

Arrow Reservoir Constant Mid-Elevation Scenarios: Scoping Evaluation

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Arrow Reservoir Management

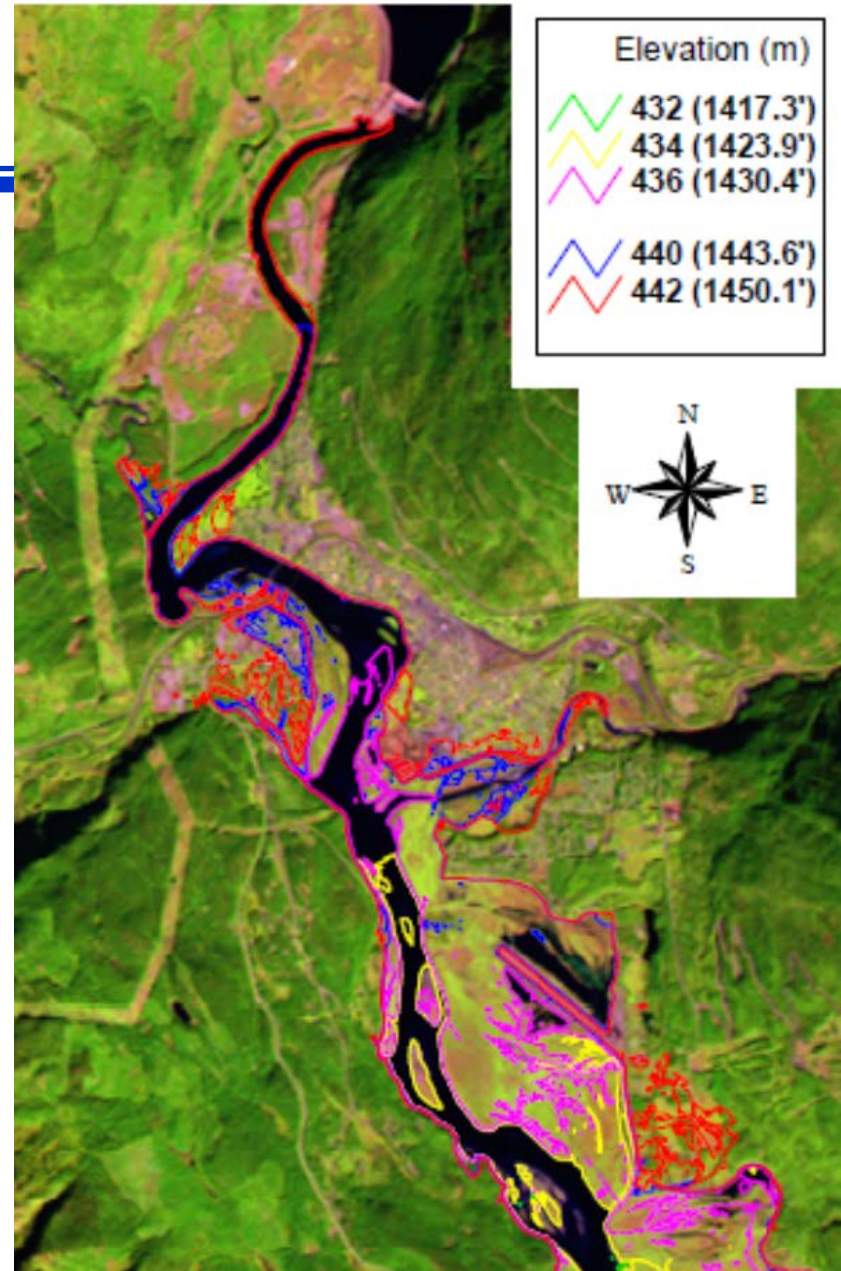
Scoping Evaluation of 2 Alternative Scenarios

- Evaluation of two scenarios, including :
 - potential benefits and negative impacts
 - information gaps
 - scenario alternatives to increase benefits and/or offset impacts
 - criteria for assessing future modeling



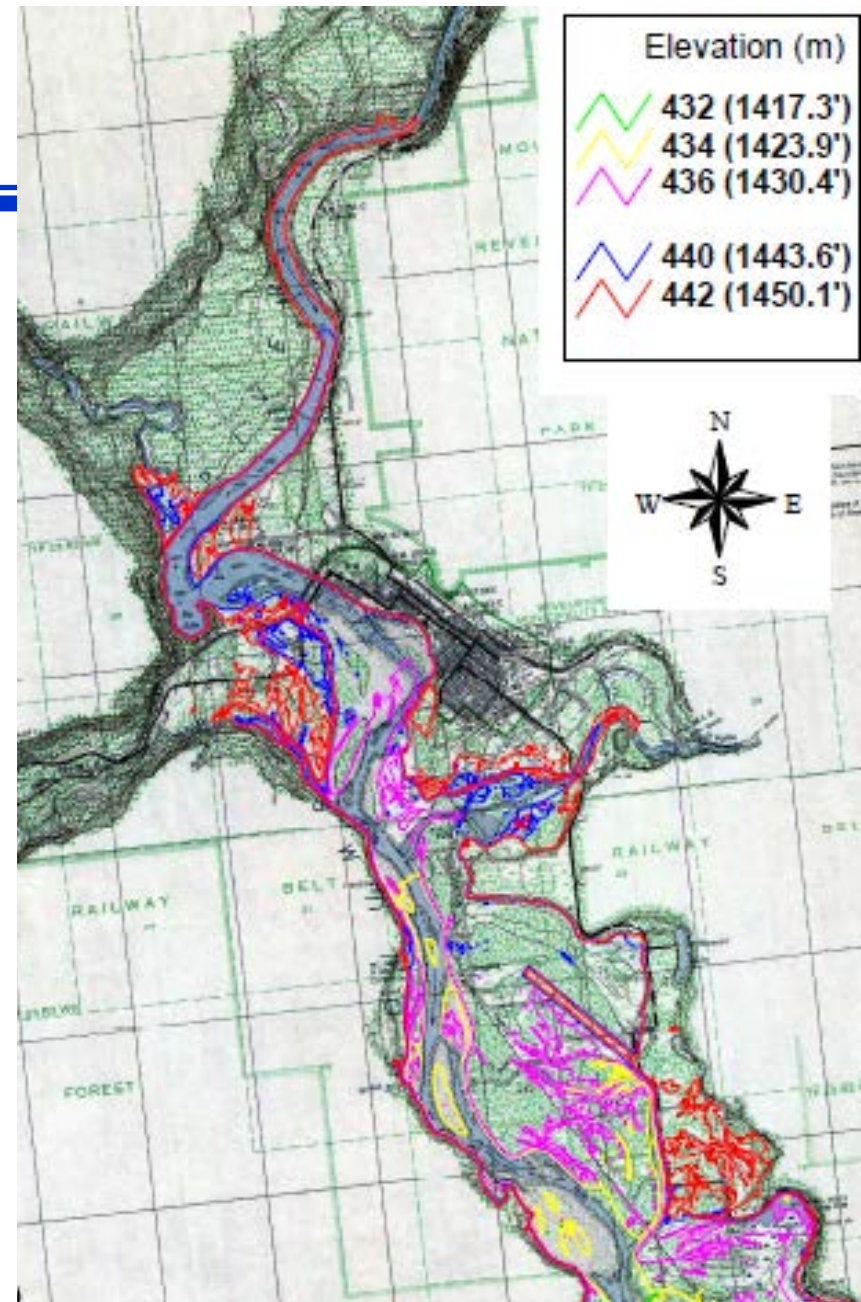
Assessment Criteria

- Vegetation
- Wildlife
- Fish and aquatic resources
- Recreation
- Agriculture
- Erosion
- Archaeology
- Commercial navigation
- Power generation
- Flood Storage

