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Barkley Sound Sockeye: Intro to Strategic Management Planning

April 27, 2011

Wilf Luedke,
Bill Shaw,
Diana Dobson,
Kim Hyatt,
Erin Porszt

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Outcome is a long term strategic plan.

- Overview biology and stock status,
- Overview fishery and socio-economics,
- Assess habitat and ecosystem interactions,
- Factors limiting productivity and sustainability… 'the issues table'

Fishery Management Framework
- Management objectives
- Access and allocation
- Management measures
- Compliance

Production Framework
- Identify causal factors limiting productivity
- Stewardship Arrangements
- Restoration and Enhancement

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Initial focus on sockeye. Why?

- Risks to productivity, climate change, local environmental factors, GCL dam.
- Issues related to management such as Somass bands EO, catch reporting, escapement goal at higher run size
- Maanulth Treaty and implications for management of Henderson sockeye.
- MSC
- We promised a review of Somass sockeye management about 5 years ago.

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Factors Limiting Productivity of Sockeye

- List factors by life history stage. Identify gaps in issues table from January 27 meeting.
- Identify causal factors… human or natural
- Identify linkage, Assess risk, develop priorities
- Develop options, evaluate,
- Action

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The Management Framework… *the table*

1994 planning (poorly documented) to develop a management table.

- Aggregation of Somass CUs, Henderson managed passively
- stock benchmarks and escapement goals,
- Variable harvest rates and TAC at each run size
- fishery decision rules, allocations,
- production plan (e.g. lake fertilization),
- assessment and monitoring framework,
- Evolved over time.

2011-12 planning

- Propose to start with the management table.
- Use experience, considerations, principles, issues, etc.
- Incorporate WSP, Maa-nulth, and other policy considerations.

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DFO's Wild Salmon Policy recognizes that

The health of Pacific salmon depends not only on their abundance but also on their biological diversity.

That diversity includes the irreplaceable lineages of salmon evolved through time, the geographic distribution of these populations, the genetic differences and life history variations observed among them, and the habitats that support these differences."

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Management of Henderson Lake Sockeye Salmon Prior to MNA Treaty

- Prior to 2011, Henderson Lake sockeye were managed passively.
- Currently, there are no directed fisheries on Henderson Lake sockeye salmon within Barkley Sound or the approach waters. Henderson Lake sockeye salmon are harvested incidentally in Barkley Sound fisheries targeting Somass sockeye salmon.
- Time and area restrictions are used for fisheries in Barkley Sound to minimize incidental harvests of Henderson Lake sockeye salmon.

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Management of the Henderson Lake Sockeye Salmon under the April 1, 2011 MNA Treaty

DFO is now obligated to actively manage Henderson Lake sockeye for Maa-nulth First Nations FSC and economic opportunity:

- Annual FSC amounts to 26.85% of the Henderson Lake TAC up to a maximum of 17,055 pieces (as defined in the Maa-nulth First Nations Final Agreement),
- Economic opportunity will be 20% of the terminal commercial TAC (as defined in the Maa-nulth Harvest Agreement).

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Alberni/Barkley Sockeye Biology and Fishery Overview

Diana Dobson

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'Conservation Unit'

A CU is a group of wild salmon sufficiently isolated from other groups that, if lost, is very unlikely to re-colonize naturally within an acceptable timeframe (e.g., a human lifetime or a specified number of salmon generations).

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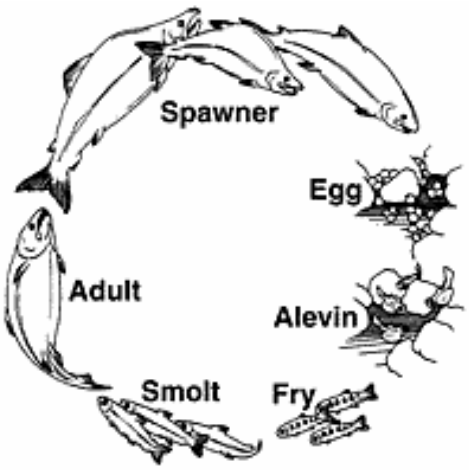
Area 23 Sockeye Conservation Units

- 4 Lake Conservation Units Defined (Great Central, Sproat, Henderson, Maggie)
- Creek sockeye populations within Area 23 are part of the larger WCVI 'River Type' Sockeye Conservation Unit

Salmon Life History

- Complex life history, using both freshwater and marine habitats to rear
- Significant life history variation within and among salmon species
- Variation in life history is often 'adaptive' – i.e. populations are adapted to the pressures of their local environment



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Area 23 Sockeye Diversity

- Lake-rearing Area 23 sockeye spend 1-2 years in freshwater and 1-3 years in the marine environment;
- Typical age at return is 4_2 and 5_2 year old fish;
- However, variation among the populations in productivity, dominant age at return, size-age of smolts, use of habitat, migration timing, etc.

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- Salmon are 'r-selected' species: They invest no energy in rearing and their offspring are subject to very high mortality rates. Therefore, they produce a lot of eggs.
- 3 orders of magnitude decline in the amount of eventual adults returning from the egg deposit,.
- Most of the mortality is natural and experienced in the early life stages.
- However, human activities influence rates of natural mortality through habitat modification, pollution, exotic species introduction, climate change, etc.

