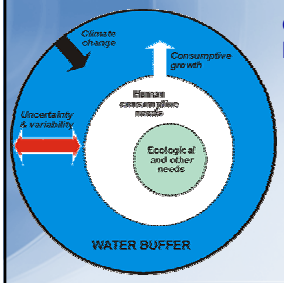

Implications of climate change for Okanagan Basin water availability & salmonid restoration

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Co-investigators:
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Fisheries and Oceans Canada | Pêches et Océans Canada

Focal Question

What is the impact of 2050s water supply and demand on threatened Okanagan River juvenile sockeye salmon survival, relative to historical conditions?

Three-steps

1. **Assemble 2050s** daily **water budget** for Okanagan Lake and River, & construct future net inflow forecasts.

$$Q_{net\ i,t} = \{Q_{surf\ i,t} + G_{i,t} + RF^{*}_{i,t} + P_{l\ i,t} + Tr^{*}_{i,t}\} - \{D^{*}_{i,t} + E_{l\ i,t}\}$$

2. **Simulate** future weekly to daily **operation of Okanagan Lake Dam**, using the Okanagan Fish/Water Management tool.

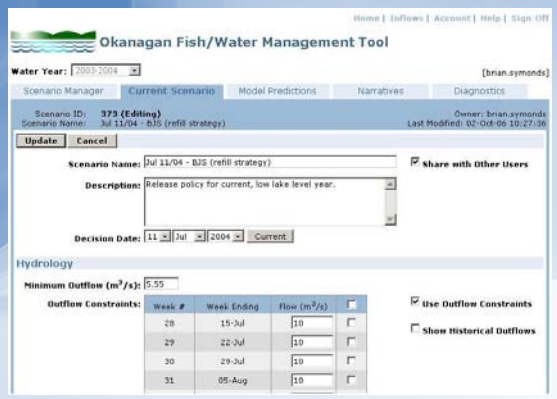
3. **Compare simulated 2050s sockeye survival rates with 1974 - 2003**

2050s Context

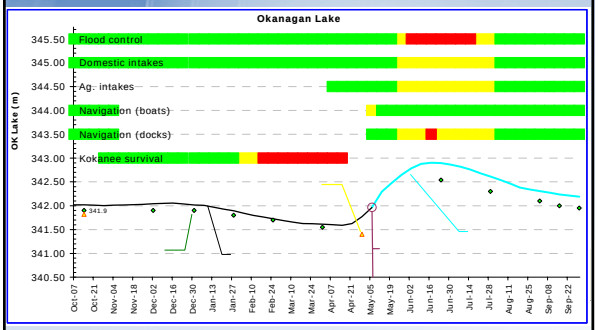
- **Water supply**: downscaled HadCM3(A2) scenario; UBC Watershed Model; some components taken from Okanagan Basin Study or from current climate data
- **Water demand**:
  - Okanagan Sustainable Water Resources Model (OSWRM) rules, Langsdale et al. (2006)
  - Basin wide 2050 population = 800,000+
  - Moderate demand side management portfolio, built into OSWRM results, see Neale et al. (2006)

Overall: "moderate" 2050 estimates of ***net*** inflows to Okanagan Lake and River