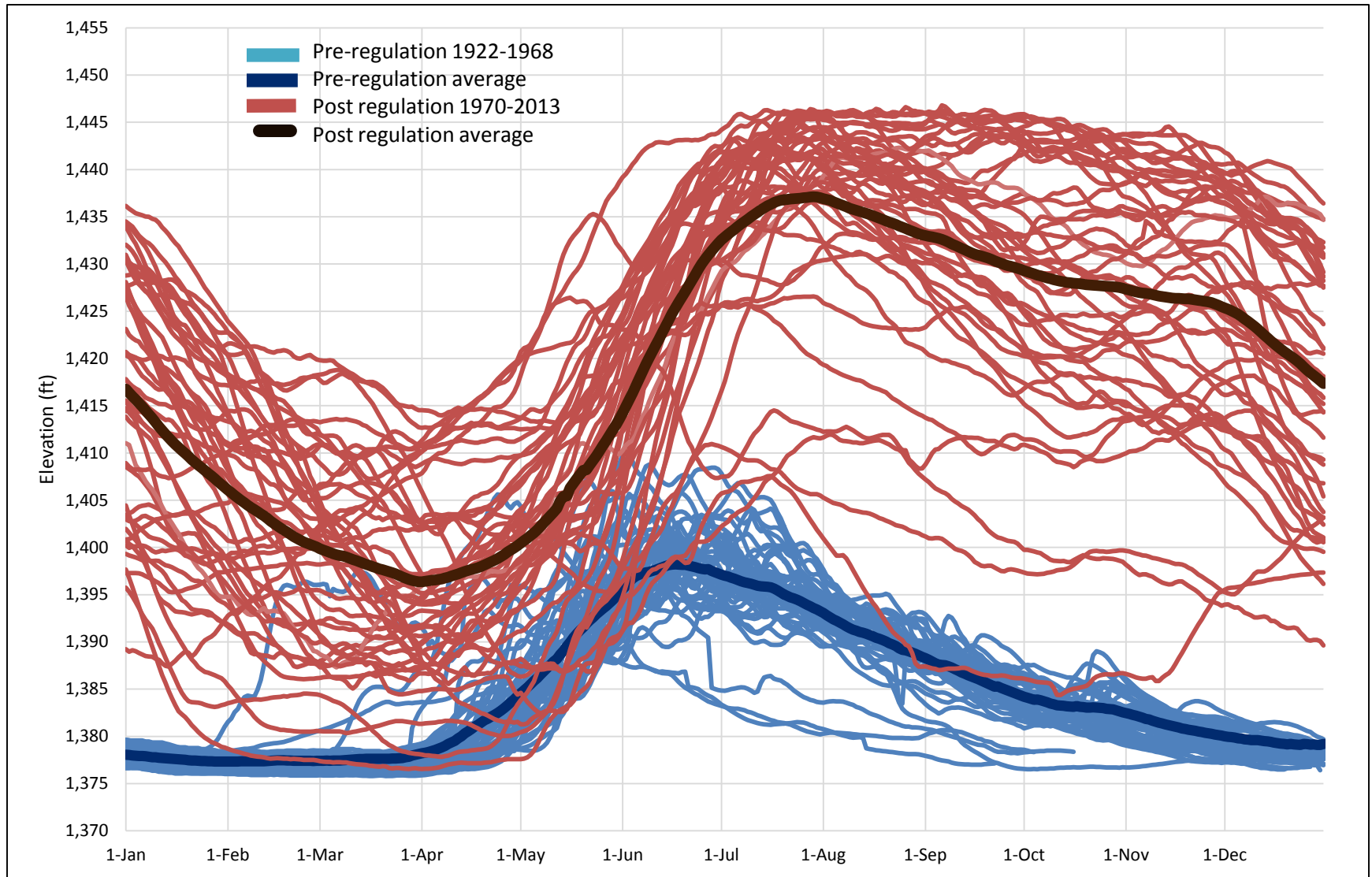


Information Sources

- Literature review
- Selected data analysis
- Interviews with and reviews by experts and stakeholders
- Site visits

