



Fish and Aquatic
CONSERVATION
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Shade Evaluation Study: Interim Data Review

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Applications for Fish Hatcheries

- Hatcheries are water and energy intensive
- Salmonids prefer shade (Meehan et al 1987)
 - UV light factor in steatitis in Steelhead (Twibell et al. 2017)
- Benefits
 - ↓ Evaporation = ↑ Water Savings
 - ↓ Plant/Algal growth
 - ↑ Photovoltaic (PV) performance
 - ↑ Water and air quality
 - ↑ Shading contribute to ↓ steatitis
 - ↓ Electricity costs through power generation

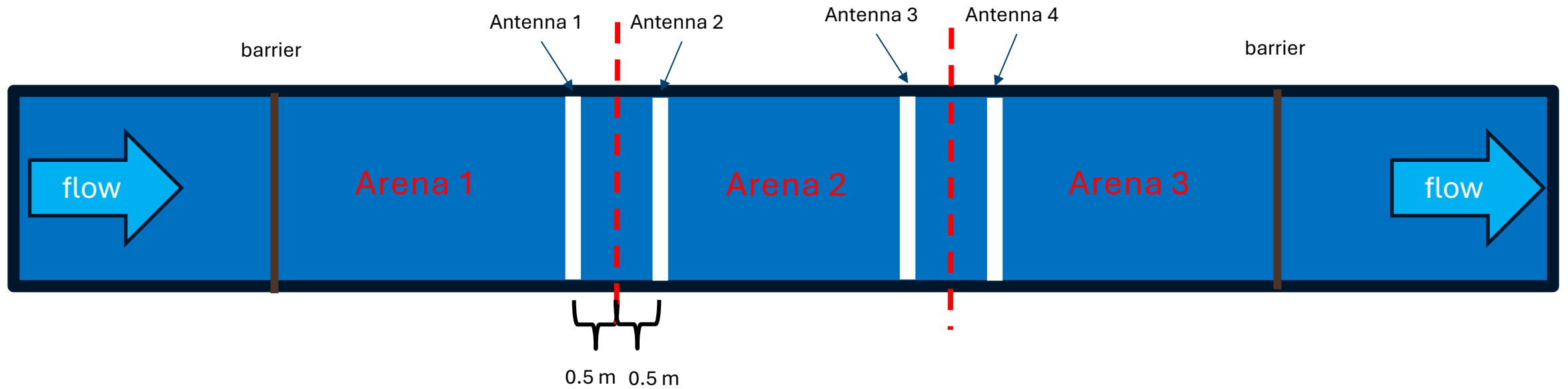


Goal

- Evaluate impact of shading intensity and pattern on fish distribution

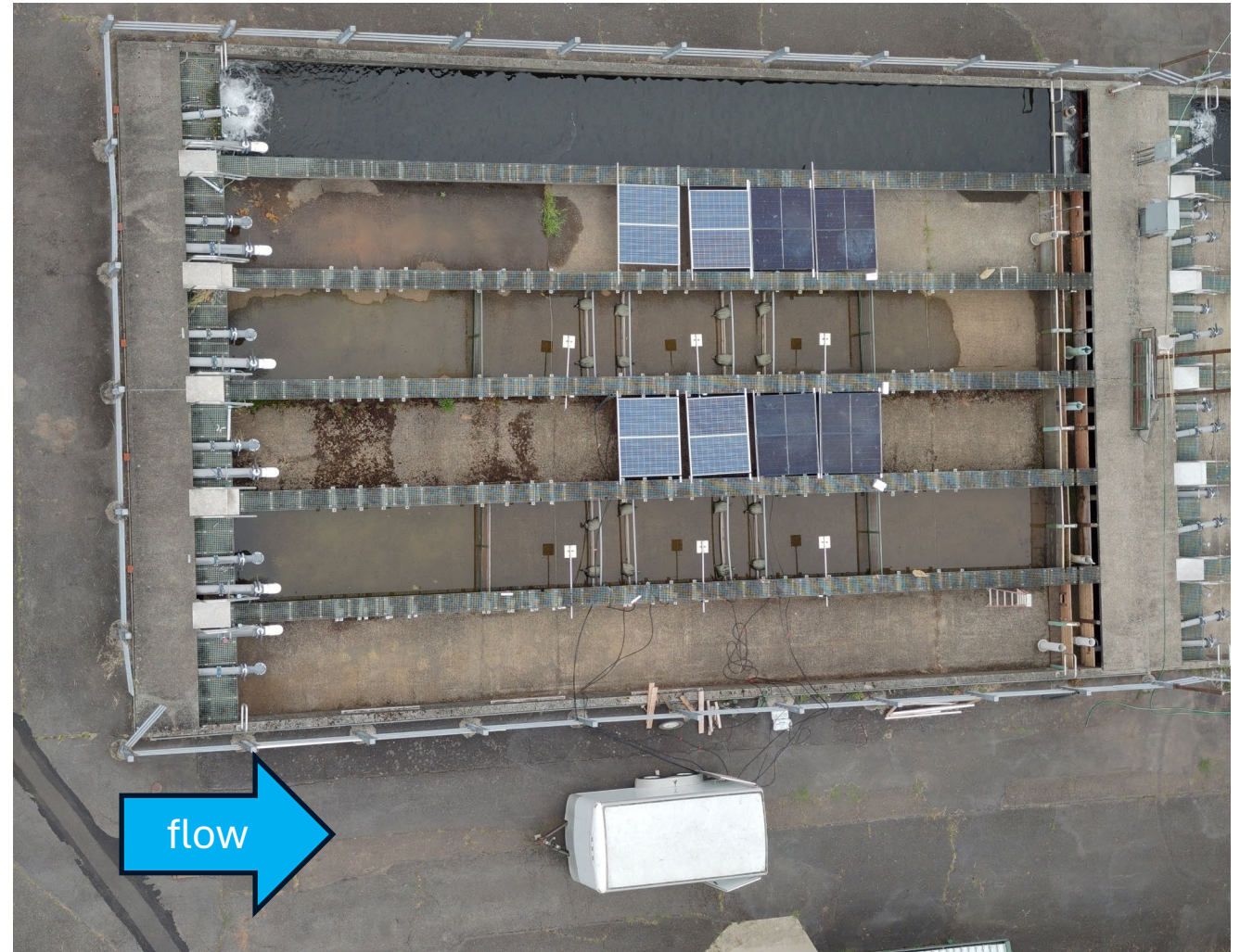
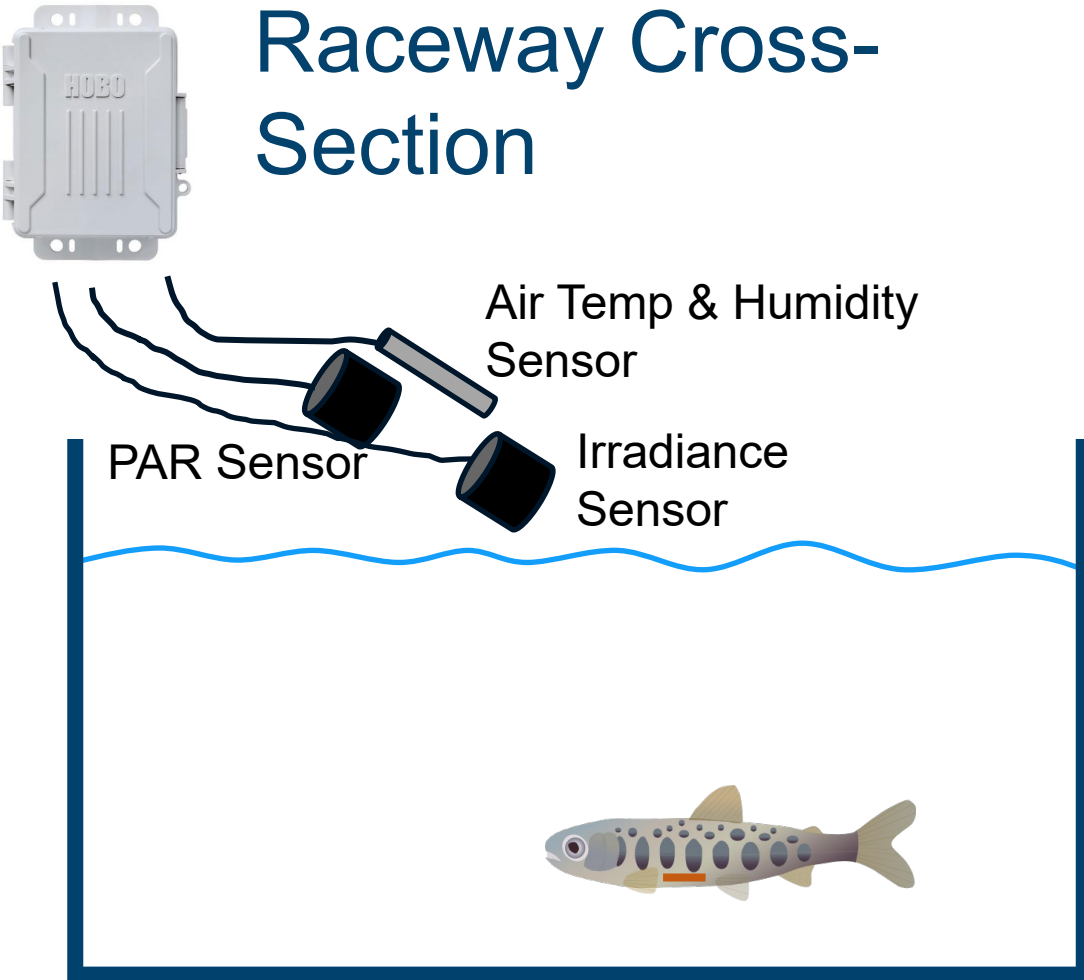