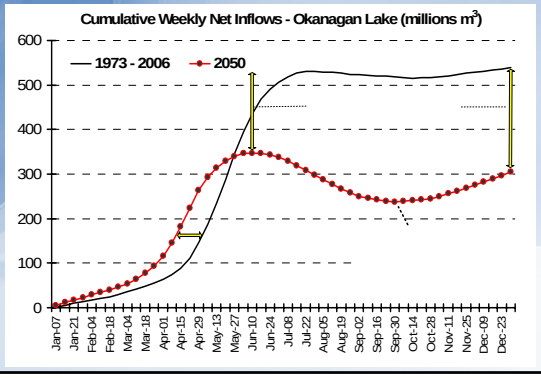
www.ok.fwmt.net



Example Output



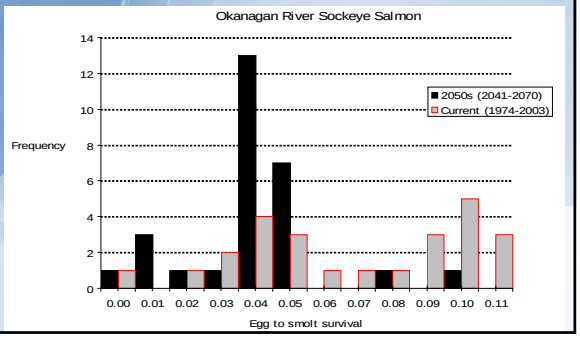
Results: Average Net Inflows



Results: Sockeye

mean egg-to-smolt survival potentially falls 44%*

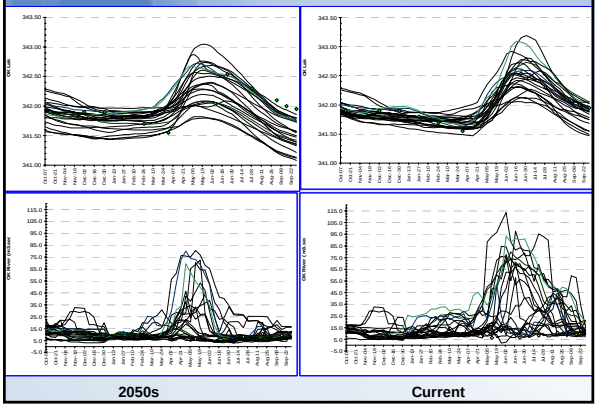
(*subject to a range of uncertain but plausible assumptions about climate change & water supply variations adopted to drive FWMT model outputs between 2035 and 2065)



2050 Animations

- Okanagan Lake <link to other PPT>
- Okanagan River flows at Oliver <link to other PPT>

Emergent patterns..



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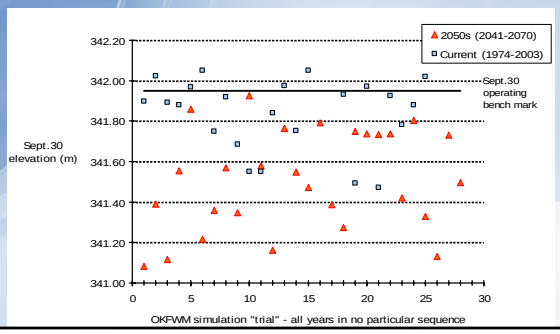
Okanagan Lake draw-down..

- 2050 fish/water managers were unable to achieve the current September 30 operating benchmark



Summary

1. The Okanagan is speeding towards a tipping point.
   We can seriously prepare now or react in panic later (but by then the problem will be intractable).
2. The actions needed will not be "popular"; bold leadership & more awareness is required.

ak

4 weeks

Recommendations

- Establish and **update** an **Okanagan Basin water budget**
  - approve/reject water extraction proposals based on this budget
- **More potent regulations**:
  - surface & groundwater license restrictions
  - enforceable demand management regulations on all new & existing water extraction activities (incld. metering, paying for H2O)
  - actively plan for water license buy-backs
- Be more creative: evaluate role of **water banks, water markets** (e.g., learn from other jurisdictions, like California rather than painfully re discover)

Recommendations

- **Strengthen endangered species legislation** in British Columbia and Canada
- Entrench **ecosystem "rights" to water**
  - i.e., explicitly remove water from the 'surplus' supply considered available for allocation
    - Different from approach that assumes such needs can be defined later, based on vague notions of "societal choices" "if and when necessary"
- Adaptive management experiments on **mitigating temperature-oxygen squeeze** mortality, Osoyoos Lake

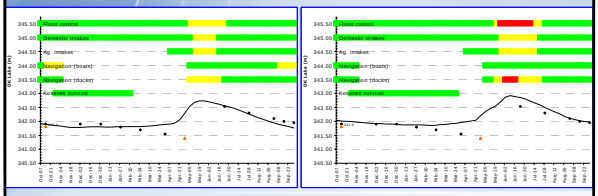
Further Information

- Canadian Okanagan Basin Technical Working Group, Fish/Water Management Tools (www.obtwg.ca/)
  - Dr. Kim Hyatt, hyattk@pac.dfo-mpo.gc.ca
  - Clint Alexander, calexander@essa.com
- Adaptations and Impacts Research Division, UBC (www.ires.ubc.ca/aird/publications.html)
- Okanagan Fish/Water Management tool:

Alexander, C.A.D., B. Symonds and K. Hyatt, eds. 2006. The Okanagan Fish/Water Management Tool (v.2.0.000): Guidelines for Apprentice Water Managers. Prepared for Canadian Okanagan Basin Technical Working Group, Kamloops, BC. 127 pp.

