USACE-Seattle District Lake Washington General Investigation

JUVENILE CHINOOK SALMON DISTRIBUTION, DIET AND PREY RESOURCES BELOW THE LOCKS*

*This presentation contains preliminary work, NOT final forms of data OR interpretations, which will be in final report to USACE. Anyone interested in using this information for ANYTHING should contact Si.

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USACE-Seattle District Lake Washington General Investigation

Greater Shilshole Bay Investigations of Juvenile Salmon Passage and Habitat Utilization

Task I.A Recover in Shilshole Bay PIT-tagged juvenile Chinook salmon that have used alternative pathways through the Locks

Conduct high intensity, low frequency sampling to recover the maximum number of PIT-tagged juvenile chinook salmon during peaks in their migration from the Lake Washington Ship Canal through the Locks to Shilshole Bay.

Task I.B Assess the overall use of Shilshole Bay by juvenile salmon, irrespective of their origin, and related (potential predators and competitors) fishes

Conduct low intensity, high frequency "background" sampling of all species of fish in several "indicator" locations/habitats in Shilshole Bay.

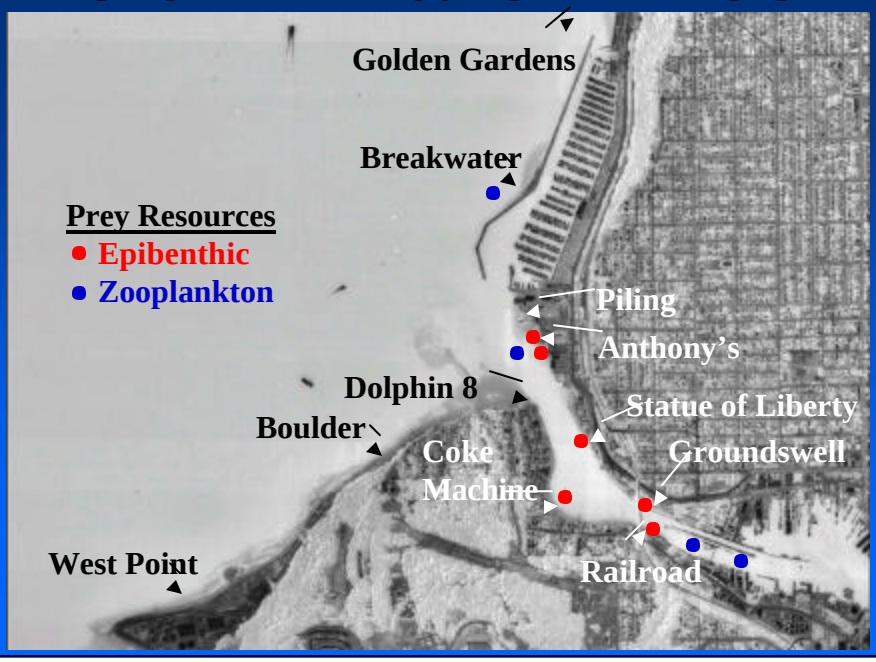
Task II.C Document juvenile salmon diet and prey resources in the greater Shilshole Bay estuary.

Address the natural and unique capacity of the greater Shilshole Bay estuary to support foraging by juvenile salmon that are both migrating through the Ship Canal and Locks as well as rearing in the estuary. An effort will be made to also collect diet and prey resource information above the Locks.

APPROACH

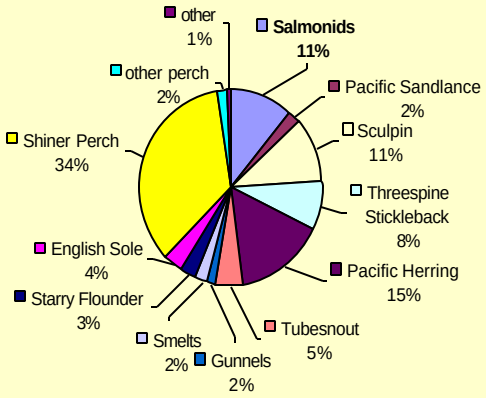
- Regular (weekly), systematic beach seine sampling at 11 sites across estuarine gradient, May-October 2001
- Intensive "blitz" sampling during 18-22 June 2001, to obtain maximum recovery of PIT tags
- Basic data: species, wild/adipose clipped, length, stomach contents (gastric lavage) and PIT tag recovery.
- Regular (biweekly) sampling of (a) epibenthic prey resources at six site using excavated sampling cylinder and (b) pelagic prey at four sites (including one upstream of Locks) using vertical plankton hauls, to document potential prey availability relative to shoreline habitat and position along estuarine gradient.