Raceway Design

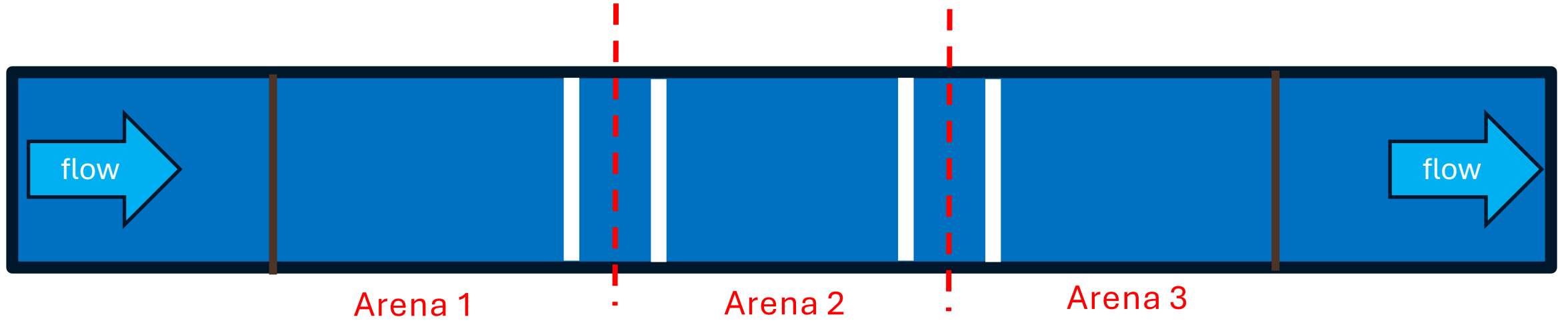
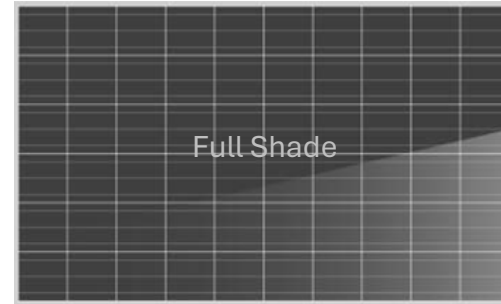
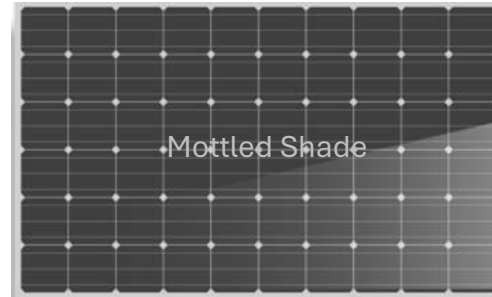


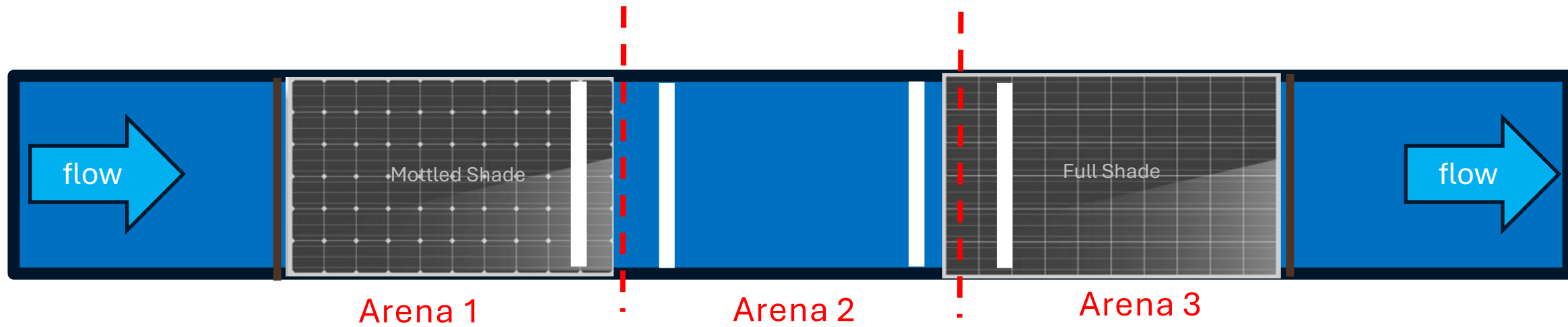
PV panel

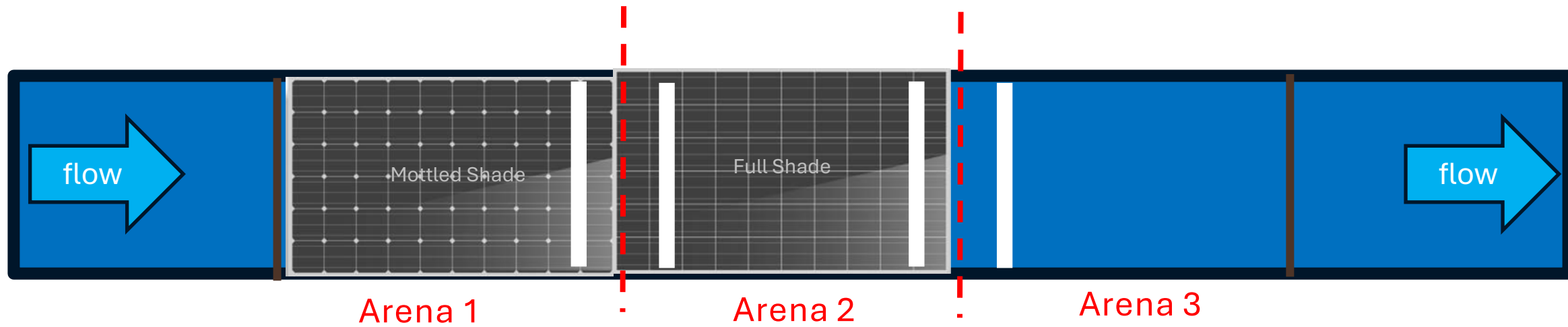
Raceway Cross-Section

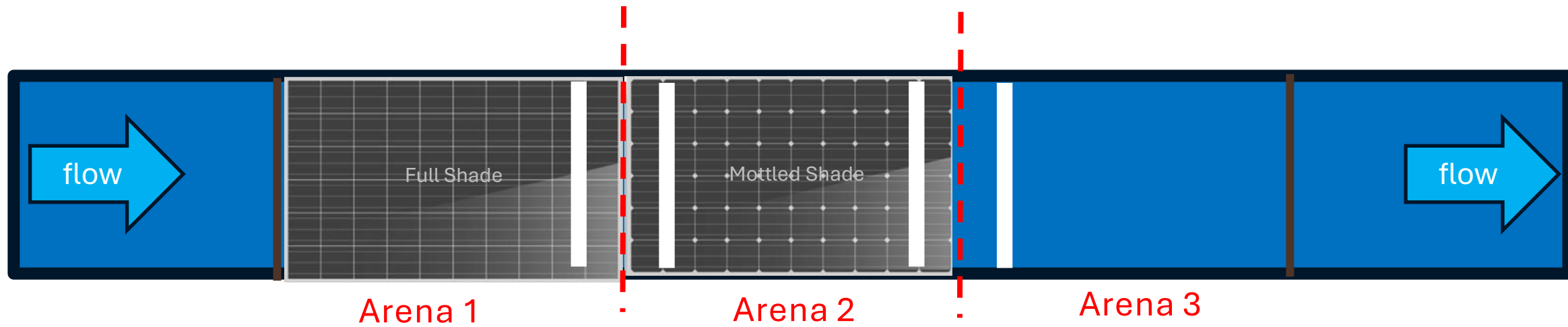


Drone Pilot = Ben Kennedy;
Spotter = Jessie Hintzsche









Etc...

