

Evaluating Effects of Atmospheric and Terrestrial Disturbance in a Southwest Alaska Lake

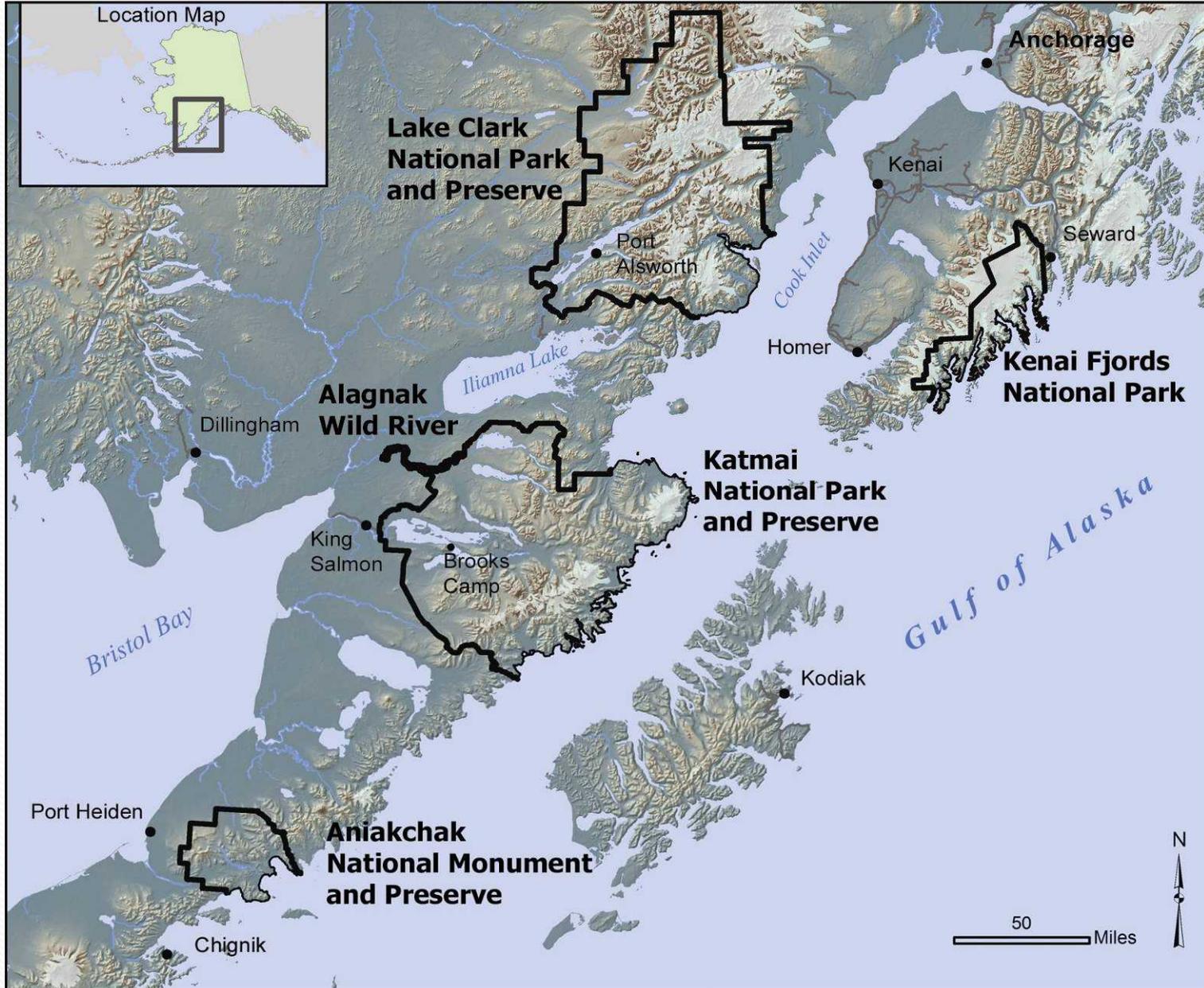
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Presentation Outline

- Objectives of Freshwater Vital Signs
- Sampling Design for Large Lake Systems
- Spatial and Temporal Disturbance Considerations
- Disturbance Factors
 - Weather / Climate
 - Geologic
- Inter-Annual Variability
 - Example – Lake Clark
- Future Analysis

Southwest Alaska Network Park Units



SWAN Freshwater Vital Signs

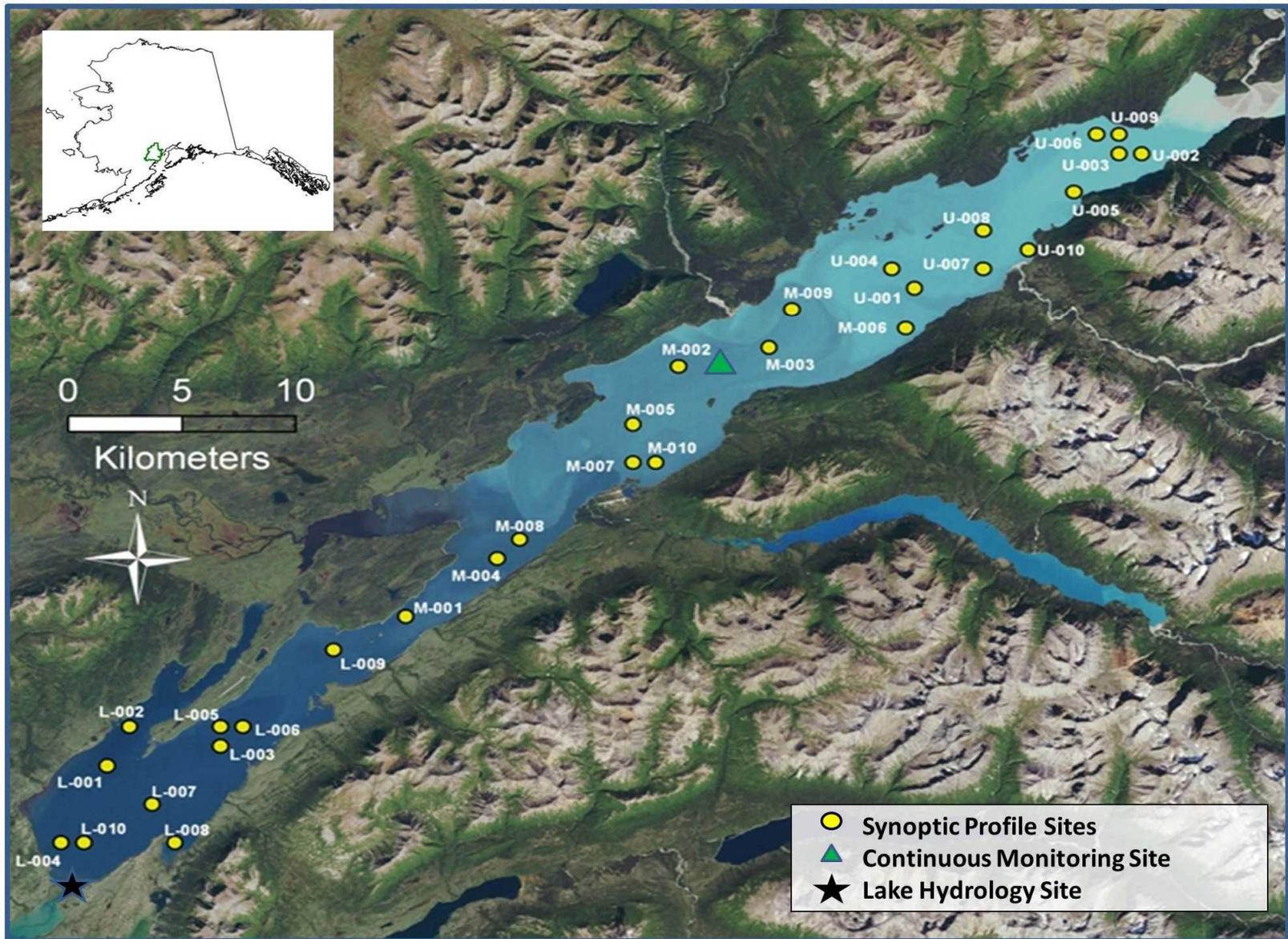
- **Surface Hydrology**
 - Seasonal Hydrographs
 - Level Loggers
- **Water Quality**
 - Thermal Stratification
 - Moored temperature arrays
 - Seasonal Lake WQ
 - Multi-parameter sondes
 - Vertical Lake Profiles
 - Multi-parameter sondes
- Water clarity
 - Moored temperature arrays
 - Secchi depth