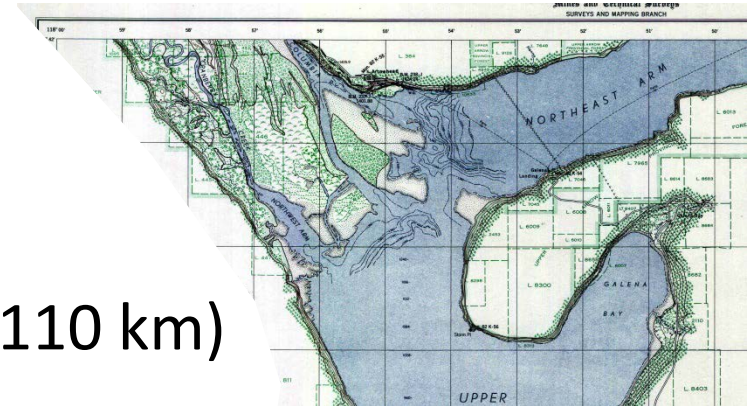


Arrow Lakes Pre and Post Regulation



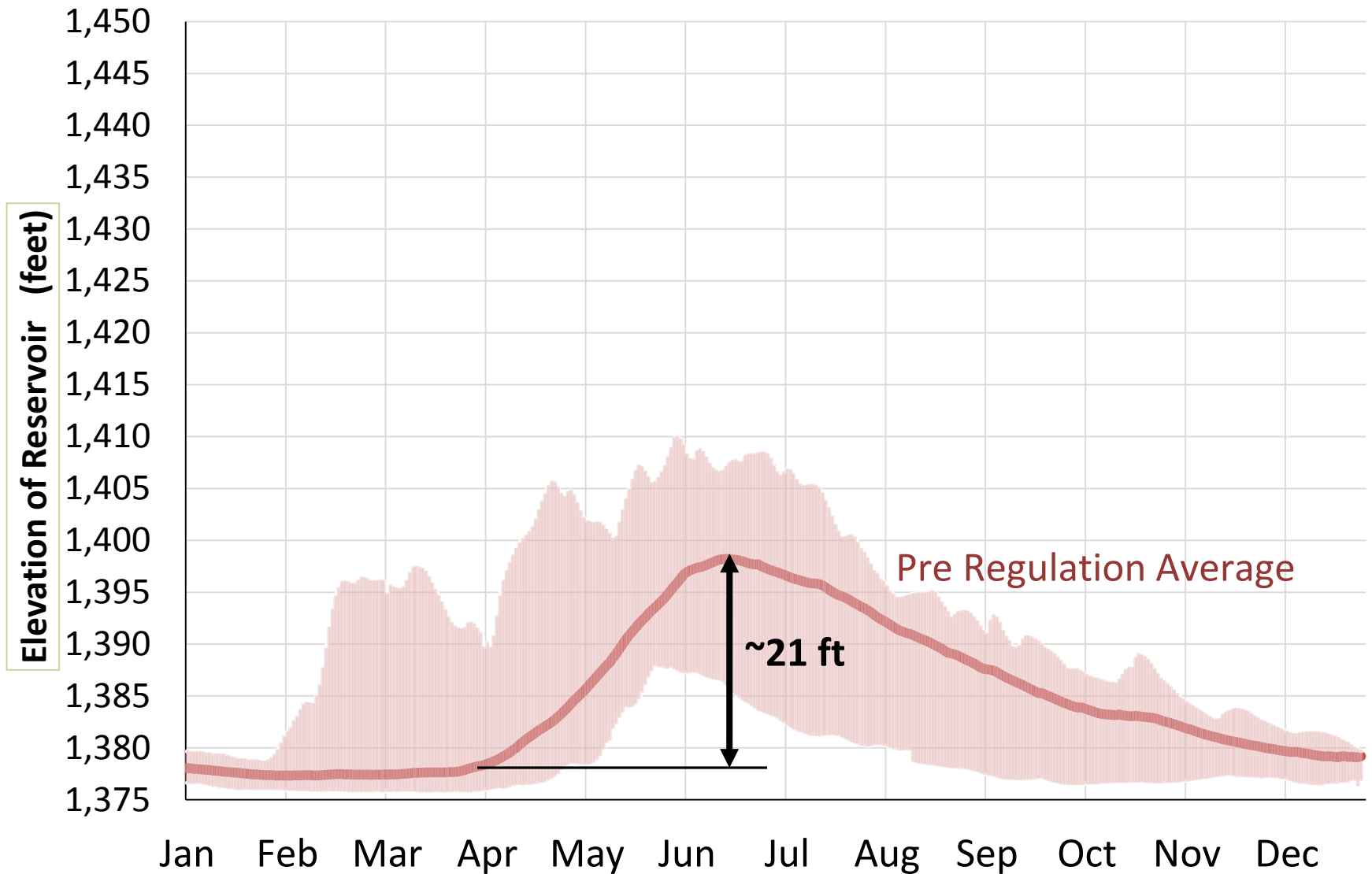
Dam Footprint Impacts - Examples

- Ecosystems and Habitat
 - Lakes 34,992 ha
 - Wetlands/ Ponds 3,535 ha
 - Rivers/Floodplains 8,849 ha (110 km)
 - Streams 52 ha (93 km)
 - Uplands 3844 ha
- Farmland/ Orchards
 - 2,300 ha of active agricultural lands
 - 260 farmsteads
- Numerous rural communities and infrastructure

