Limnological influences on fish distribution and implications for trophic interactions in Lake Sammamish, Washington

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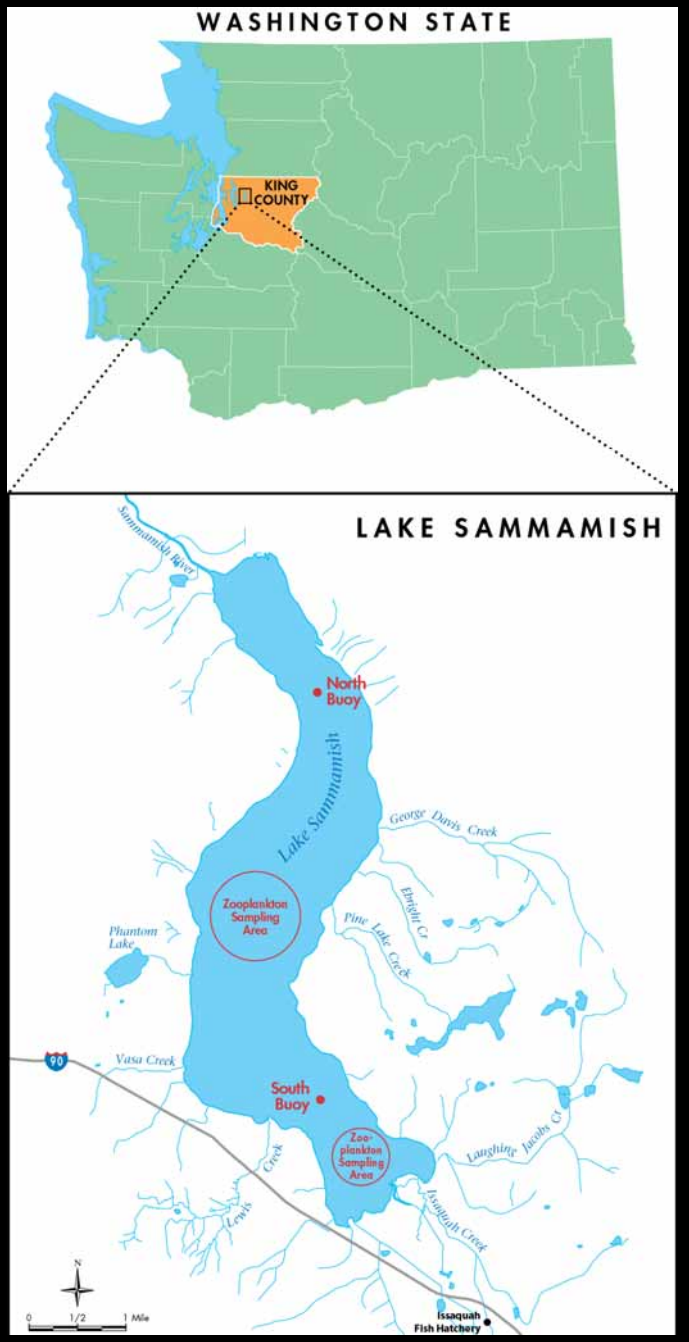
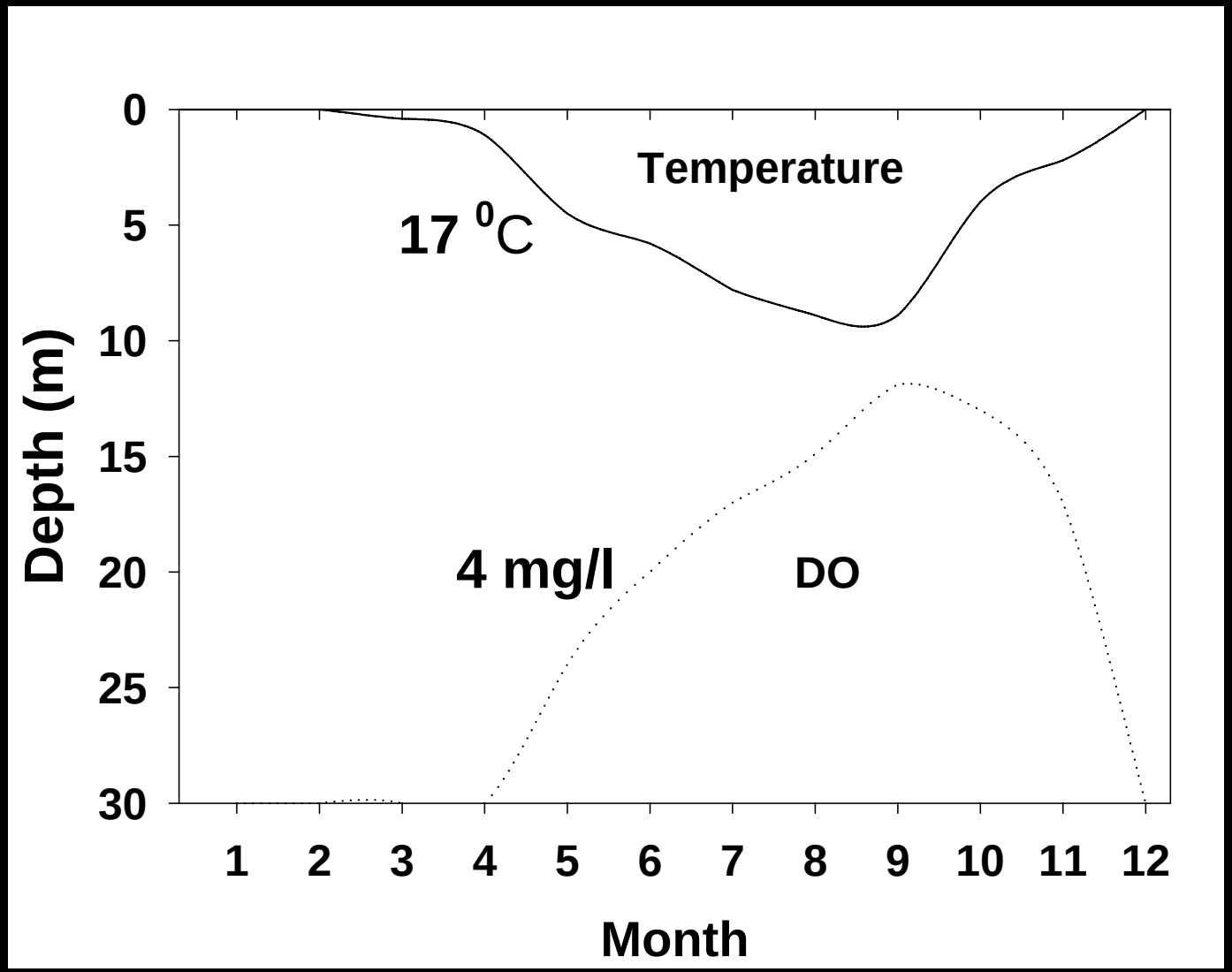
King County