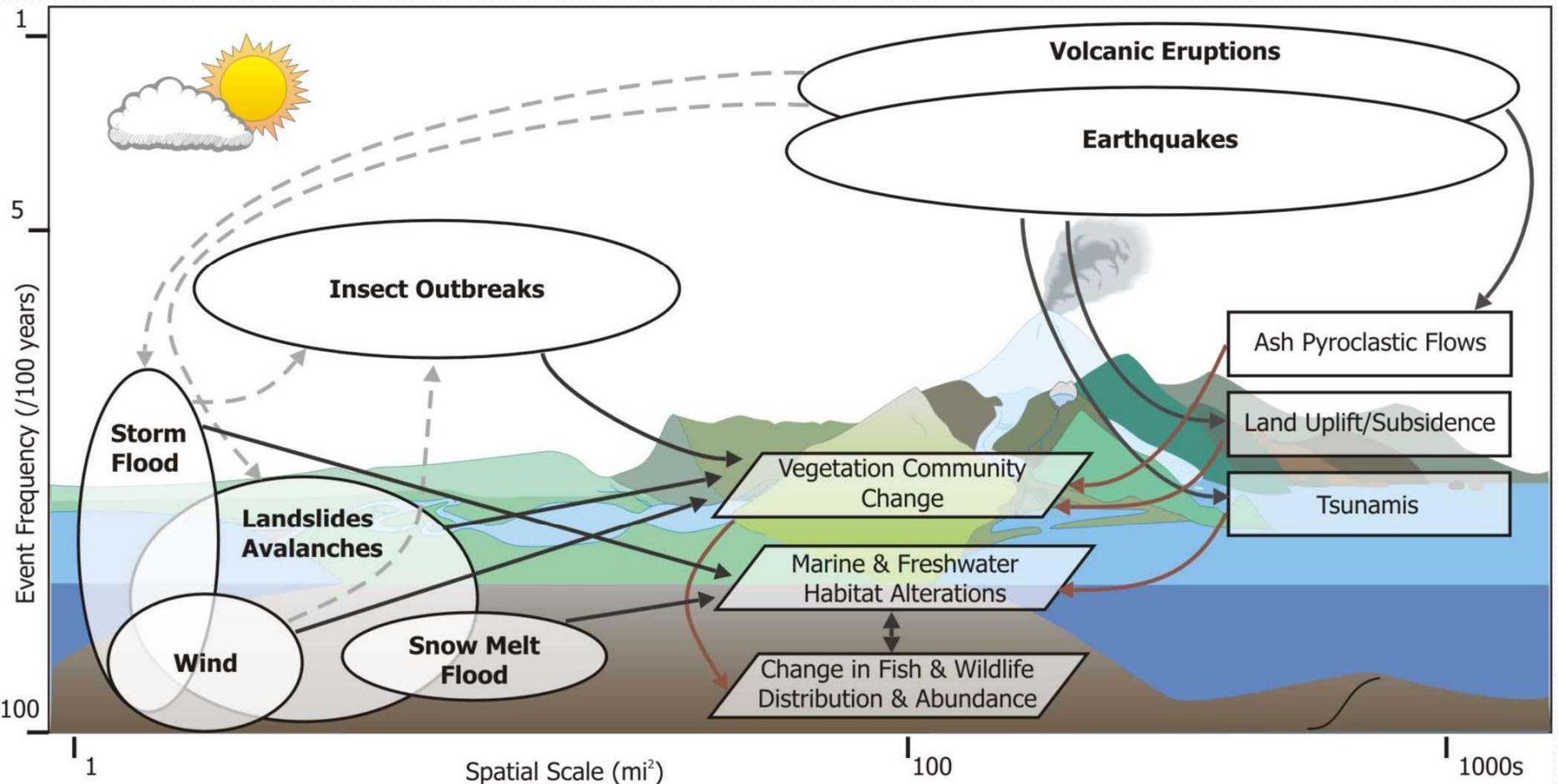
Freshwater Sampling Design

| | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|--------------------|---|------|------|------|------|------|------|
| Tier 1 | Combination of sampling strategies | | | | | | |
| LACL-Lake Clark | X | X | X | X | X | X | X |
| KATM-Naknek Lake | X | X | X | X | X | X | X |
| | Synoptic mid-lake sample – one location / Temperature Array | | | | | | |
| LACL-Kijik Lake | X | X | X | X | X | X | X |
| KATM-Lake Brooks | X | X | X | X | X | X | X |
| Tier 2 | Synoptic mid-lake sample – one location | | | | | | |
| LACL Panel 1 Lakes | X | | | | | X | |
| LACL Panel 2 Lakes | | X | | | | | X |
| KATM Panel 1 Lakes | X | | | | | X | |
| KATM Panel 2 Lakes | | X | | | | | X |
| KEFJ Lake Panel | | X | | | | | X |

Sampling Design for Large Lake Systems

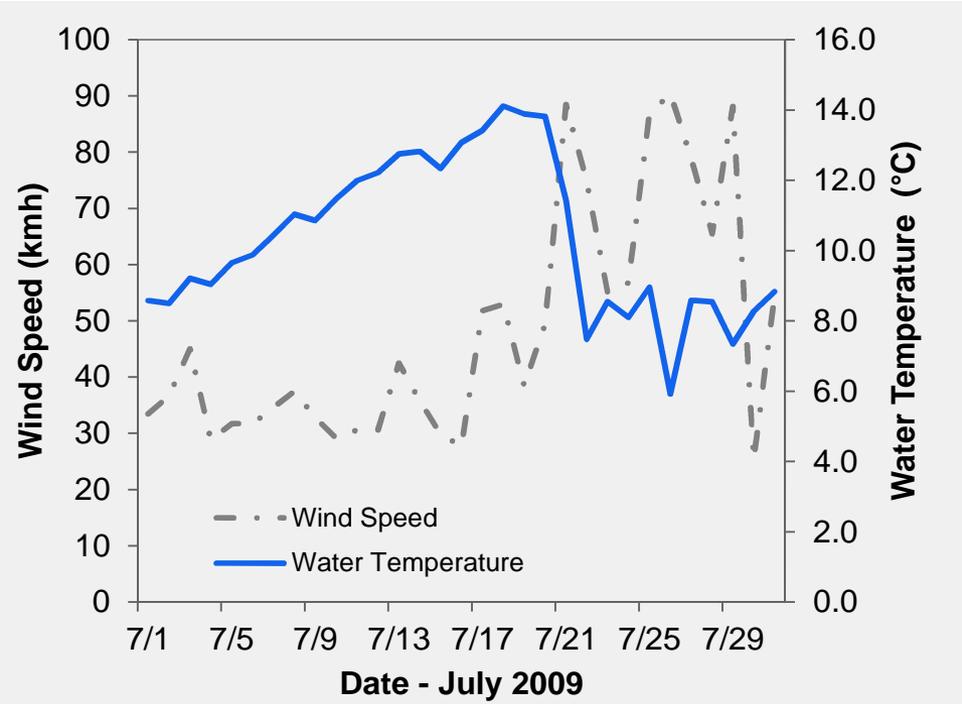
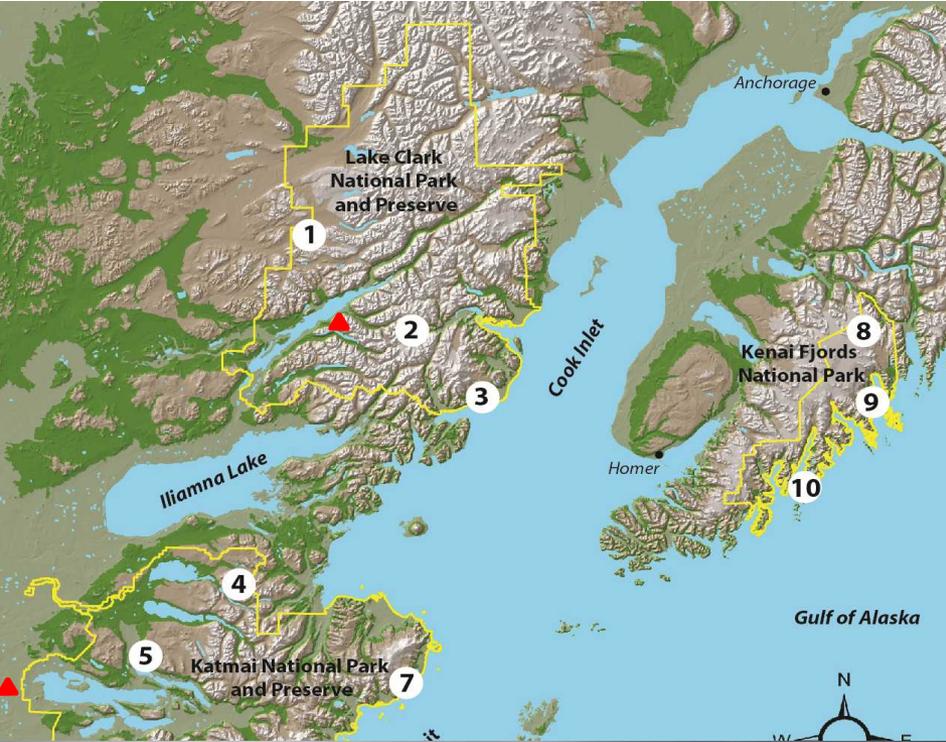