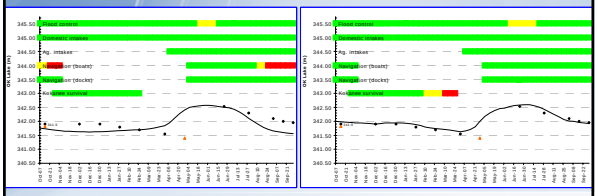
Hyatt, K., C. Alexander, S. Langsdale and M. Stockwell. *In prep.* Implications of climate change on recovery and restoration planning for salmon populations: a flow management case study. *Ecological Applications*.

Ok Lake: year 1



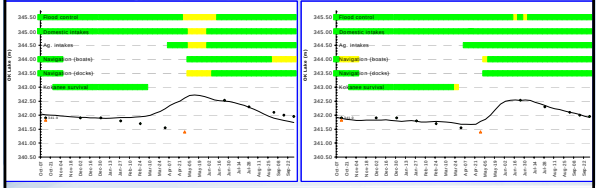
2050s - avg | Current - wet

Ok Lake: year 2



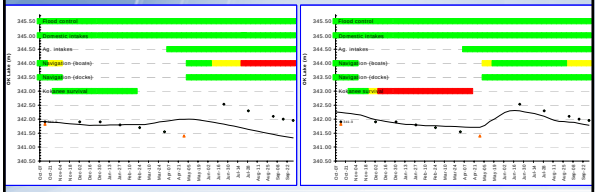
2050s - dry | Current - avg

Ok Lake: year 3



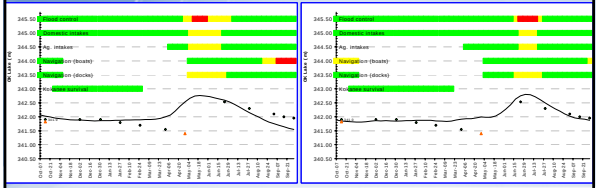
2050s - avg | Current - avg

Ok Lake : year 4



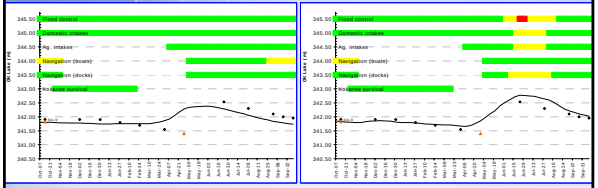
2050s - dry | Current - dry

Ok Lake: year 5



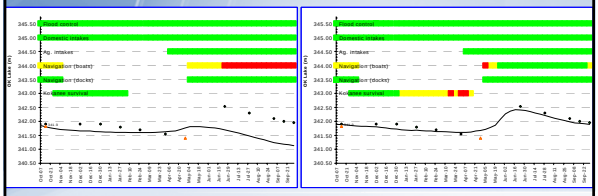
2050s - avg | Current - wet

Ok Lake: year 6



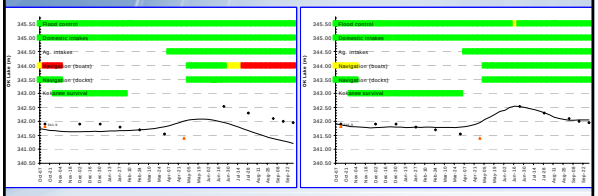
2050s - dry | Current - avg

Ok Lake: year 7



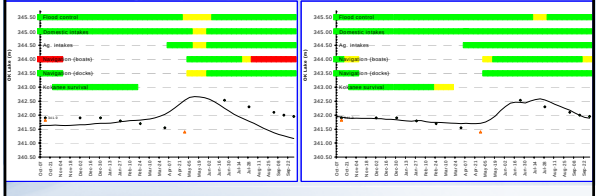
2050s - dry | Current - dry

Ok Lake: year 8



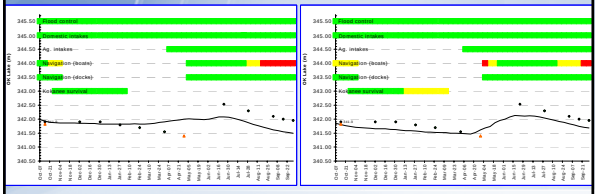
