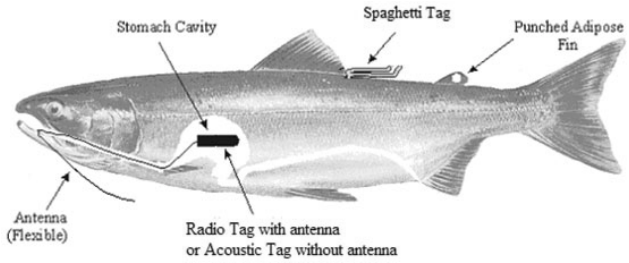
Fisheries and Oceans Canada

Dead Fish Swimming

Science AAAS

Genomic Signatures Predict Migration and Spawning Failure in Wild Canadian Salmon
Kristina M. Miller, *et al.*
Science **331**, 214 (2011);
DOI: 10.1126/science.1196901



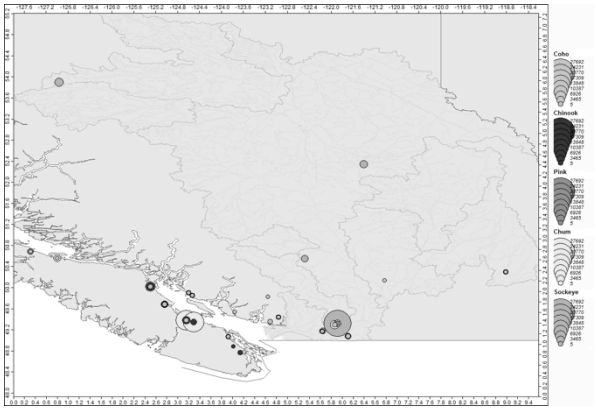
Diseases and Temperature

- Fraser River is getting warmer
- Parasites, bacteria and fungal infections are more severe at higher temperatures
- Warmer temperature means more disease and higher mortality

Technical Report 1A: Hatchery Diseases

UNIVERSITY OF CALGARY

- Could not prove or disprove that diseases associated with SEP facilities have been transmitted to Fraser River sockeye salmon
- No conclusion possible



Are diseases and parasites <u>responsible</u> for Fraser sockeye declines?

- No evidence for, or against, a relationship between sockeye productivity declines and fish diseases
- Disease remains on the table but can't be ruled out
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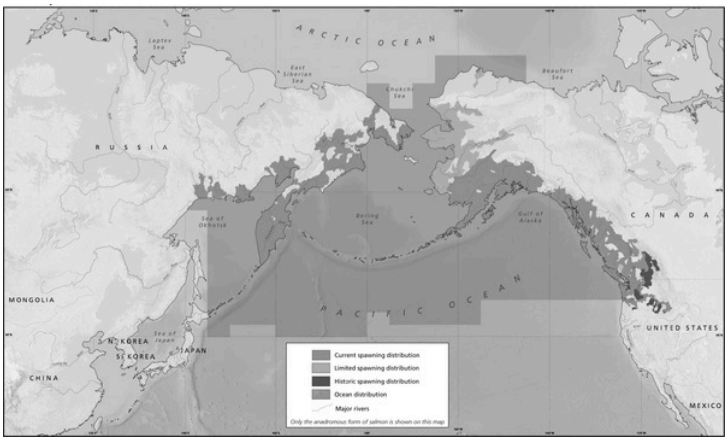
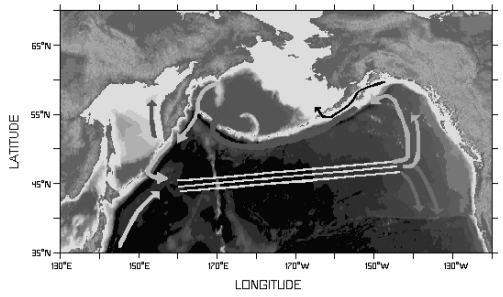
Effects of Climate Change