SHILSHOLE BAY 2001 SAMPLING SITES



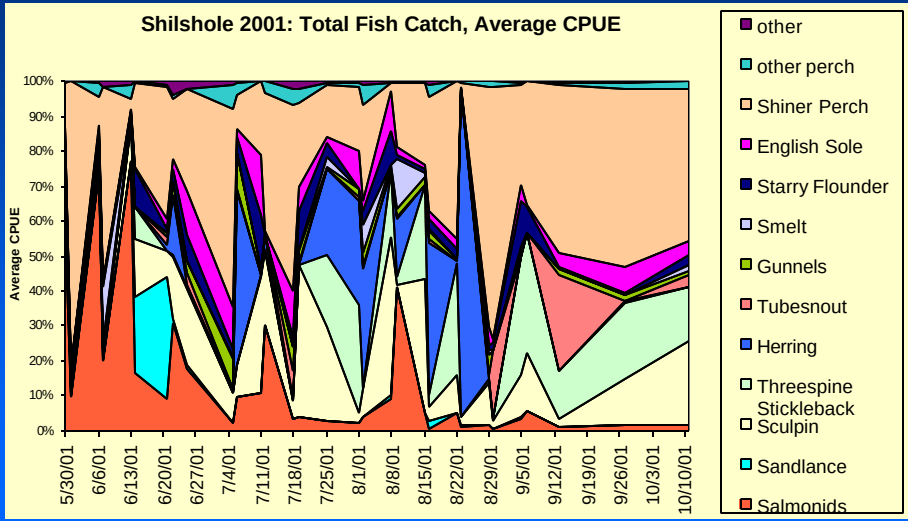
SHILSHOLE BAY 2001
Catches Overall

Shilshole 2001: Total Average CPUE



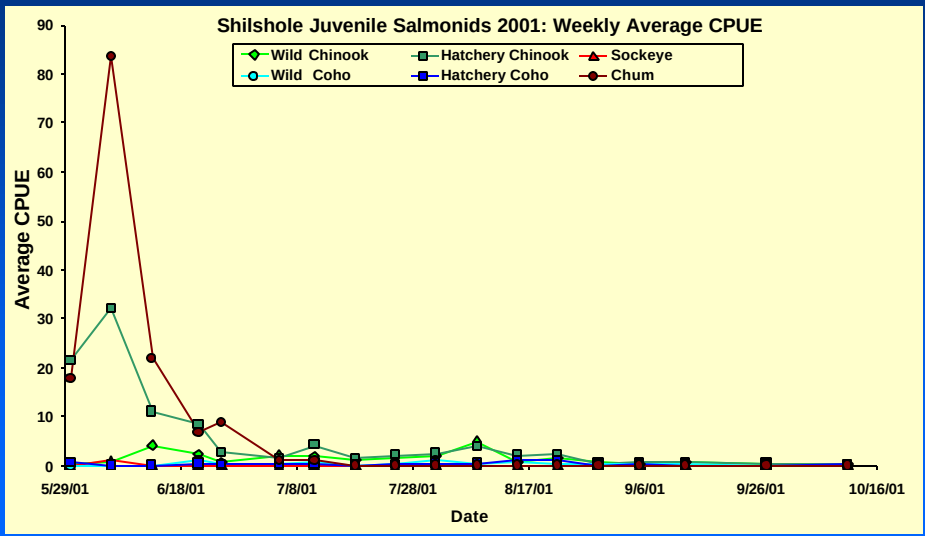
SHILSHOLE BAY 2001
Fish Catches Over Duration of Sampling Period