Lake Sammamish

- 6th largest lake in Washington
- 32 km east of Seattle
- 19.8 km^2
- Mean depth 17.7 m
- Max depth 32 m
- Elevation 12 m above msl
- Mesotrophic
- Popular for recreation
- One state park, and several city and county parks



Annual limnological patterns



Fish species

Kokanee

Over 20 different fish species in Lake Sammamish!

Cutthroat Trout

Research objectives

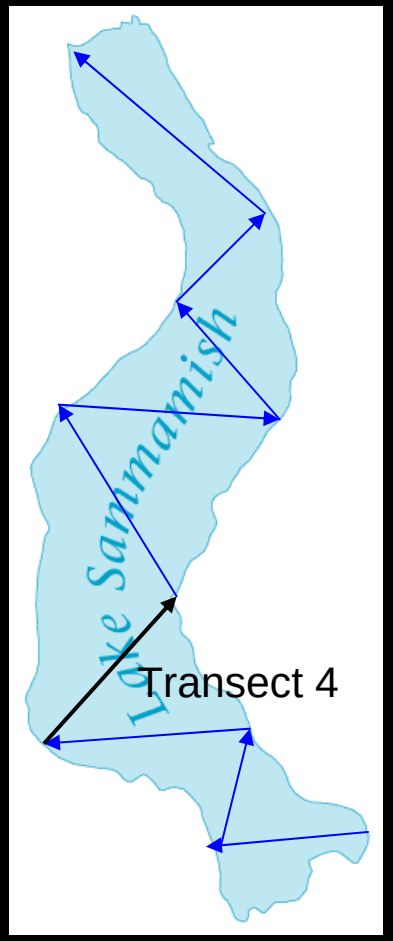
- Investigate the relationship between temperature and dissolved oxygen on the distribution of salmonids
- Investigate the implications of a temperature/DO “squeeze” on trophic dynamics in Lake Sammamish

Methods

- King County RUSS buoys provide continuous water quality data at two stations

Methods

- Split beam hydroacoustic surveys of entire lake

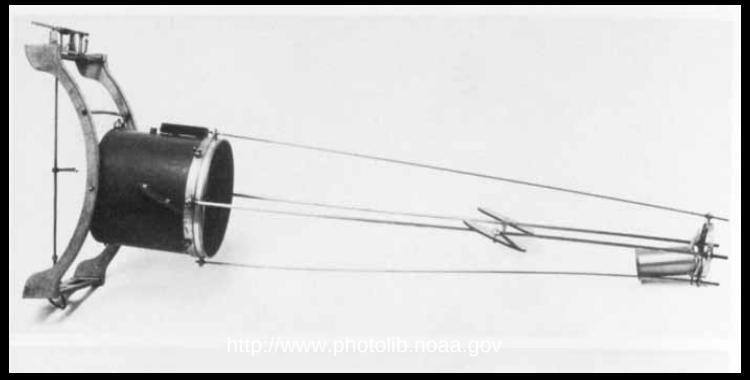


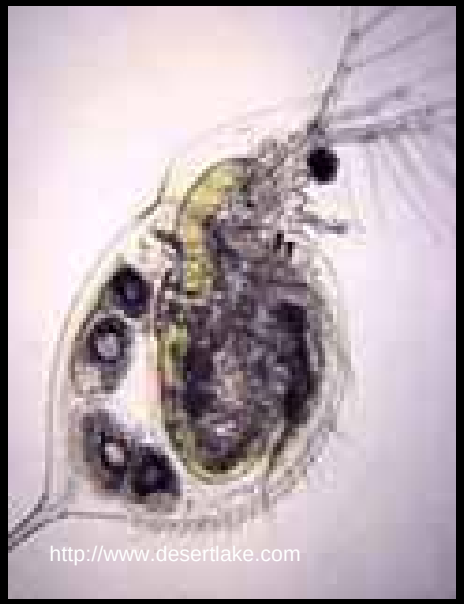
Methods

- Horizontal Gillnets set for target verification of acoustic data and to gather biological information

Methods

- Monthly zooplankton samples collected by King County Environmental Lab and analyzed by UW limnologists

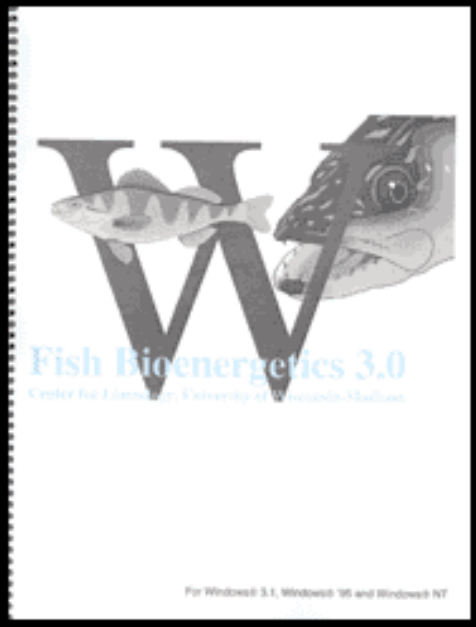




Methods

- Bioenergetics modeling
  - Wisconsin Model (Hanson et al. 1997)