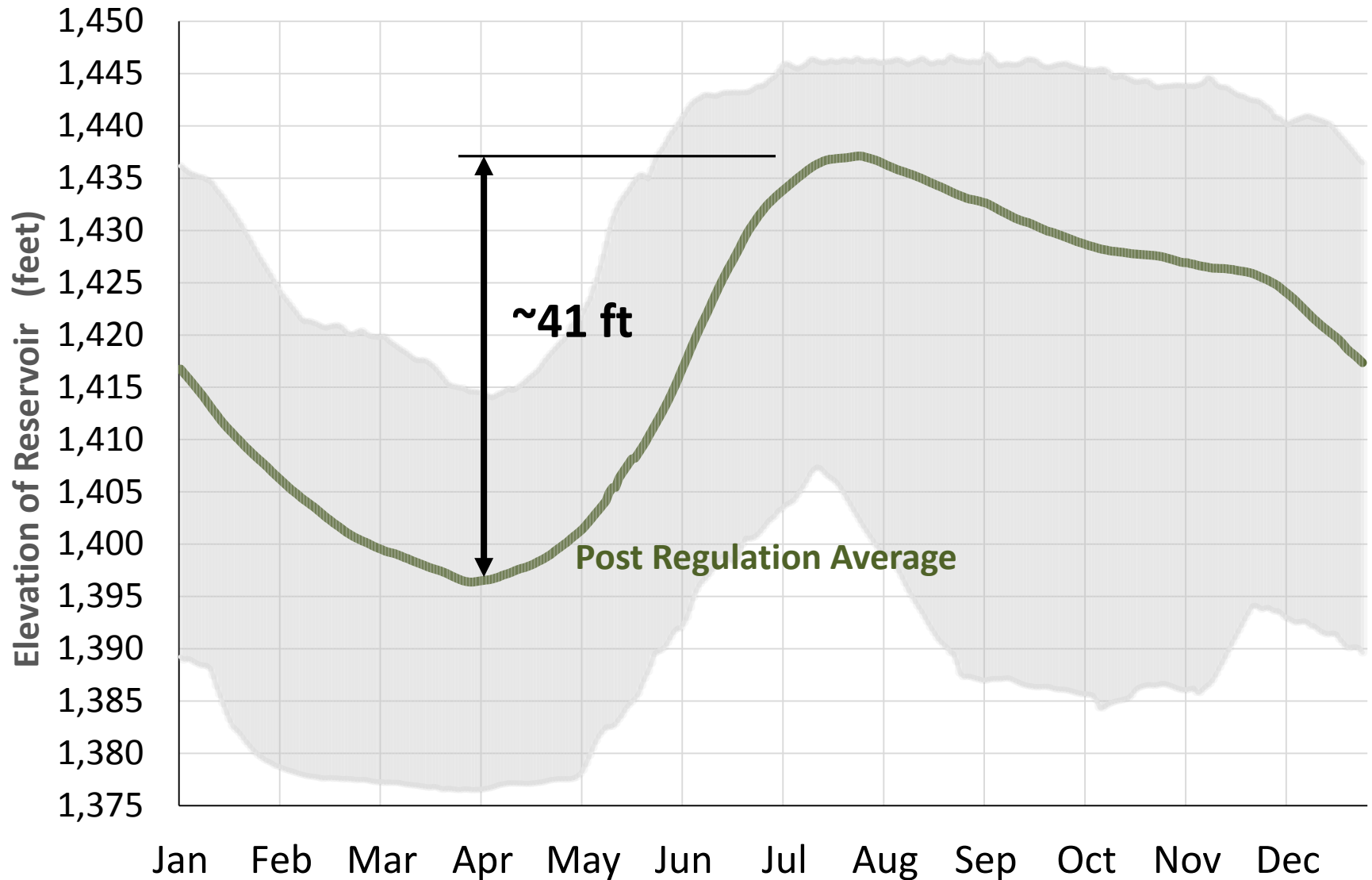


C. Spicer

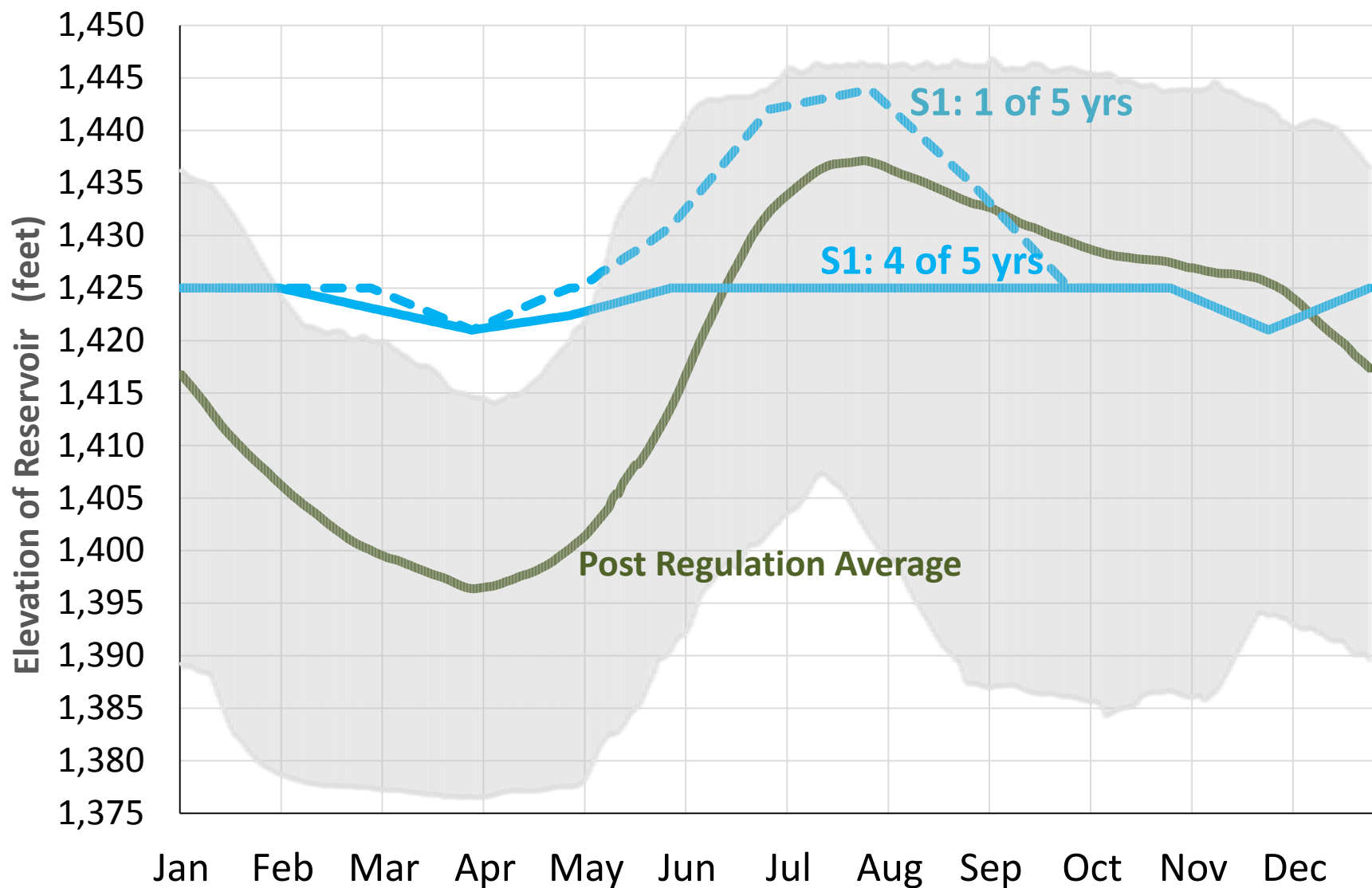
Pre Regulation Hydrograph



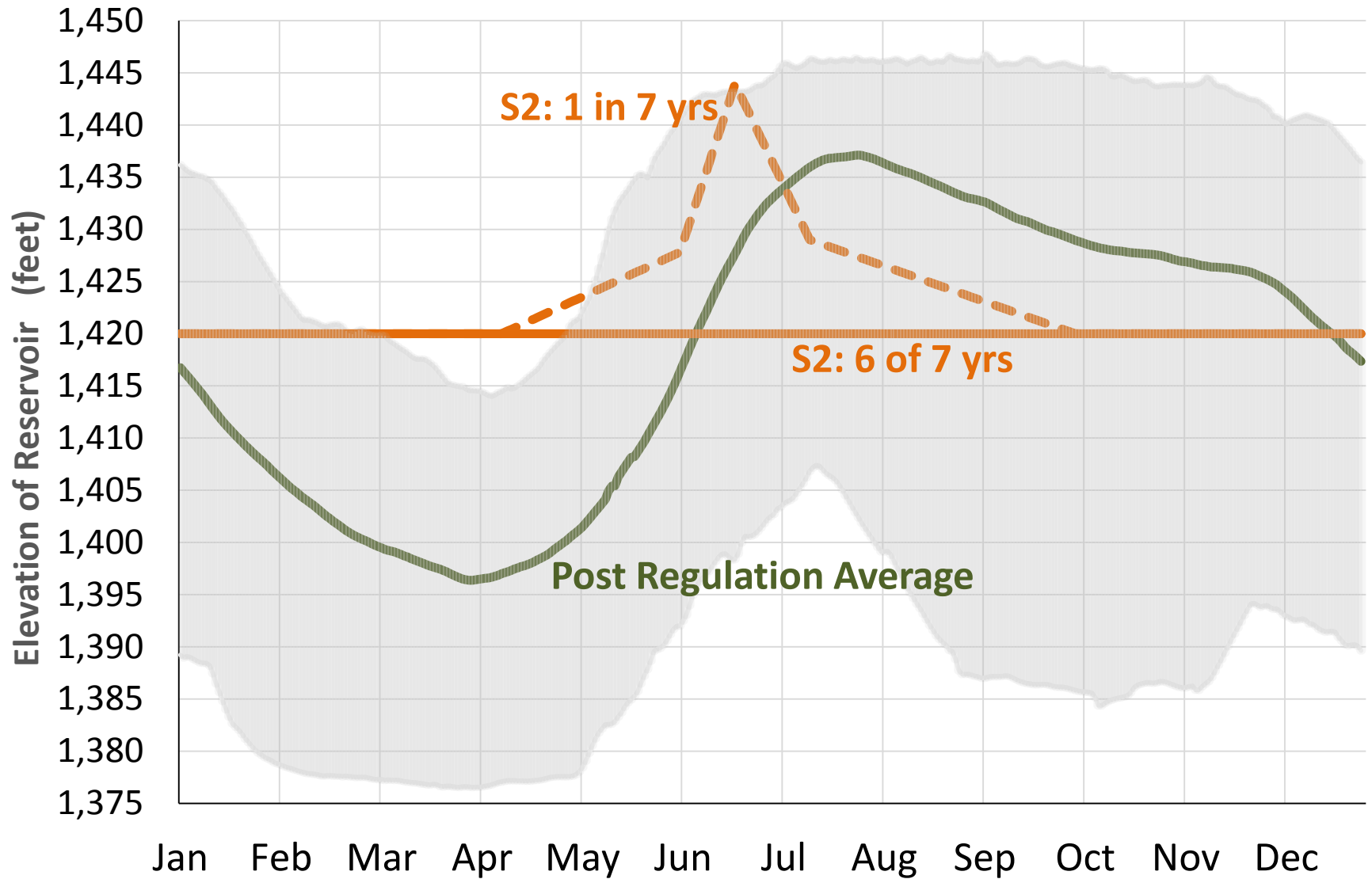
Post Regulation Hydrograph



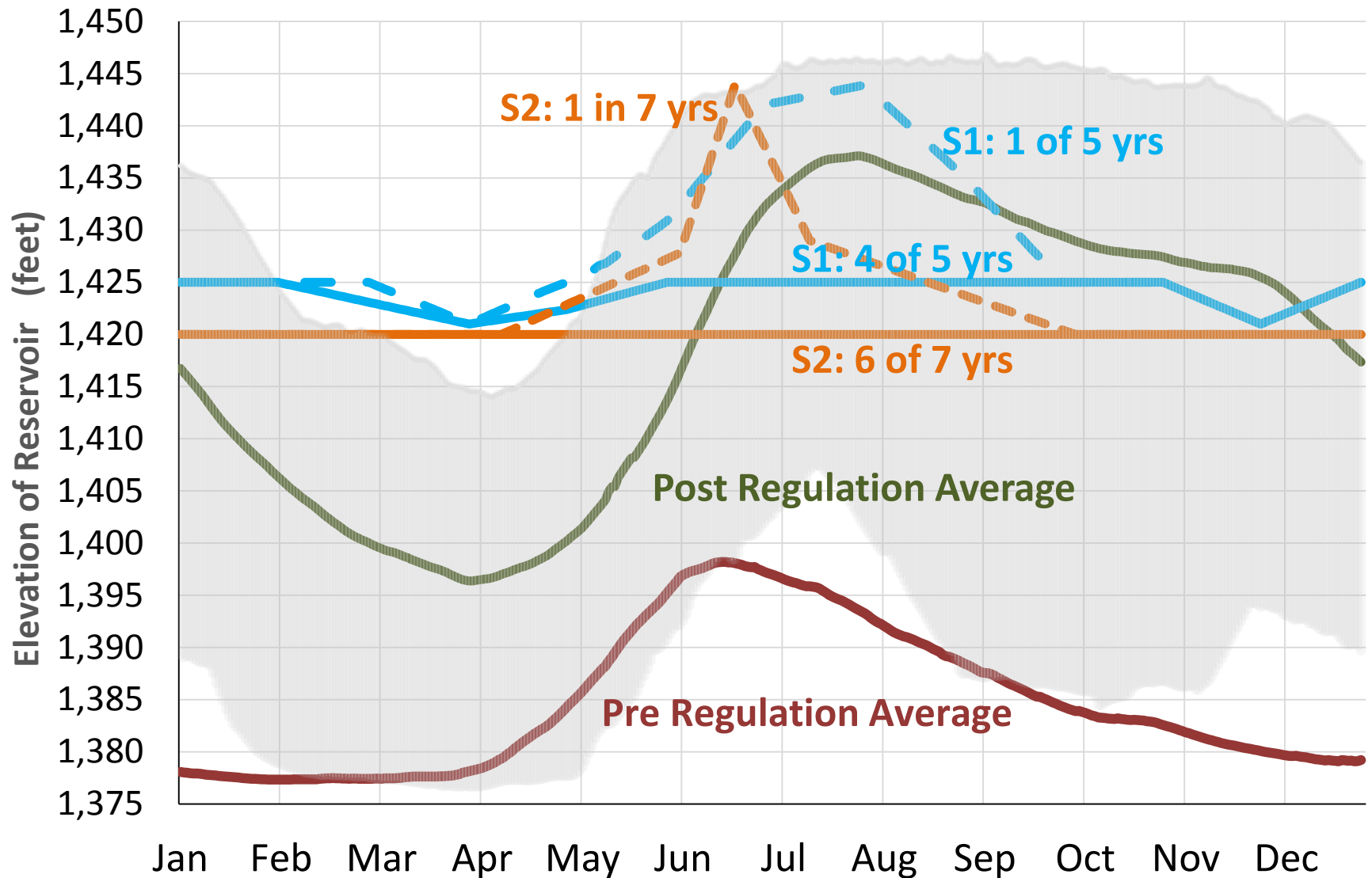
Scenario 1



Scenario 2

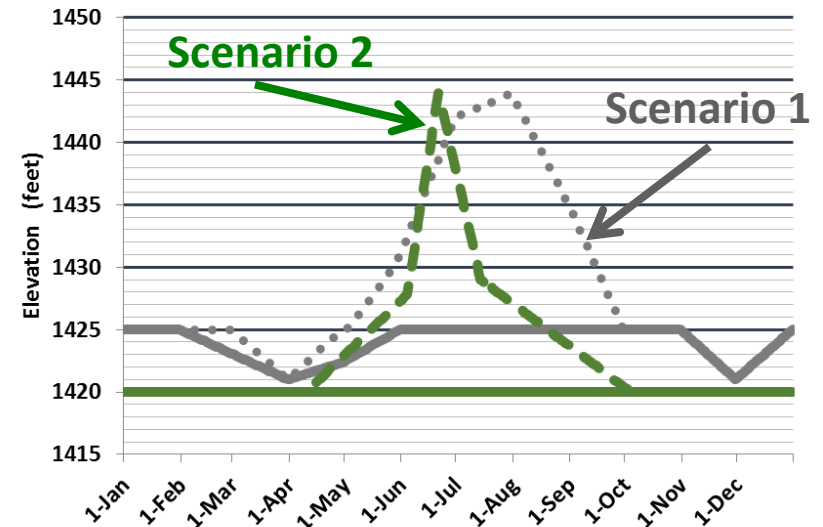


Scenarios 1 & 2





Reservoir Operations



Scenario 1

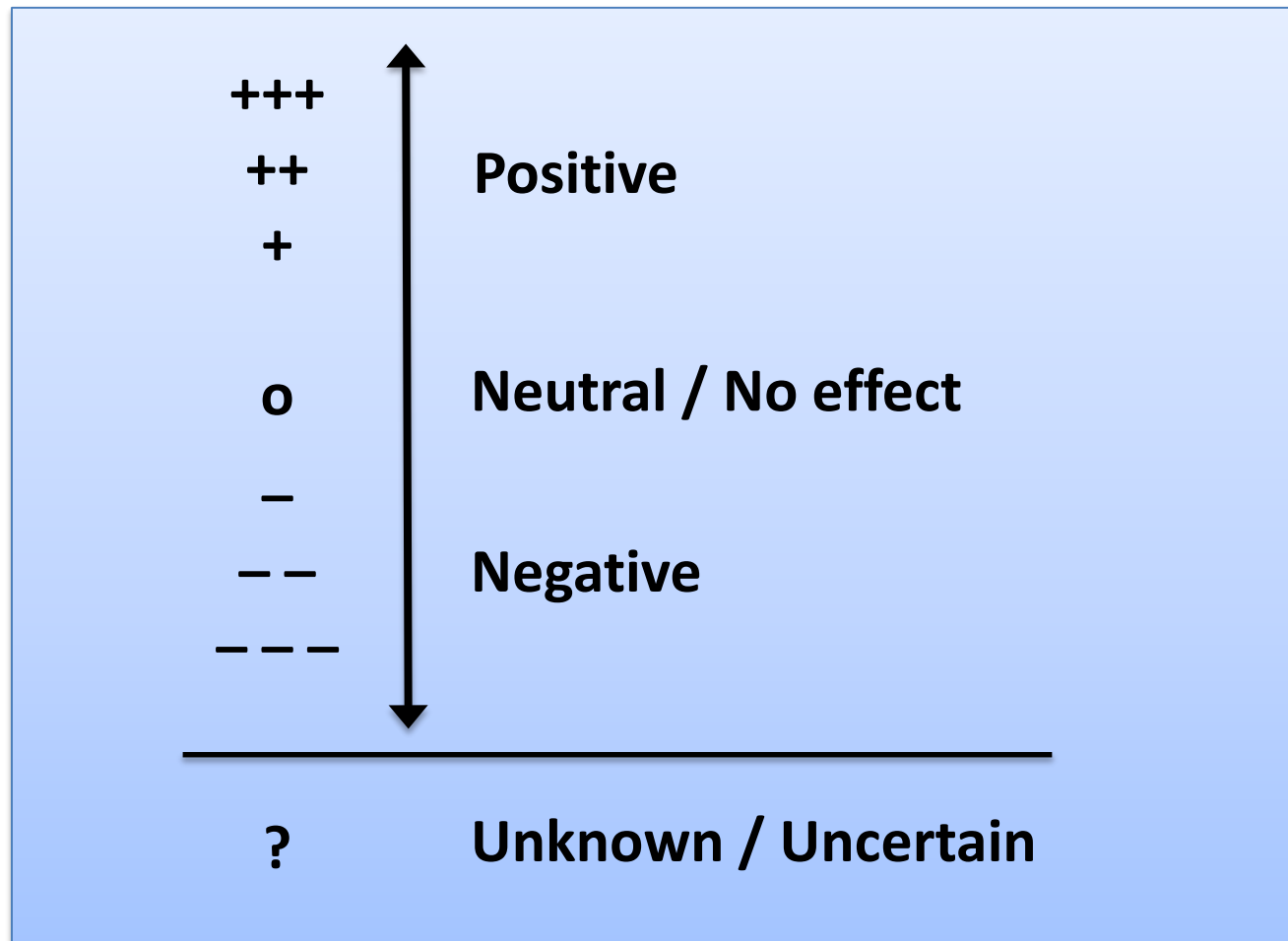
- reservoir generally held at approx. 1,425'
- dips to approx. 1,421' in spring and late fall
- fills to 1,444' at freshet in 1 of 5 years on average
- empties slowly over a couple months or more

Scenario 2

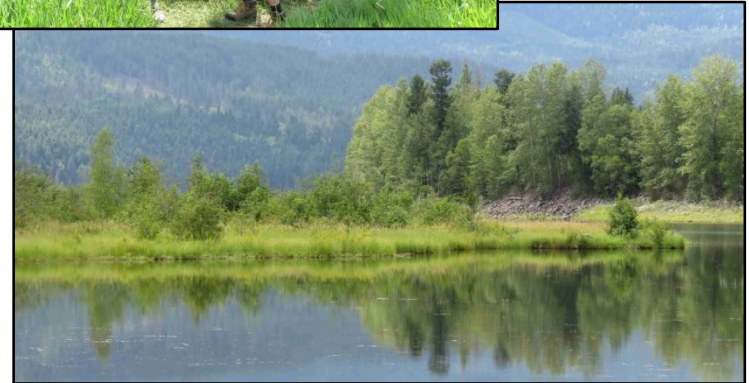
- reservoir generally held at approx. 1,420'
- fills to 1,444' at freshet in 1 or 7 years on average
- empties down to 1,430' within 35 days, and then slowly to 1,420' over the next couple months

Scenario Issue Evaluation

When compared to existing ALR operation



Vegetation



Vegetation

Current

- vegetation mostly limited to herbaceous grass and sedges below 1,440' due to lengthy inundation and wave scour
- limited development of trees and shrubs in upper 4 ft. of drawdown zone

Scenario 1

- herbaceous vegetation increases cover and vigour above 1,425'
- species diversity increases during non-flood years and then decreases after flood years