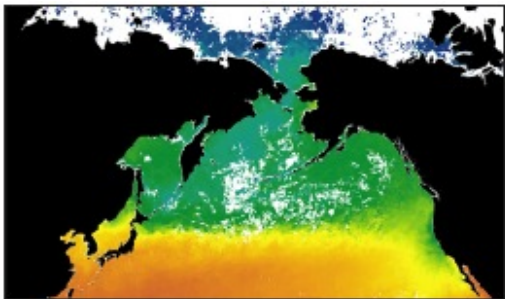
Sockeye salmon distribution



Effects of Climate Change in N. Pacific Ocean

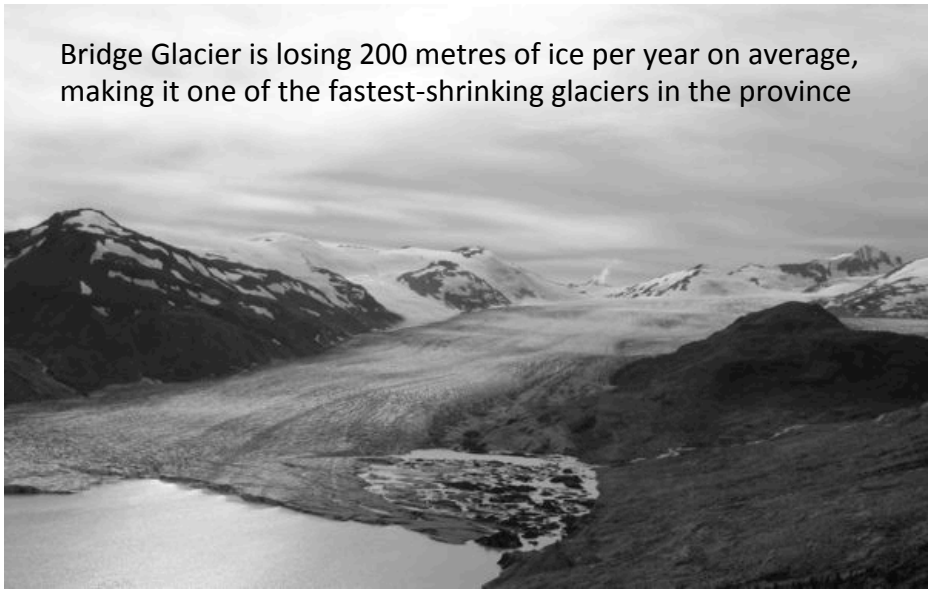


Ocean currents

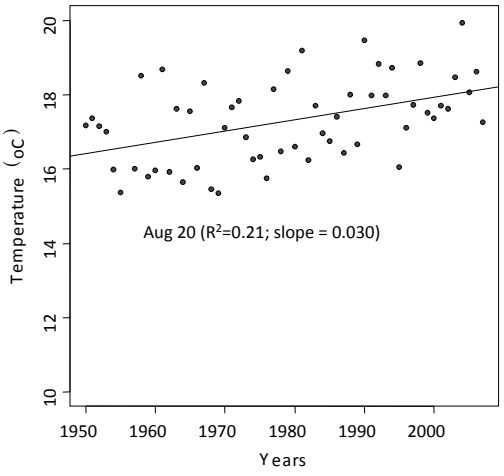


Sea surface temperature

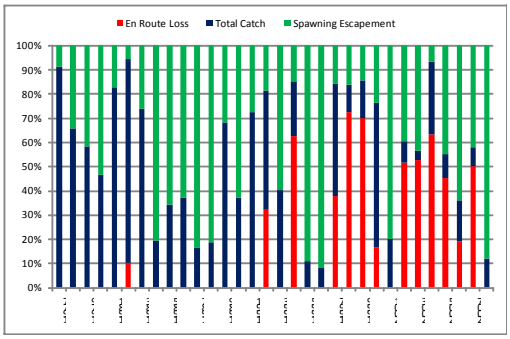
Effects of Climate Change in the Fraser Watershed



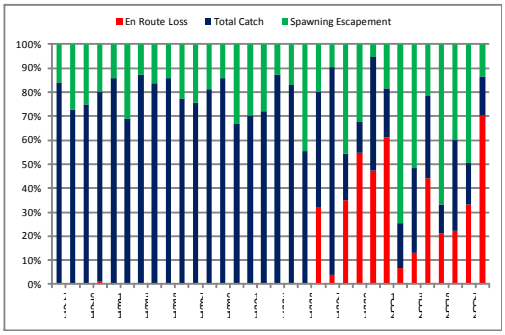
Long-term temperature increases in lower Fraser River
-18 C now routinely experienced