Consumption= Growth + Metabolism Costs+ Waste



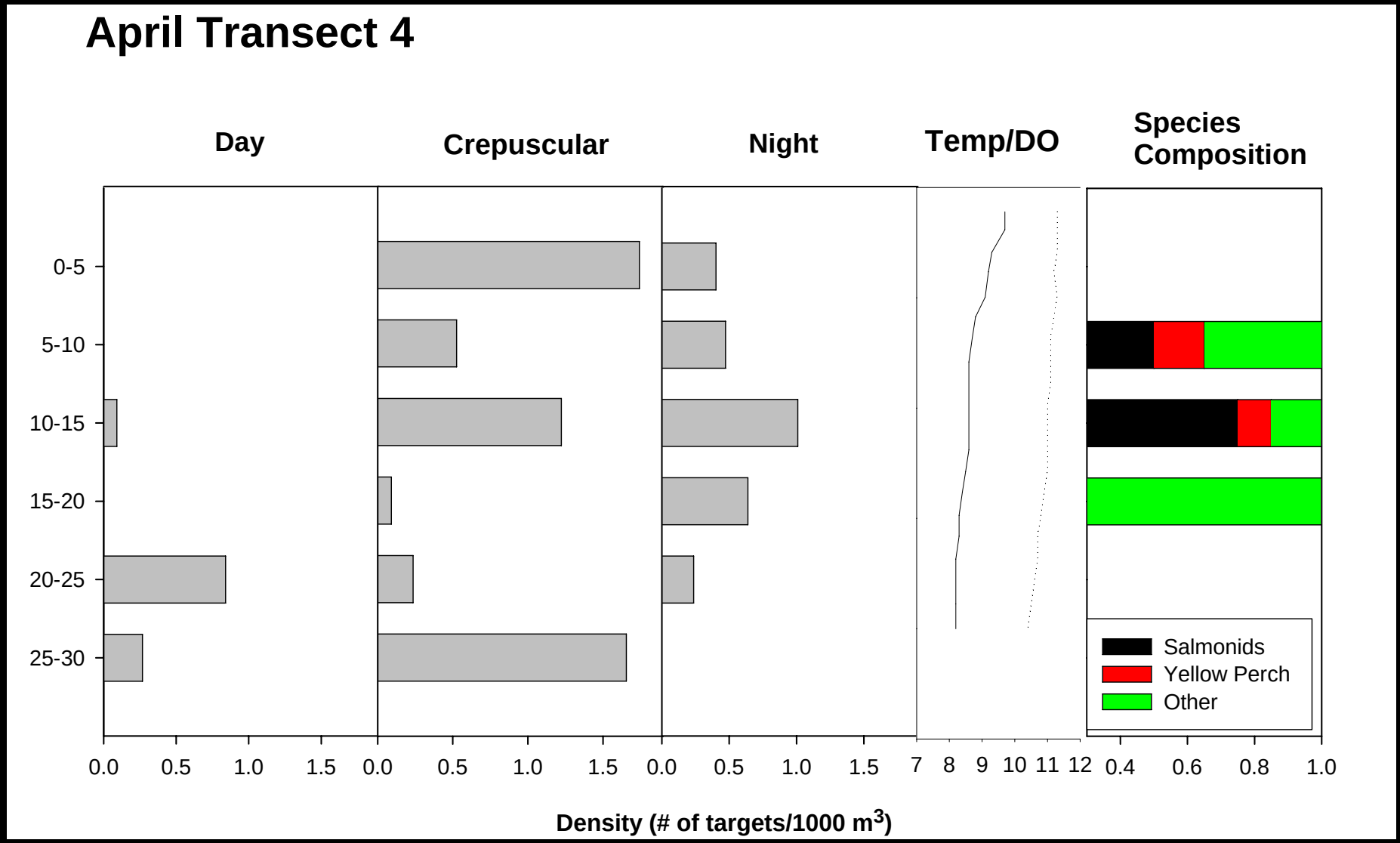
Specific inputs include:

Temperature (thermal experience)
Diet information
Growth of cohorts

Results: Winter and Spring

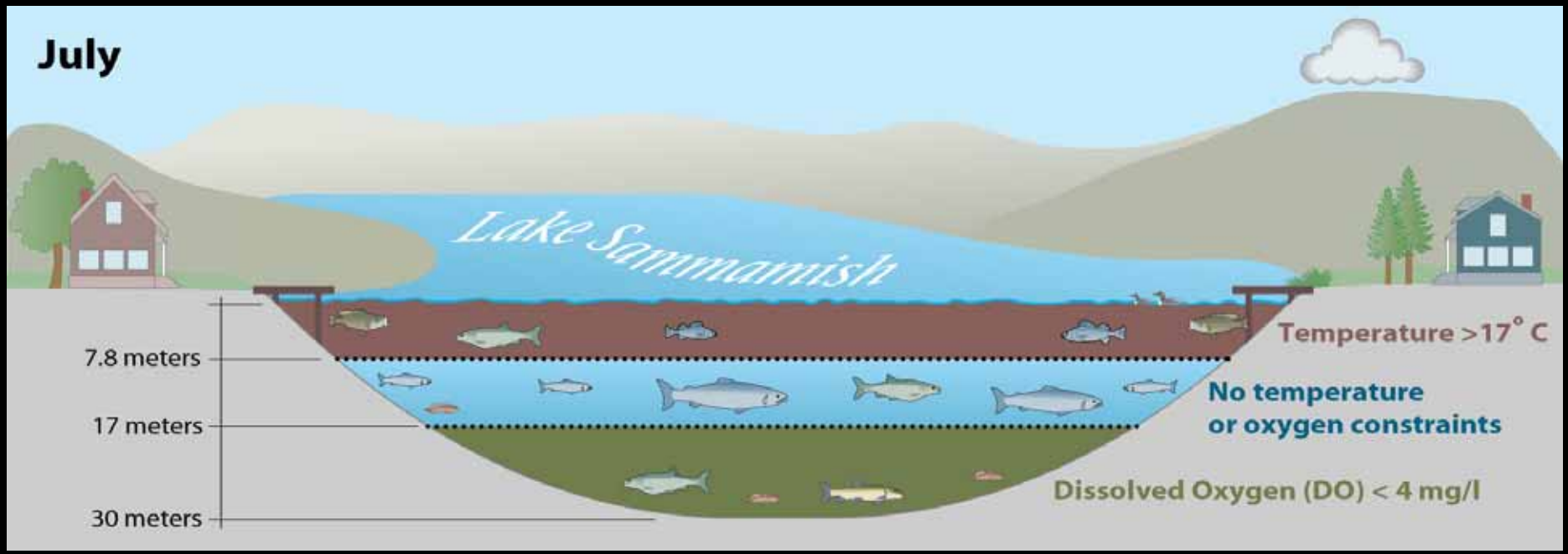
- Salmonids throughout water column