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Life History Table

	SPL	GCL	HDL
Spawners	130,000	173,000	32,000
Eggs	260,000,000	346,000,000	64,000,000
Fry	26,000,000	24,220,000	5,760,000
Smolts	6,500,000	6,055,000	1,152,000
Adults	260,000	302,750	40,320

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Fecundity	3500 to 4000
Egg-to-Fry-Mortality	***90 to 95%***
Fry-to-Smolt Mortality	***70 to 80%***
Smolt-to-Adult Mortality	96%
Harvest	20 to 36%

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Area 23 Sockeye Stock and Fishery

1. Production trends
2. Productivity trends
3. Catch trends, statistic

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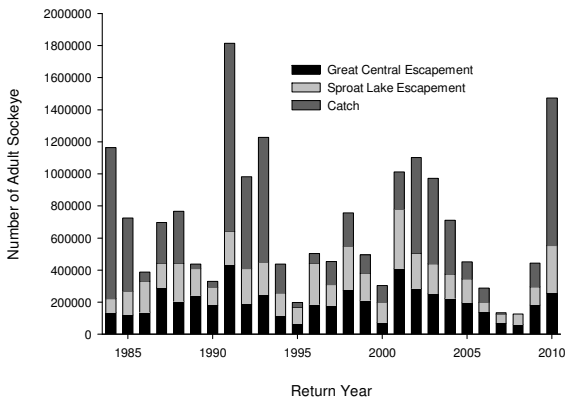
Production Trends



Average Return:

1980s – 867,000

1990s – 650,000

2000s – 490,000

(n.b. early averages skewed by high return years. Still, in recent years the frequency of high returns has decreased while the frequency of low returns has increased)

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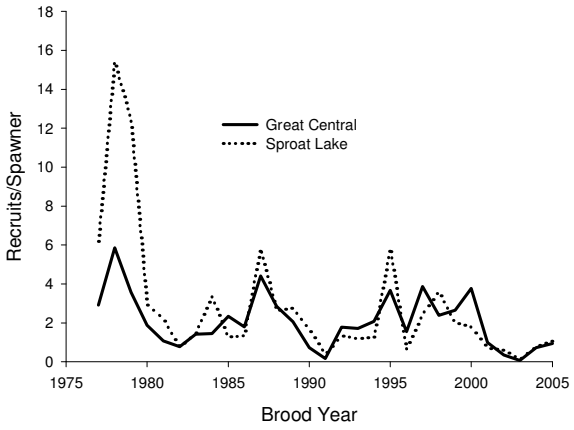
Productivity Trends



Average Adult Recruits per Spawner:

1980s:
GCL 2.0 SPL 2.4

1990s:
GCL 2.1 SPL 2.0

2000s:
GCL 1.7 SPL 1.4

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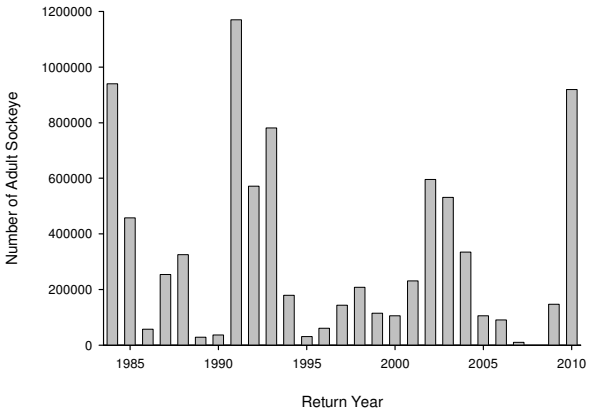
Catch Trends



Average Catch:

1980s – 521,000

1990s – 324,000

2000s – 206,000

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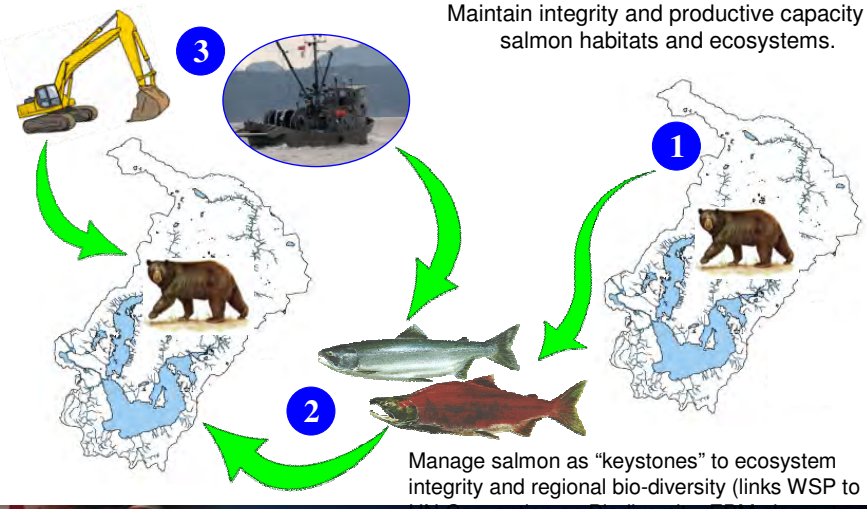
Ecosystem Considerations under Canada's policy for Conservation of Wild Pacific Salmon (WSP)

Barkley Sound Salmon Initiative

April 27, 2011

Kim Hyatt

EBM under WSP-S3 acknowledges that: (1) ecosystems influence salmon, (2) salmon influence ecosystems and (3) DFO sectoral activities influence both salmon and ecosystems.



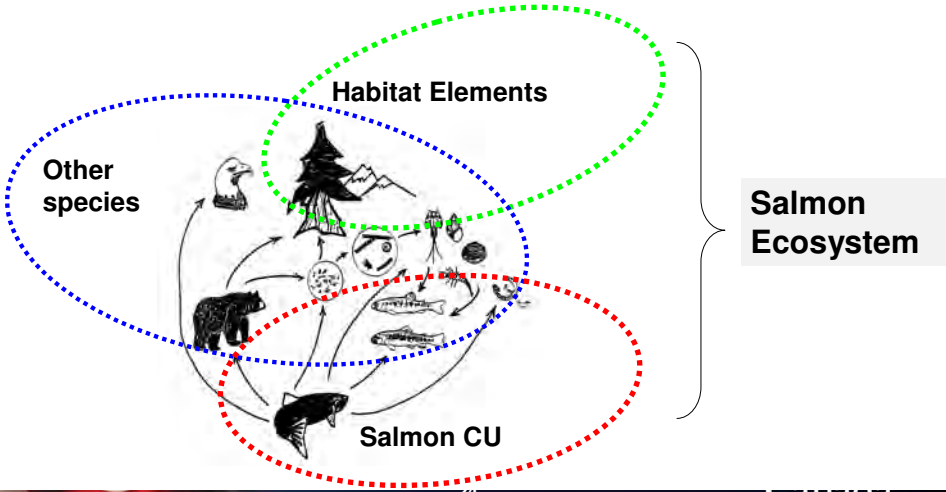
Maintain integrity and productive capacity of salmon habitats and ecosystems.