Shilshole 2001: Total Fish Catch, Average CPUE



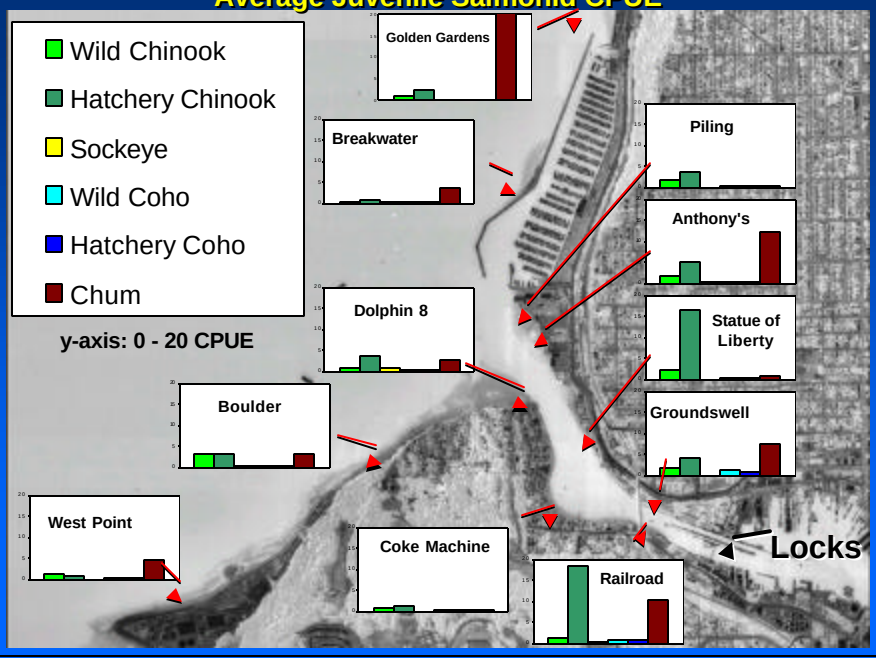
SHILSHOLE BAY 2001

Juvenile Salmon Catches 5/29-10/16/03

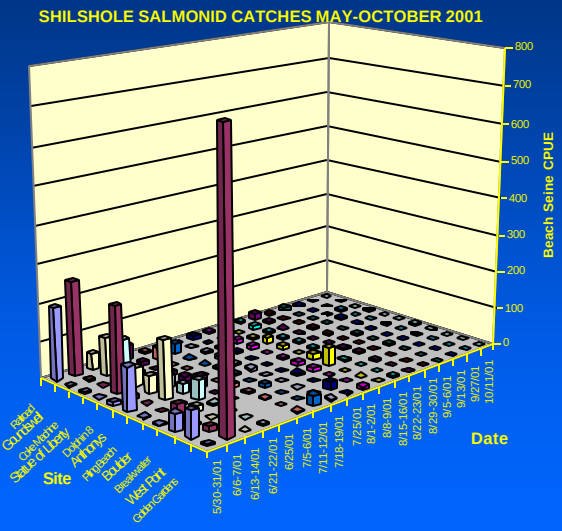


SHILSHOLE BAY 2001

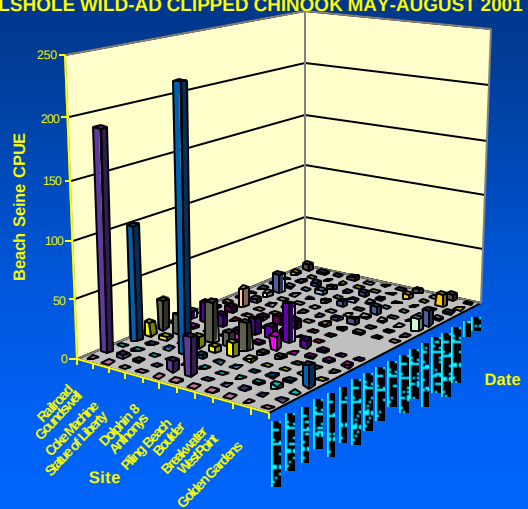
Average Juvenile Salmonid CPUE



SHILSHOLE BAY 2001
Juvenile Salmonid CPUE by Site and Date

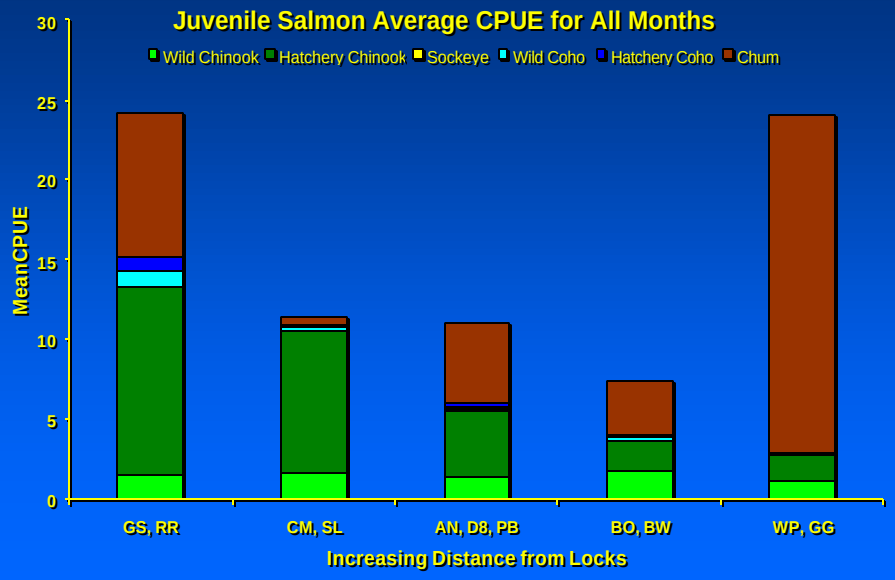


SHILSHOLE BAY 2001