- somewhat reduced vegetation loss due to wave/debris scour
- tree/shrub communities do not develop



S1 Evaluation:
Terrestrial: +
Wetland: +

Scenario 2

- herbaceous vegetation increases in diversity, cover and vigour above 1,420'
- species diversity decreases slightly after flood years
- significantly reduced vegetation loss due to wave/debris scour
- tree/shrub and riparian communities develop above 1,430'



S2 Evaluation:
Terrestrial: +++
Wetland: ++

Wildlife - Songbirds

Current

- songbird diversity and abundance significantly limited due to the lack of tree/shrub habitats
- significant mortality due to nest flooding



Scenario 1

- minor increase in grassland songbird species due to increase in herbaceous cover
- decrease in nest losses in non-flood years

➡ S1 Evaluation: +

Scenario 2

- significant increase in songbird species diversity and abundance due to increase in tree/shrub communities and increased availability of wetland and riparian habitats
- decrease in nest losses in non-flood years

➡ S2 Evaluation: ++

Wildlife – Waterbirds and Shoreline Birds

Current

- limited access to shoreline, wetland and pond habitats due to periodic spring, summer and fall inundation
- nesting failures due to nest flooding



Scenario 1

- complete access to wetland, pond and shoreline habitats above 1,425' in 4 of 5 years