2050s - dry | Current - avg

Ok Lake: year 9



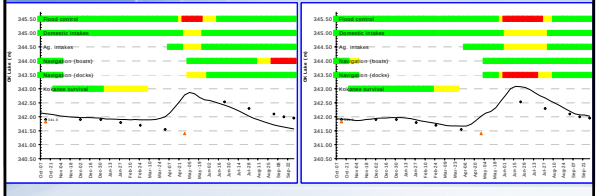
2050s - avg | Current - wet

Ok Lake: year 10



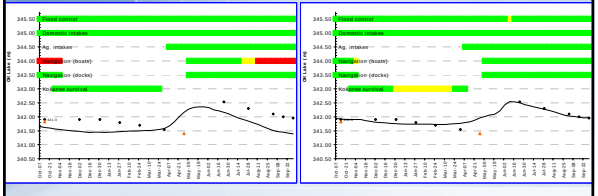
2050s - dry | Current - dry

Ok Lake: year 11



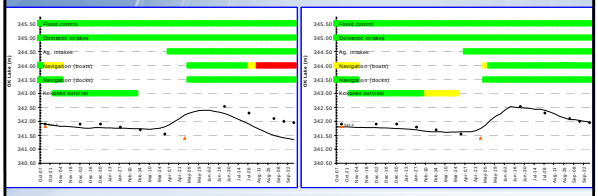
2050s - avg | Current - wet

Ok Lake: year 12



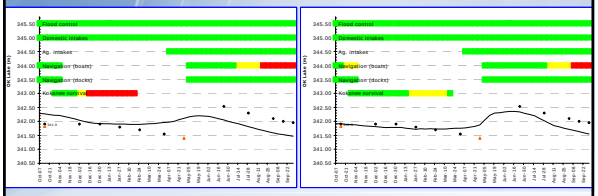
2050s - dry | Current - avg

Ok Lake: year 13



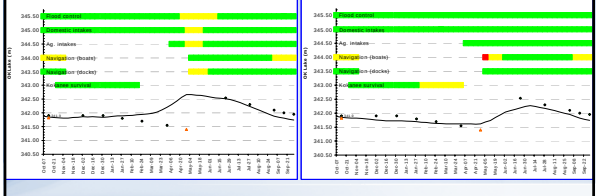
2050s - dry | Current - avg

Ok Lake: year 14



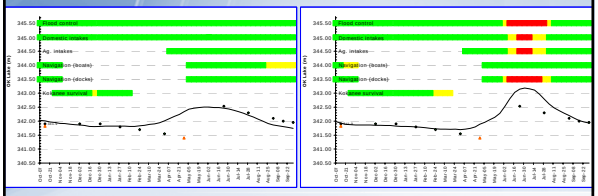
2050s - dry | Current - dry

Ok Lake: year 15



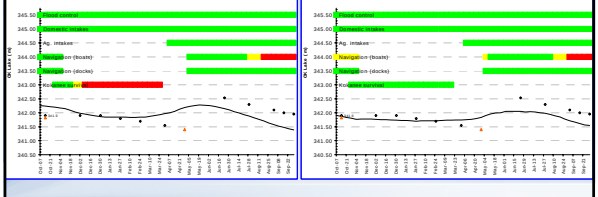
2050s - dry | Current - dry

Ok Lake: year 16



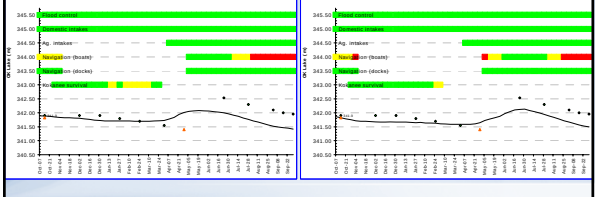
2050s - dry | Current - wet

Ok Lake: year 17



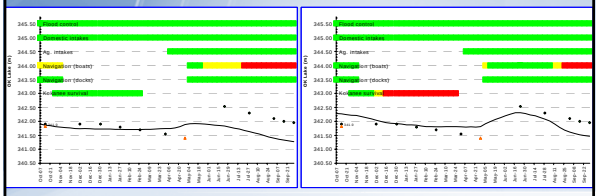
2050s - dry | Current - dry

Ok Lake: year 18



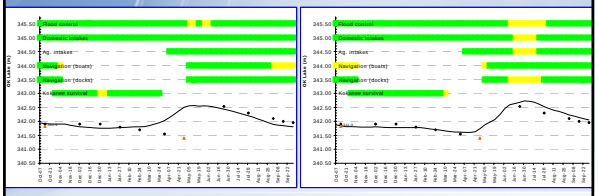
2050s - dry | Current - dry