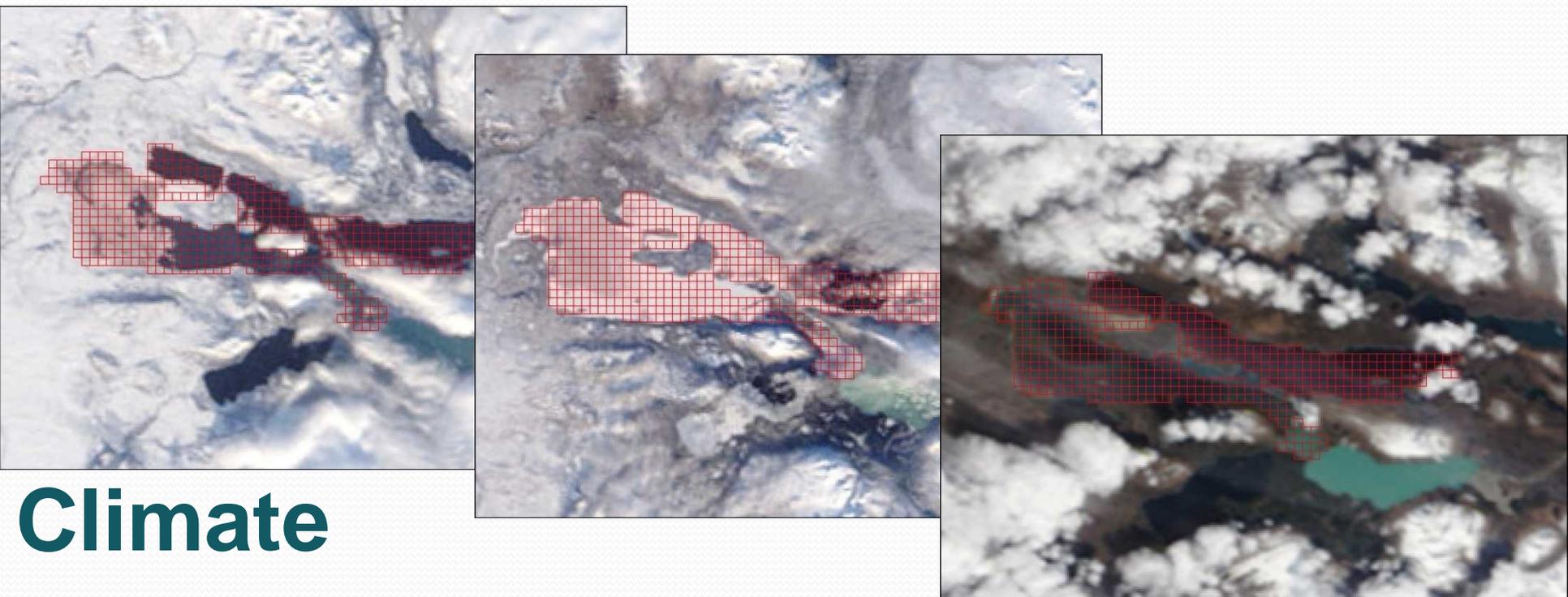
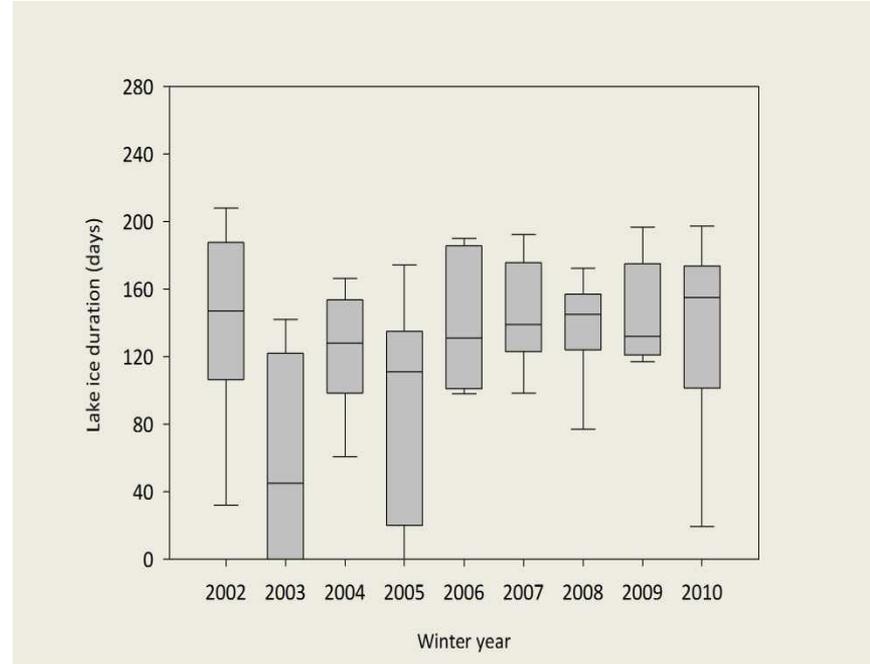
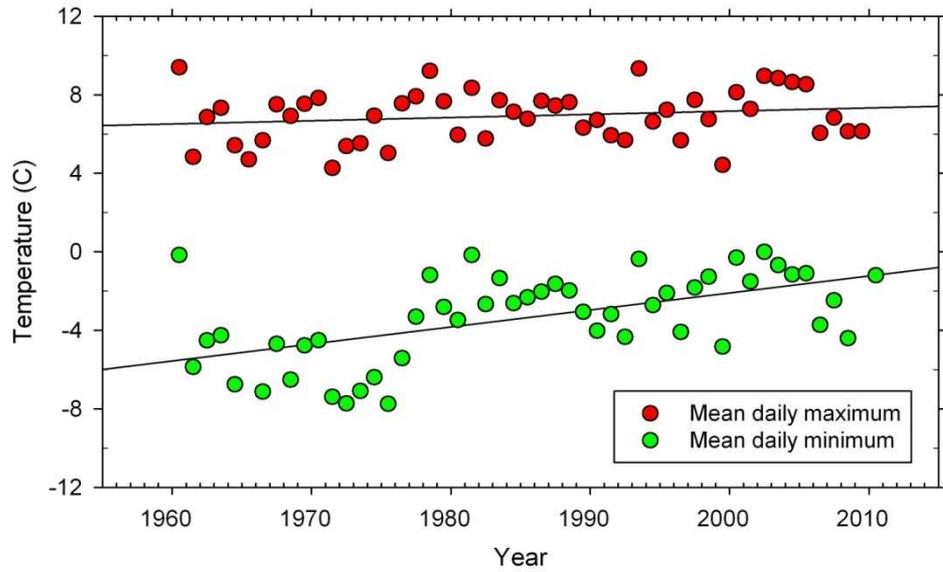
Spatial and Temporal Disturbance Considerations in SWAN Park Units