Early Stuart run

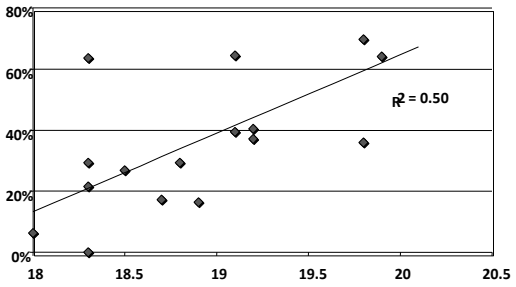


Late runs



En route loss can be large relative to harvest and spawning escapement, and very important in recent years

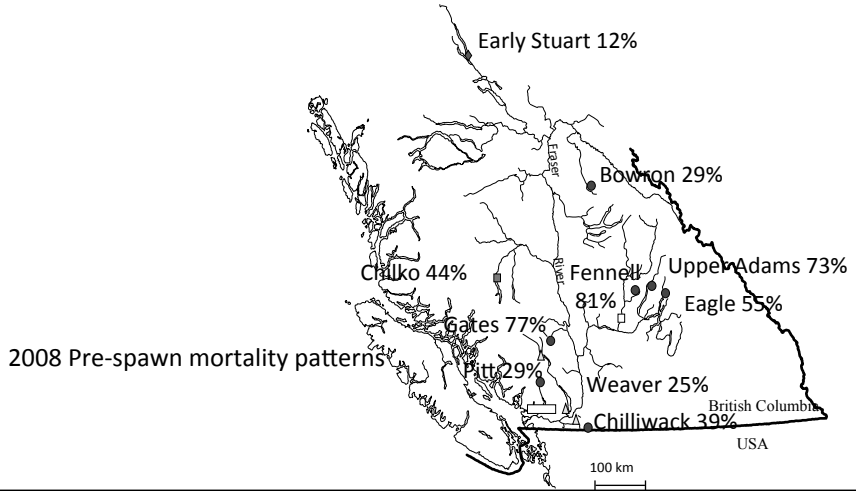
En route loss during thermally stressful years (> 18 ºC; 8 of 17 years) for Early summer and Summer runs (1992-2008)



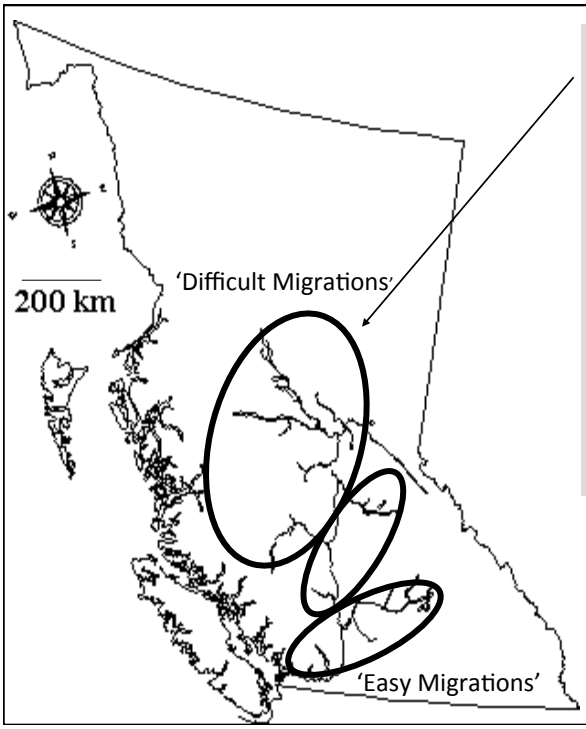
Mean 31 day Temperature (ºC)

Pre-Spawn Mortality

- Effects all stocks and can range among years from 0 to 90% in some stocks
- Higher and more variable in recent years



2008 Pre-spawn mortality patterns



Adults with long distance or high elevation spawning areas have:

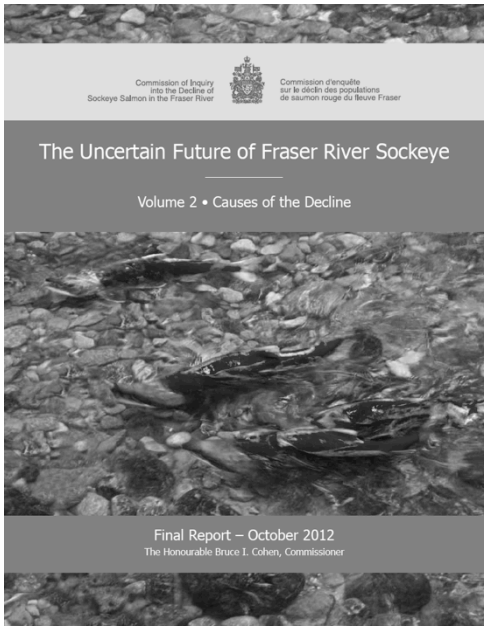
-small torpedo shaped bodies
-few and small eggs
-high max swimming speeds
-more efficient hearts
-large and broad 'metabolic scope'