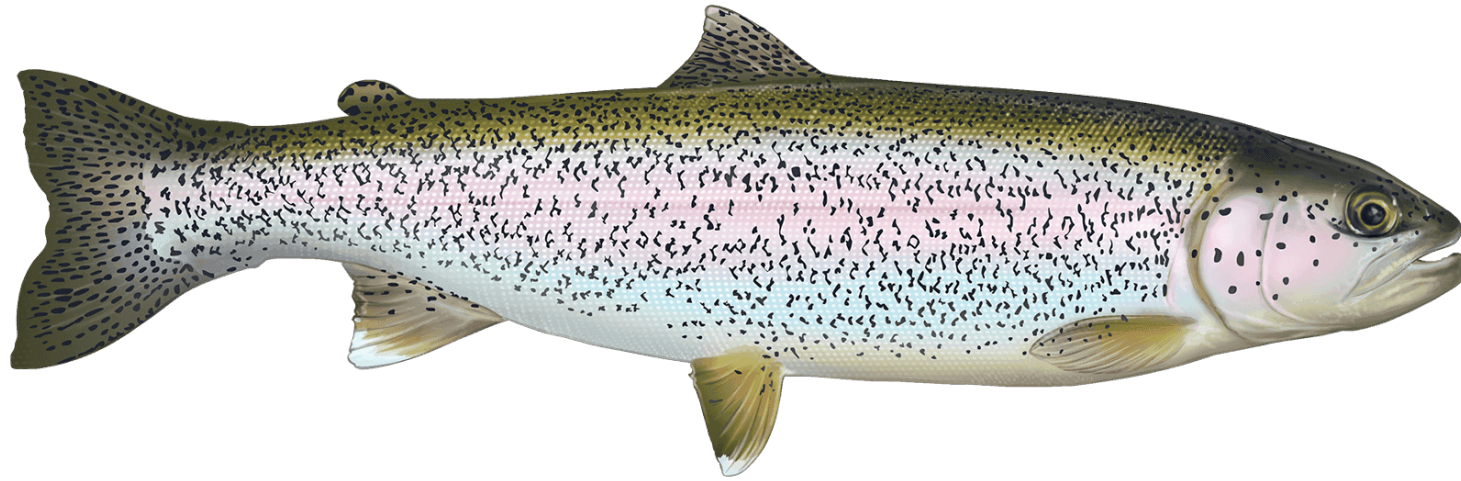


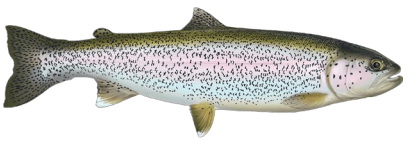
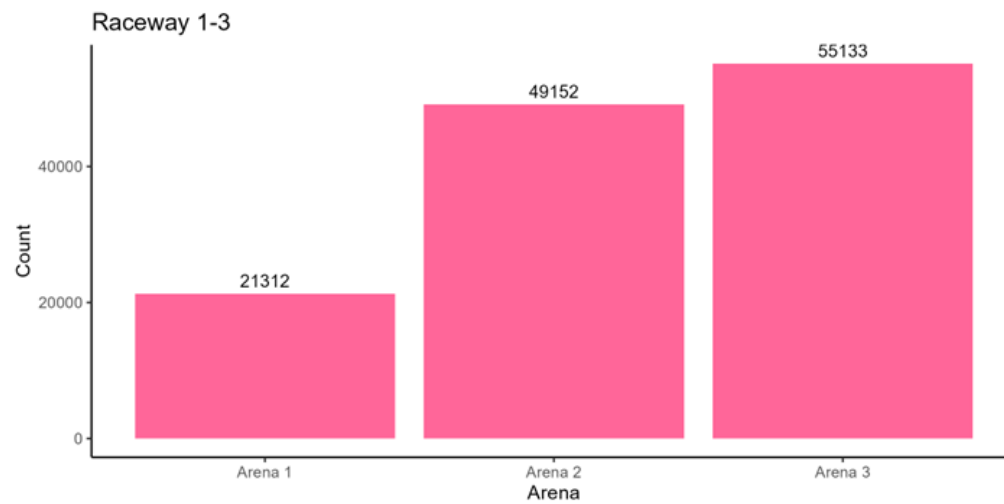
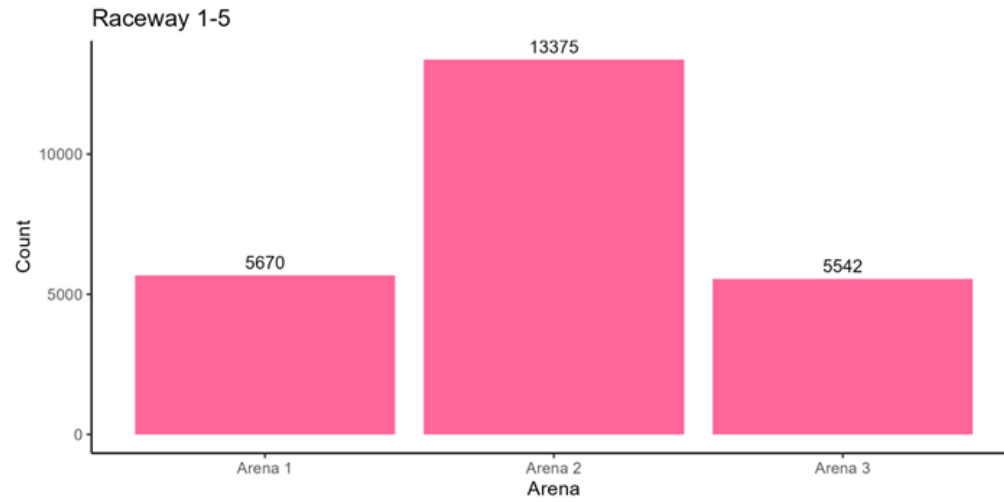
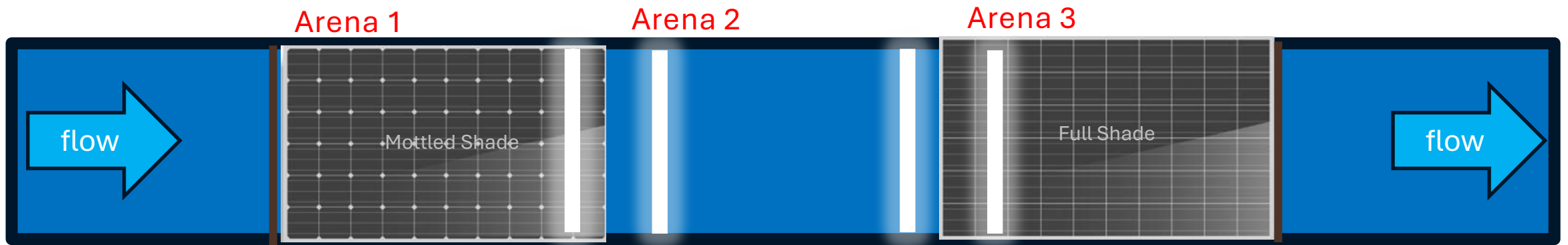
Experimental design