Weather and Climate







Climate

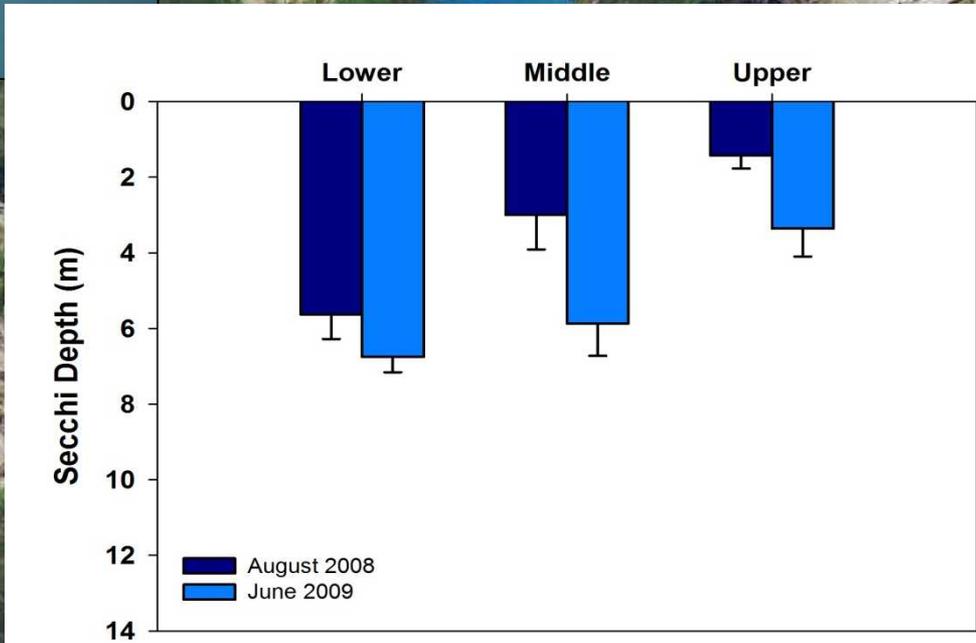
Geologic Disturbance

**Annual Time Scale –
Glacial Sediment Plume**



**Multi-Decadal Time Scale –
Volcanic Eruptions**



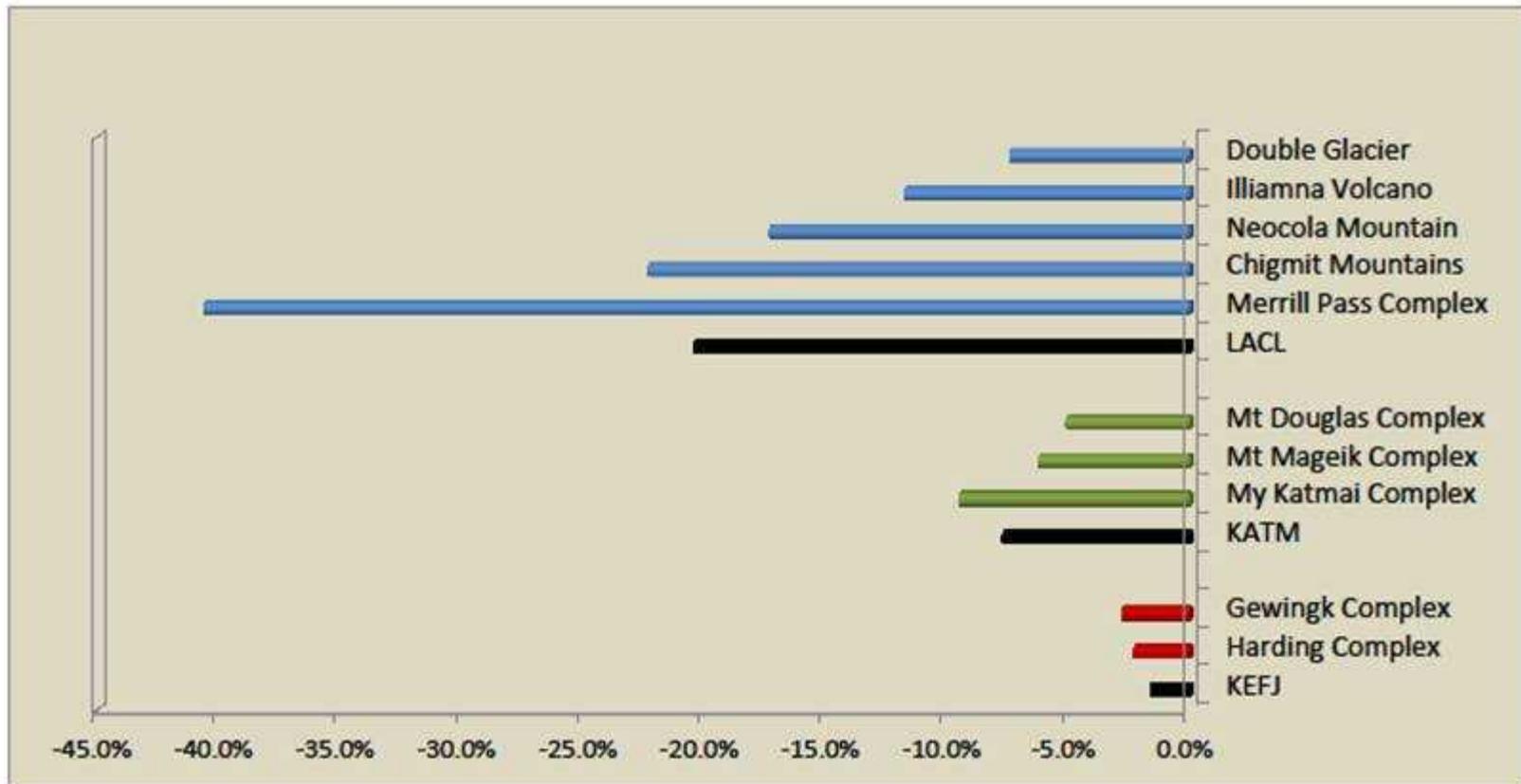


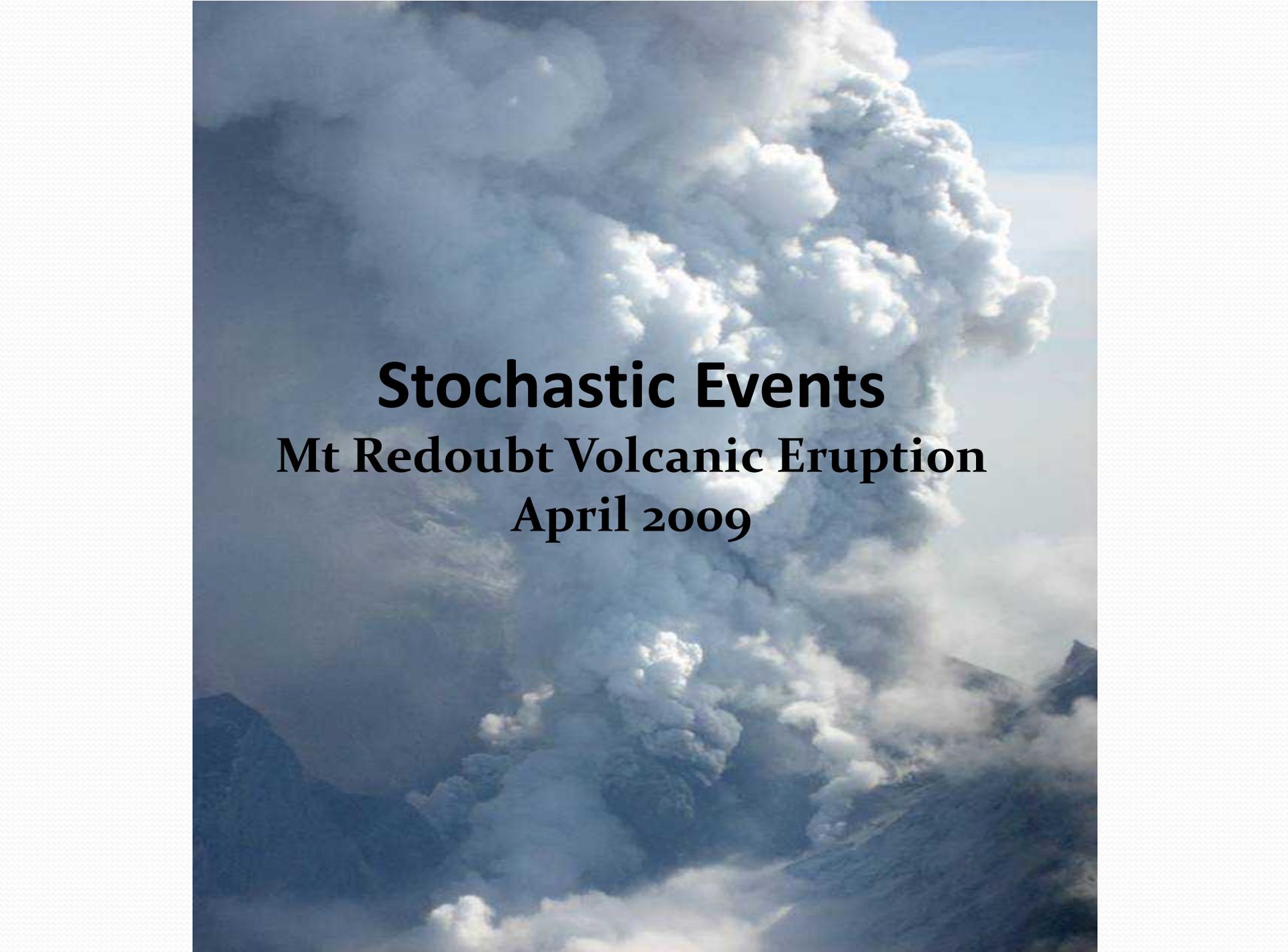
Glacial Extent

- Glaciers cover 13% of landscape in Lake Clark NPP
- Glacial loss between 1987 and 2007 estimated at 20%



Glacial Loss Across SWAN Parks



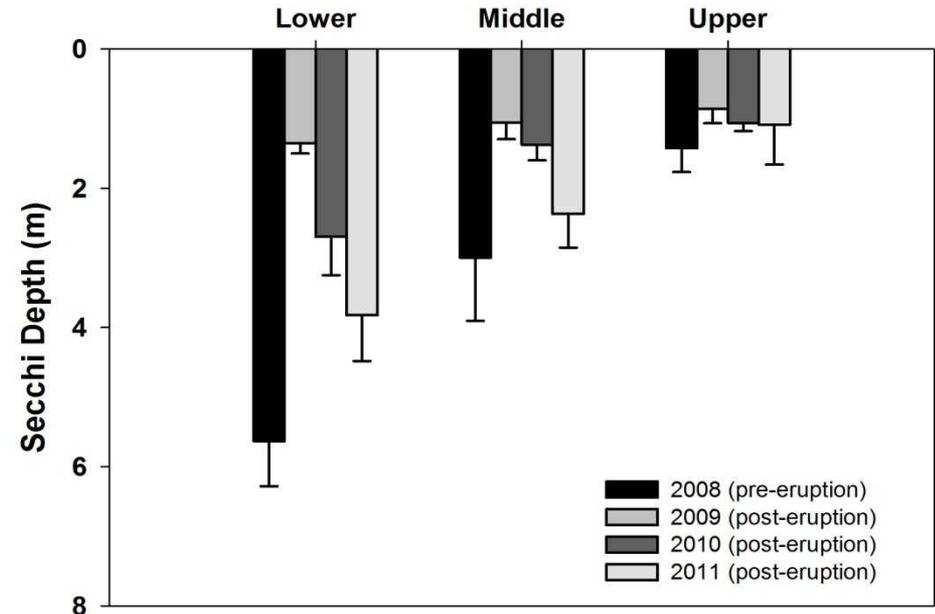
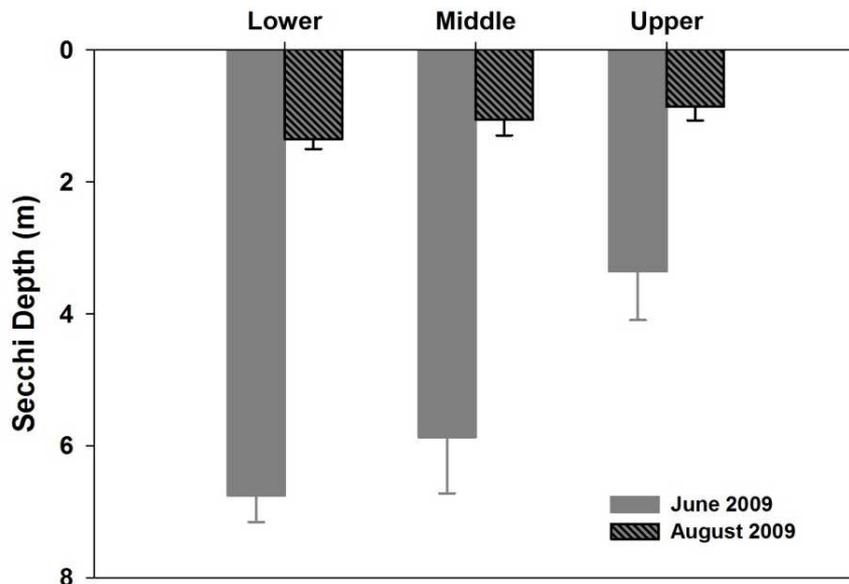
A photograph of a massive volcanic eruption plume from Mt. Redoubt in April 2009. The plume is a thick, billowing column of white and grey ash and steam that rises high into the sky, partially obscuring the blue sky. The plume has a cauliflower-like texture with many smaller clouds within it. In the foreground, the dark, rocky slopes of the volcano are visible, with some lower-level ash clouds or steam rising from the crater floor. The overall scene is dramatic and powerful.