Manage salmon as "keystones" to ecosystem integrity and regional bio-diversity (links WSP to UN Convention on Biodiversity, EBM elements of Oceans Act etc.)

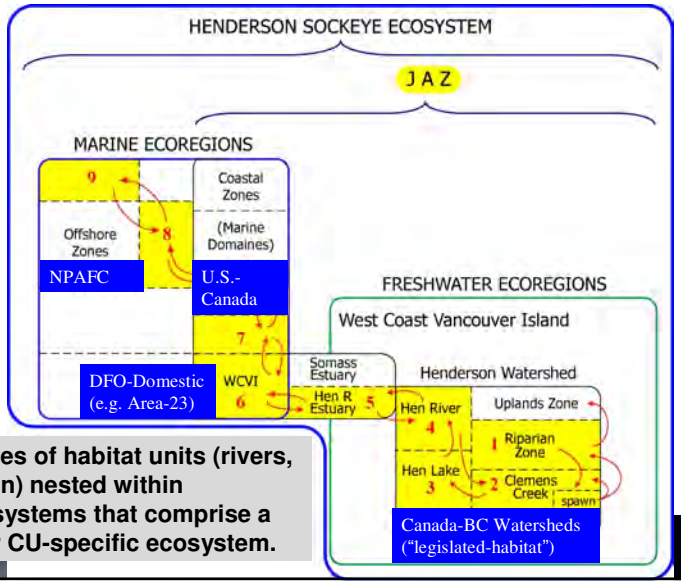
Approach to developing ecosystem objectives and indicators

1. Define operational ecosystem units
2. Determine reference state
3. Identify sector specific EBM objectives with Sectors, FN & other Stakeholders
4. Develop Indicators
5. Develop Monitoring plan

Definition : Ecosystems are groups of organisms and their environment , so a salmonid ecosystem, under WSP, consists of (1) a salmon CU, (2) associated habitat elements and (3) species that salmon interact with.

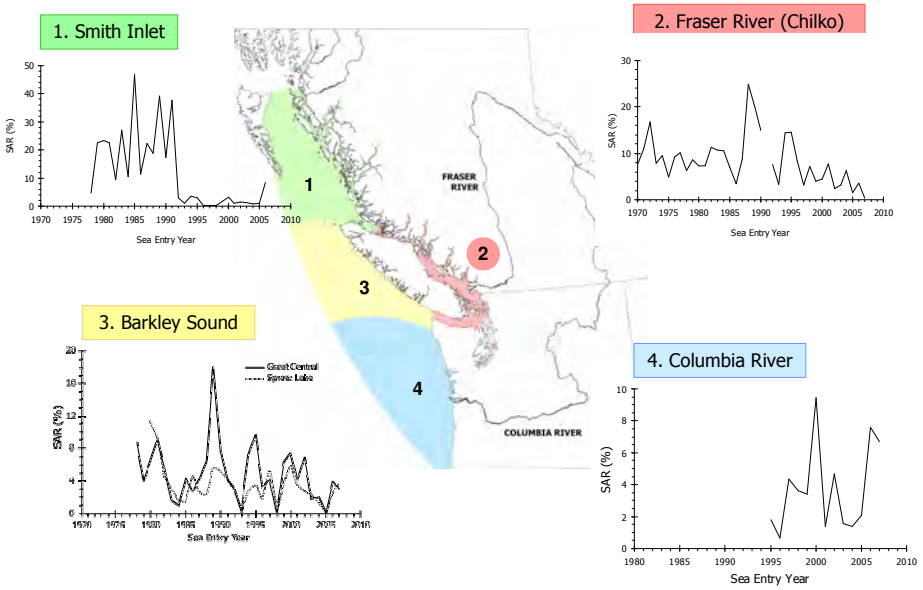


Operational Ecosystem Units



Salmon occupy a series of habitat units (rivers, lakes, estuaries, ocean) nested within freshwater & marine systems that comprise a joint adaptive zone or CU-specific ecosystem.

Sockeye Salmon Index Stocks Marine Survival Trends



Recent among stock comparisons provide compelling evidence supporting the "HOMS hypothesis" (Hyatt et al. 2010, *in prep*) !

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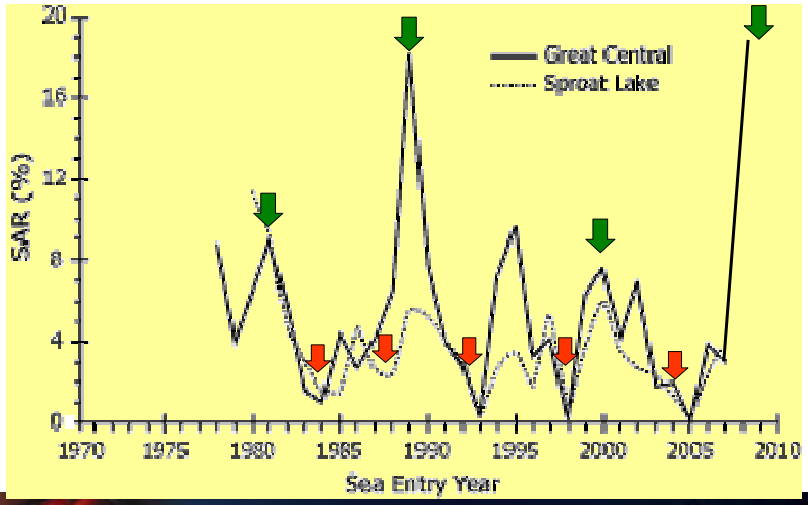
Powerful La Niña (green) and El Nino events in the year of sea entry are clearly associated with above and below average marine survivals for Barkley Sd sockeye stocks.