Marked/Unmarked Juvenile Salmonid CPUE by Site

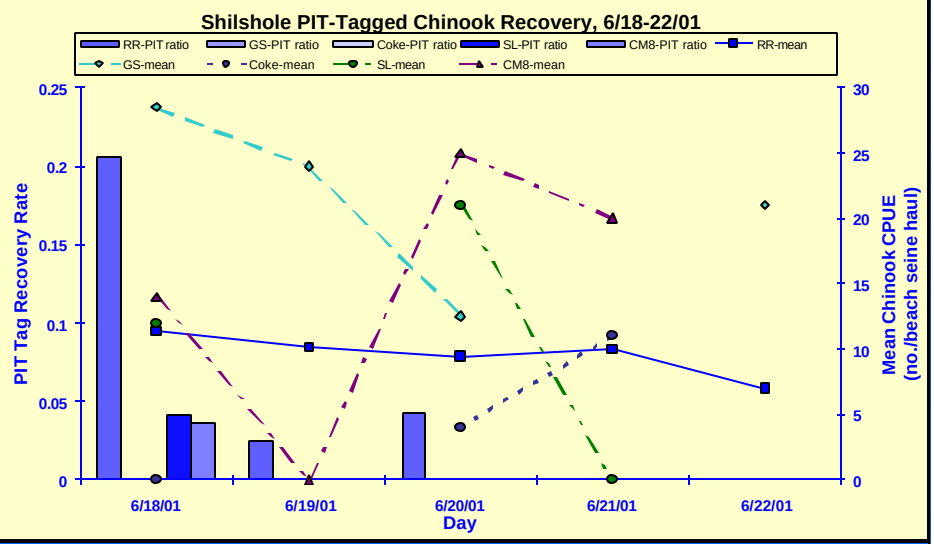


NOTE: adipose-clipped (hatchery) fish are indicated by cross-thatched histogram bars and unmarked (unknown proportion wild) by solid bars.

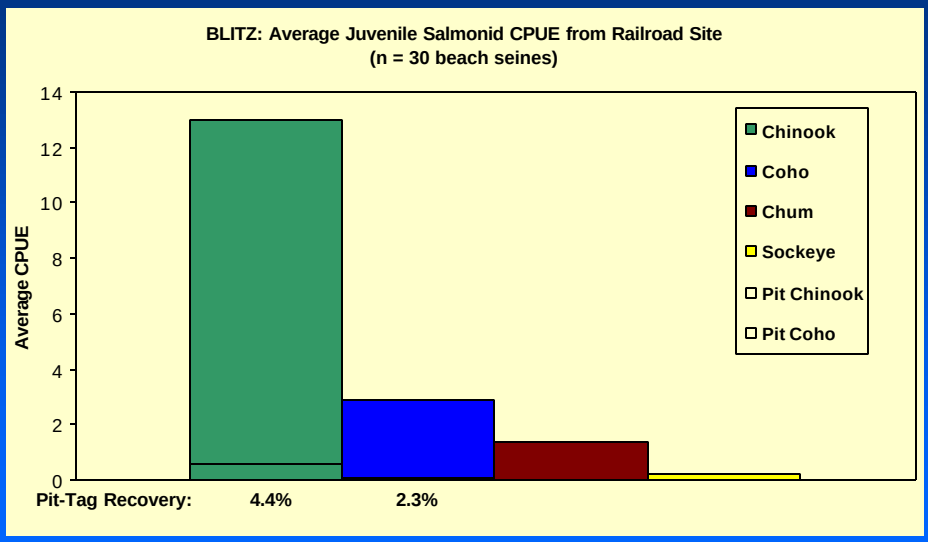
SHILSHOLE BAY 2001
Composition and Mean SPUE by Distance from Locks



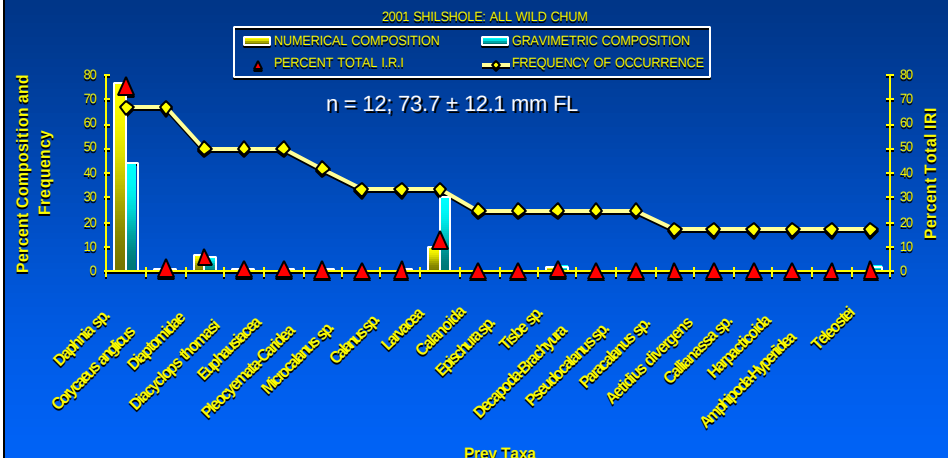
SHILSHOLE BAY 2001
Recovery of PIT Tagged Chinook