Results: Winter and Spring



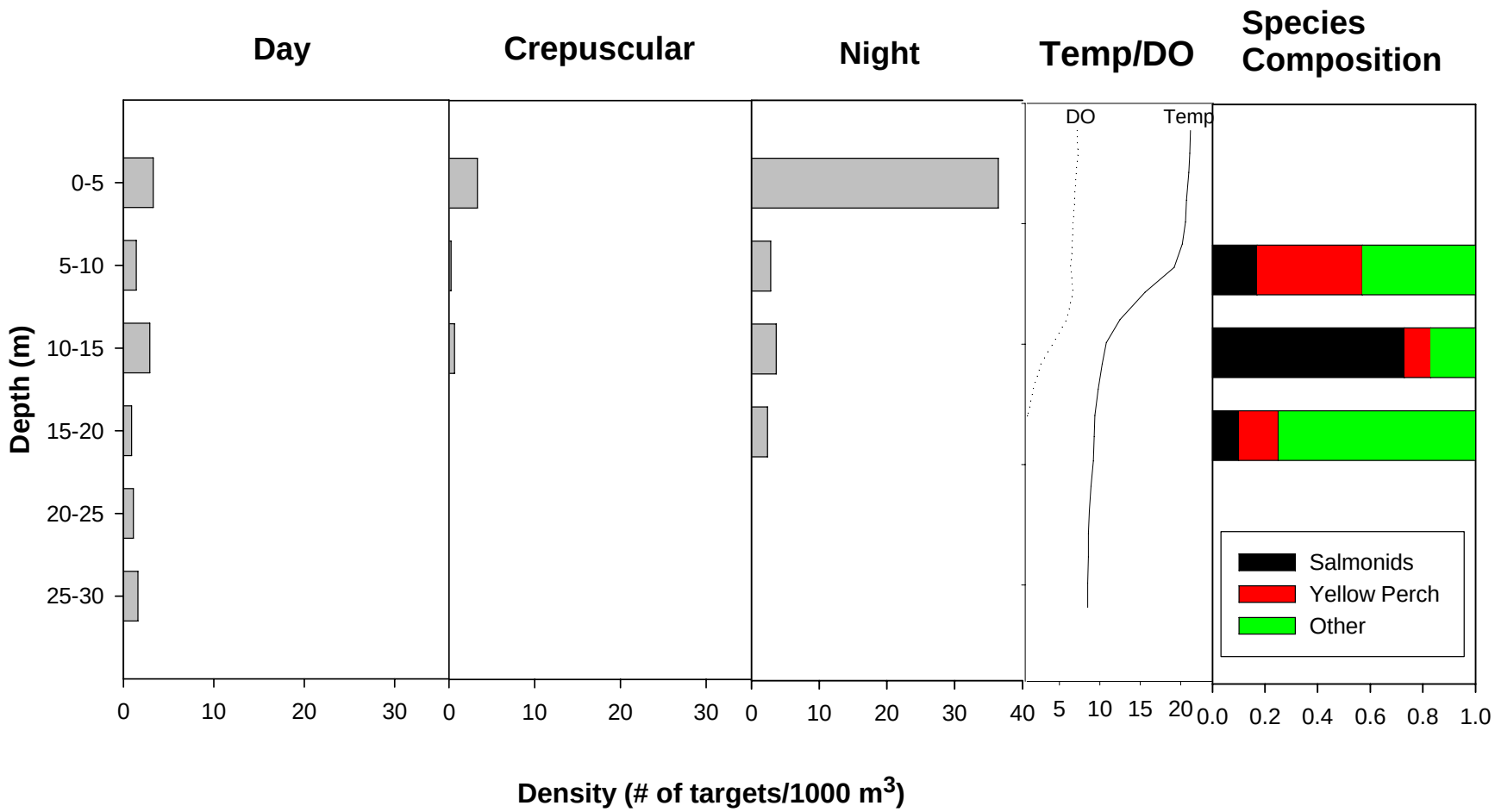
Results: Summer

- Temp/DO “squeeze” intensifies in July



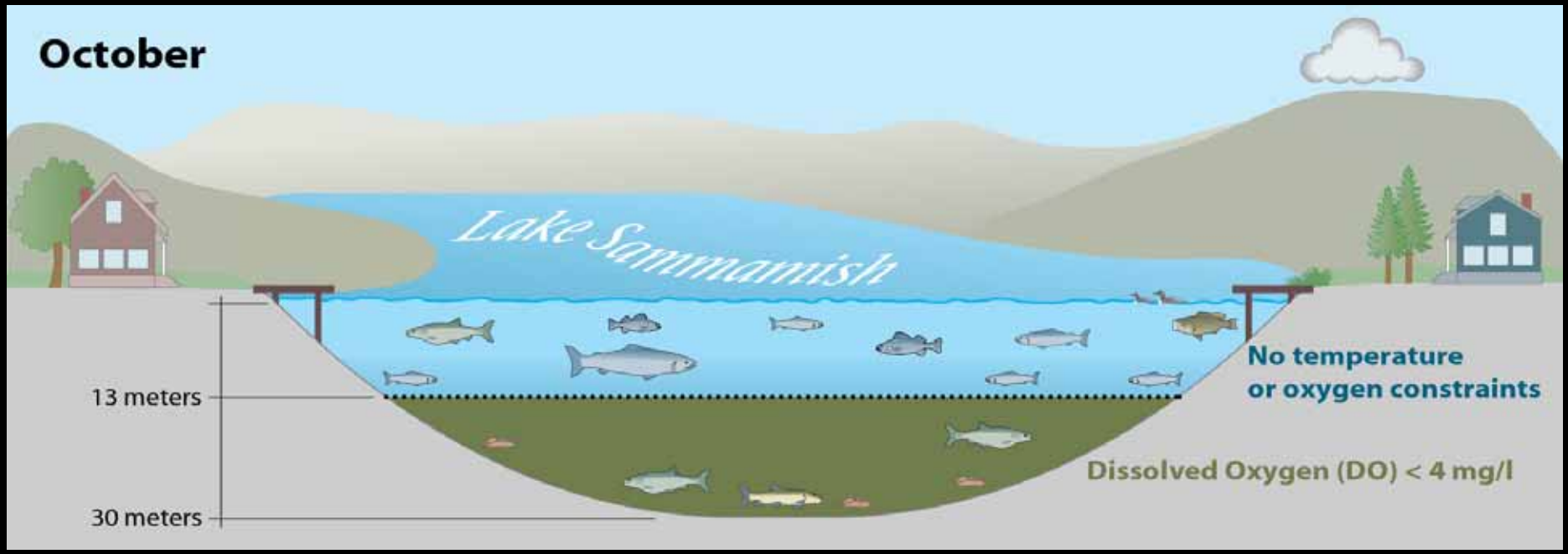