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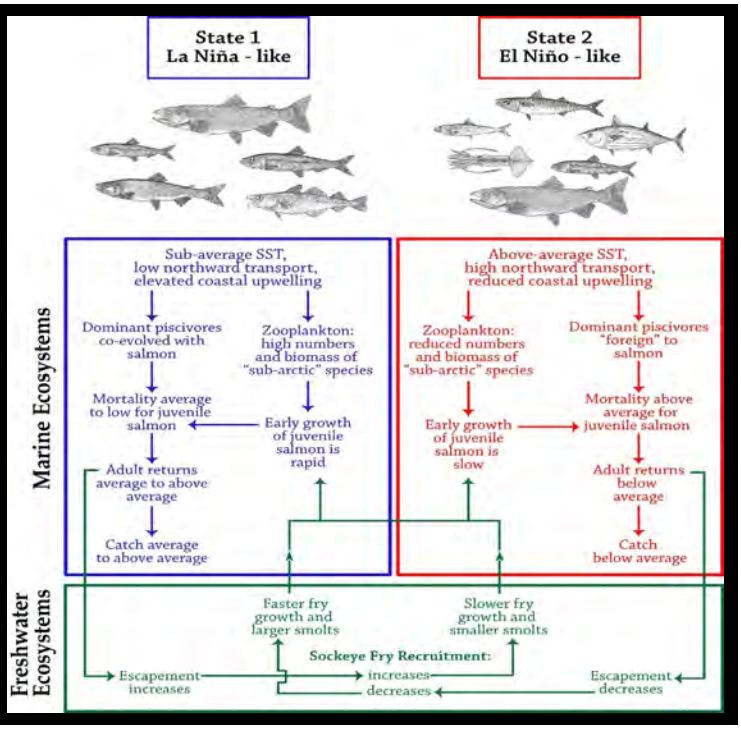
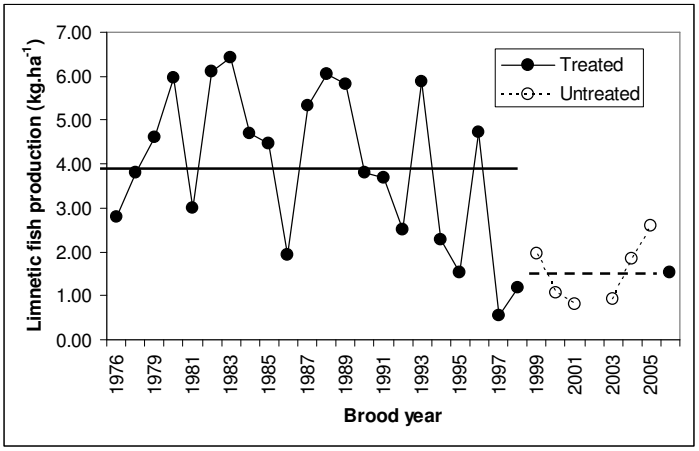
Out of Basin Effects

Two-state model of ocean conditions and salmon survival for Barkley Sd sockeye & the origin of the "HOMS hypothesis" (Hyatt & Steer 1988)



Productivity & Carrying Capacity of the Henderson Sockeye CU



Nutrient additions to Henderson L. indicate the extent to which sockeye productivity is controlled by habitat state changes. On average, treated year production of sockeye was more than twice that observed in untreated control years. Impacts on maximum carrying capacity are even larger (i.e. factor of 5!)

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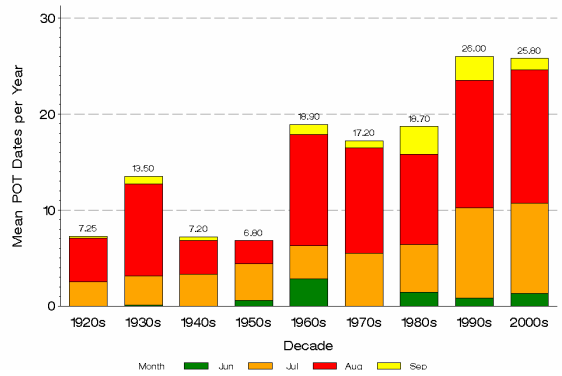
Somass River Water Temperature Exceedance Analysis

Linear Reconstructed Somass River Water Temperature based on RC10DayBMAT

Decadal Mean Annual MWT Peaks > 20c



Decadal Mean Monthly MWT Peaks > 20c

Site: Somass River

Decade	Years in Decade	Mean Days Jun	Jul	Aug	Sep	Mean Annual Total
1920s	12		2.5	4.6	0.2	7
1930s	10	0.1	3.0	9.6	0.8	14
1940s	10		3.3	3.5	0.4	7
1950s	10	0.6	3.8	2.4		7
1960s	10	2.8	3.5	11.6	1.0	19
1970s	10		5.5	11.0	0.7	17
1980s	10	1.4	5.0	9.4	2.9	19
1990s	10	0.8	9.4	13.3	2.5	26
2000s	10	1.3	9.4	13.9	1.2	26

Bars indicate mean frequency of dates where MWT of 20c exceeded, across years within each decade

Another way of looking at the previous graph, in which stacked bars show monthly contribution to total mean decadal POT_{20}.