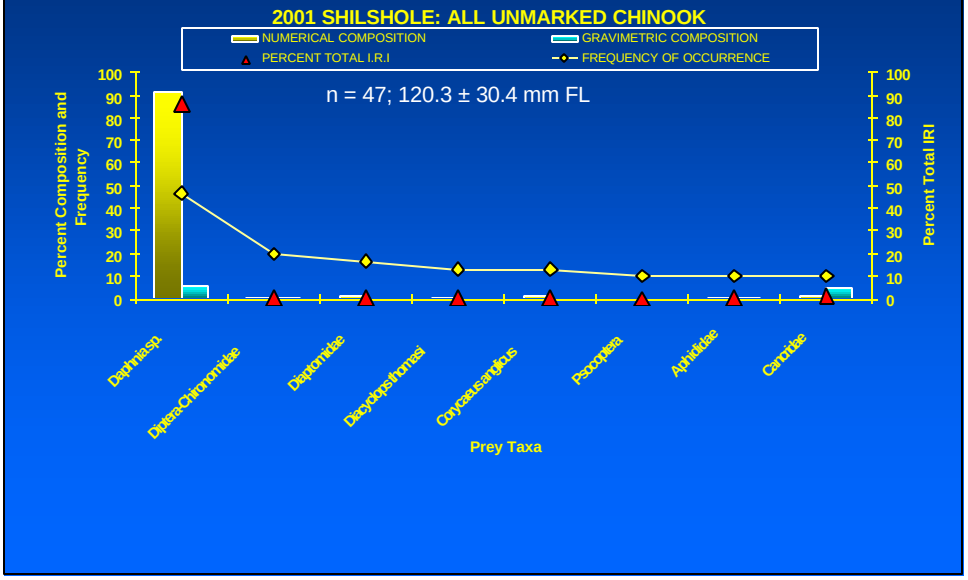
SHILSHOLE BAY 2001
Proportion of PIT Tagged Salmonids



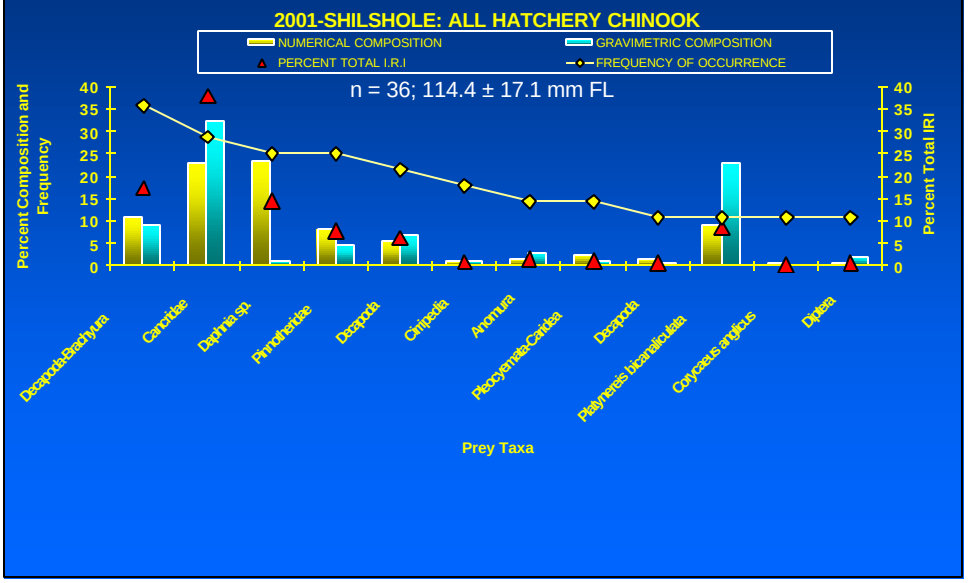
SHILSHOLE BAY 2001
Juvenile Chum Salmon Diet Composition