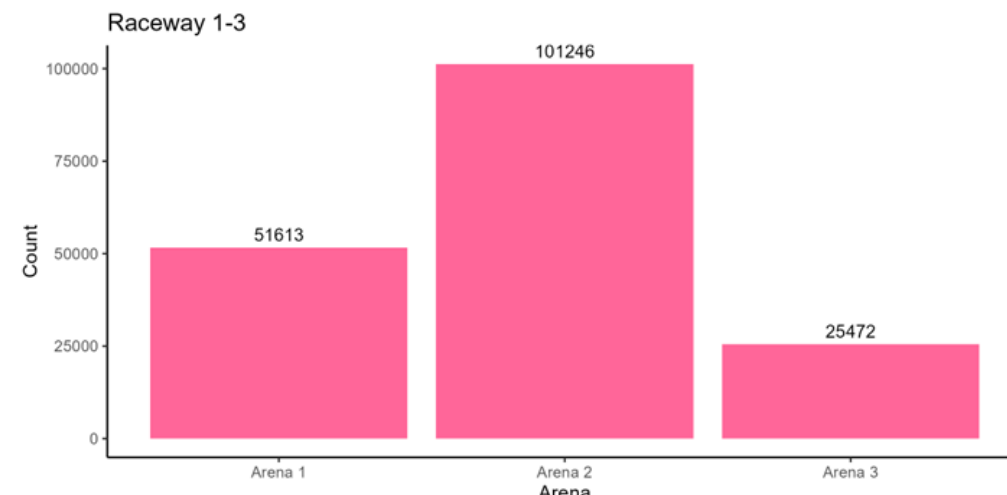
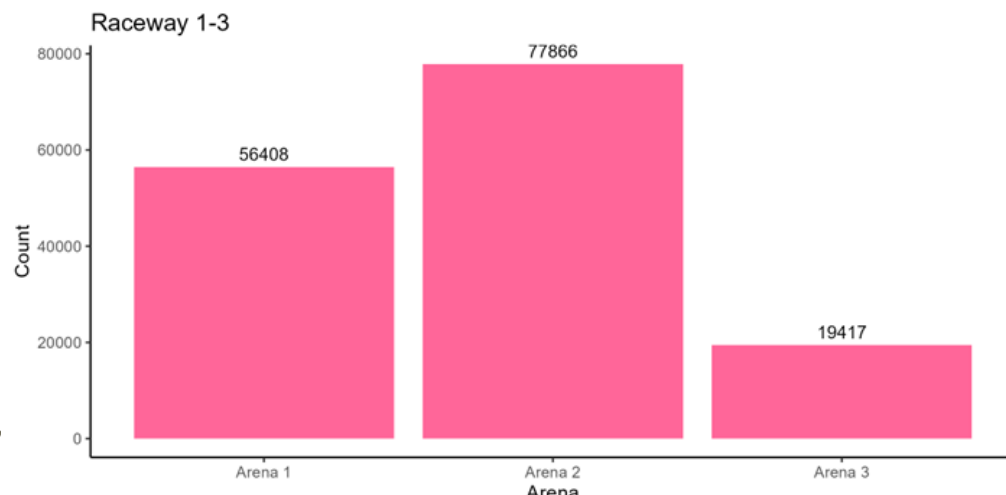
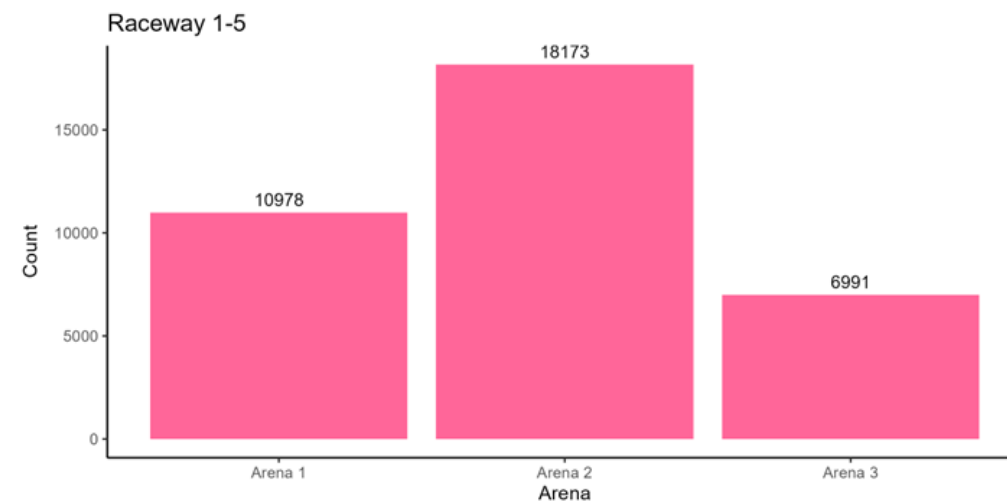
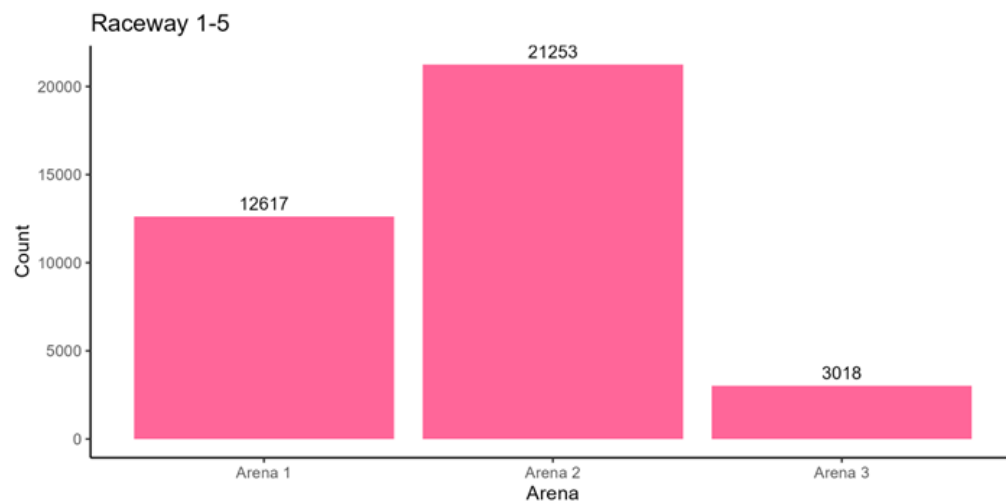
- Species
 - Spring Chinook Salmon (Little White Salmon NFH)
 - Steelhead (Kalama Falls Hatchery)
- 100 juveniles (70 – 110 mm)
- Each PV panel arrangement lasted 3 days
- Panels were moved and then fish allowed to acclimate for 7.4 hours

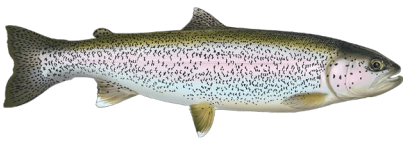
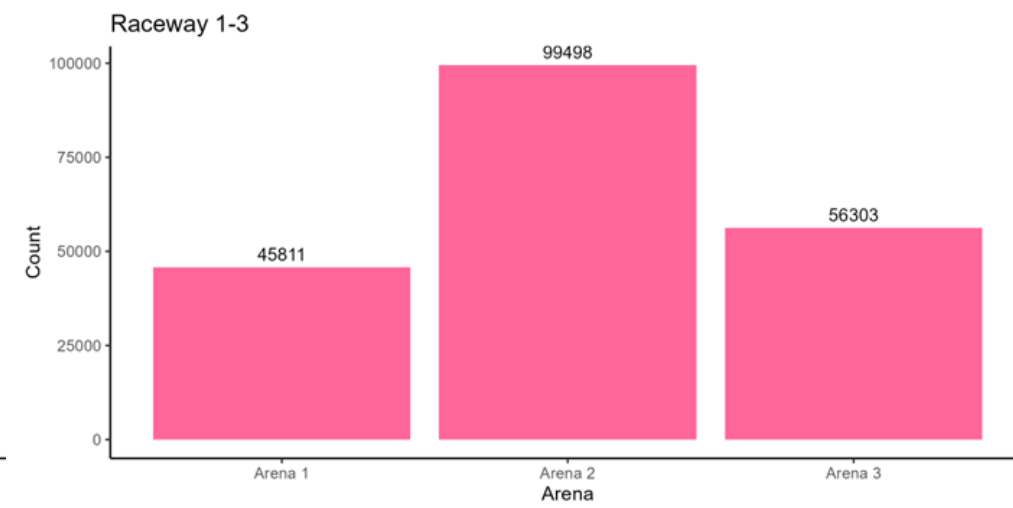
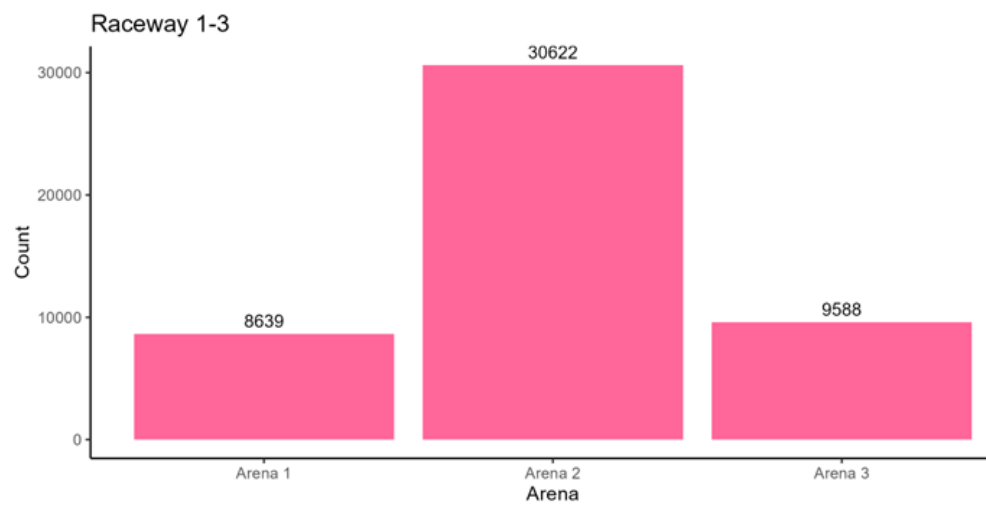
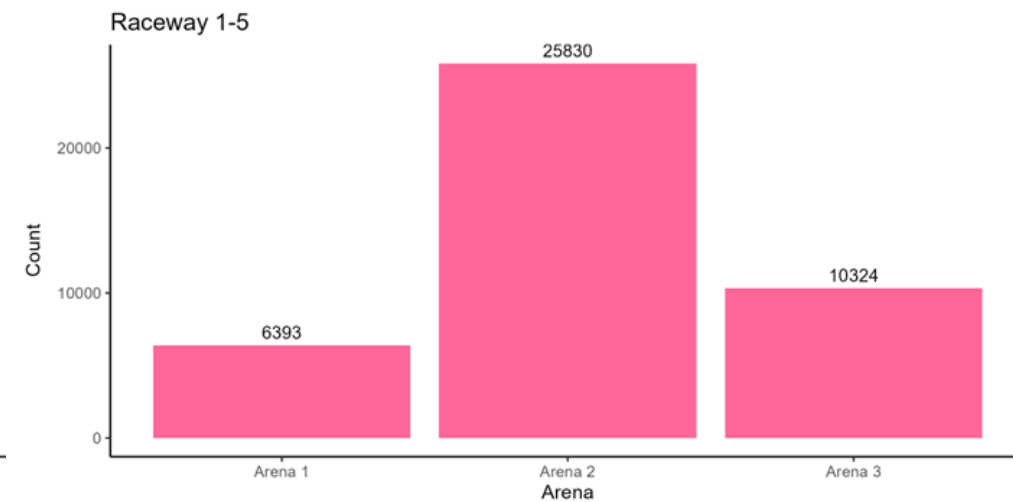
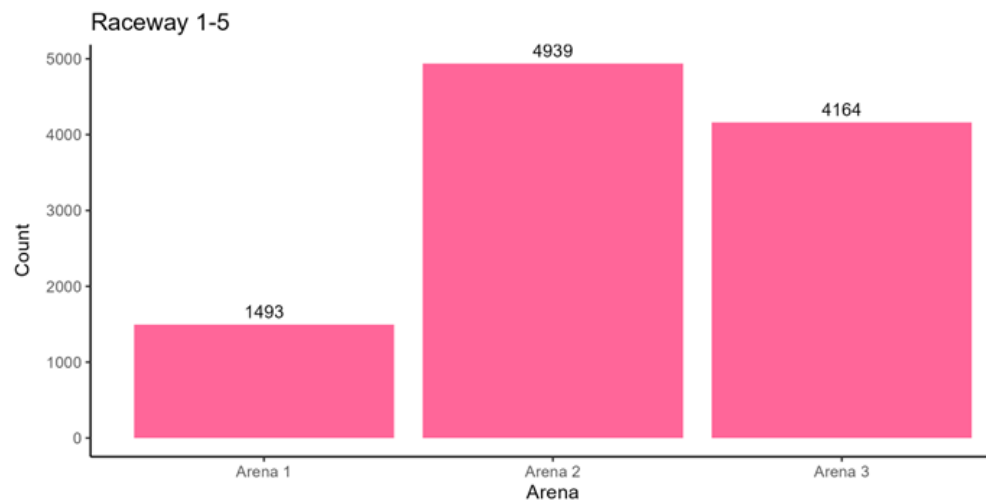
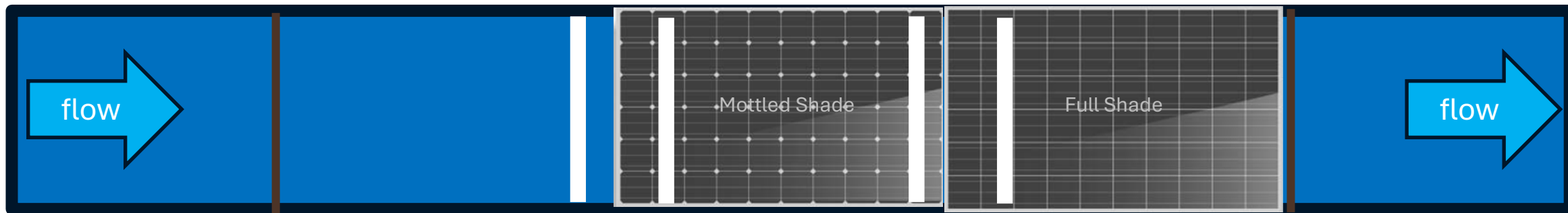


