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RESEARCH

Appendix B: Habitat Rearing Capacity Estimations

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CAPACITIES

Habitat quality is defined uniquely for each habitat type (Sacramento River, Delta, etc.) to reflect the different habitat attributes (Greene and Beechie 2004; Beechie et al. 2005). We estimated the monthly capacities in five habitats of the LCM: (1) Sacramento River, (2) Yolo Bypass, (3) Sutter Bypass, (4) Delta, and (5) Bay.

River, Yolo and Sutter Bypass, Delta, and Bay Capacities

We calculated capacities for the Sacramento River, Yolo Bypass, Sutter Bypass, Delta, and Bay habitats as a function of habitat-specific capacity models, initially developed for winter-run LCM (Hendrix et al. 2014).

SFEWS Volume 18 | Issue 4 | Article 3
https://doi.org/10.15447/sfews.2020v18iss4art3

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We defined the River and Bypass capacities as a function of velocity (cm s^{-1}) and depth (cm). We defined, for each variable, preferred versus not-preferred categories. The possible combinations of the two levels of two variables provided four categories of habitat quality for rearing Chinook salmon (Figure B1). Because the Central Valley is primarily a hatchery-dominated system, with fish released at smolt size for rapid migration to the ocean, and natural stocks are at historically low levels, current estimates of fish density from the Central Valley may not indicate densities at capacity. As a result, we used densities from the Skagit River, WA to inform the maximum density estimates for each category (Greene et al. 2005). We used two densities to calculate capacities: the 90th percentile and the 95th percentile of the distribution of densities by habitat category in the Skagit River.

To estimate River and Bypass capacities based on channel velocity and depth, a suite of HEC-RAS models at varying discharge values (2,000-200,000 ft^3 s^{-1}) were simulated on the Sacramento River, Yolo Bypass, and Sutter Bypass. The HEC-RAS geometry was based on a series of Sacramento River cross-sections that define locations surveyed in the mid-1990s at longitudinal intervals of approximately 500 m. From the HEC-RAS output, the cross-sectional width of a given river reach was broken up into

	Preferred Velocity (> 0 cm/sec & < 15 cm/sec) 0 = no, 1 = yes	
Preferred Depth (> 20 cm & < 100 cm) 0 = no, 1 = yes	Depth = no Velocity = no (00)	Depth = no Velocity = yes (01)
	Depth = yes Velocity = no (10)	Depth = yes Velocity = yes (11)

Figure B1 Channel depth (cm) and velocity (cm s^{-1}) criteria used to define preferred habitat for River and Bypass capacity estimates

45 lateral sections (i.e., cells), with the main channel composed of 25 cells and the banks composed of 20 cells (10 left and 10 right bank). At each lateral cell the HEC-RAS, simulated channel depth and velocity were grouped into one of the four habitat capacity categories described above (Figure B1). Each cell in the cross-section has a depth and velocity, and altering the flow changes the depth and velocity of a particular cell. The area of each cell that corresponded to a specific combination of velocity and depth category was tabulated for each monthly flow associated with a cross-section. The appropriate density of Chinook Salmon for each of the four categories was applied to each lateral cell. To arrive at a monthly capacity estimate for the Sacramento River, Yolo Bypass, and Sutter Bypass habitats, we summed the capacity estimates for each lateral cell in a given habitat. Figure B2 shows how habitat capacity changes as a function of flow for the Sacramento River, Yolo Bypass, and Sutter Bypass.