-built for high performance and energy conservation

Technical Report 9: Climate Change

- *En route* mortality and pre-spawning mortality are temperature-dependent
- Reduced catch and spawning escapement, but not productivity
- Climate change is a likely contributor to the long term decline and a possible contributor to the 2009 decline

Causes for the decline



Are diseases and parasites responsible for Fraser sockeye declines?

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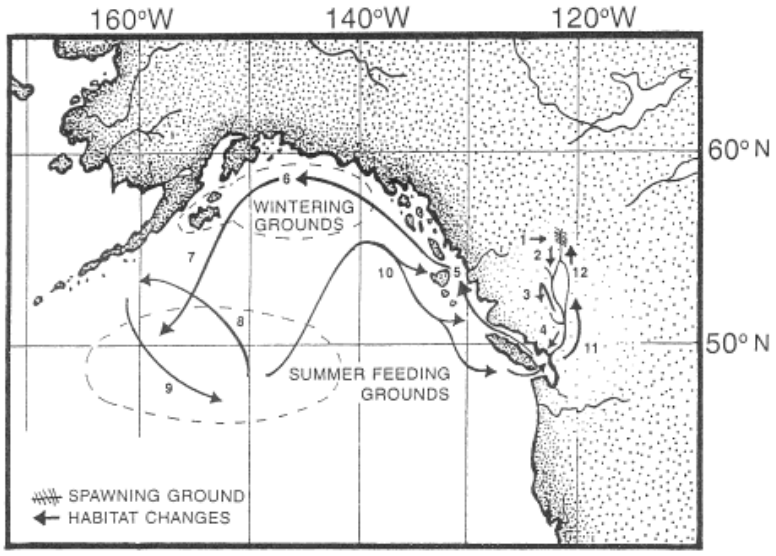
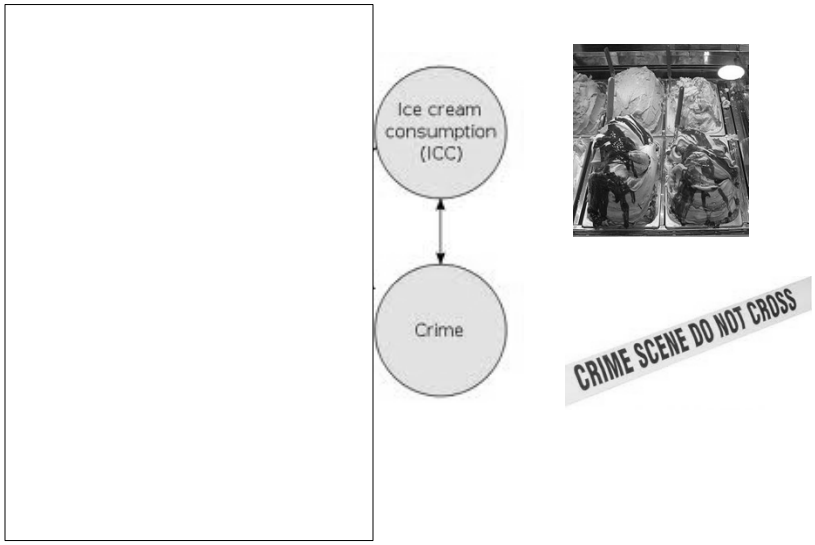
Why are scientists so cautious about making conclusions?