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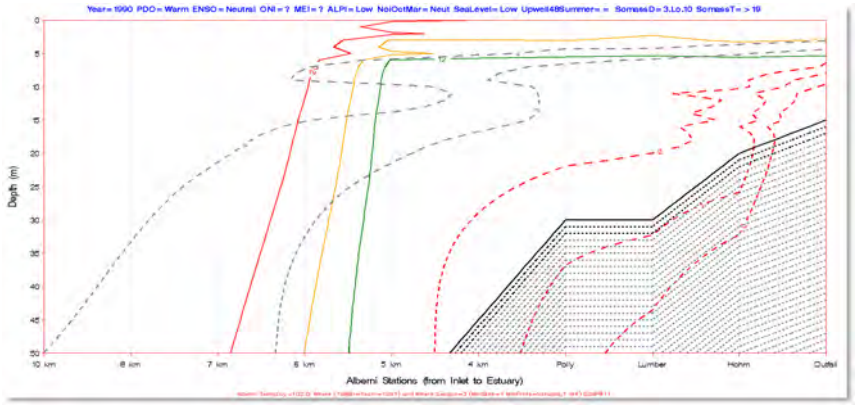
1990 – July, Aug, Sep
Stn: Outfall to 5km only available



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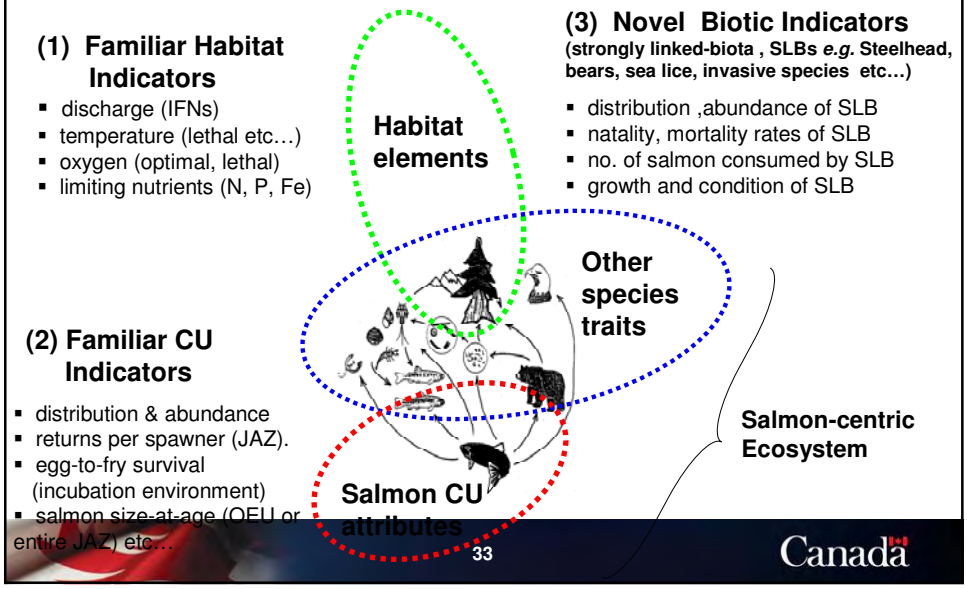
Integrating WSP Strategy 1-3 Assessments to Inform S-4

To engage DFO in "progressively considering ecosystem values in salmon management" & in "providing the scientific understanding plus technical capacity to include ecosystem values over time" we will:

- ❑ Complete EBM paper & a peer review workshop (Jan. 2010).
- ❑ Develop/test/refine WSP-EBM **concepts*** in "pilot" areas to focus on area-specific, sectoral objectives and priority freshwater OEUs (e.g. Barkley Sound Pilot, sockeye and Chinook CUs).
- ❑ Identify suites of simple or aggregate indices as informative and affordable indicators of progress in meeting EBM objectives in priority CU-OEUs (*e.g.* in the Barkley Sound WSP Pilot)
- ❑ Organize a DFO workshop early in 2010 to examine ocean climate factors and salmon survival predictions.
- ❑ Identify information gaps impeding effective EBM and prioritize research required to fill these gaps.

EBM Indicators: Identification of sectoral impacts on ecosystem integrity will rely on use & development of familiar & novel indicators associated with CUs, habitat & salmon-dependent biota



Reference state(s) for maintenance of "ecosystem integrity"* and associated indicators.

- **Historic, "natural" ecosystem**: state characterized by "unimpaired," pre-industrialized conditions (< 1900s, *e.g.* Gwaii Haanas National Park).
- **Current, but altered, ecosystem**: a current state exhibiting an acceptable range of desirable conditions (*e.g.* possibly Barkley Sound ecosystem).
- **Future, altered ecosystem**: state reflecting movement towards a more desirable range of conditions than the current state (*e.g.* Okanagan sub-basin).

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Barkley Sound Sockeye: Provisional Biological Benchmarks and Status

April 27, 2011

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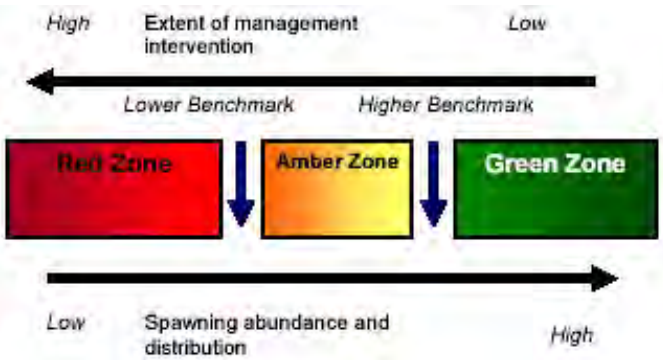
Benchmarks and zones of biological status



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WSP Biological benchmarks used to indicate status

- **Red when**:
  - Spawner abundance is below the lowest level which would rebuild to MSY in 1 generation with no fishing.
  - Greater than 25% decline in abundance over the last 3 generations (12-15 years).
  - Average spawner abundance over last 4 years is less than 25% of historic average spawner abundance.
- **Amber when**… between red and green.
- **Green when**:
  - Spawner abundance is greater than 80% of MSY.
  - Less than a 15% decline in abundance over the last 3 generations (12-15 years).
  - Average spawner abundance over last 4 years greater than 50% of the historic average spawner abundance.