Steelhead PIT plots

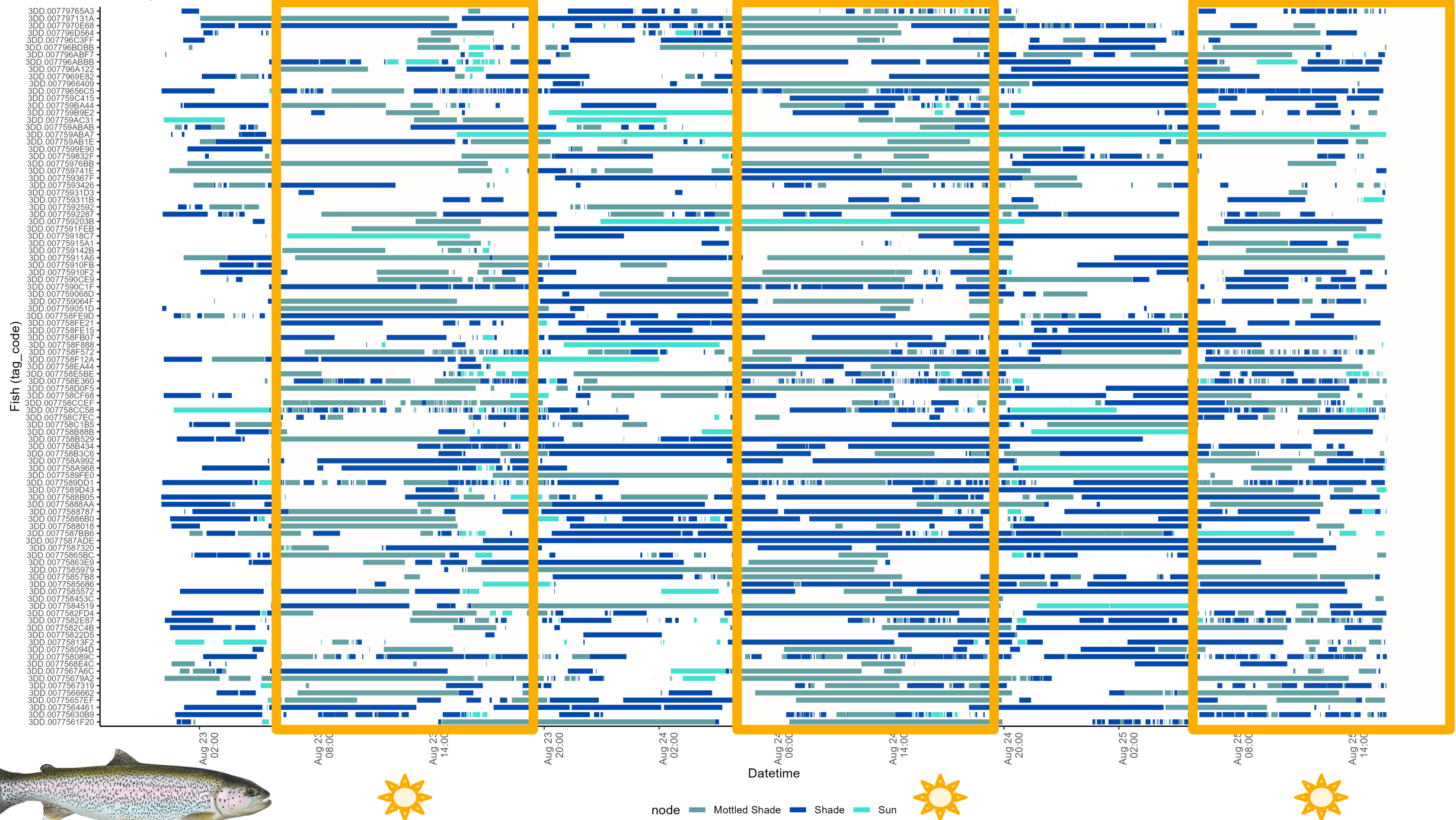






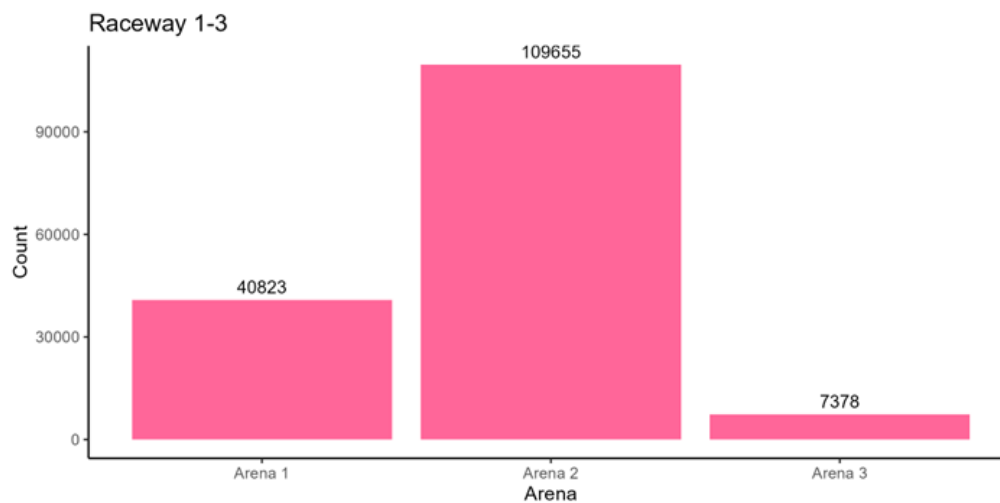
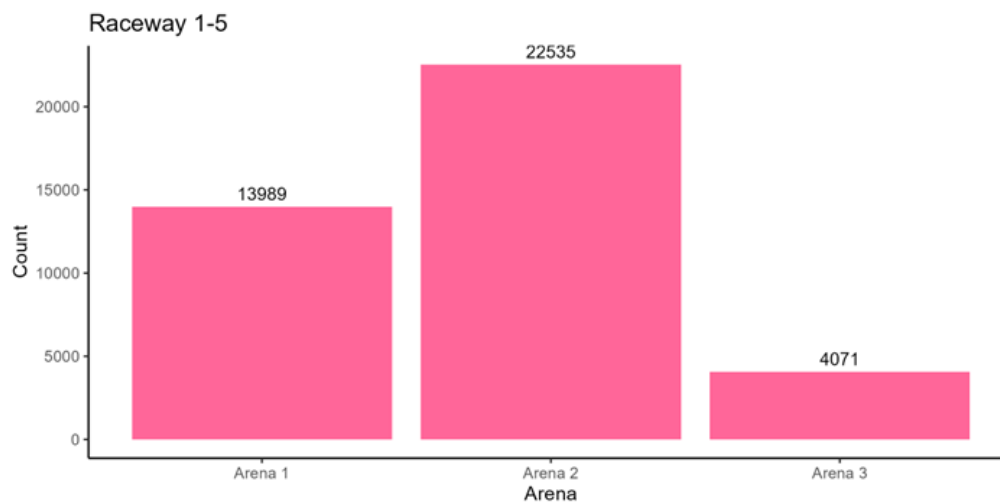
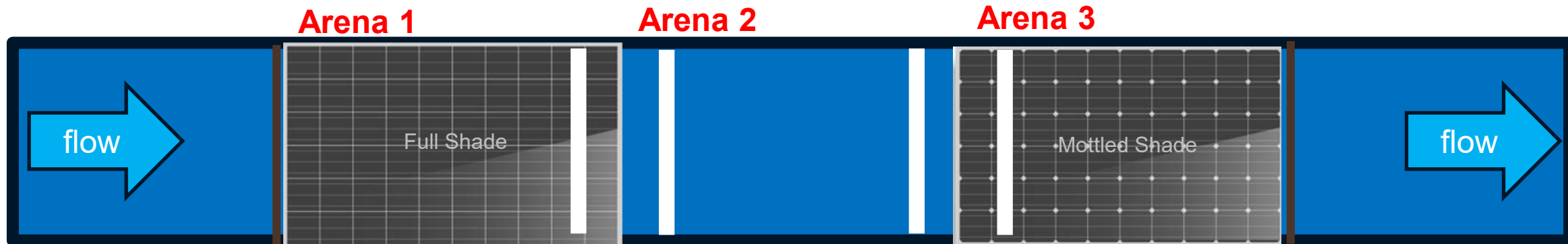