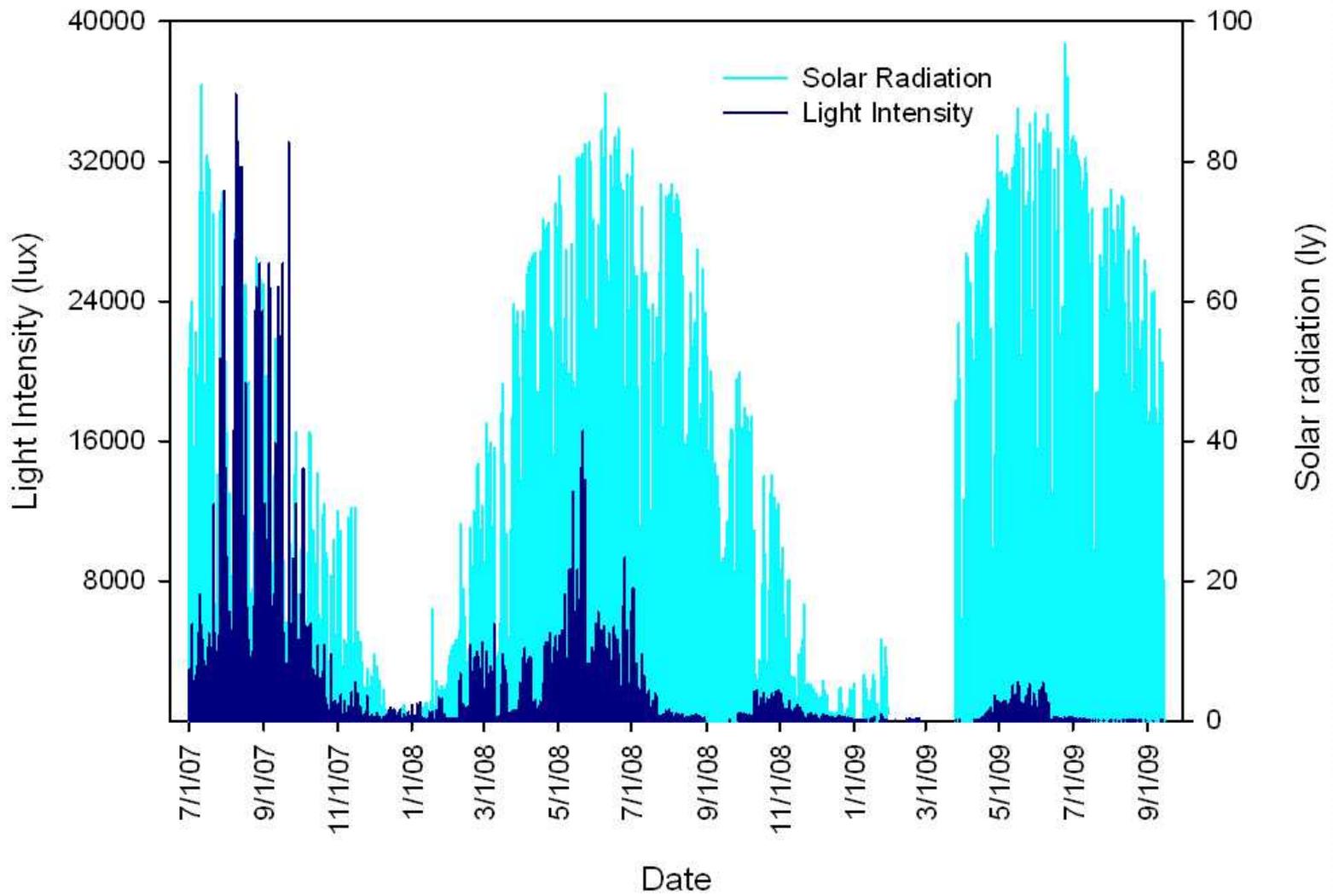
Stochastic Events
Mt Redoubt Volcanic Eruption
April 2009