Ok Lake: year 19



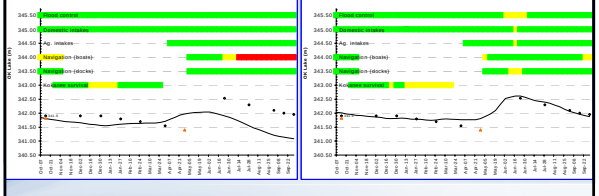
2050s - dry | Current - dry

Ok Lake: year 20



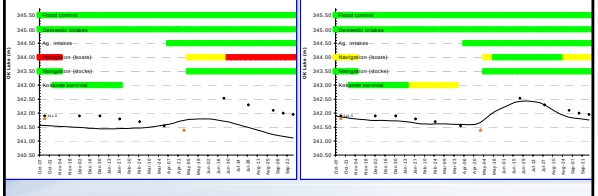
2050s - avg | Current - wet

Ok Lake: year 21



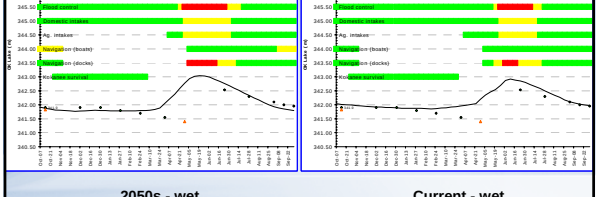
2050s - dry | Current - avg

Ok Lake: year 22



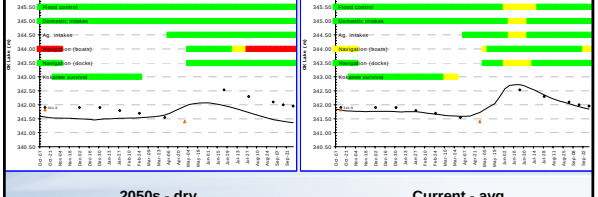
2050s - dry | Current - dry

Ok Lake: year 23



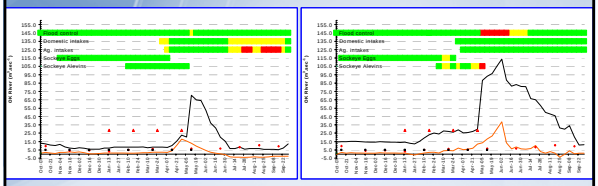
2050s - wet | Current - wet

Ok Lake: year 24



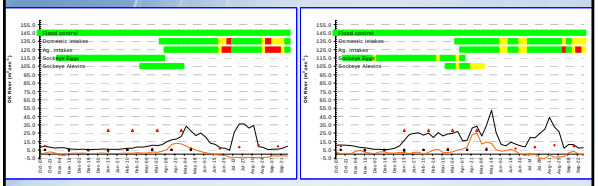
2050s - dry | Current - avg

Ok River Oliver: year 1



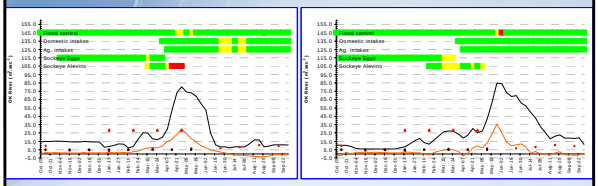
2050s - avg | Current - wet

Ok River Oliver: year 2



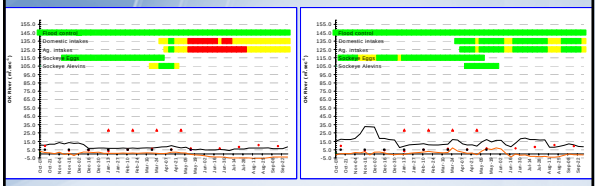
2050s - dry | Current - avg

Ok River Oliver: year 3



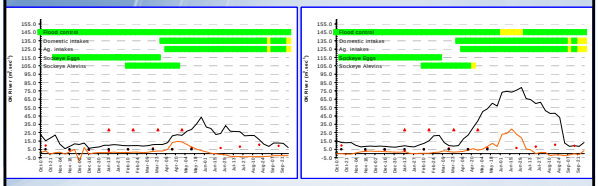
2050s - avg | Current - avg

Ok River Oliver: year 4



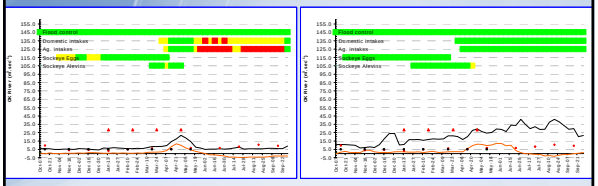
2050s - dry | Current - dry