- establishment of semi-permanent shoreline habitats at approx. 1,425'
- reduced nesting losses due to flooding in non-flood years

➡ S1 Evaluation: ++

Scenario 2

- complete access to wetland, pond and shoreline habitats above 1,420' in 6 of 7 years
- establishment of semi-permanent shoreline habitats at approx. 1,420'
- reduced nesting losses due to flooding in non-flood years
- development of riparian habitats above 1,430'

➡ S2 Evaluation: +++

Wildlife - Herptiles

Current

- limited use by frogs, toads, turtles and snakes
- mainly in Revelstoke Reach wetlands/ponds
- habitat access limited by spring/summer/fall inundation

Scenario 1

- during non-flood years, increased year-round habitat access for all species above 1,425'
- during flood years access limited by spring/summer/fall inundation

➡ S1 Evaluation: +

Scenario 2

- during non-flood years, increased year-round habitat access for all species above 1,420'
- during flood years access limited by spring/ early summer short duration inundation
- increased riparian and other tree/ shrub habitats
- likely decrease of grassland habitat for some snakes

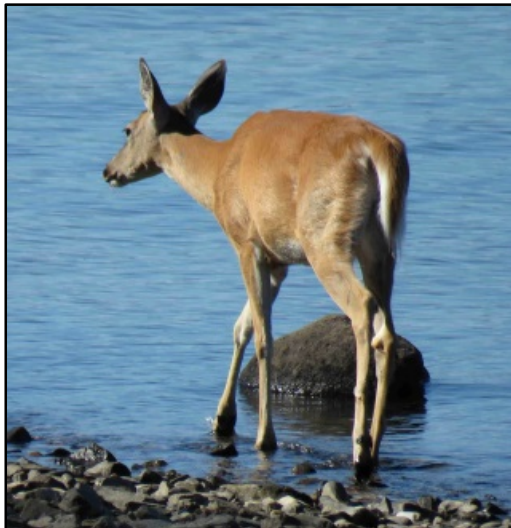
➡ S2 Evaluation: ++



Wildlife - Mammals

Current

- small mammals and bats frequently use the drawdown zone
- use by large mammals is limited and sporadic