Results: Summer

July Transect 4

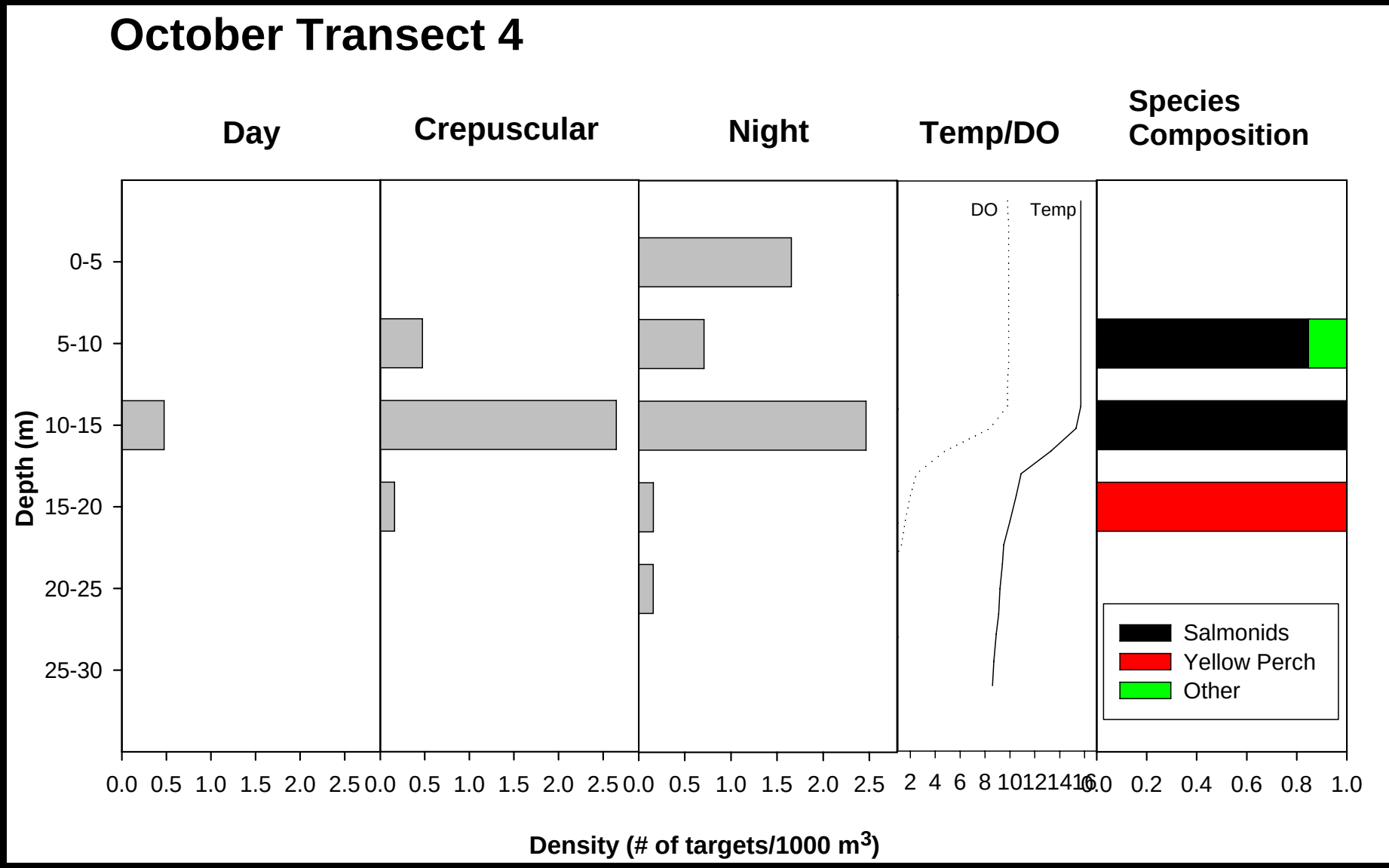


Results

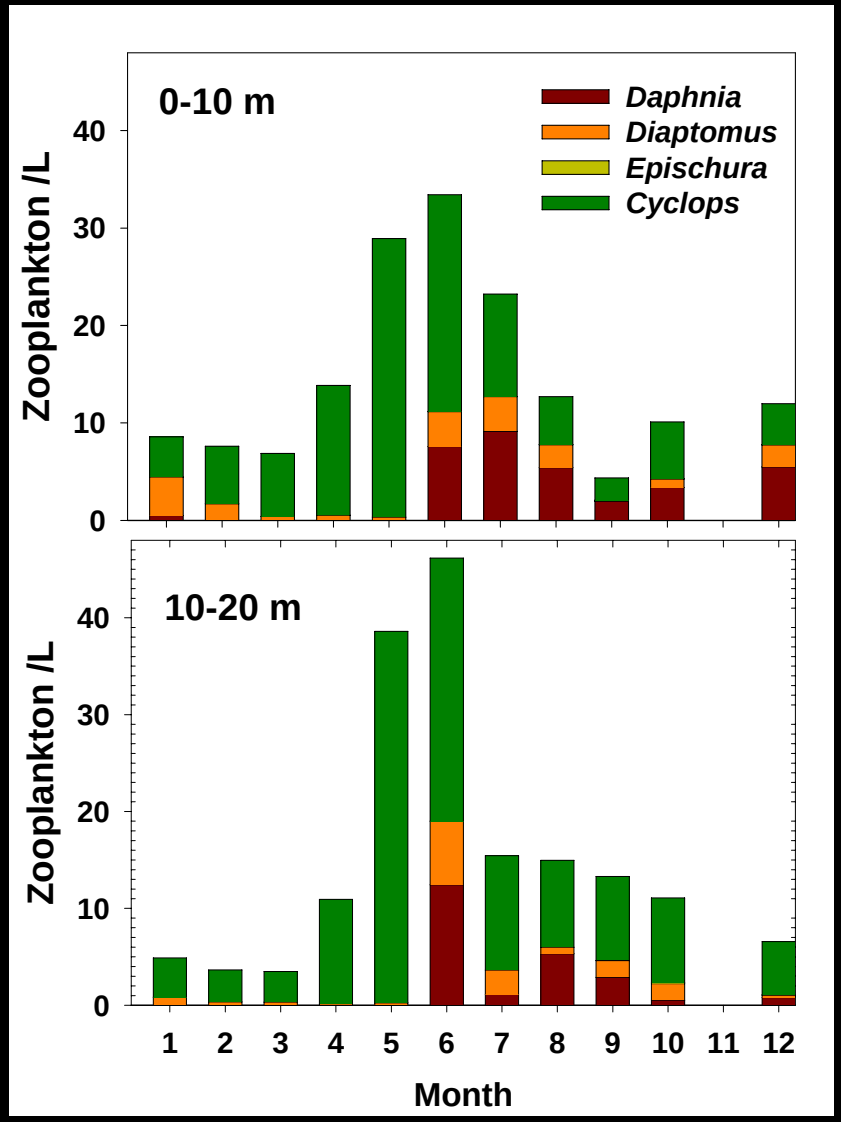
- Temperature cools off in epilimnion in September

