Overview of the status of salmon in the North Pacific and trends in marine mortality

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Alaska Fisheries Science Center
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Presentation for Salmon at Sea: Scientific Advances and their Implications for Management
La Rochelle, France
11-13 October 2011
The North Pacific Anadromous Fish Commission
Convention Area (High Seas)
Western North Pacific (Russia, Japan, and RO Korea
Eastern North Pacific (Canada and USA)
Salmon Long-Term Catch Trend, 1925-2009 (Total N. Pacific)

4-5 Regime Periods
- **Period 1**, 1925-46: Pink Dominant
- **Period 2**, 1947-76: Lower Pink dominance & lower catches
- **Periods 3 to 5** (77-88, 89-98, 99-2009): Increasing Catch Trend, Pink & Chum dominance, 625 Million fish, 1.14 mmt

Ref: ICES Pub. By Irvine & Fukuwakura
Total Salmon Catches in the North Pacific
By Country, 1993-2010
Western N. Pacific Salmon Catch Trends – Russia + Japan + Korea

1. Pink and chum salmon dominance
2. Decline of Sockeye between Period 1 to 2
3. Period 3 – Chum increased, pink declined
4. Periods 4-5 Substantial increases, particularly pink and chum, even some increases in sockeye
Western North Pacific Total Catch of Salmon By Species, 1993-2010

Mostly by Russia and Japan

Dominant Species: Pink and Chum
Eastern North Pacific Salmon Catch Trends, USA + Canada

1. Pink and sockeye are prominent, but Chum is less so
2. Overall increasing trends in Periods 3-4
3. Period 5 catches are still high

Millions of Fish

Metric Tones
Eastern North Pacific Total Catch of Salmon
By Species, 1993-2010

Dominant Species: Sockeye, Pink and Chum
Explanations for Changes -- particularly of recent high catches

1. Subject of Coordinated NPAFC Studies – BASIS (Bering-Aleutians Salmon International Studies), Started in 2004

2. Main Research Topics
   a. Ocean Distribution
   b. Survival Studies – Food and Habitat
   c. Ecosystem changes – Structure, Dynamics, Functional Relationships
   d. Genetics ID
Bering-Aleutian Salmon International Survey (BASIS)
Looking for Factors Affecting Early Marine Growth of Juvenile Salmon

- Distribution and Migration Pattern
- Habitat Features
- Primary Production (biomass and composition)
- Secondary Production (Zooplankton (meso and micro) and higher trophic level abundance)
- Diet and Energy Pathways
Do coccolithophore blooms influence juvenile salmon distributions? (From Eisner, NMFS)

SeaWiFS coccolithophore mask images with juvenile sockeye catches:

### 2000
- **Catch**
  - 0
  - 1 - 25
  - 26 - 60
  - 51 - 100
  - 101 - 200
  - 201 - 300
  - 301 - 400
  - 401 - 600


### 2003
- **Catch**
  - 0
  - 1 - 25
  - 26 - 50
  - 51 - 100
  - 101 - 200
  - 201 - 300
  - 301 - 400
  - 401 - 600

19-Sept-03, Saitoh and Iida (unpubl.)
Food-Supply: Higher availability of Food

From Stephani Zador, NMFS

- Euphausiid biomass index increased 3 fold from 2004-2009 but decreased 30% in 2010
- This suggests high food base for planktivorous species, including juvenile salmon
- Juvenile salmon may accumulate higher energy content during late Summer-Autumn periods to better survive harsh Winters
### Diet Studies -- Major Zooplankton Prey Consumed by Salmon by Body Size (FL)

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Credit: Davis et al. NPAFC 2008 BASIS Symposium
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Energy density of Important Salmon Prey

From: Davis et al. NPAFC 2008 BASIS Symposium

- ctenophore
- small medusae
- Chaetognaths
- Clione limacina
- Limacina helicina
- Neocalanus cristatus
- Appendicularia
- Themisto pacifica
- Themisto libellula
- Thysanoessa raschi
- Thysanoessa spinifera
- Thysanoessa inermis
- Thysanoessa longipes
- juv. Squids mean 13mm
- Berryteuthis anonychus 82-90mm
- Sebastes 11mm (Jul)
- Walleye pollock 52-55mm (summer)
- Walleye pollock 75-95mm (Oct)
- Atka mackerel 44mm (Jul)
- capelin 63-71mm (Oct)
- sablefish 184-258mm (Feb & Aug)
- Pacific herring 97-104mm (Oct)
- Northern smoothtongue 117mm (Jun)
- Northern lampfish 43-112mm (summer)
EBS Phytoplankton Structure Changes, Warm & Cold Years (ratio of large to total Chla) in E. Bering Sea N & S of 60N