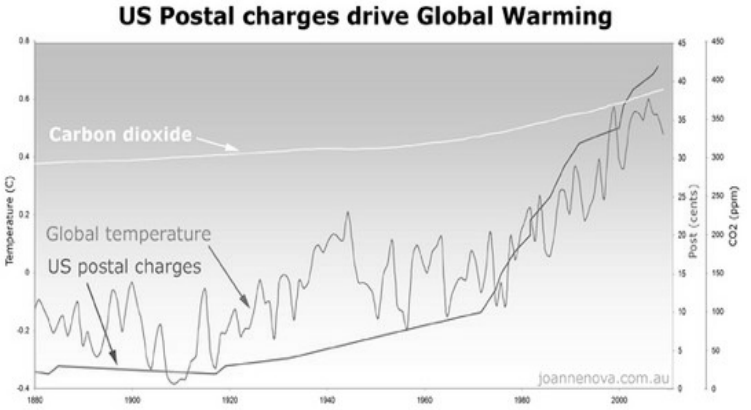
Fraser Salmon Marine Distribution



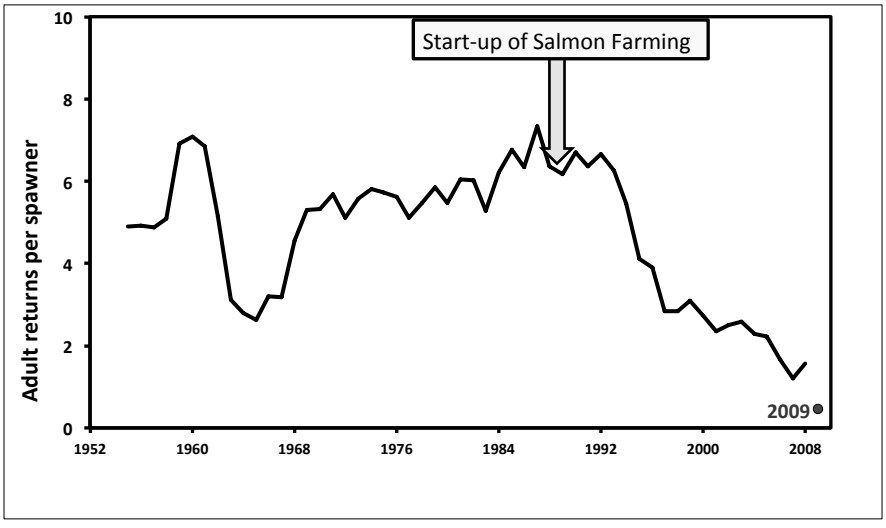
Does ice cream cause crime?



Another (absurd) example!



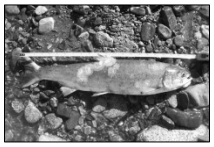
Are Fraser sockeye declines the result of salmon farming?



Proof?

- Absolute proof is largely unobtainable in most branches of science, especially in aquatic ecology
- All scientific statements and concepts are open to re-evaluation as new data is acquired and novel technologies emerge
- Preferred focus is to disprove hypotheses, leaving on the table those which cannot be disproven

Do diseases and parasites <u>contribute</u> to Fraser sockeye declines?

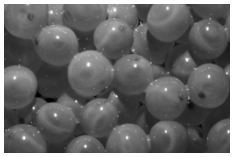


Analysis by life history stage

1. Incubation, emergence and freshwater rearing
2. Smolt outmigration
3. Coastal migration
4. Growth to adulthood
5. Return migration

Incubation, emergence and freshwater rearing

- Lack of quantitative evidence for increased stressor intensity over period of decline
- Survival from spawners to juveniles for 7 of 9 stocks has not declined; only Gates ↓. Ability of the Fraser to produce smolts hasn't declined
- No evidence to support adverse cumulative effects from numerous stressors

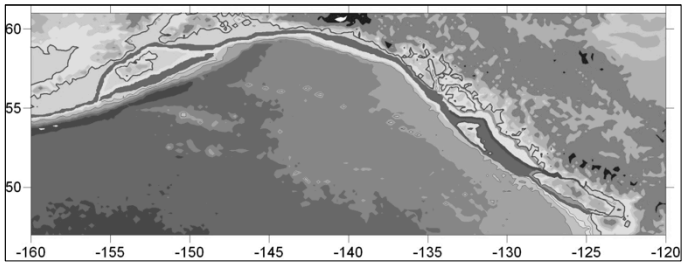


Smolt outmigration

- Available evidence doesn't support a conclusion that stressors e.g. contaminants or compromised estuarine habitats, have contributed to declines
- Harrison sockeye – the most vulnerable to estuarine habitat impacts since protracted residency in these habitats
- Significant knowledge gaps e.g. predators, pathogens, disease