Scenario 1

- mammal use may increase slightly in non-flood years due to increased vegetation cover

➡ S1 Evaluation: 0

Scenario 2

- potentially significant increase in mammal use due to development of riparian habitats and tree/ shrub communities
- availability of browse and cover will contribute to increased mammal use
- likely will contribute to ungulate winter range – a key limiting factor

➡ S2 Evaluation: +

Agriculture

Current

- agricultural production limited to grazing and hay production on approx. 400 ha in the Revelstoke reach
- limitations due to inundation during the growing season and occasional in-washed debris

Scenarios 1 and 2

- agricultural production potential would increase in areas above 1,425' (S1) or 1,420' (S2) principally in the Revelstoke reach, but also in small local areas in other parts of the reservoir
- potential for annual crops in non-flood years
- productivity would increase significantly in non-flood years due to lack of annual inundation

➡ S1 Evaluation: +

➡ S2 Evaluation: +++



Erosion and Sediment Deposition



Erosion, Sediment Deposition & Slumping

Current

- ongoing bank erosion and slumping in fine textured terrace faces
- sediment deposition on flooded stream fans
- significant erosion and redistribution of sediments in wave-exposed zones
- localized and periodic erosion due to debris pounding
- dust generation

Scenario 1

- above 1,425' somewhat decreased erosion due to lack of inundation 4/5 years
- decreased erosion below 1,421' due to lack of exposure to wave action
- ongoing erosion and beach formation at 1,425'
- reduction in dust generation
- uncertain as to changes to mass wasting events



S1 Evaluation:
Shoreline: +
Mass Wasting: ?

Scenario 2

- decreased erosion above 1,430' due to revegetation and above 1,420' due to lack of inundation 6/7 years
- decreased erosion below 1,420' due to lack of exposure to wave action
- ongoing erosion and beach formation at 1,420'
- greater reduction in dust generation
- uncertain as to changes to mass wasting events



S2 Evaluation:
Shoreline: +++
Mass Wasting: ?

Fish – Pelagic (open water)

Current

- fisheries production variable, supported by nutrient restoration and expanded pelagic (open/deep lake) area during the growing season
- effects of current operations on nutrient dynamics complex and highly variable year over year

Scenarios 1 and 2

- net reduction in pelagic (kokanee, etc.) habitat area during productive late spring-summer for S1, greater reduction for S2
- high degree of uncertainty regarding impacts on nutrient retention and primary productivity
- uncertain effects on kokanee and piscivores abundance

➡ S1 Evaluation: ?

➡ S2 Evaluation: ?



Fish – Tributary Access/ Spawning/ Rearing

Current

- water levels sometimes impair fall spawner access to tributaries
- tributary spawning success limited due to stream channel instability and reservoir level fluctuations



Scenarios 1 and 2

- access changes will vary from tributary to tributary, overall effect likely negative for fall spawners
- modest improvement in tributary spawning and incubation habitat conditions within the drawdown reaches
- improved access into tributaries as channel stability improves significantly due to riparian vegetation
- significant improvement in spawning and incubation habitat conditions

➡ S1 Evaluation: +/-

➡ S2 Evaluation: ++

Aquatic – Littoral Habitats

Current

- significantly impaired and unstable littoral (shoreline/shallow water) habitats.
- development of macrophyte communities (aquatic vegetation) significantly impaired

Scenarios 1 and 2

- significant improvement in littoral habitat conditions and productivity ; may result in increased nutrient retention
- expansion of macrophyte communities (aquatic vegetation)
- possibly increased support for invasive species (e.g. northern pike)

➡ S1 Evaluation: -/+

➡ S2 Evaluation: -/+



Aquatic – Large River Productivity

Current

- riverine habitat at upper end of Revelstoke Reach only occurs seasonally
- habitat conditions and productivity impaired by reservoir operations and peaking at Revelstoke Dam

Scenario 1

- longer length of riverine habitat during productive late spring to early fall
- benefits are uncertain due to overall negative effects of Revelstoke Dam peaking

Scenario 2

- longer length of riverine habitat during productive late spring-early fall when compared to current operations and S1
- benefits are uncertain due to overall negative effects of Revelstoke Dam peaking

➡ S1 Evaluation: ?

➡ S2 Evaluation: ?



Aquatic – Burbot and sturgeon

Current

- Current operations unlikely to affect burbot spawning and incubation
- White sturgeon spawning and incubation habitat at Revelstoke affected by hydro peaking and reservoir operations

Scenarios 1 and 2

- Unlikely to affect burbot in comparison to current
- Likely beneficial for sturgeon spawning and incubation; uncertain for larval dispersal



➡ S1 Evaluation: +/-

➡ S2 Evaluation: +/-

Archaeology

Current

- archaeological sites in and around the reservoir have been recorded between 1,407' and 1,500'
- sites within the drawdown zone are regularly disturbed and destroyed by wave action erosion
- exposure of artifacts leads to loss to "pot-hunters"

Scenario 1

- sites below 1,420' would be inundated
- sites between 1,420' and 1,426' (1,430' some locations) would likely be destroyed by continuous wave action without mitigation efforts
- erosion of sites above 1,426' would be decreased due to lack of inundation in 4 of 5 years; but pot-hunting may increase

➡ S1 Evaluation: +

Scenario 2

- sites below 1,419' would be inundated
- sites between 1,419' and 1,421' (1,425' in some locations) would likely be destroyed by continuous wave action without mitigation efforts
- erosion of sites above 1,422' would be decreased due to lack of inundation in 6 of 7 years; pot-hunting should decrease above 1,421' due to revegetation

➡ S2 Evaluation: ++

Commercial Navigation

Current

- log towing operates with no limitation with reservoir >1,420'
- minor limitations to towing when reservoir 1,410'-1,420'
- major limitations to towing when reservoir < 1,410'

Scenarios 1 and 2

- exceeds minimum elevation for full tows through the Narrows
- no days with limitations to log towing
- significant improvement in log dump efficiency and safety

➡ S1 Evaluation: +++

➡ S2 Evaluation: +++



Power Generation – Arrow Lks. Gen. Station

Current

- as reservoir elevations vary through the year, power generation at ALGS increases with increasing elevation and discharge, and decreases with lower elevations and lessor discharge

Scenario 1

- modelling suggests moderate increase in average power production over current production at ALGS

➡ S1 Evaluation: +

Scenario 2

- modelling suggests power production roughly equal to current production at ALGS

➡ S2 Evaluation: o



Flood Storage

Current

- since 2008, annual storage has ranged from 3.7-4.8 million acre-ft
- maximum storage capacity is 7.1 million acre-ft (1,378'-1,444')

Scenarios 1 and 2

- in flood years storage of 2.8 million acre-ft (S1) and 2.9 million acre-ft (S2)