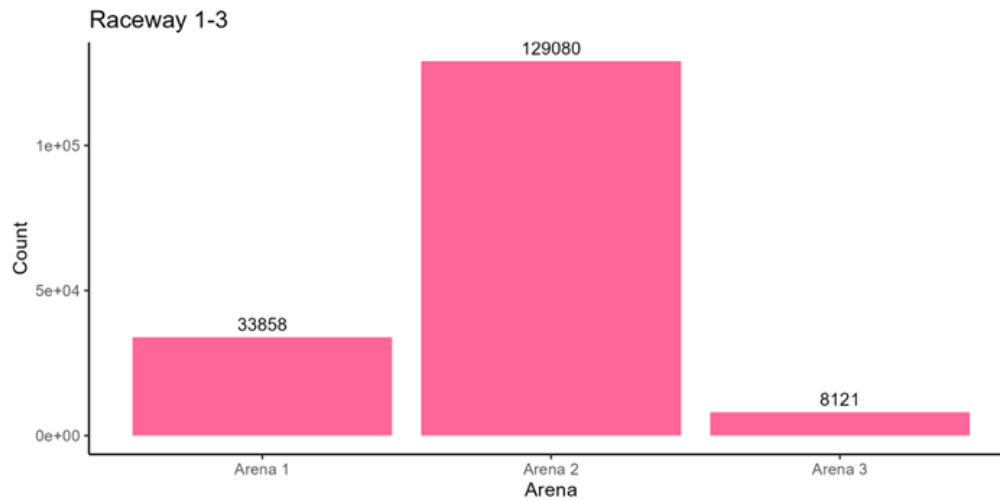
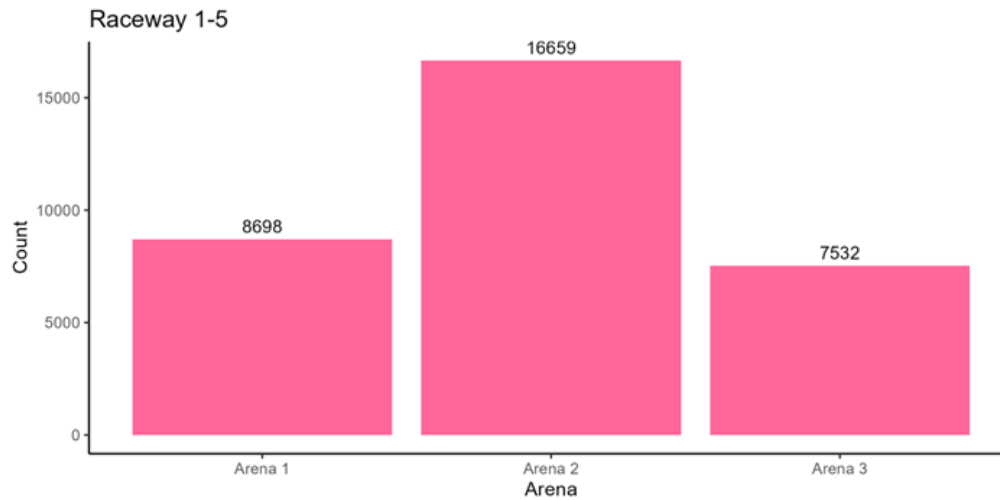
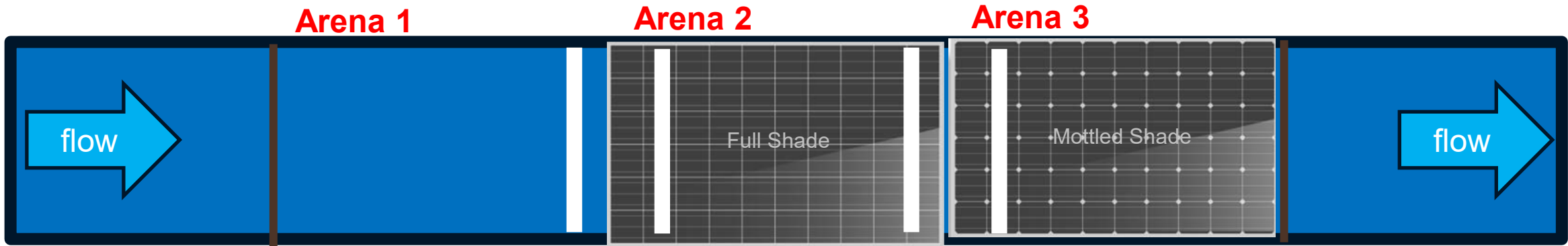
Time Spent in Each Arena by Fish (Raceway 1-5)

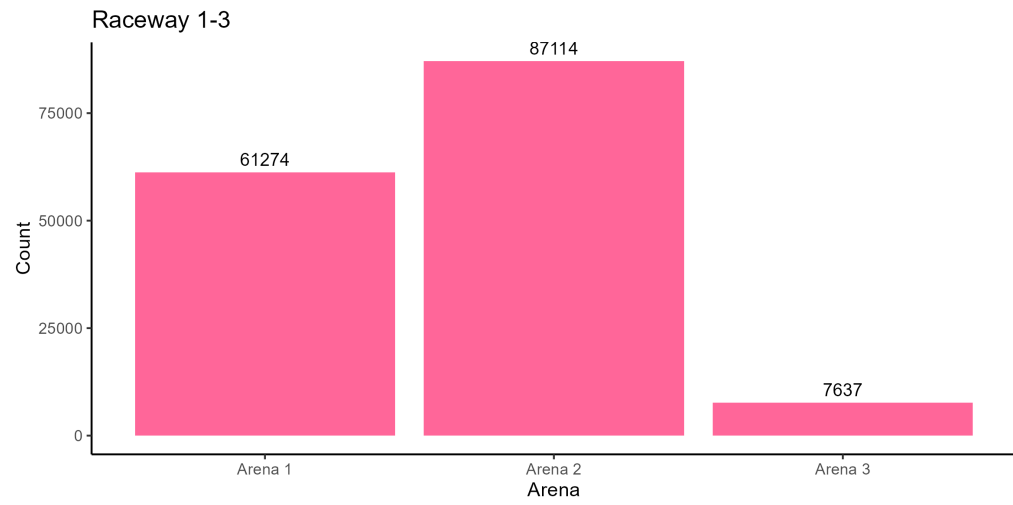
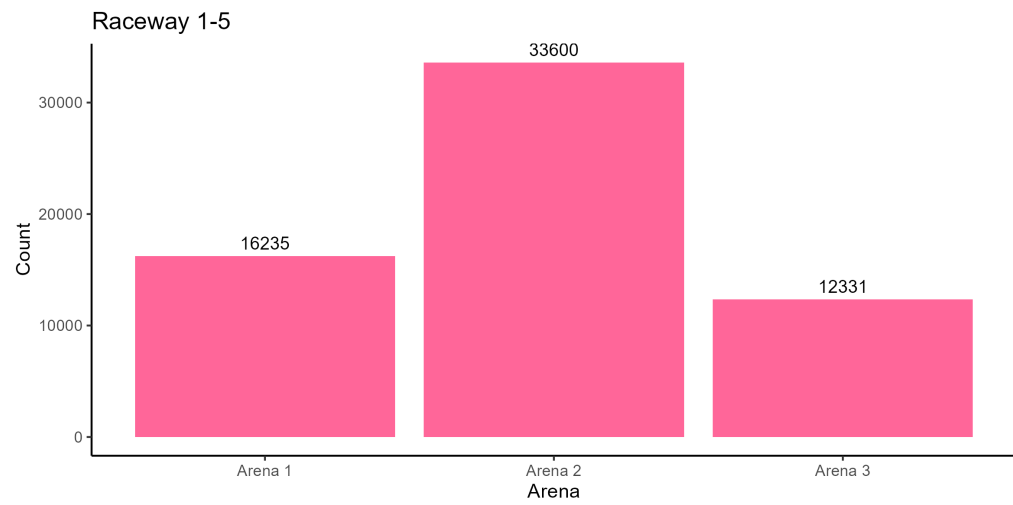
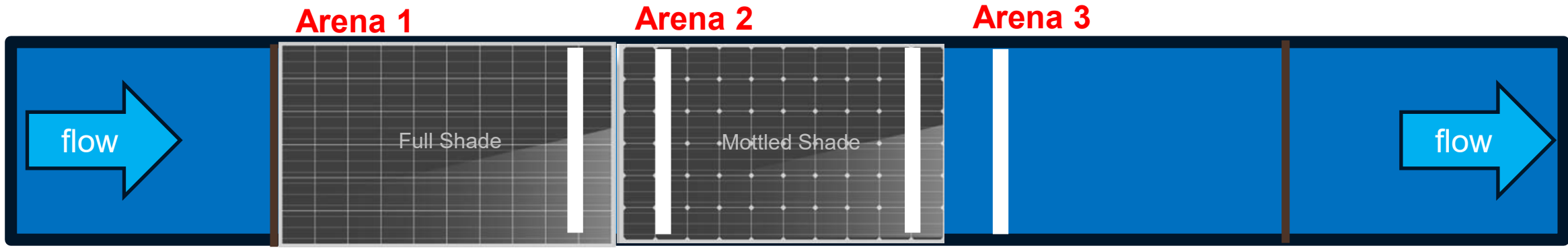