Great Central Lake

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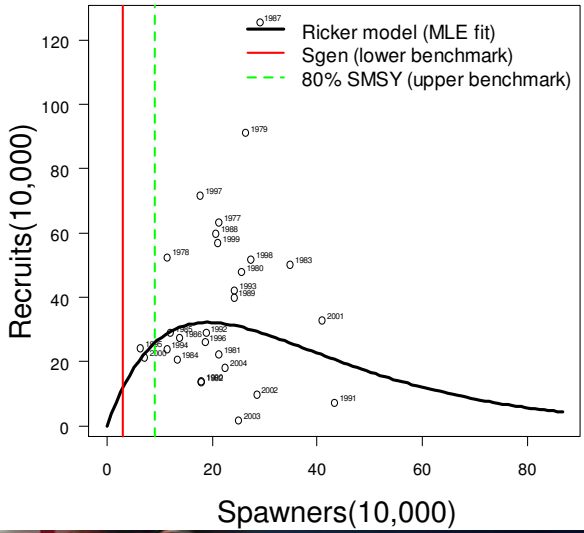

Great Central Lake

Lower: 29,290

Upper: 91,640

Average spawners (2007-2010): 126,366

Status: GREEN

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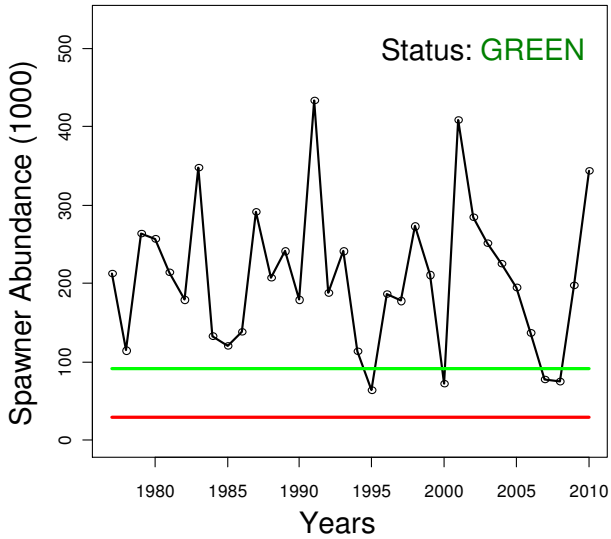

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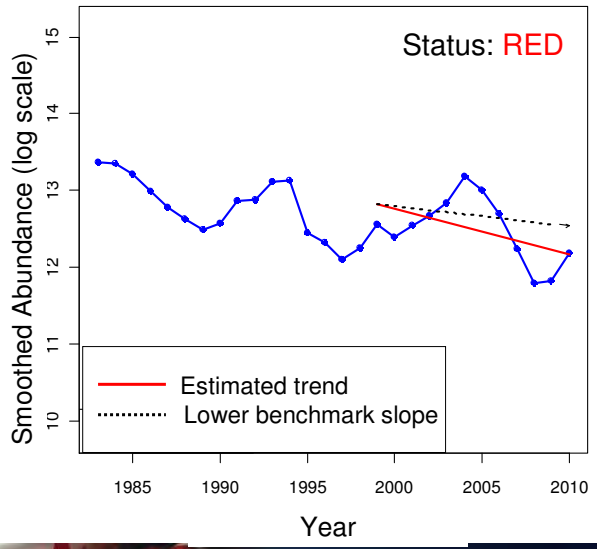

Great Central Lake

RATE of decline over last 3 gen

Lower: 25%

Upper: 15%

Observed rate of decline: 49%

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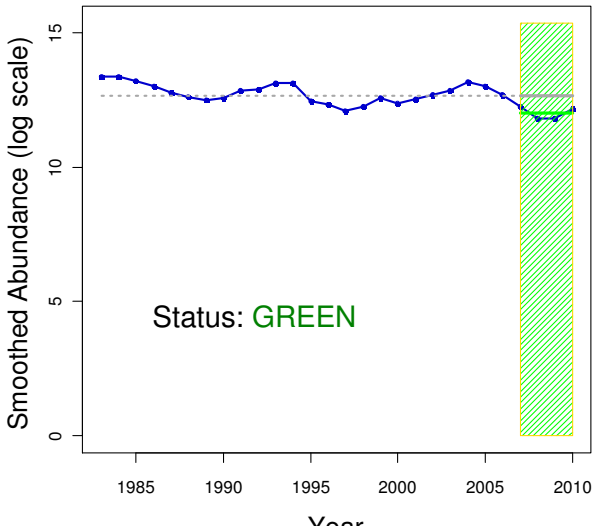

Great Central Lake

Average of current generation compared to historic average

Lower: 25%

Upper: 50%

Observed: 52%

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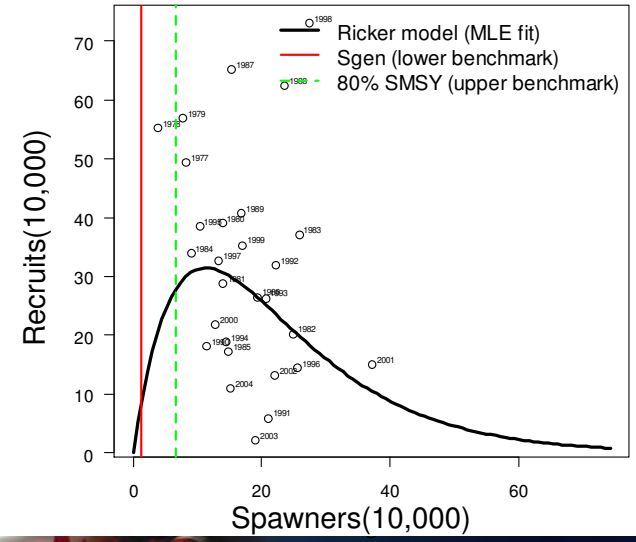
SPROAT LAKE