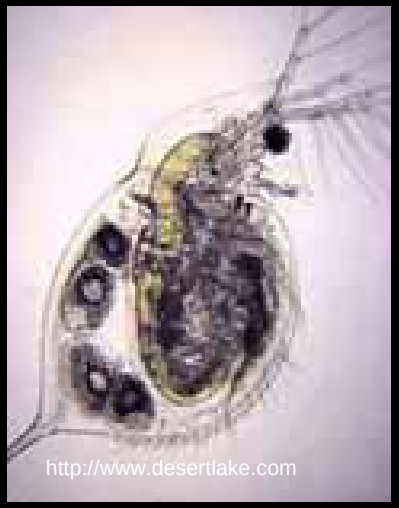


Results: Autumn

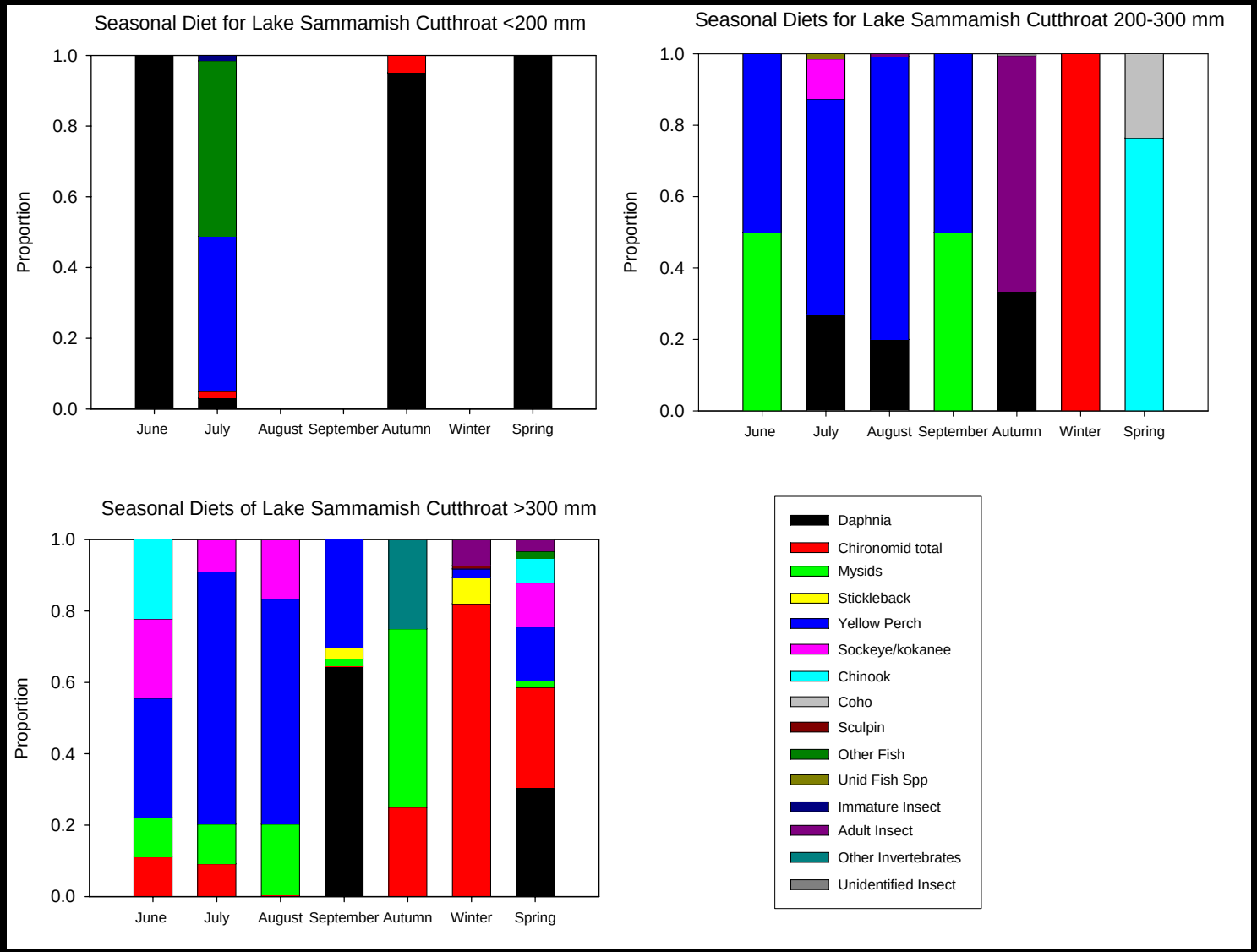


Zooplankton density

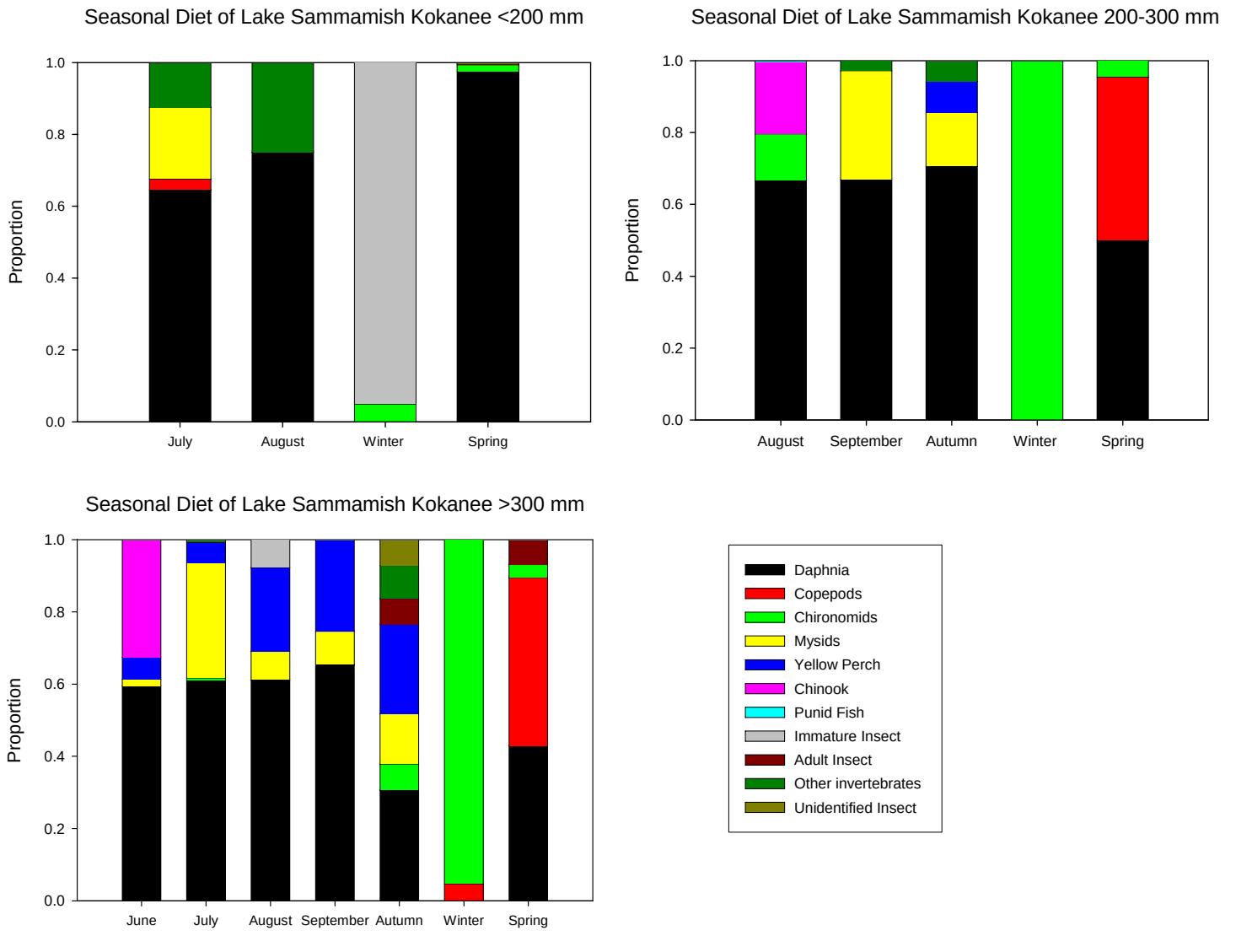




Seasonal diets of cutthroat trout



Seasonal diets of kokanee



Bioenergetic consequences of temp/DO “squeeze”

