
  - Multiple species
  - Different productivities, migration patterns, maturities
- Many fisheries & social goals
- Specific legal obligations

The Manager's Dilemma

- Biological Complexity
  - Mixed stocks - differences
    - Knowledge & uncertainty
    - Productivities
    - Exploitation patterns
    - Management requirements
- Various stages of maturity
- Interannual variability in abundance & distribution

Fishery Management Planning Needs

- Constrain stock-specific impacts
  - Shaping - time/area/size limits
  - Catch ceilings
- Rely on management models

More Information

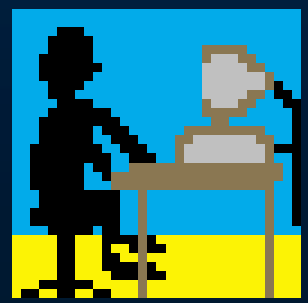
Quick

Stratification of Planning Models

	PSC Chinook Model	Chinook FRAM	Coho FRAM
Years	Multiple	Single	Single
Time Steps/Year	1	3	7
Ages	2-5	2-5	3
Stocks	30	32	128
Fisheries	28	73	206
Total Possible ER Ests Rqd	3,360	28,032	184,576

Why do we use models?

- Encapsulate knowledge, theory, assumptions, and information in a convenient, transferable form
- Improve accessibility
- Provide consistency in analysis
- Function within demanding time schedule for decision processes



Models Come in Many Flavors

Differ in scope

- Stocks
- Fisheries
- Time Periods

Types of Mortality

- Landed Catch
- Release
- Drop Off
- Selective Fisheries
  - Mark Retention Error
  - Mark Recognition Error

Specialized Purpose

- Coho FRAM
- Chinook FRAM
- Klamath Fall Chinook
- Sacramento Winter Run
- PSC Rebuilding
- Coast Model

Descriptions for PSC & FRAM models in Modeling/Sampling Workgroup Report

Current Capabilities

- Regulations
  - Catch Ceilings
  - Catch Quotas
  - Harvest Rates
  - Size Limits

- **Reports & Stats**
  - **Catches**
  - **Incidental Mortalities**
  - **Escapements**
  - **Exploitation Rates**
  - **Abundance**

Model Commonalities

- **Account for Impacts on "Stocks"**
  - Aggregate complexes of interest
  - Hatchery & Natural
- **Fisheries**
  - Principal impacts
- **Single Pool**
  - Exploitation Rate-Based
  - No explicit migration
- **Deterministic**
  - Uncertainty and risk only in parameters
- **Structure**

Model Structure

Two Main Components

What Happened?

What If?

Reconstruction

Projection

Cohort Analysis

OBJECTIVE: Estimate

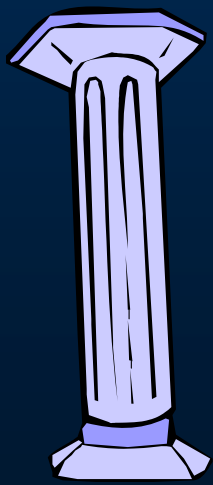
- Exploitation & Harvest Rates
- Maturation Rates

What happened

At the Heart of Reconstruction

COHORT ANALYSIS

- CWT Recoveries of indicator stocks
  - ✓Fisheries
  - ✓Escapement
- Assumptions on mortality rates
  - ✓Incidental
  - ✓Natural



BASE PERIOD

- Extensive, intensive fisheries – adequate recoveries

Projection

- Estimate impacts of regulatory packages
- Assuming base period distribution
- Project exploitation patterns under proposed regulations

- DETERMINISTIC

<u>INTERPRETATION</u>

- Average expectations
- Not exact predictions

What if?

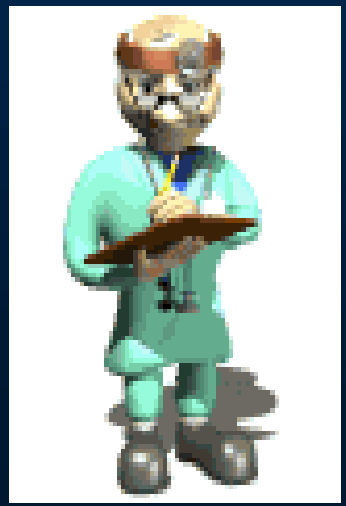
Recent Change in Focus

- **FROM: Evaluation of Alternative Rebuilding Strategies - FORWARD PROJECTIONS**

- **TOWARD: Single year projections and Backcasting**
  - **»Annual Update (Calibration)**

Current Situation

- Escalating demands for more information
- Models pushed beyond their intended capabilities



Harvest Management Models

What are the Weaknesses?

And the Strengths?

Weaknesses

- Tendency to push models beyond intended limits
- Temptation for fishing constituents to engage in gaming (taking advantage of quirks in available data)
- Dependence on input values (e.g., abundance forecasts, fishing patterns)
- Lack complete picture of stocks and fisheries coastwide results in need to combine model results & integrate disparate data

Weaknesses

- Technical limitations
  - Time periods & discrete catch equations
  - Unable to evaluate interactions between concurrent fisheries
  - Mark-selective fisheries
  - Single pool structure (exploitation rates vs harvest rates)
  - Availability of data for some stocks during the model base period
  - Indicator stocks (representative of wild stocks?)

- Current documentation – heavy dependence on a few individuals who can maintain program code

Strengths *– Experts on tap, not on top*

- Consistent methods for analysis accepted by co-managers & users
  - Force resolution/containment of technical issues and disputes over data, assumptions, and methods
  - Decision makers can focus on issues
- Provides useful information for decision-making in timely manner
  - Organize relevant information and make it readily accessible
  - Independent exploration of alternatives – manager & constituency access to expertise
  - Rapid turnaround of scenarios
  - Custom reports can be readily generated to meet specific needs

Strengths

- Expectations can be evaluated using observational data in short time period
  - Catch & effort
  - Escapement & exploitation rates
- Annual review & evaluation of performance provides opportunity for correction and improvement
  - Bias correction
  - Methods improvements
  - Incorporate new information, e.g., El Nino, monitoring of compliance in mark-selective fisheries, research results

Areas For Future Development

- **Extend**
  - Stratification - Stocks, Fisheries, & Time Periods
  - Evaluation of Selective Mark Retention Fisheries
- **Convert**
  - New cohort analysis algorithms
  - Stock-specific growth functions
  - Stock-age distribution patterns
  - Dump results to database
  - Remove legacy code
  - Continuous catch equations
- **Add uncertainty**
  - Survivals, Stock Distribution Patterns, Maturation, Fishing Patterns, mark-selective fishing

Questions:

1) Required level of **stock-age-group resolution** using GSI?
   - ✓ Hatchery-Wild
   - ✓ Release strategies (yearling v. fingerling)
   - ✓ Stock assignment error
   - ✓ Aging error
2) **GSI sample size required** to accurately estimate contributions that comprise a small proportion of the exploited population?

Questions:

3) **Infrastructure** needed to collect and exchange the data required to support cohort analysis using GSI?

4) Use GSI to **improve management capacity** to achieve stock-specific objectives?

- Combine with CWTs to estimate escapements
- Estimate composition of non-landed mortalities
- In-season “shaping” of fisheries

The End