Sproat Lake

Lower: 12,060

Upper: 65,570

Average spawners (2007-2010): 109,777

Status: GREEN

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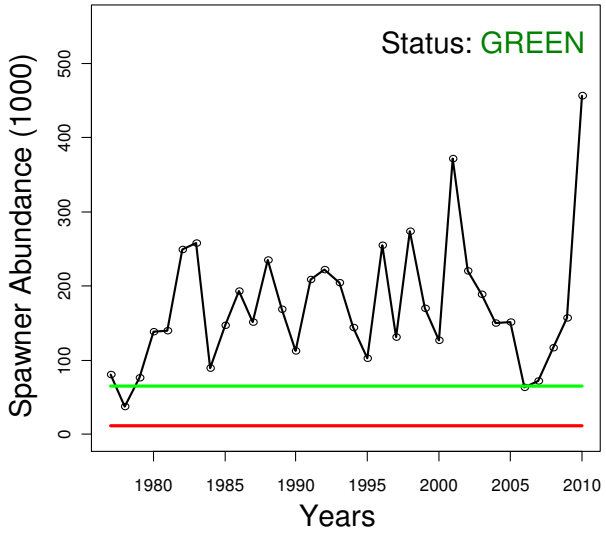

Sproat Lake

Average spawners (2007-2010): 109,777

Upper: 65,570

Lower: 12,060

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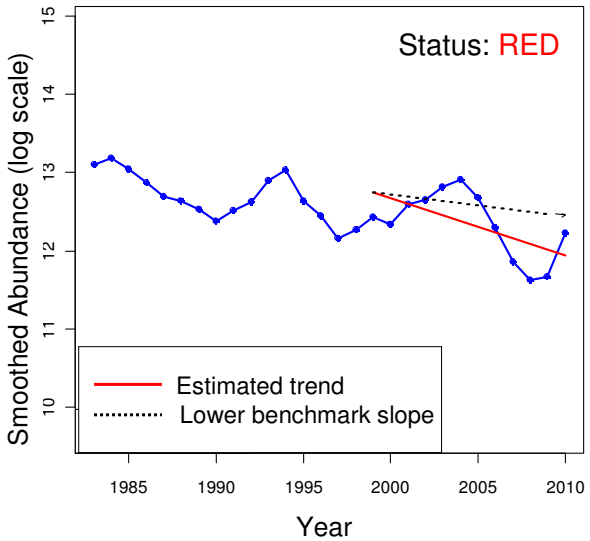

Sproat Lake

RATE of decline over last 3 gen

Lower: 25%

Upper: 15%

Observed rate of decline: 57%

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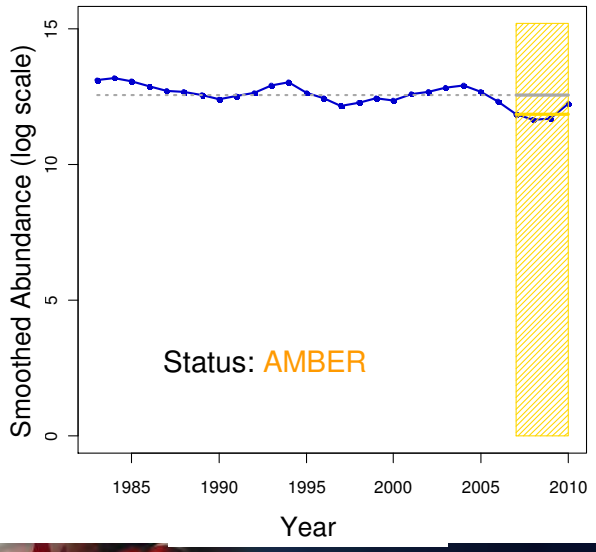

Sproat Lake

Average of current generation compared to historic average

Lower: 25%

Upper: 50%

Observed: 50%

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HENDERSON LAKE

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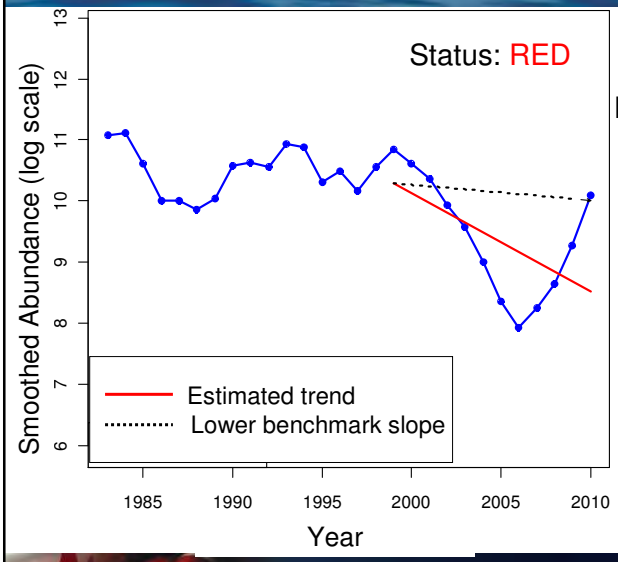

Henderson Lake

RATE of decline over last 3 gen

Lower: 25%

Upper: 15%

Observed rate of decline: 86%

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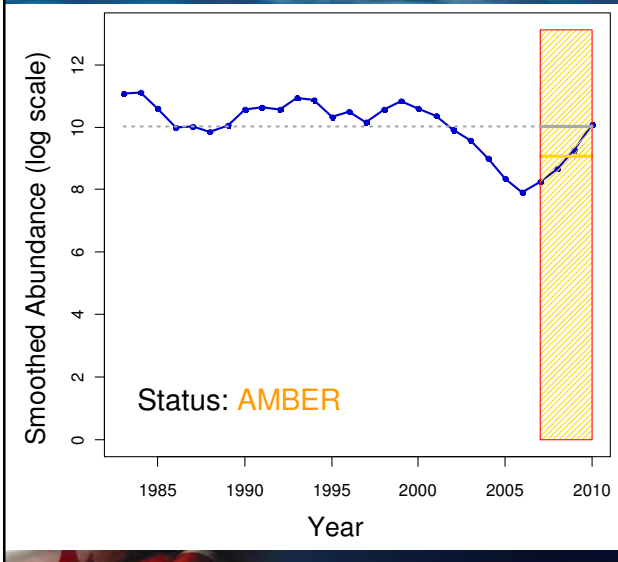