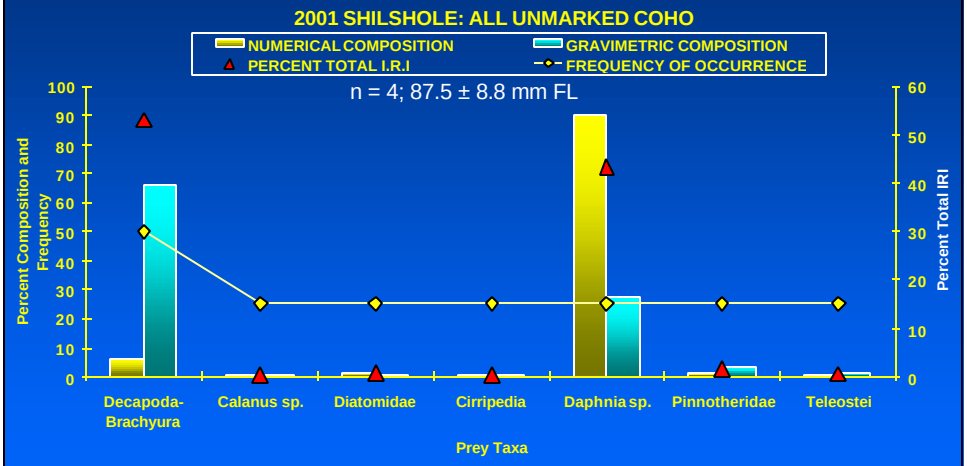
SHILSHOLE BAY 2001
Unmarked Juvenile Chinook Salmon Diet Composition

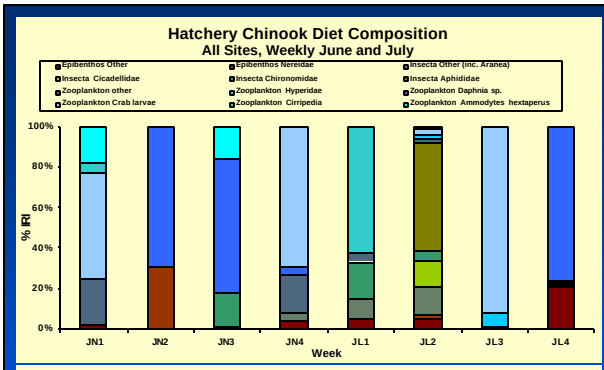


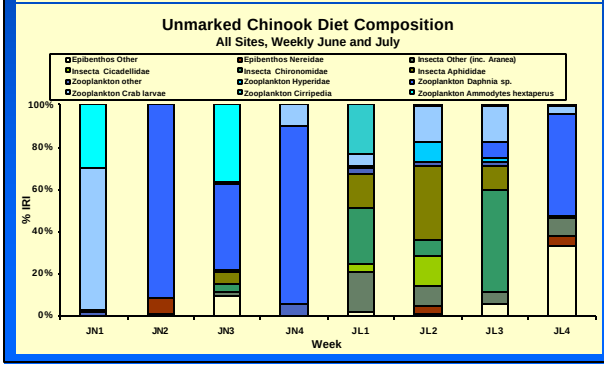
SHILSHOLE BAY 2001
Hatchery Juvenile Chinook Salmon Diet Composition