Spring Chinook Salmon PTT plots

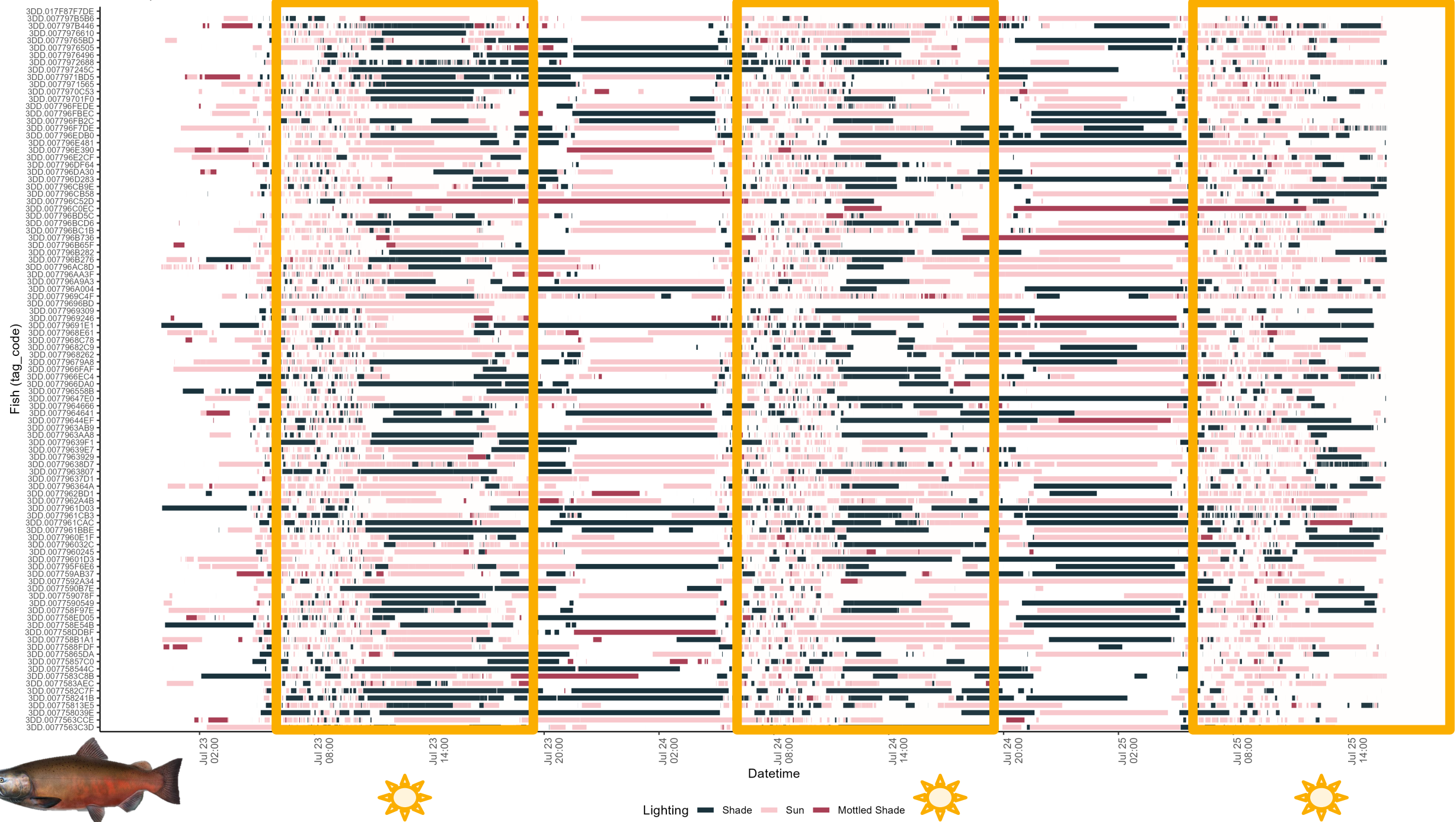








Time Spent in Each Arena by Fish (Raceway 1-3)



Time Spent in Each Arena by Fish (Raceway 1-3)



Conclusions and Next Steps

- Main Takeaway:
 - Species-specific differences
 - Steelhead distribution correlated to PV panel placement (shading)
 - Spring Chinook distribution tentatively not correlated to panel placement
 - Concentrate in the middle of the experimental area
- When capacity increases, complete analyses
- Elements to consider in future analyses
 - Filter data and analyze data from daytime
 - Examine impact of cloud cover
 - Rearing differences between evaluated species
 - Steelhead reared inside until added to experiment
 - Spring Chinook reared outside

Thank you!

Gerald Robinson (Department of Energy)

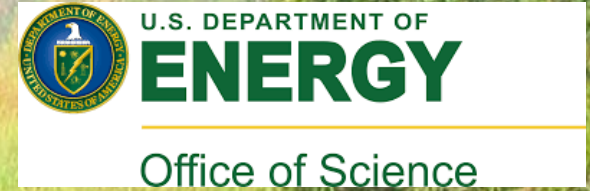
Caroline Kreiser (FWS- IMD)

Brian Mijiga (Kiwa PVEL)

Kalama Falls Hatchery Team (WDFW)

Little White Salmon NFH Hatchery Team (USFWS)

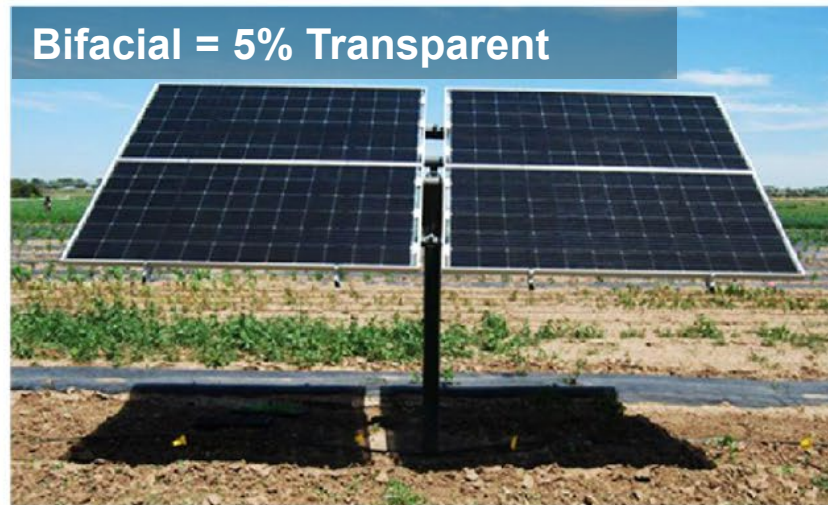
Eagle Creek NFH Hatchery Team (USFWS)