Henderson Lake

Average of current gen compared to historic average

Lower: 25%

Upper: 50%

Observed: 38%

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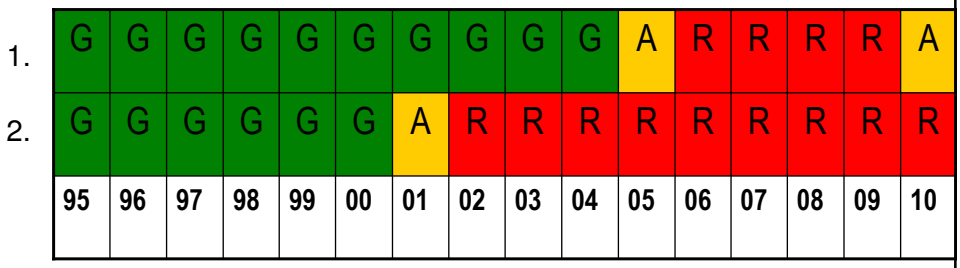
Trend in status of Henderson sockeye

1. Current generation average compared to historical average (top)
2. Rate of change over last three generations (bottom)



YEAR

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WSP Benchmarks vs Current Management Reference Points

	Wild Salmon Policy		Current	
	Lower Benchmark	**Upper Benchmark**	**Lower Ref. Point**	**Upper Ref. Point**
Great Central	30,000	92,000	114,000	200,000
Sproat	12,000	66,000	86,000	150,000
Combined Somass	42,000	158,000	200,000	350,000
Henderson	?	?	?	50,000

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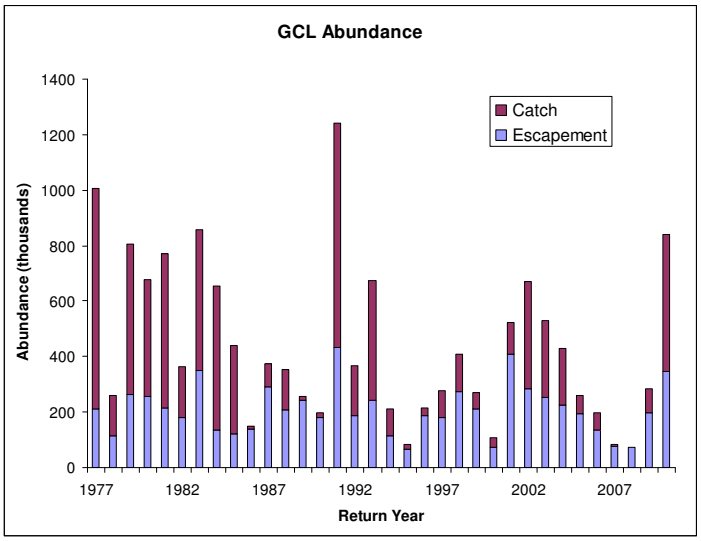

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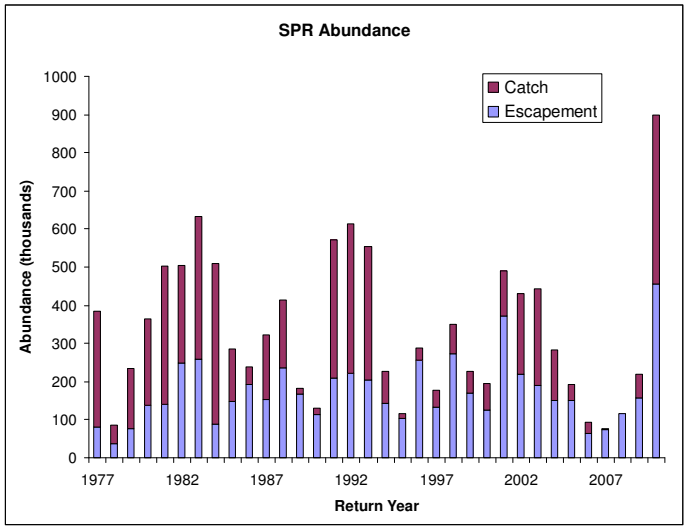

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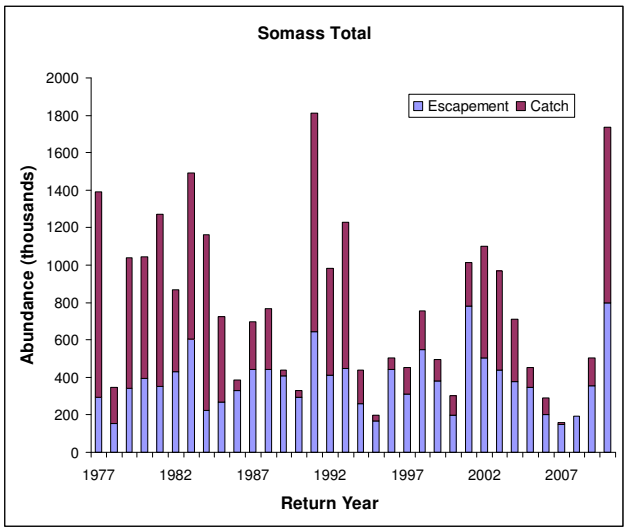
Somass Total
Escapement
Catch
Abundance (thousands)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1977
1982
1987
1992
1997
2002
2007
Return Year