Post-Eruption Changes in Water Clarity

- Water clarity decreased over 4 m in Middle and Lower Basins in 2009

- Water clarity continues to recover three year post-eruption

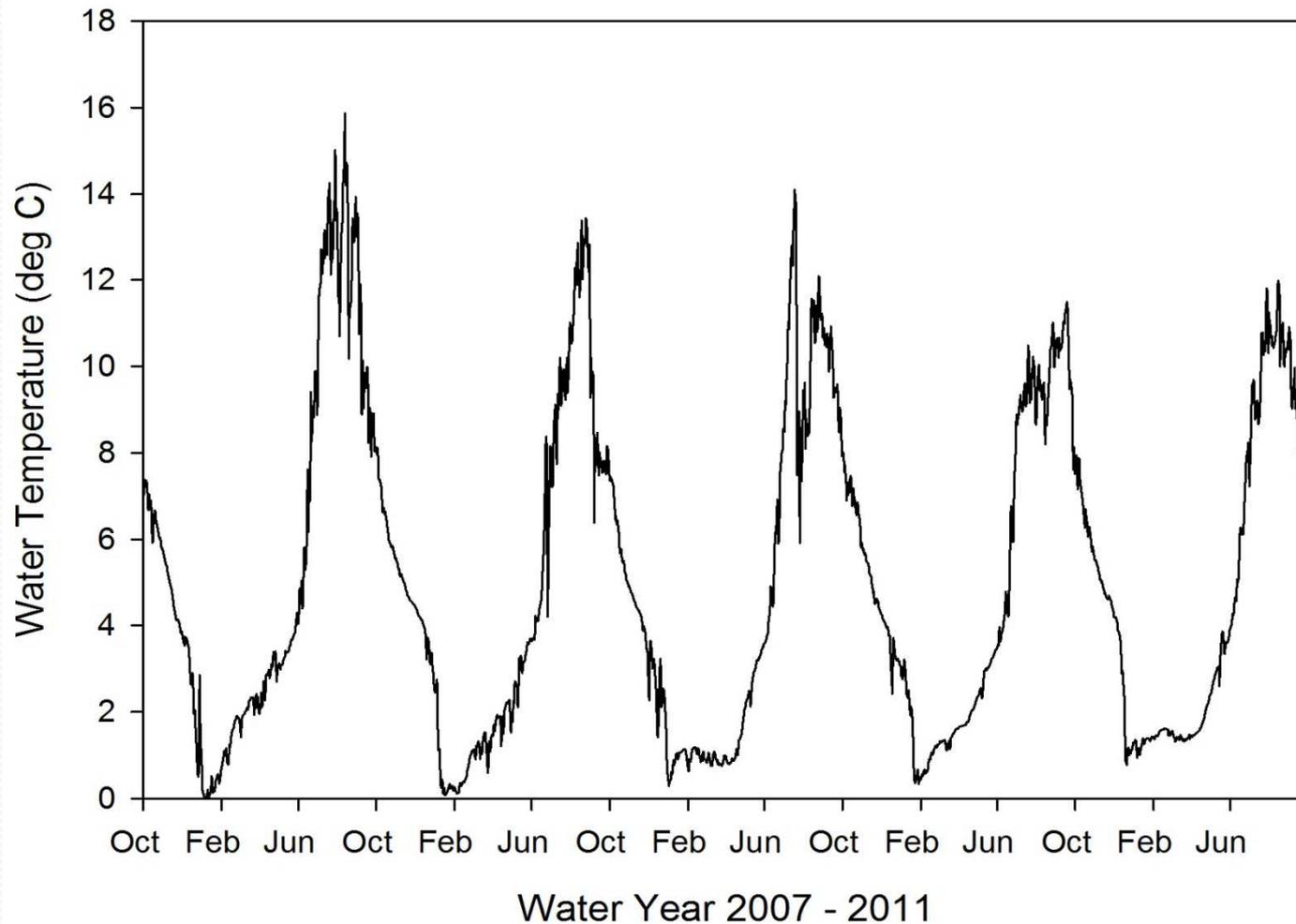


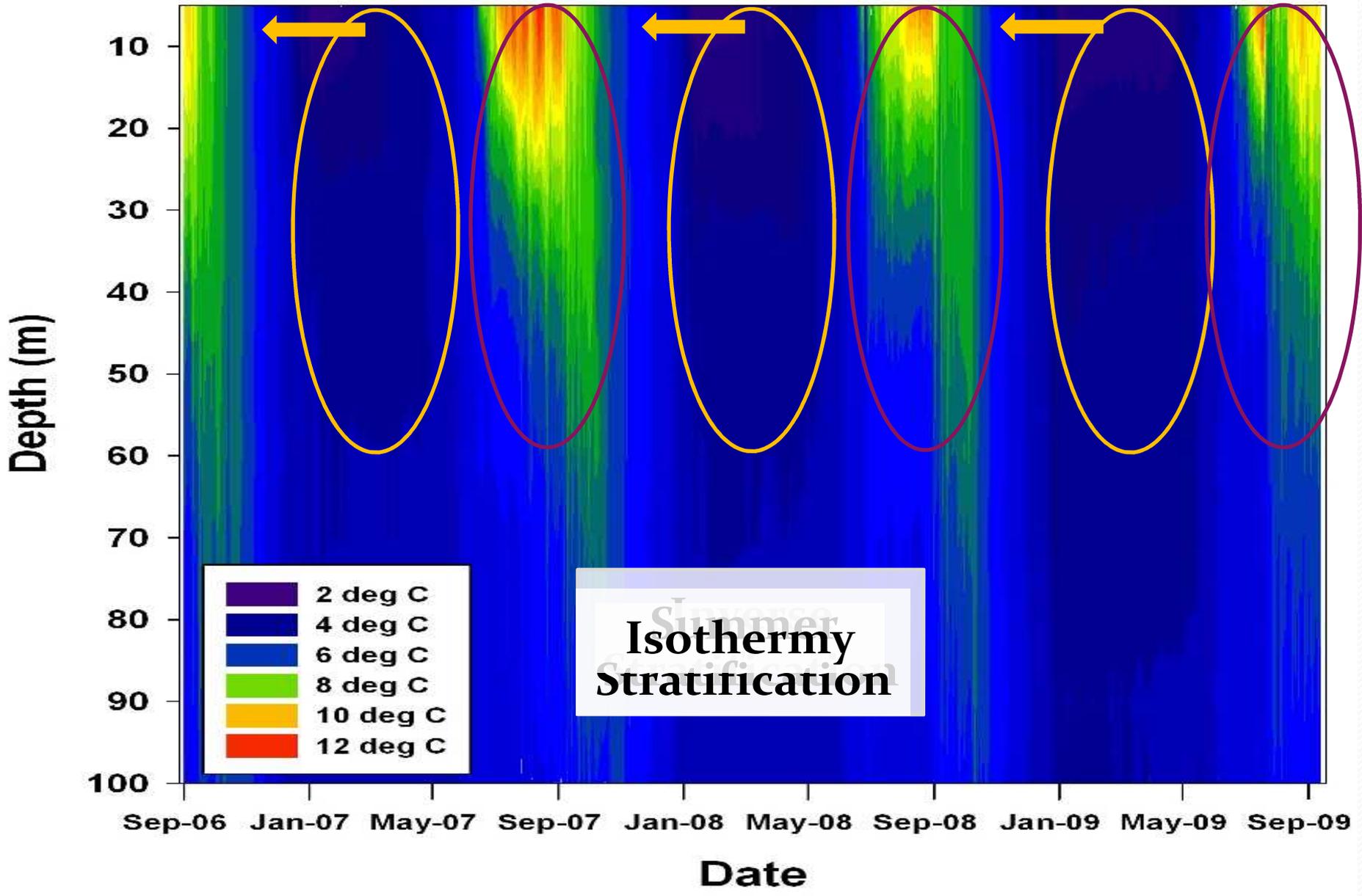


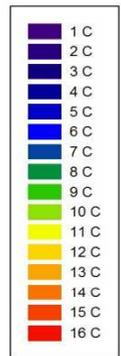
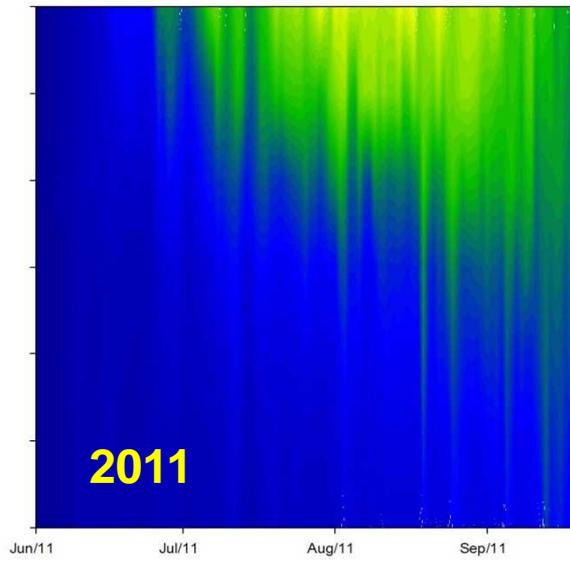
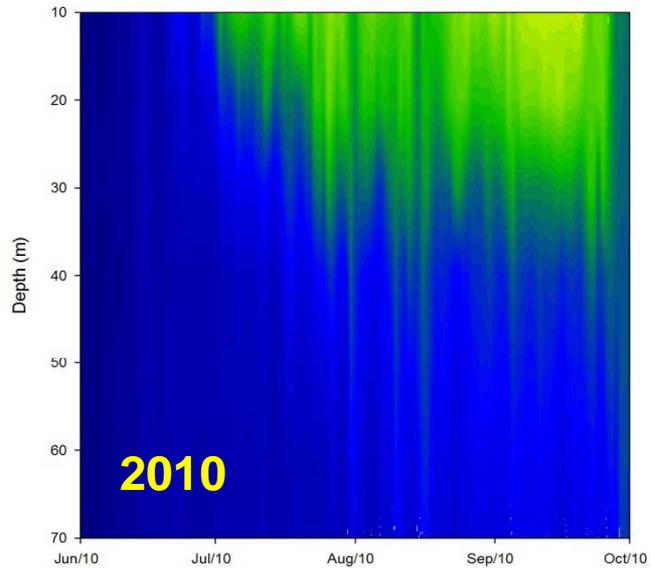
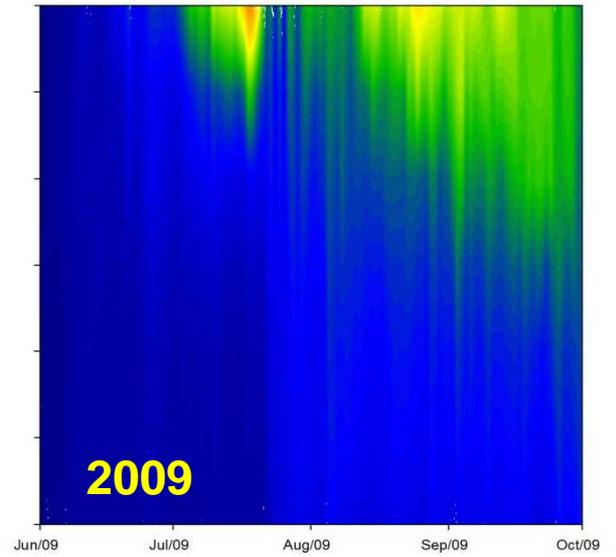
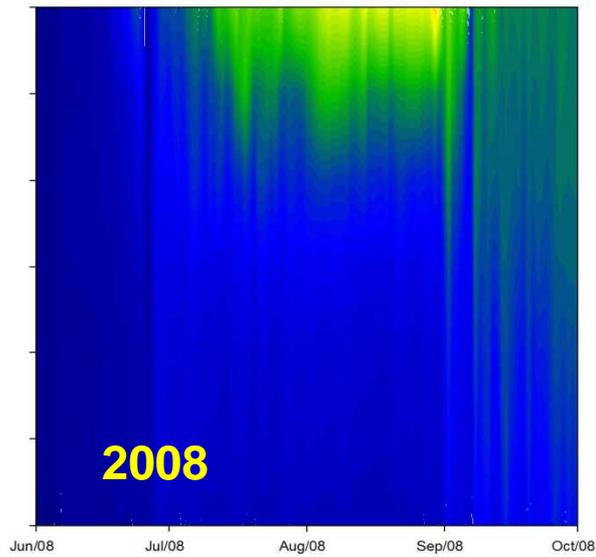
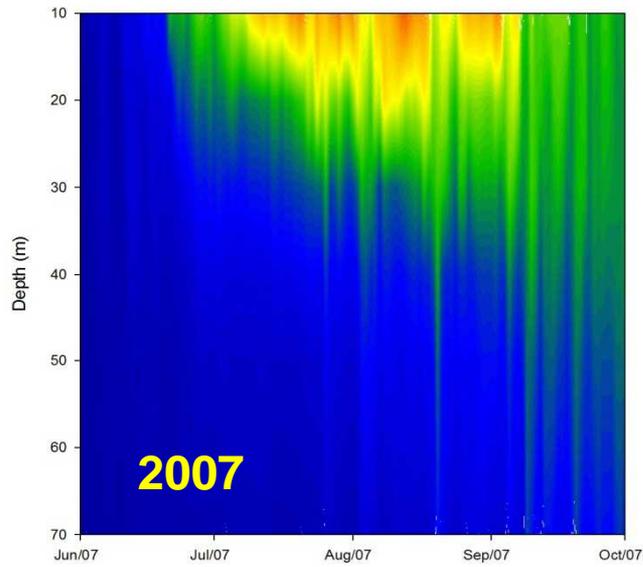


