Map of the study area.

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Report Title and Number

Assessing and Mitigating Dock Shading Impacts on the Behavior of Juvenile Pacific Salmon (Oncorhynchus spp.): Can Artificial Light Mitigate the Effects?

Short Title: Mitigating Dock Shading Impacts on Salmon with Artificial Light
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Research Note

Mitigating Dock Shading Impacts on Salmon with Artificial Light

From the WSDOT Research Office
July 2010

Habitat restoration is important for salmon species preservation

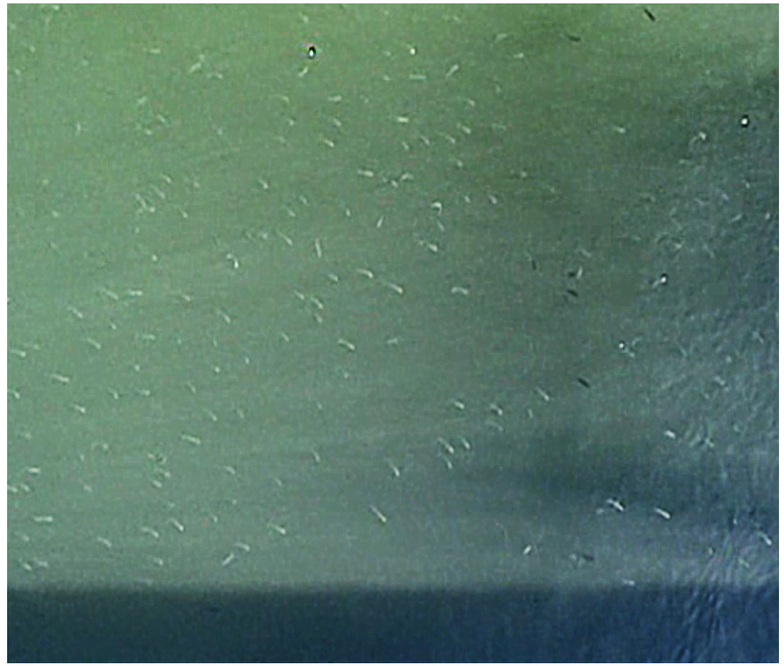
Salmon (*Oncorhynchus spp.*) is an icon for the Pacific Northwest. The nearshore environment plays an especially critical role for this species during their juvenile stage by providing food, growth, and protection against predators. However, extensive nearshore modifications in the last decades have potentially interfered with the migration, rearing, and survival rates of this species.

Washington State
Department of Transportation

WSDOT needed effective techniques to mitigate the effects of dock shading on salmon

One of the most prominent nearshore modifications in Puget Sound is the construction of over-water structures such as large docks and marinas. Today, large docks cover almost 2.5 square miles of Puget Sound nearshore and marinas cover 2.4 square miles. Perhaps the most evident effect of large over-water structures on juvenile salmon is their avoidance of shaded areas created by these docks and marinas.

The Washington State Department of Transportation (WSDOT) is concerned about shading from the overwater docks owned and operated by the Washington State Ferry system. As a result, WSDOT initiated several projects to investigate techniques to mitigate dock shading effects on salmon. These included the comparison of artificial lighting systems (the Sun Tunnel™, deck prisms, metal halide light, glass blocks, and metal grating) to increase the light level underneath the dock, but none were particularly successful. WSDOT with the help of Battelle Marine Sciences laboratory (BMSL) found a promising new lighting system: the Sunlight Direct fiber optic lighting system. This system could transmit natural light beneath the terminal and supposedly needed less maintenance, less energy supply, and induced minimal impact on the structural integrity of the terminal.



An image showing juvenile salmon interaction with the ferry terminal shading

A chum salmon under the water surface

Researchers evaluated fiber optic lighting system's effect on salmon behavior

The research evaluated the Sunlight Direct fiber optic lighting system to mitigate underdock shadows and impacts on juvenile salmon behavior. Fish behavior was video filmed at the edge of the dock throughout 2008 and 2009 during major juvenile salmon migration. Researchers developed a new statistical model, the mixed effect statistical model, to determine the effect of dock shading and light on the juvenile salmon.

Dock shading affected juvenile salmon behavior. Dock shading generally caused juvenile salmon to stay further away from the dock and to make complex movements around it. Conversely, the use of artificial light to lighten the dock edge shadow reduced this negative effect and salmon approached the dock more closely with higher directionality.

Scientists gathered to collect light intensity produced by the fiber optic lighting system

Researchers recommend natural light systems and higher, narrow structures to mitigate impacts on salmon

Although the use of a fiber optic system was able to show a small but significant effect on juvenile salmon behavior, the absolute level of light intensity produced by the system was quite low. The findings indicate a more powerful lighting system producing natural light and following dock shadow may be beneficial for future work aimed at reducing dock shading impacts on juvenile salmon behavior. However, for any future overwater structure construction, the general recommendation is to build higher and narrower structures to decrease the effect of dock shading to the underwater organisms.

Research provided direction for future study

Based on these findings, WSDOT will not be able to use the Sun Direct fiber optic lighting to resolve shading from over water structures. However, the results of this research provide a promising direction for future study as more powerful natural lighting systems are developed that can operate in the harsh marine environment. In addition, the statistical model used in this study is a promising tool to evaluate the effect of biotic and abiotic factors on shoaling fish behavior.