Coastal migration

- Cohen Commission, PSC and Govt of Canada reports point to marine conditions during this life history stage as the most likely cause for the 2009 decline
- Extreme biophysical conditions during 2007: QCS and SOG
- Salmon farms +/-
- Peterman and Dorner findings suggest that causes for the long-term decline will be found in contiguous marine areas that are subject to similar environmental conditions



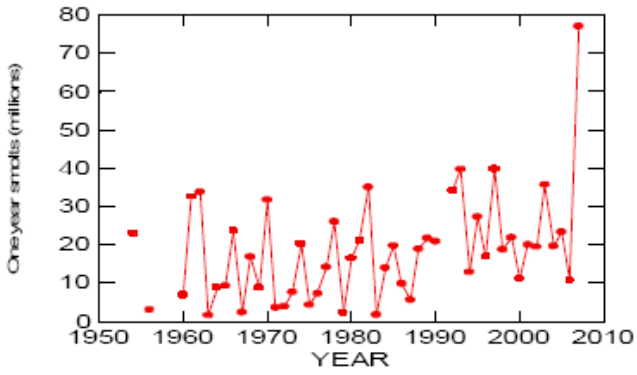
Growth to adulthood

- Marine conditions and climate change are possible contributors to the long-term decline – SSTs in Gulf of Alaska
- Competition with pink salmon
- Decline has occurred over large regional spatial scales
- Major knowledge gaps in North Pacific region

Return migration

- Increasing river temperatures pose a large risk
- Exposure to contaminants like endocrine disruptors may compromise immunocompetence (ability to fight disease) making sockeye more susceptible to disease, especially under warm temperatures

Chilko smolt numbers



2007 – twice the previous maximum; size was above the long-term average

Freshwater causative factor unlikely

- Spawning escapement (2005) was 3,300,000 fish; 1,000,000 fish greater than average escapement on this cycle
- Harvest rates in 2009 were very low
- Fry/smolt abundance not an issue
- High river temperature was not a factor in 2009 – in-season estimates of adults in marine approaches and at Mission indicated very low abundance

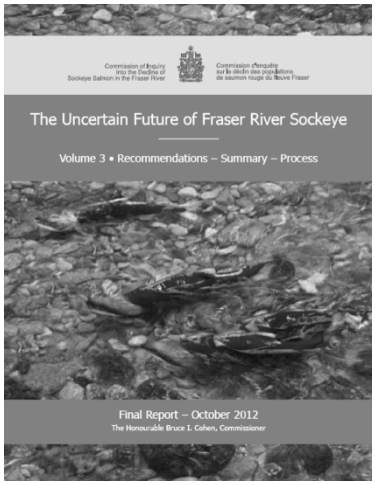
Sockeye smolts leaving Chilko Lake

Mike Lapointe
Pacific Salmon Commission

No smoking gun

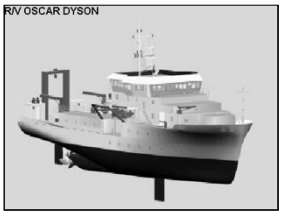
"Some, I suspect, hoped that our work would find the "smoking gun" – a single cause that explained the two-decade decline in productivity. The idea that a single event or stressor is responsible for the 1992–2009 decline in Fraser River sockeye is appealing but improbable."

75 Recommendations



<u>Research Recommendations:</u>

- Mortality during downstream migration
- Marine mortality
- Harrison River sockeye
- Regional production dynamics
- Cumulative effects



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NEWS RELEASE

Seaspan and Government of Canada Celebrate the Completion of the NSPS Umbrella Agreement

For Immediate Release – January 12, 2012

TIMES COLONIST

Search

March 18, 2013

Design work for three new offshore fisheries and science vessels is underway at Vancouver Shipyards, a milestone in the $8 billion worth of federal shipbuilding work anticipated on the west coast.

Wild Salmon Policy Recommendations (6)

Key Recommendations	➢New position: associate RDG ➢Dedicated funding ➢Annual reporting
March 31, 2013	- WSP implementation plan - Identification of red-zoned CUs - Response teams for red-zoned CUs - Socio-economic framework for Strategy 4
Sep. 30,2013	- Overview reports for FRS watersheds and marine areas
Dec. 31, 2013	- Habitat indicators and benchmarks for SOG, JFS, JS, QCS - Response teams to complete plans for restoration and protection of priority CUs

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Two benchmarks for the success of the Cohen Commission

1. Implementation of the recommendations

2. Future sustainability of Fraser River sockeye and the Fraser sockeye fishery