Inter-Annual Variability

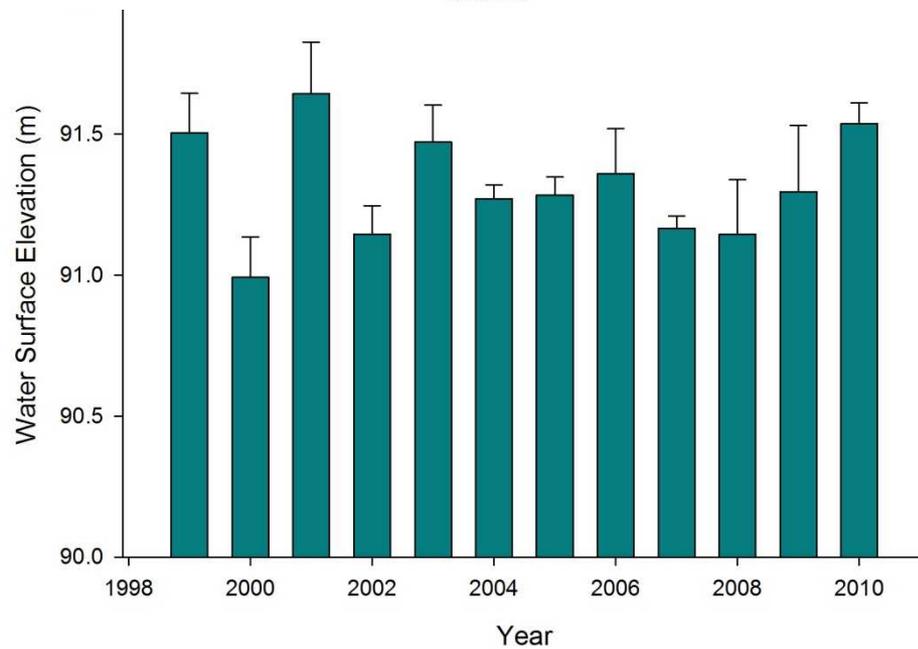
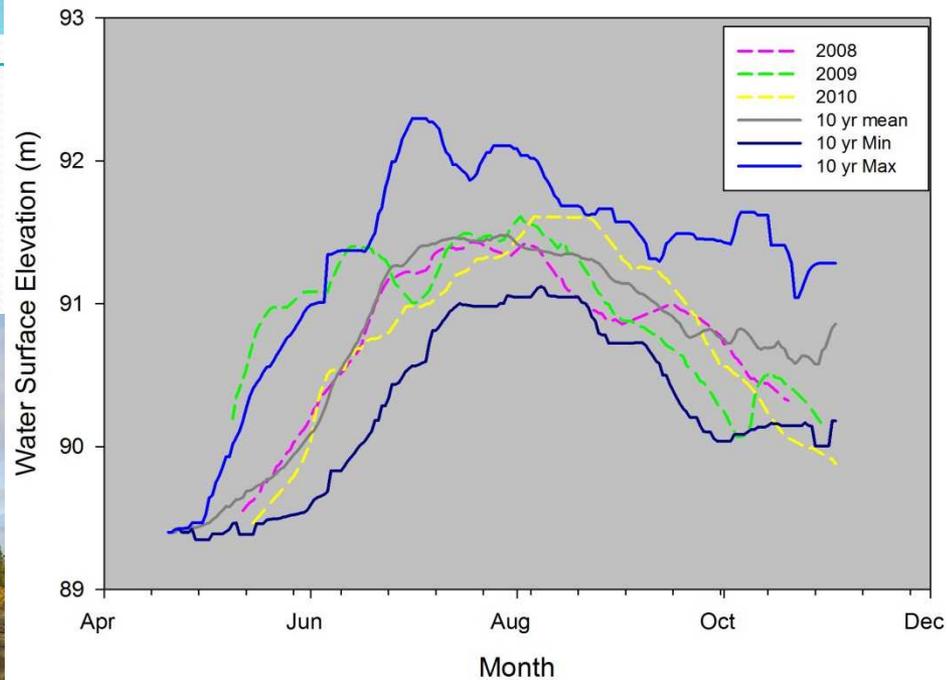
Lake Temperature Inter-annual Variability



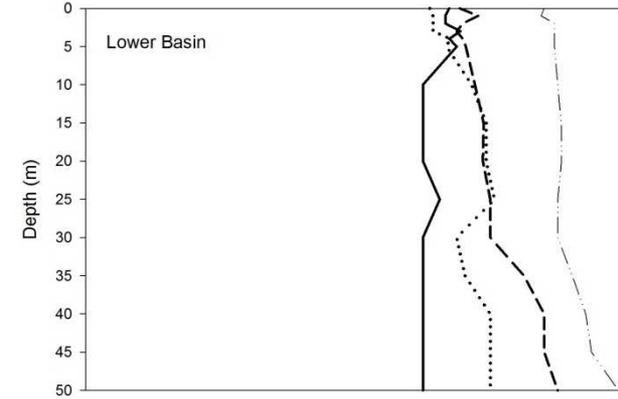
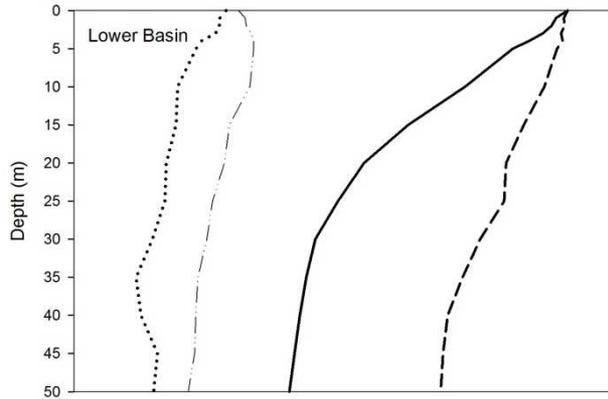
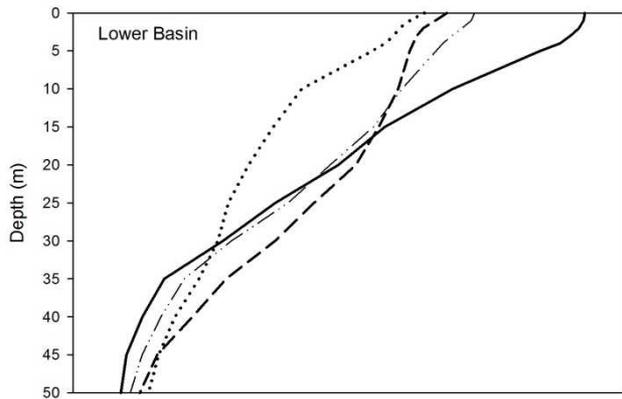
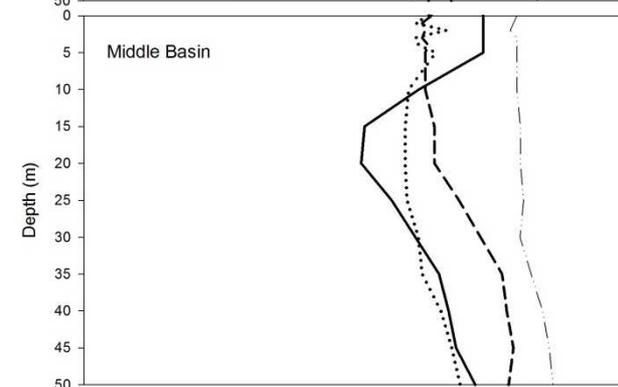
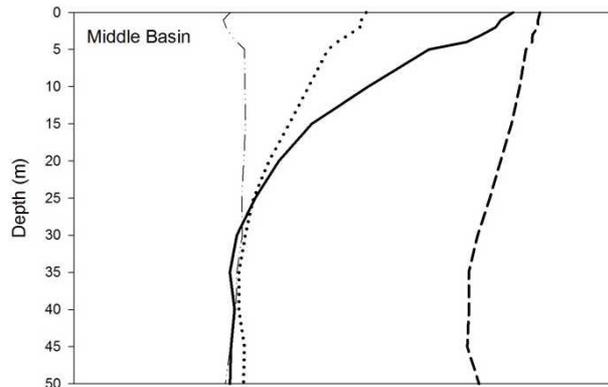
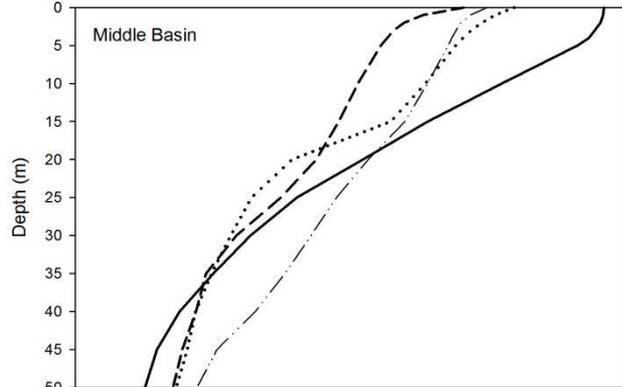
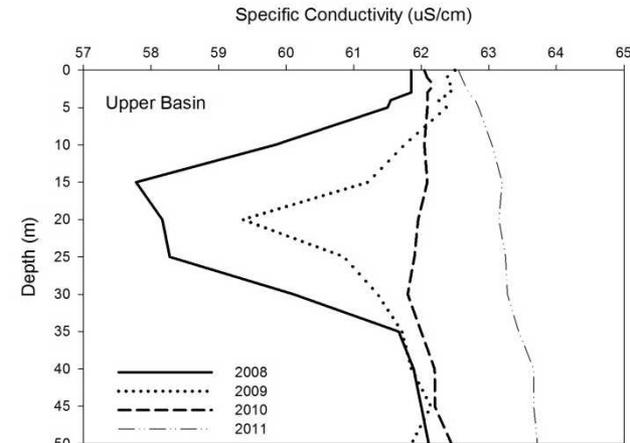
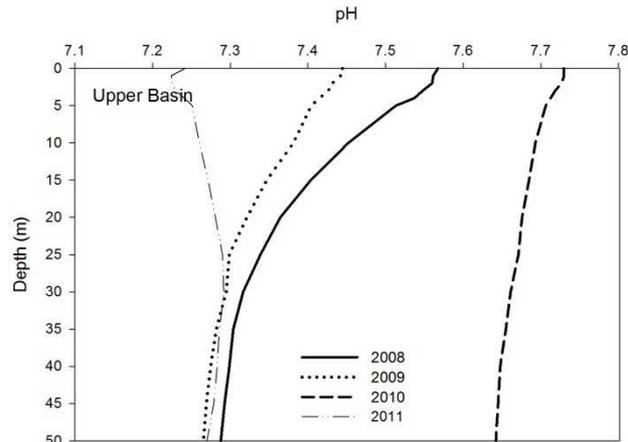
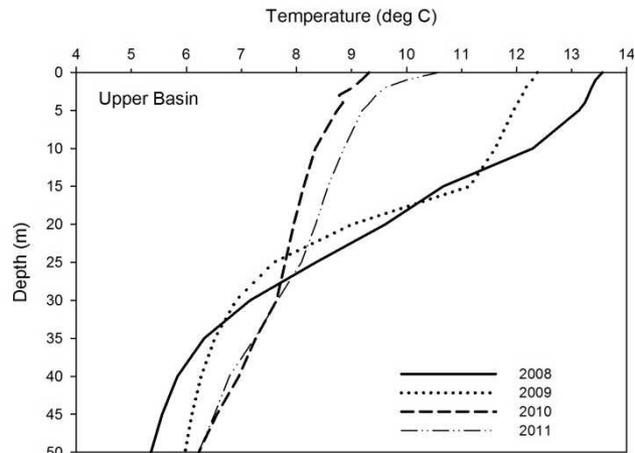