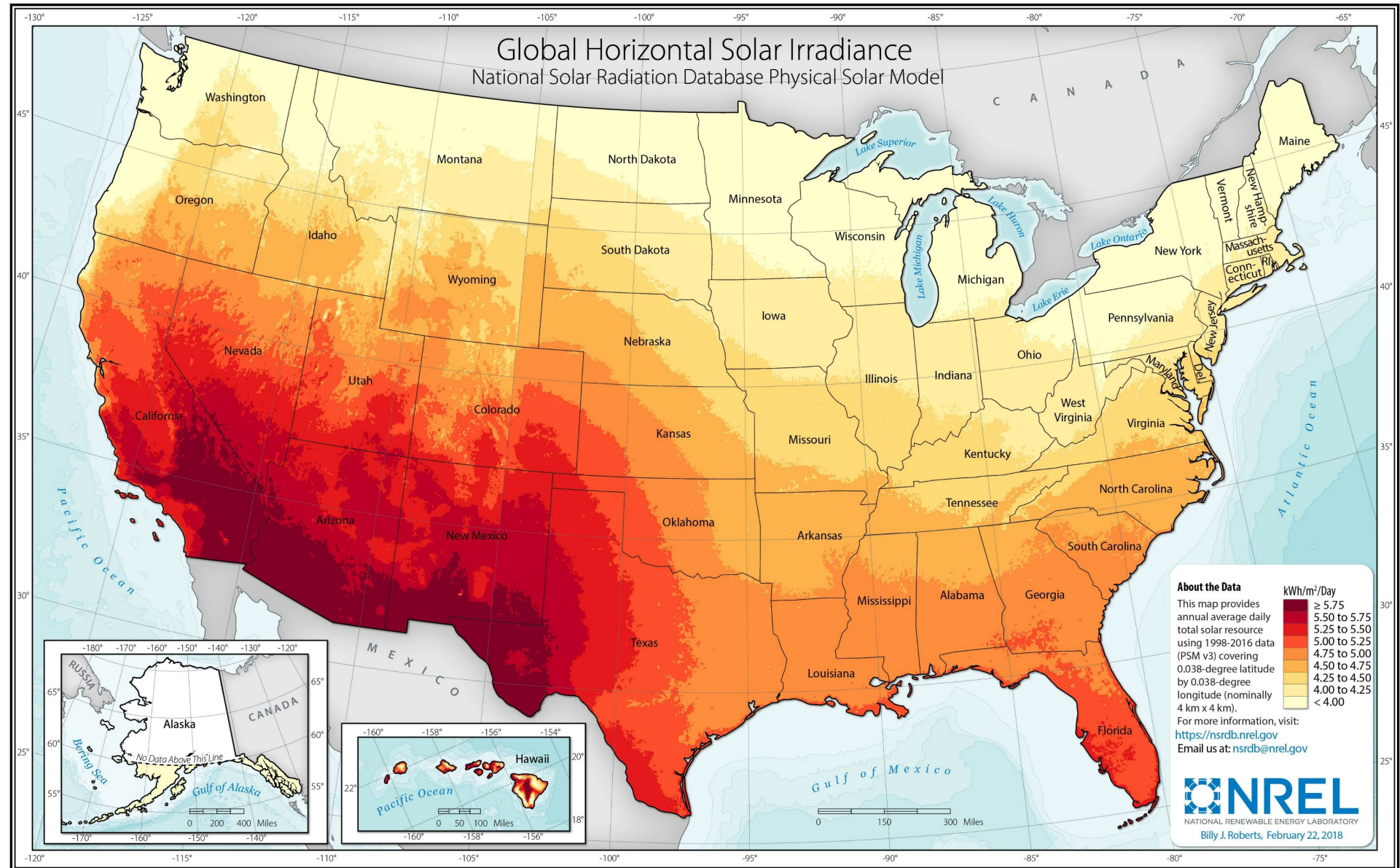
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Advancements in PV Panels

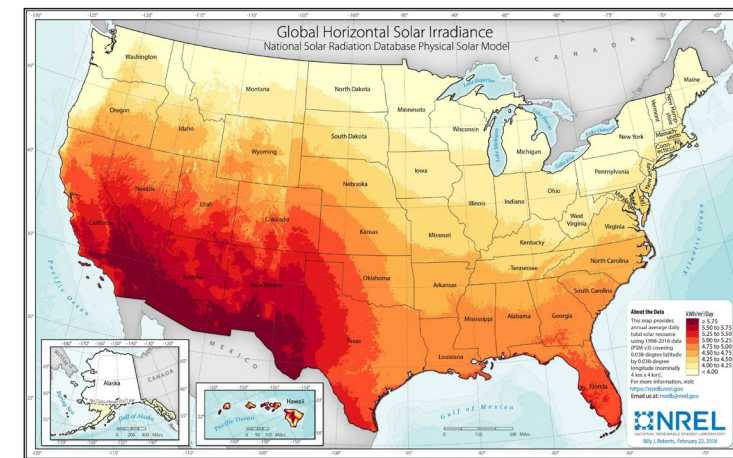
- 2 main types of panels
 - Monofacial- electrical generation on surface facing sun
 - Bifacial- variable transparencies available
 - Electrical generation both sides of panel



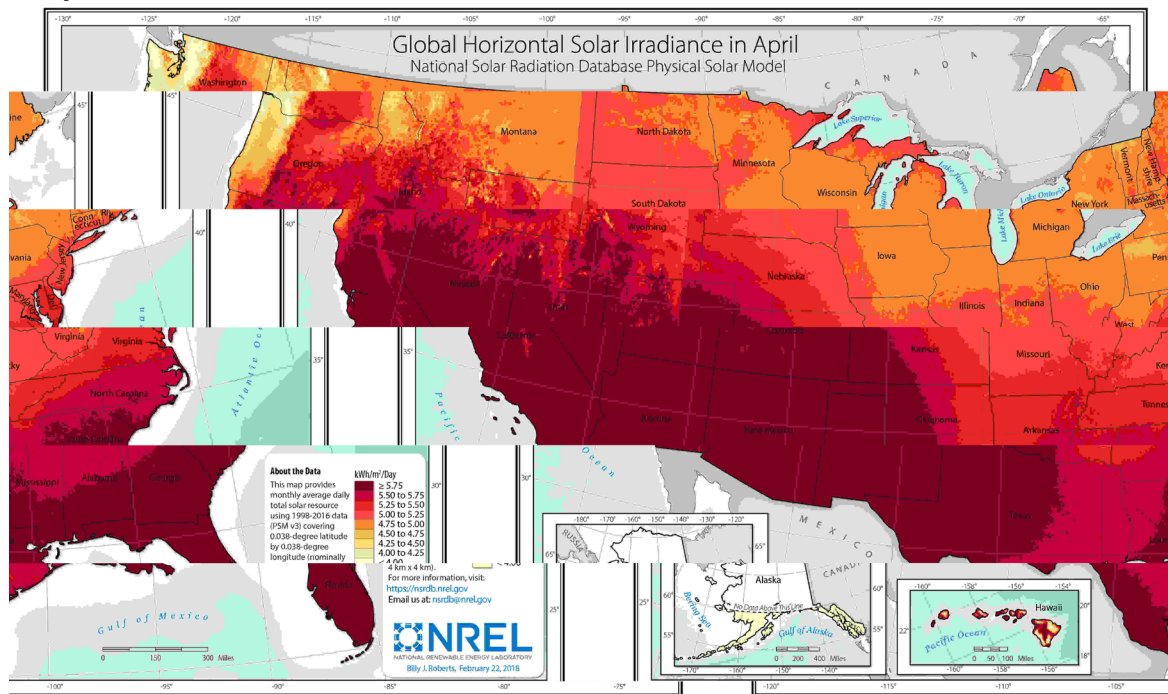
Solar Potential



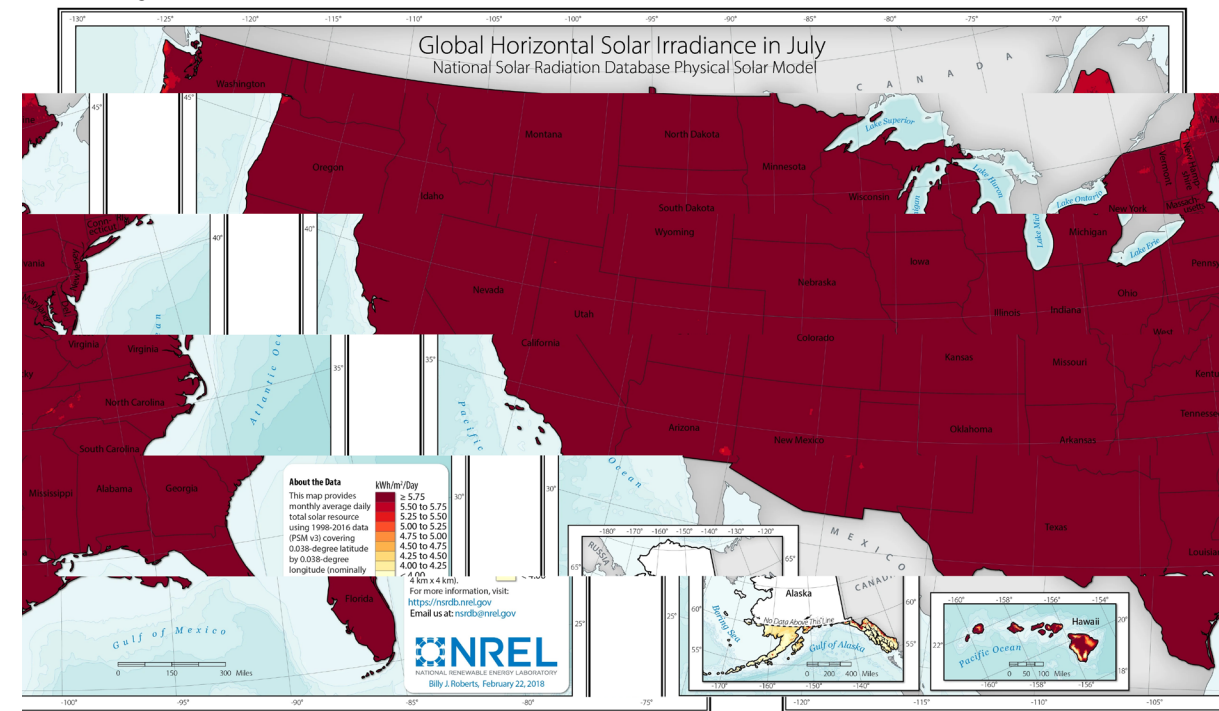
Solar Potential



April



July



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Time Spent in Each Arena by Fish (Raceway 1-3)