The monthly capacities in the Delta and Bay were defined as a function of several habitat attributes including: channel type, cover, shoreline type, blind channel area, salinity, and vegetated cover along riverbanks. We conducted our analysis by using GIS data layers. Habitat quality was determined by defining binary high/low ranges for each axis of habitat quality, similar to the preferred and not-preferred approach used in the River habitat. In the Delta, eight categories of habitat quality were defined, each with an associated maximum density. Because not all habitats are accessible by rearing Chinook, we conducted a subsequent analysis to restrict habitat areas based on connectivity. Using beach seine data collected by the US Fish and Wildlife Service (Speegle et al. 2013), a generalized linear model was used to estimate the probability of juvenile habitat use by seining location. This model was subsequently used to restrict habitat use by juvenile salmonids throughout the Delta. Monthly estimates of capacity in the Delta reflected the restricted access to particular areas of the Delta and the seasonal absence of juvenile salmonids during the summer months (Figure 12 in Hendrix et al. 2017). Additional details on the capacity calculations can be found in Hendrix et al. (2014).

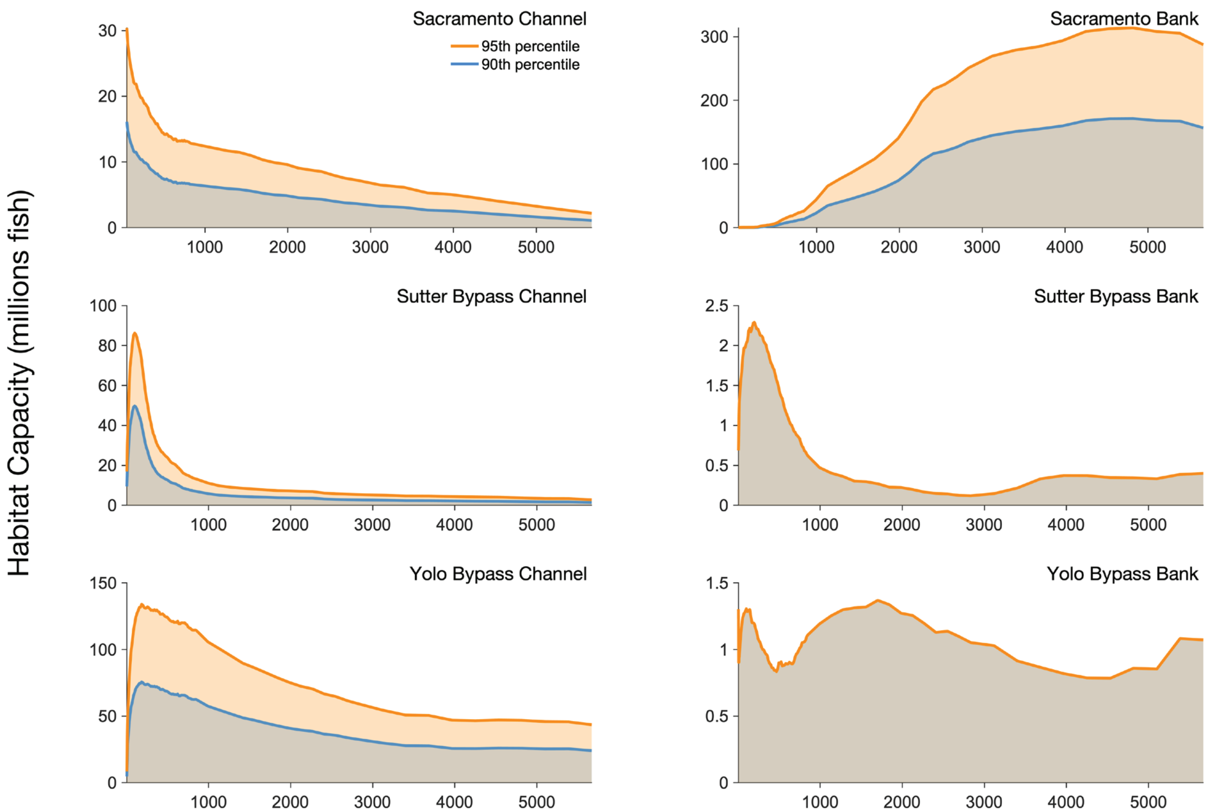

Figure B2 Habitat capacity to flow relationship for the Sacramento River, Yolo Bypass, and Sutter Bypass under the 90th and 95th percentile estimate, with both main channel and bank habitat values shown

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