Ok River Oliver: year 5



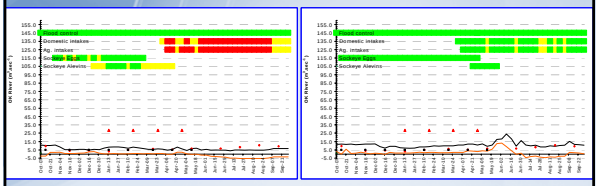
2050s - avg | Current - wet

Ok River Oliver: year 6



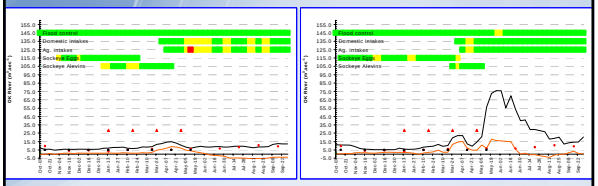
2050s - dry | Current - avg

Ok River Oliver: year 7



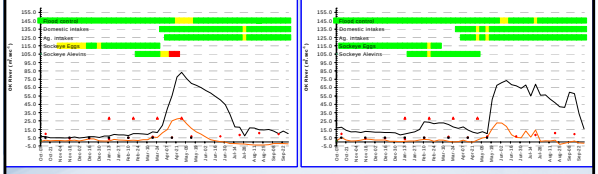
2050s - dry | Current - dry

Ok River Oliver: year 8



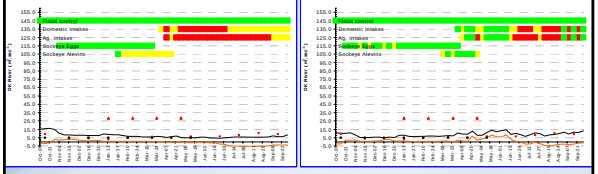
2050s - dry | Current - avg

Ok River Oliver: year 9



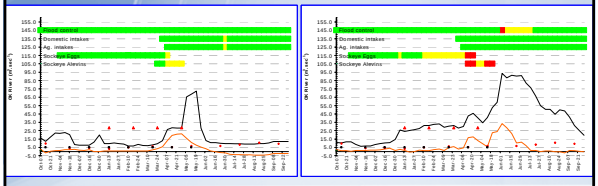
2050s - wet | Current - wet

Ok River Oliver: year 10



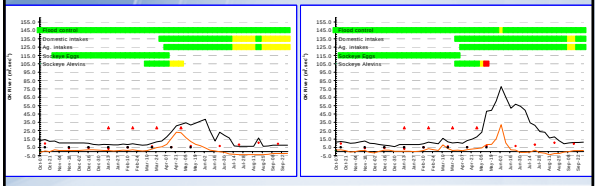
2050s - dry | Current - dry

Ok River Oliver: year 11



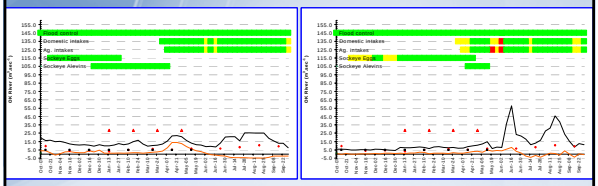
2050s - dry | Current - wet

Ok River Oliver: year 12



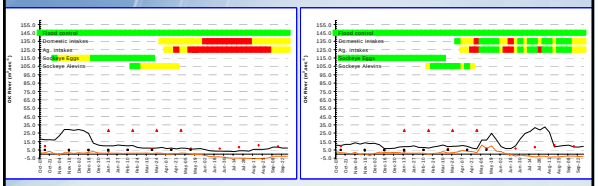
2050s - dry | Current - avg

Ok River Oliver: year 13



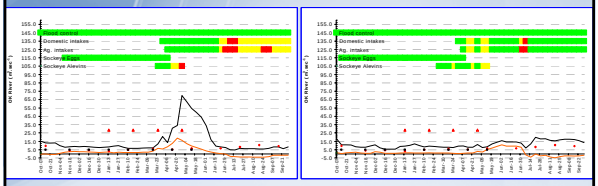
2050s - dry | Current - avg

Ok River Oliver: year 14



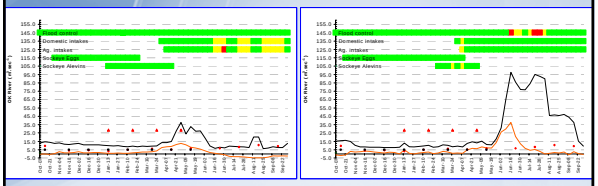
