# Ocean habitat of juvenile Chinook salmon at the southern end of their range

Arnold J. Ammann*, David D. Huff, Sean A. Hayes, Jeffery A. Harding, R. Bruce MacFarlane
NOAA Fisheries, Southwest Fisheries Science Center, 110 Shaffer Road, Santa Cruz, CA 95060 USA

## GOAL:

Determining the preferred ocean habitat of juvenile salmon is an important step in understanding how changes in available habitat could affect movement and survival.

## METHODS:

We sampled juvenile Chinook salmon during the summer and fall of 1999 to 2011 from Monterey, California (36.57°N) to Newport, Oregon (44.67°N) using a Nordic RT 264 Rope trawl. Catch was standardized to # fish/30 minute haul. Hauls were compared with:

1. temporal variable of season (summer or fall) and year,
2. spatial variables of bottom depth, distance from shore and latitude
3. in situ variables of temperature, salinity, and chlorophyll a concentration.

The relationships between salmon and covariates were assessed using Generalized Additive Models (GAM's).

## RESULTS:

Chinook salmon juveniles (< 250mm fork length) were present in 45.8% of the 463 total hauls (**Poster background- Figure 1**.)

Significant relationships between abundance and predictor variables existed when models included year, depth, chlorophyll a and either latitude or distance to shore.

A negative binomial error distribution was used with a log link.

Deviance explained = 59.3%

**Table 1.**

| **Parametric coefficients:** | **df** | **Chi Squ** | **p-value** |
|---|---|---|---|
| Season | 1 | 28.12 | <0.001 |

**Approximate significance of smooth terms**

| | **Effective df** | **Chi Squ** | **p-value** | **Figure #** |
|---|---|---|---|---|
| Chlorophyll | 1.02 | 13.25 | <0.001 | 2 |
| Depth | 3.98 | 16.45 | <0.001 | |
| Depth:Autumn | 0.01 | 0.00 | 0.17 | 3 |
| Depth:Summer | 1.00 | 12.66 | <0.001 | 3 |
| Temperature | 1.09 | 5.17 | 0.01 | |
| Temperature:Autumn | 4.00 | 22.38 | <0.001 | 4 |
| Temperature:Summer | 2.61 | 19.45 | <0.001 | 4 |
| Latitude | 0.67 | 3.88 | 0.01 | |
| Latitude:Autumn | 0.00 | 0.00 | 1.00 | |
| Latitude:Summer | 2.85 | 50.09 | <0.001 | |

## CONCLUSIONS:

Chinook salmon were strongly associated with several habitat features. Abundance declined from summer to autumn. While many patterns are likely common across Chinook salmon range, the regional influence of narrow shelf breaks and strong upwelling influenced the distribution in ways that were regionally specific to the Central California coastal environment.

Chlorophyll:

- Optimal Chla values were 10-18 mg/l
- No interaction with summer and autumn

Depth:

- Salmon were shallow during summer
- Salmon were more dispersed and deeper during autumn

Temperature:

- Optimal summer temp was 10-14°C
- Salmon experience narrower and cooler temperature range in autumn

Newport, Or

San Francisco Bay

**Juvenile Salmon**
1 - 3
4 - 30
31 - 477
Absent

Fig. 2 Response curve between juvenile salmon catch and chlorophyll (Chla)

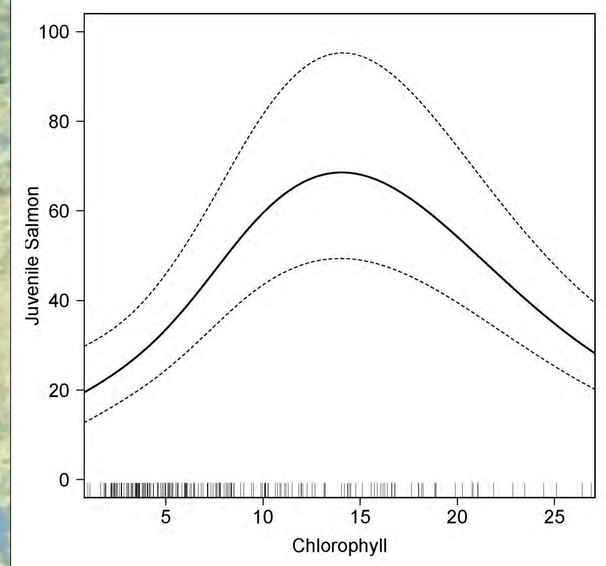


Fig. 3 Response curve between juvenile salmon catch and ocean bottom depth

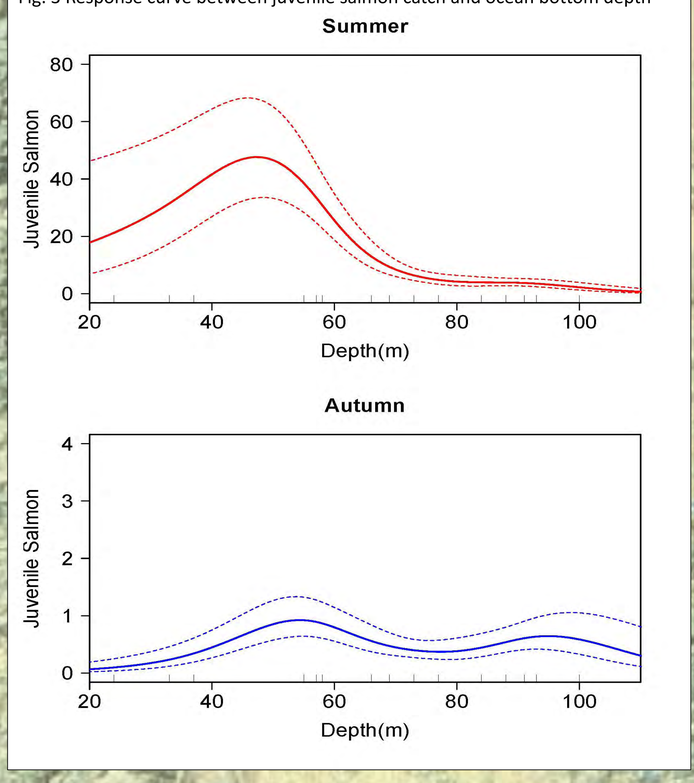


Fig. 4 Response curve between juvenile salmon catch and surface temperature