Implications: Phytoplankton dynamics determine the amount and quality of food available to Zooplankton. Larger phytoplankton assemblages may lead to shorter food webs and a more efficient transfer of energy. Critical in late summer-fall period prior to the over-wintering of key forage species (e.g. juvenile pollock, salmon).
Zooplankton Structure Changes, Warm & Cold Years

Implications: Larger sized zooplankton provide higher energy value for survival of juvenile salmon (and age-1 pollock) to over winter. Abundance of larger zooplankton (C. marshallae and euphausiids) are higher in colder years.

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<thead>
<tr>
<th>Year</th>
<th>Population Density (#/m^3)</th>
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<td>2003</td>
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<tr>
<td>2004</td>
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<td>2005</td>
<td>75</td>
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<td>2006</td>
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<td>2007</td>
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<td>2008</td>
<td>225</td>
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<td>2009</td>
<td>50</td>
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Graph showing population density over years:
- Warm
  - 2003: 0
  - 2004: 50
  - 2005: 75
  - 2006: 25
  - 2007: 10
  - 2008: 225
  - 2009: 50

- Cold
  - 2003: 0
  - 2004: 50
  - 2005: 75
  - 2006: 25
  - 2007: 10
  - 2008: 225
  - 2009: 50

Legend:
- Pteropods
- Polychaeta
- Larvaceans
- Hyperiid Amphipods
- Euphausiids
- Cnidaria
- Chaetognath
- Calanus marshallae
- Balanidae
Possible Shortening of Energy Flow through Food-web

- Large copepod biomass index increased 10 fold from warm 2002-05 period to cold 2009 period
- This suggests shortening of food base for more efficient energy flow to Age-0 pollock and then to larger fish,
- Juvenile salmon preys on Age-0 pollock and larger zooplankton
Parasite Infestations and Predators
– Not conclusive in rates of mortality

1. Sea Lice Infestations -- Increased infestations occur near salmon farms; but not many salmon farms in the N. Pacific. Russian 2004-05 studies by Bugaev showed infestations on pinks (55%), Chum (25%) and sockeye (7%)

2. Other forms of predation – by daggerfish, lampreys, etc. – these have not been monitored on a wide scale but regional predators were noted. Injuries on salmon were not indicative of rates in mortality.
Hatchery Releases, 1993-2010
Western N. Pacific vs Eastern N. Pacific
Relating Hatchery Releases to Catch Levels

1. Catches have generally increased; but hatchery release numbers have been quite steady
2. Prominent increases in salmon catches, like for pink salmon catches cannot be explained by just hatchery releases over recent years
3. Russian scientists believe ocean survival for pink salmon have evidently increased with more abundant food base; Japanese Oshoro Maru cruises generally confirms high food bases.
4. But bigger runs in recent years must also have contributed more natural production of juvenile salmon; thus increasing higher returns
Better Management

A. NPAFC
   1. Treaty bans all High Seas Fisheries on Salmon
   2. Has rigorous enforcement coordination, at-sea patrols, and in-port enforcement

B. Coastal Countries
   1. Mitigate conflicts of fresh-water use (for irrigation, power-generation and other use)
   2. Protects salmon strongholds, restores freshwater habitat
   3. Better Forecasting
   4. Better control of catches and escapement goals
Sample juvenile pinks and ocean conditions in SECM from May to August. Indices are CPUE, peak migration, N.Pac Index, Catch Prop, May temp. Best model is 2-parameter (peak CPUE and May Temp). Forecast that 2011 catch will be high.
Protecting Pacific Salmon Strongholds

Source: Wild Salmon Center
International Workshop on the High Abundance of Pink and Chum Salmon in the North Pacific Ocean

DATE: October 30-31, 2011 (following 19th NPAFC Annual Meeting)

VALUE: Vancouver Island Conference Centre, Nanaimo, BC, Canada

PURPOSE: Understand why pink and chum salmon can keep high abundance in the ocean ecosystems

HOST: NPAFC

Current CO-SPONSORS:
North Pacific Research Board (NPRB)
North Pacific Marine Science Organization (PICES)

Organizing Committee:
Richard Beamish (Canada), Toru Nagasawa (Japan)
Ki Baik Seong (Korea), Alexander Bugaev (Russia)
Edward V. Farley, Jr. (USA)
End of Presentation

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