Lake Clark Surface Water Elevation

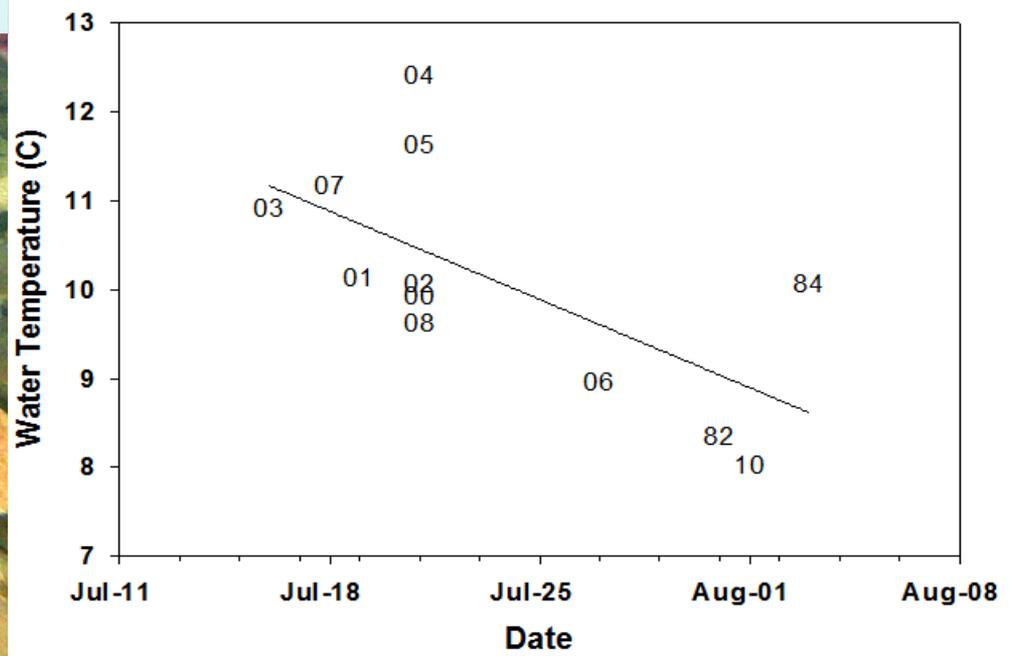
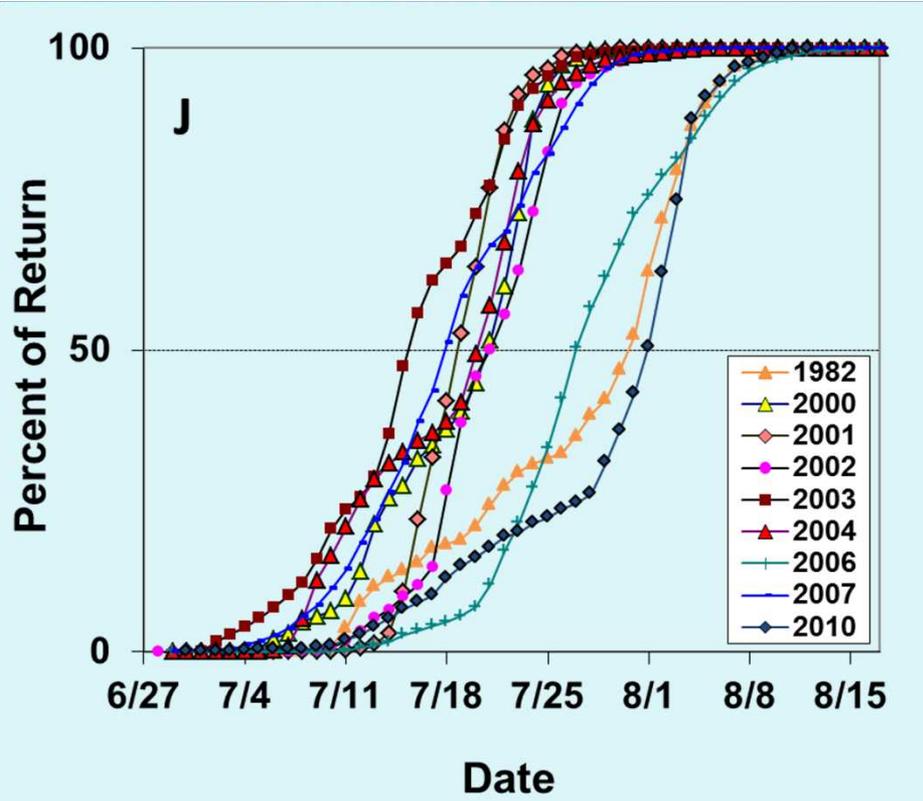


Vertical Profile Summaries



Physical Controls on Salmon Escapement





Future Monitoring and Analysis

- Conduct statistical and cluster analysis to determine if there are differences in water quality parameters between the upper, middle and lower basins. Are 10 samples/basin necessary?
- Compare water quality data from Lake Clark and Naknek Lake. Is there a regional signal in the data?
- Compare WQ in interior and coastal lakes. Is there a detectable marine signal?
- Work with LCC partners to determine trends in surface lake temperature. Are lakes in SW Alaska warming at rates observed in other large lake system (e.g., Great Lakes)?
- Initiate nutrient and DOC sampling using optical sensors.

Questions

A serene sunset over a calm body of water. The sky transitions from a deep blue at the top to a bright orange and yellow near the horizon. The sun is partially obscured by a range of dark mountains. The water in the foreground is still, reflecting the colors of the sky and the silhouette of the mountains.