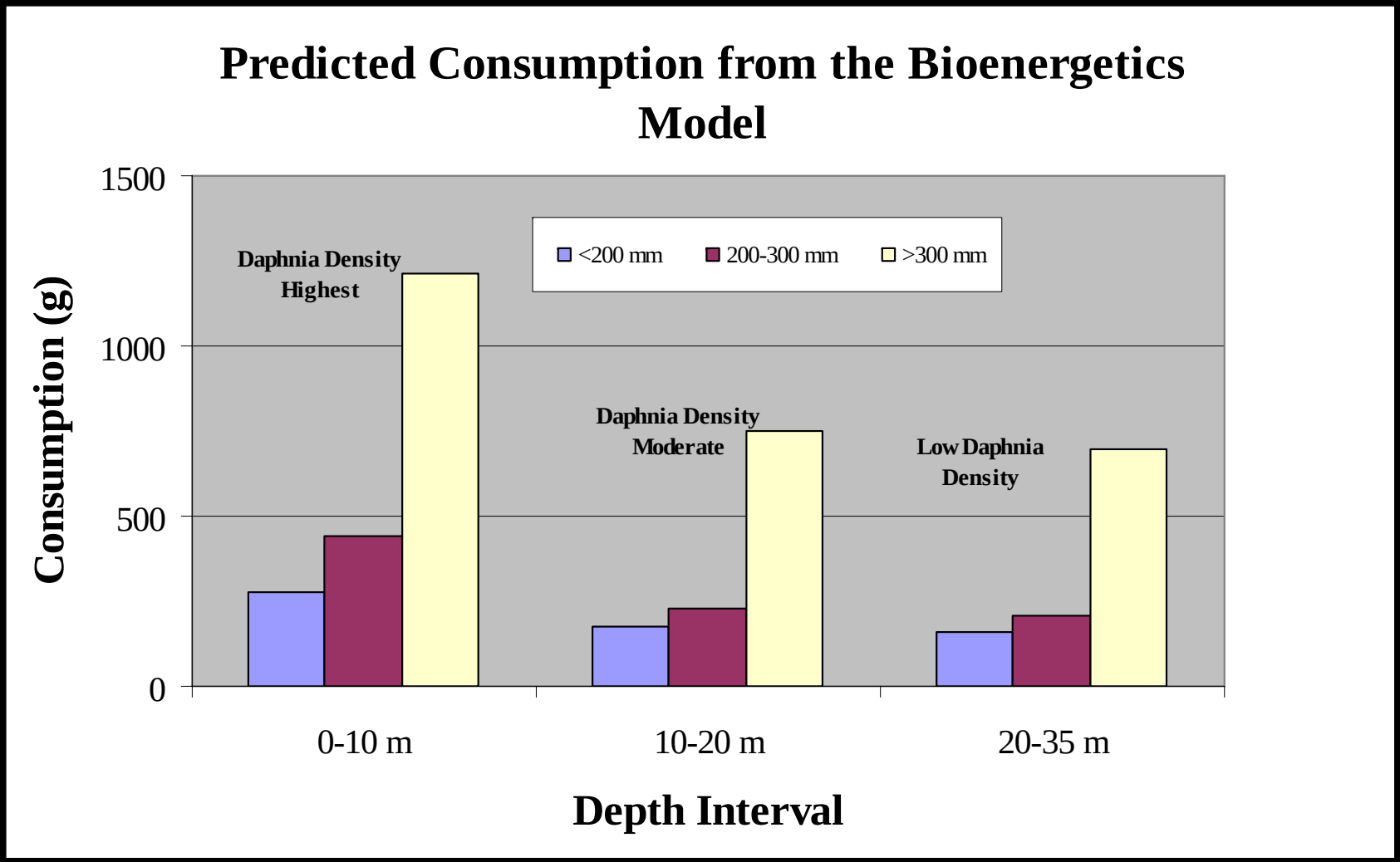
- Kokanee as an example
- Simulation from July 2nd (day 1) through November 15th (day 139)
- Inputs: thermal experience, diet proportions, and size classes
- DO is not an input into this model

Thermal experience

Day of Simulation	Epilimnetic thermal experience °C	Metalimnetic thermal experience °C	Hypolimnetic thermal experience °C
1	***18.18****	9.16	8.3
17	***20.4****	10	8.5
24	***21.65****	9.77	8.6
38	***18.65****	9.51	8.6
60	***21.9****	10.24	8.35
89	***18.7****	9.91	8.6
110	16.18	10.75	8.6

**** Denotes temp >17 ℃***

Kokanee consumption



Risk of predation

- When predators and prey are “squeezed” into the same depth interval, predation is more intense
- Our data suggests that kokanee and yellow perch are the targets of pelagic piscivores more during the stratified period than the rest of the year

Conclusions

1. Salmonids respond to changes in temperature and dissolved oxygen
2. Salmonid diets change seasonally as a result of changes in the environment
3. Kokanee and yellow perch are preyed upon more heavily during thermally stratified conditions, when their distribution is confined to the same depth intervals as the piscivorous cutthroat trout
4. In order to maintain growth, kokanee in the epilimnion would need to consume almost 2x the number of daphnia as those in the metalimnion and hypolimnion

Acknowledgments

- **Funding:** King County DNRP
- **Facilities and Equipment:** WACFWRU
- **Field:** Beauchamp lab, particularly Mistie Hammer; KC staff, Kollin Higgins and David Robinson
- **Laboratory:** Mistie Hammer and Angie Lind
- **RUSS Buoy Data:** Rob Blomquist
- **Zooplankton Data:** Kevin Li and Judy Shepherd