➡ S1 Evaluation: - -

➡ S2 Evaluation: - -/- - -



Boat-based Recreation

Current

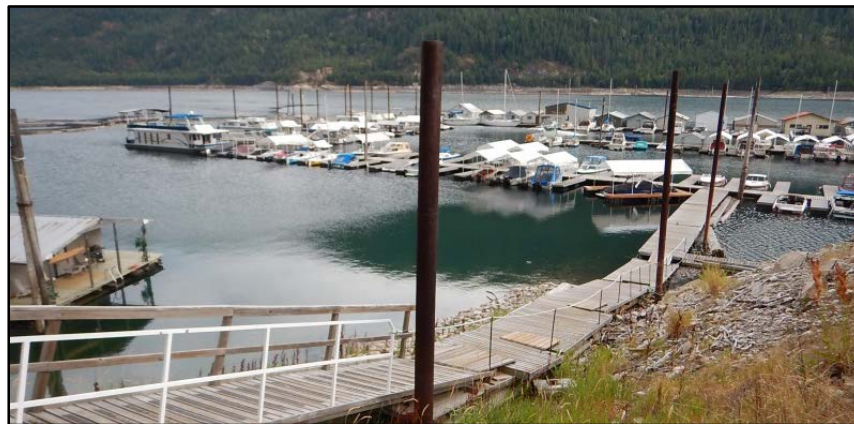
- main concern is boat ramps that are accessible at all elevations
- some launches now not available at extreme low water
- no strong preference for specific elevation
- slight aversion to very low and very high elevations

Scenarios 1 and 2

- increased certainty in non-flood years
- boat ramps available all year
- likely improved beach development
- potentially decreased boat launch maintenance costs

➡ S1 Evaluation: +/-

➡ S2 Evaluation: +/-



Shoreline-based Recreation

Current

- shoreline land owners are unhappy with current regime
- most would prefer constant elevation at 1,430-1,435'
- shoreline-based marinas unhappy with current regime – especially extreme low water

Scenarios 1 and 2

- not shoreline land owners' preferred regime, but could adapt
- preferable to present regime; would be more agreeable with mitigation assistance
- shoreline-based marinas would benefit from certainty in non-flood years; concern regarding current in Narrows and near dam

➡ S1 Evaluation: ++/-

➡ S2 Evaluation: ++/-



Terrestrial Recreation

Current

- limited access to drawdown area due to annual inundations, especially during spring and summer
- more area available when water very low

➡ S1 Evaluation: +

➡ S2 Evaluation: ++

Scenarios 1 and 2

- year-round access for activities in non-flood years
- increase in available area except winter/early spring (greater in S2)
- likely decreased maintenance costs to trails and other facilities



Conclusions

		Scenario 1	Scenario 2
Vegetation	Terrestrial	+	+++
	Wetland	+	++
Wildlife	Herptiles	+	++
	Songbirds	+	++
	Water/shoreline birds	++	+++
	Mammals	o	+
Fisheries	Pelagic productivity	?	?
	Pelagic fish	?	?
	Tributary access	-	++
	Tributary spawn/rear	+	++
	Littoral habitat	+	+
	Macrophytes & Invasive spp.	-	-
	Large River Productivity	?	?

+ relative benefits - relative negative impacts o changes are neutral ? effects uncertain

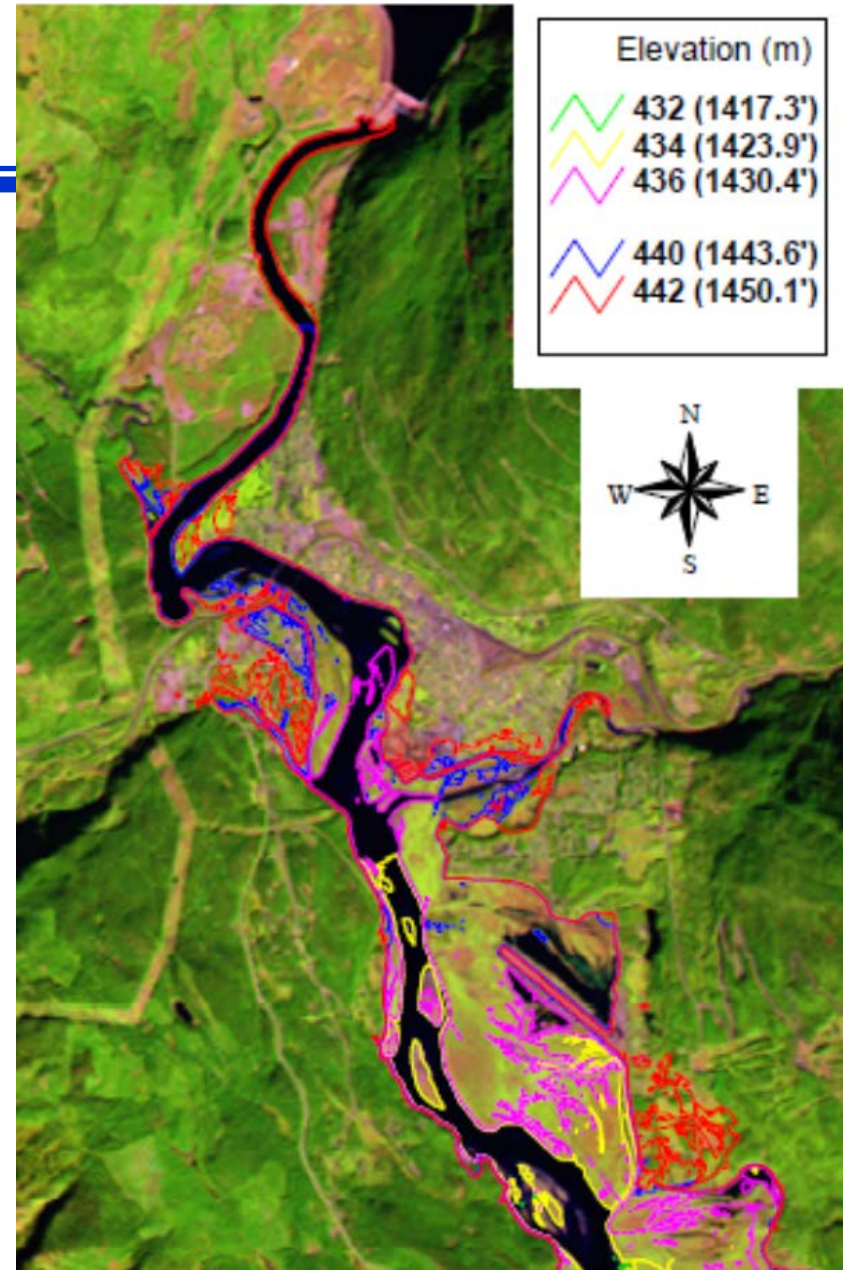
Conclusions

		Scenario 1	Scenario 2
Fisheries (cont'd)	Burbot & sturgeon	+/?	+/?
Recreation	Boating	+/o	+/o
	Shoreline	++/-	++/-
	Terrestrial	+	++
Agriculture		+	+++
Erosion	Shoreline	+	+++
	Mass Wasting	?	?
Archaeology		+/?	++/?
Commercial Navigation		+++	+++
ALGS Power Gen.		+	o
Flood Storage		--	---

+ relative benefits - relative negative impacts o changes are neutral ? effects uncertain

Suggested Further Work

- Review of concept by community and experts
- Vegetation response to inundation depth and duration
- Fisheries responses to scenarios
- Refinement of agricultural potential
- Identification of erosion hazards at 1,420' and 1,425'
- Detailed power generation and flood control modelling
- Modeling of down stream flows and system-wide impacts of the options



Arrow Lakes Reservoir Mid-Elevation Scenarios: Scoping Evaluation

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