2050s - dry | Current - dry

Ok River Oliver: year 15



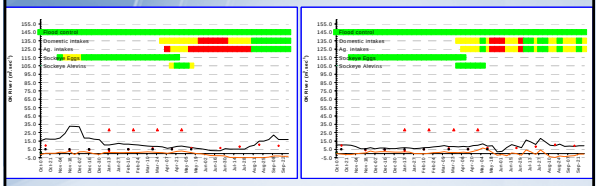
2050s - dry | Current - dry

Ok River Oliver: year 16



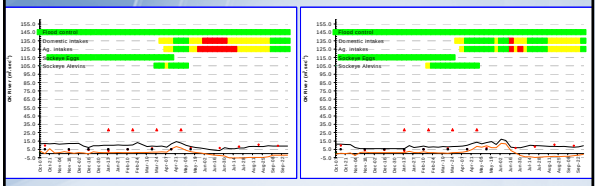
2050s - dry | Current - wet

Ok River Oliver: year 17



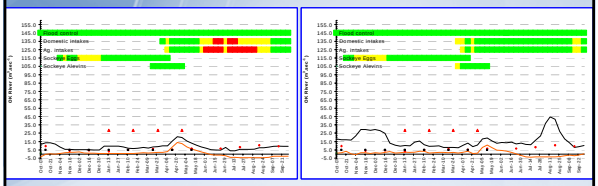
2050s - dry | Current - dry

Ok River Oliver: year 18



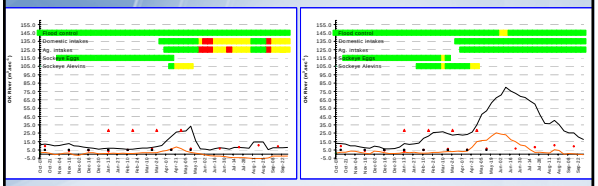
2050s - dry | Current - dry

Ok River Oliver: year 19



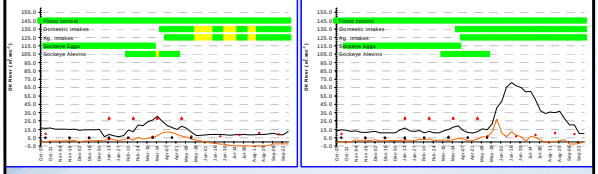
2050s - dry | Current - dry

Ok River Oliver: year 20



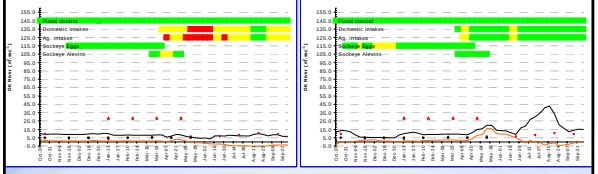
2050s - dry | Current - wet

Ok River Oliver: year 21



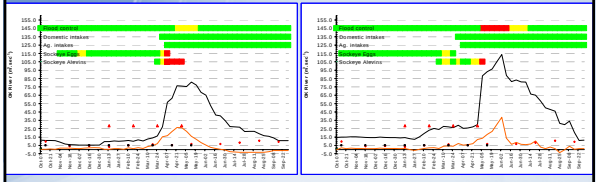
2050s - dry | Current - avg

Ok River Oliver: year 22



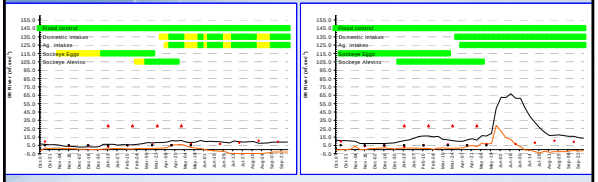
2050s - dry | Current - dry

Ok River Oliver: year 23



2050s - wet | Current - wet

Ok River Oliver: year 24



2050s - dry | Current - avg