SHILSHOLE BAY 2001
Unmarked Juvenile Coho Salmon Diet Composition

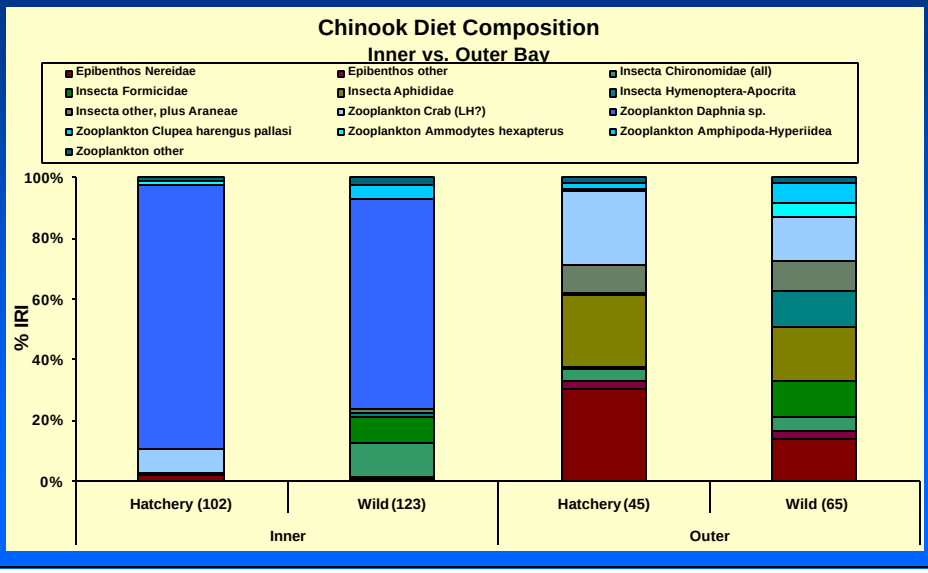


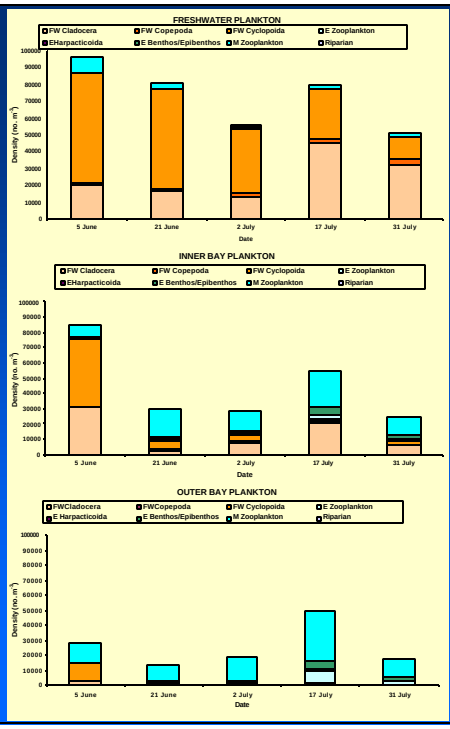




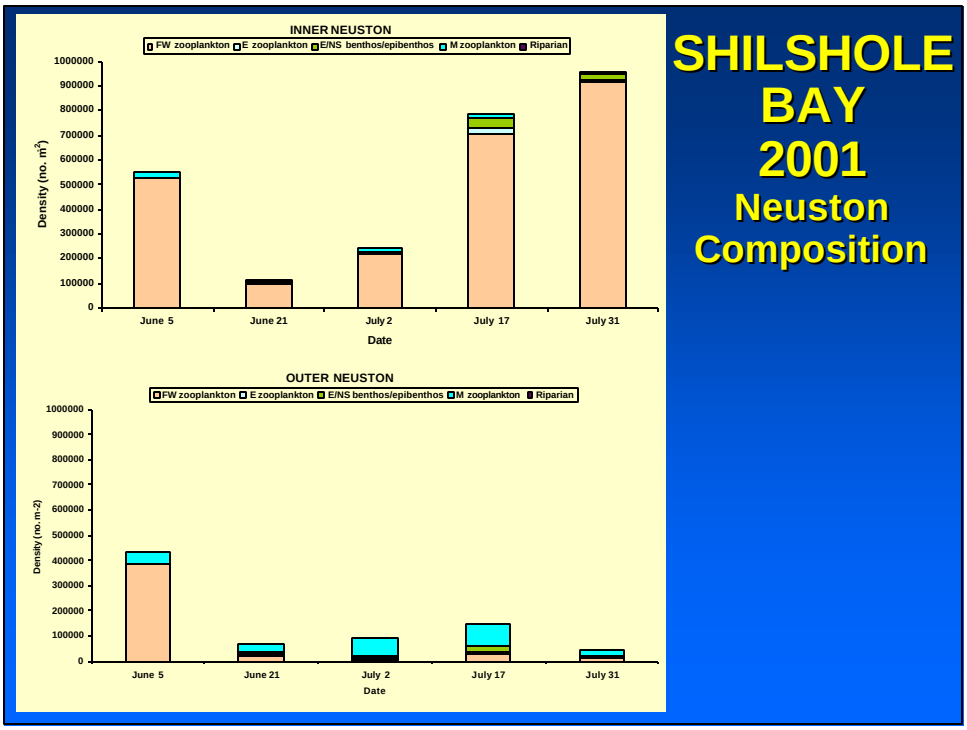
SHILSHOLE BAY 2001
Chinook Diet Composition June-July 2001

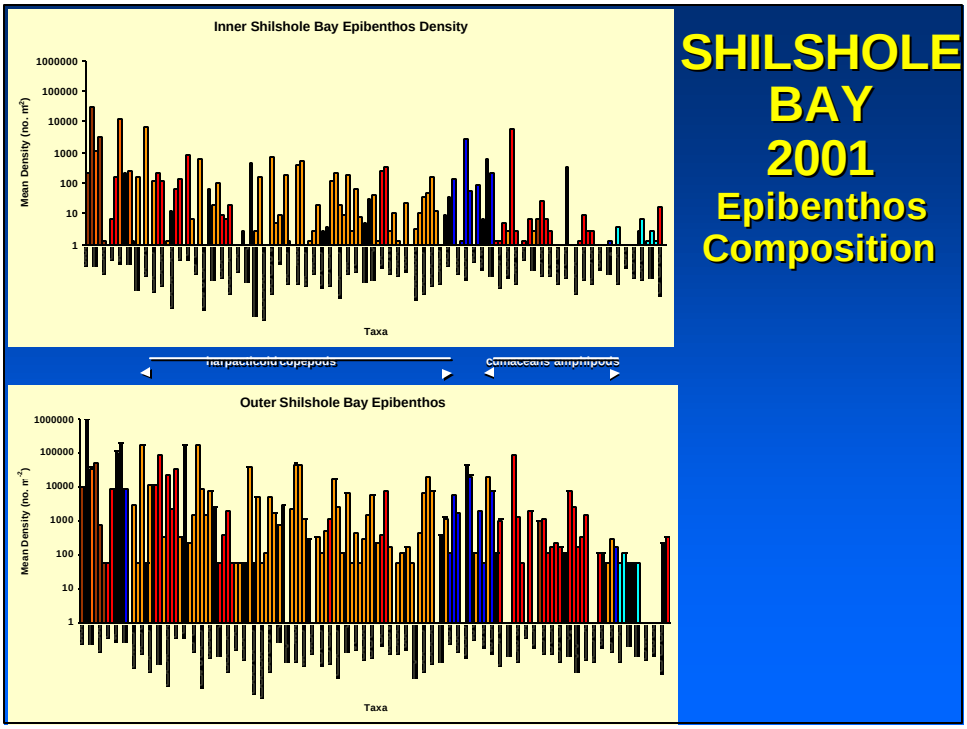
SHILSHOLE BAY 2001
Chinook Diet Composition June-July 2001





SHILSHOLE BAY 2001
Zooplankton Composition


INNER NEUSTON
FW zooplankton
E zooplankton
E/NS benthos/epibenthos
M zooplankton
Riparian
Density (no. m-2)
1000000
900000
800000
700000
600000
500000
400000
300000
200000
100000
0
June 5
June 21
July 2
July 17
July 31
Date
OUTER NEUSTON
FW zooplankton
E zooplankton
E/NS benthos/epibenthos
M zooplankton
Riparian
Density (no. m-2)
1000000
900000
800000
700000
600000
500000
400000
300000
200000
100000
0
June 5
June 21
July 2
July 17
July 31
Date
SHILSHOLE BAY 2001
Neuston Composition


Inner Shilshole Bay Epibenthos Density
Mean Density (no. m-2)
1000000
100000
10000
1000
100
10
1
Taxa
Harpacticoid copepods
Gammaridean amphipods
Outer Shilshole Bay Epibenthos
Mean Density (no. m-2)
1000000
100000
10000
1000
100
10
1
Taxa
SHILSHOLE BAY 2001
Epibenthos Composition

CONCLUSIONS

Most Significant Findings

- **JUVENILE SALMONIDS ARE PROMINENT COMPONENT OF BAY'S FISH ASSEMBLAGE:** Overall composition of nearshore fish community in Shilshole Bay dominated by shiner perch, Pacific herring, Pacific staghorn sculpin, threespine stickleback and Pacific salmon; salmon prominent in May-June but persist through October (end of sampling).
- **FISH CONCENTRATED IN INNER BAY:** Chum and chinook abundant salmonids; chum throughout but particularly nearest Locks and at Golden Gardens; chinook near Locks and along northern margin of inner estuary, with hatchery fish predominating nearer Locks compared to outside estuary
- **RELATIVELY SHORT RESIDENCE TIME FOR JUVENILE CHINOOK:** Based on PIT tag recoveries, individual juvenile chinook from Lake Washington system appear to reside less than four days.
- **PREY RESOURCES IN BAY ARE PREDOMINANTLY ALLOCHTHONOUS:** Unlike other estuarine/nearshore regions of Puget Sound (and elsewhere) feeding by juvenile salmon is supported predominantly by sources from either freshwater production (Lake Washington/Ship Canal) or planktonic, rather than epibenthic/neuston (drift insect).

CONCLUSIONS

Most Significant Things Yet to Learn

- **SIGNIFICANCE OF *Daphnia* FEEDING?** It is unclear whether there is a "cost" to feeding on the freshwater zooplankton; it may represent a HIGHLY efficient prey resource because of lack of avoidance. Approach question with bioenergetic modeling?
- **FRESHWATER ZOOPLANKTON AS ATTRACTANT TO NEARSHORE JUVENILE SALMON AND OTHER FISHES?** The apparent concentration, and potential attraction to other (Puget Sound) juvenile salmonids and fishes to the Bay (and particularly inner Bay) may well be linked to this unique prey resource? How pervasive are these prey for other fishes?
- **RESIDENCE TIME FACTOR?** The observed (PIT tag based) residence time is comparatively short for estuarine migration of juvenile chinook, albeit interpreted from limited data. Is this representative? But, conforms to concept that Lake Washington/Lake Sammamish basin chinook are treating (rearing in) the Lake as an estuary.
- **REAL-TIME BEHAVIOR?** PIT tag data can't provide real-time behavior information for individual fish. For purposes of understanding Locks outflow and other effects (e.g., Lock recycling) it would be very beneficial to have information on individual fish movement, microhabitat utilization, depth distribution, diel variability, etc.