Arrow Reservoir Constant Mid-Elevation Scenarios: Scoping Evaluation

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Columbia Basin Regional Advisory Committee (CBRAC)

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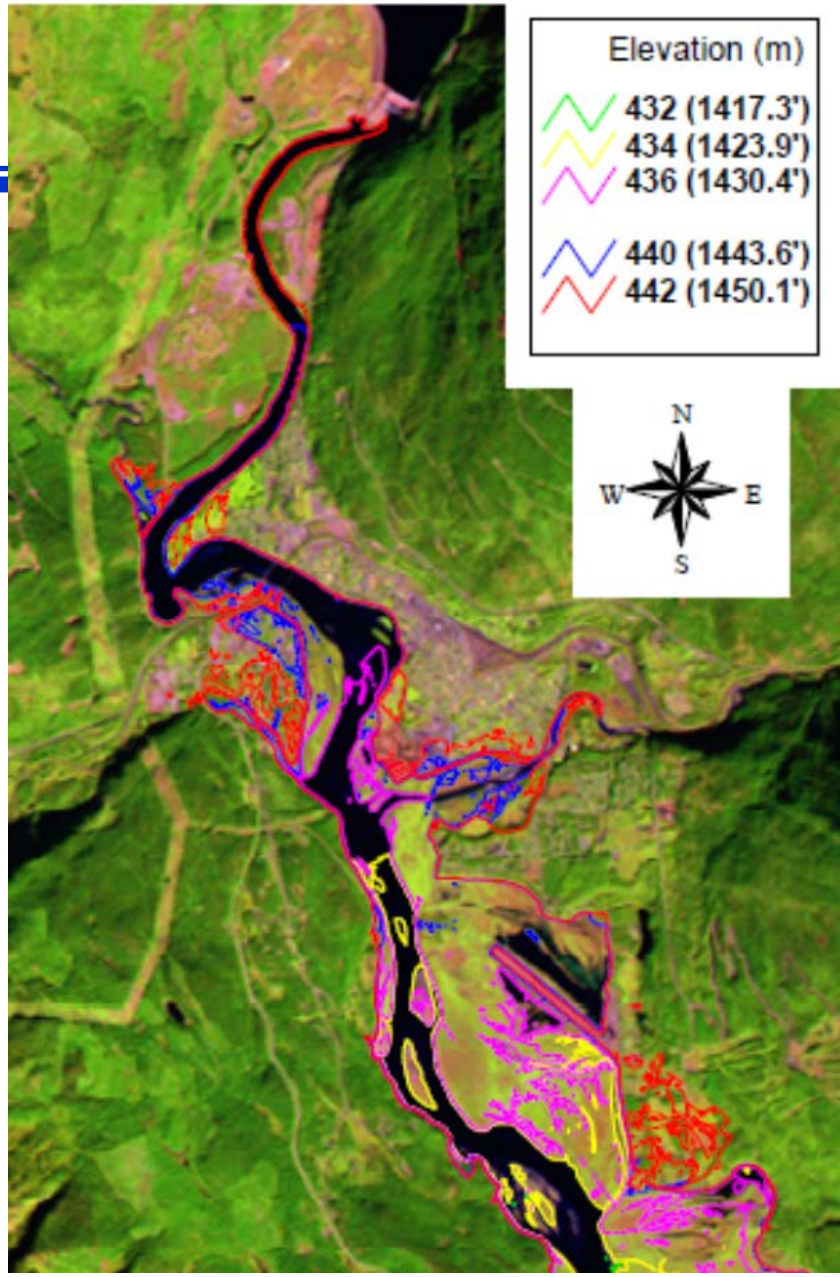
Arrow Reservoir Management

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

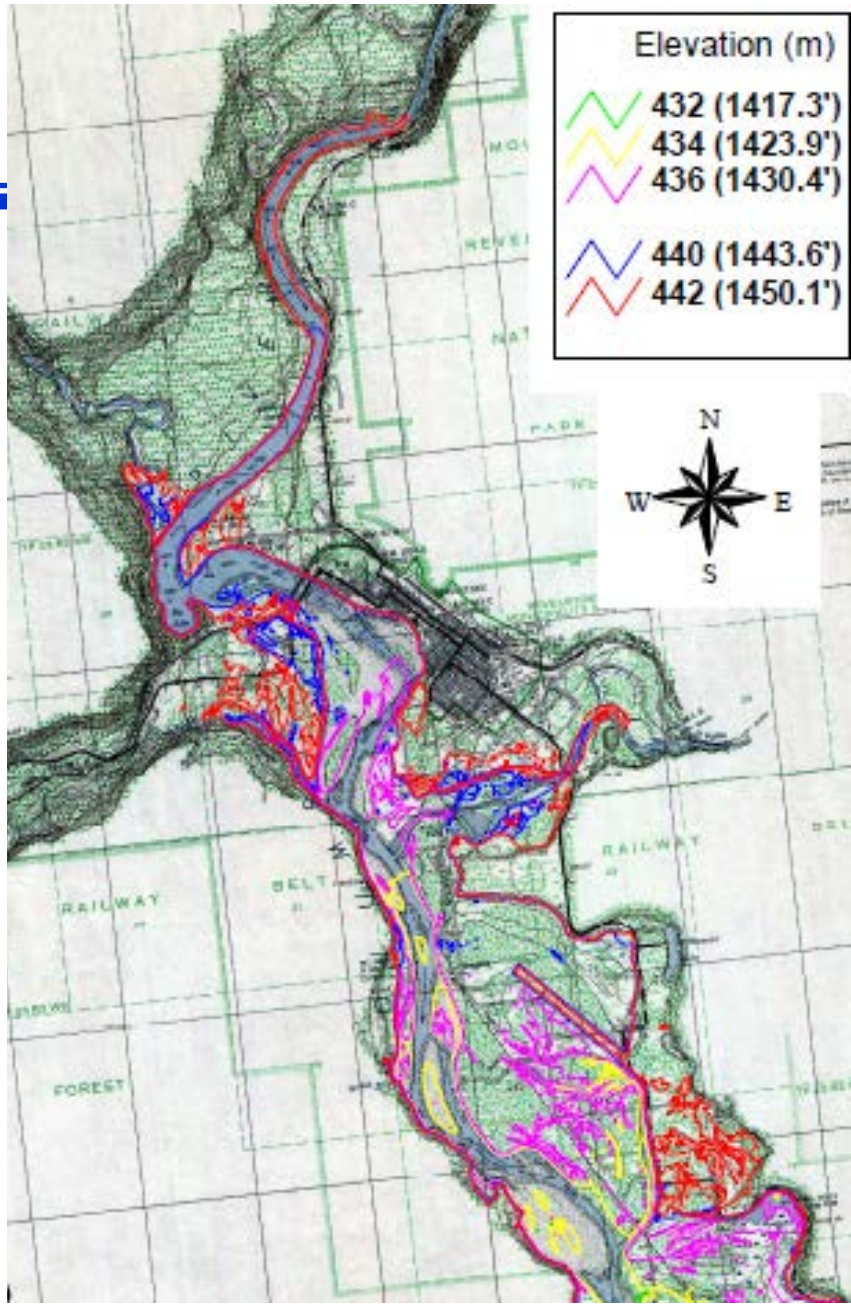
Assessment Criteria

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

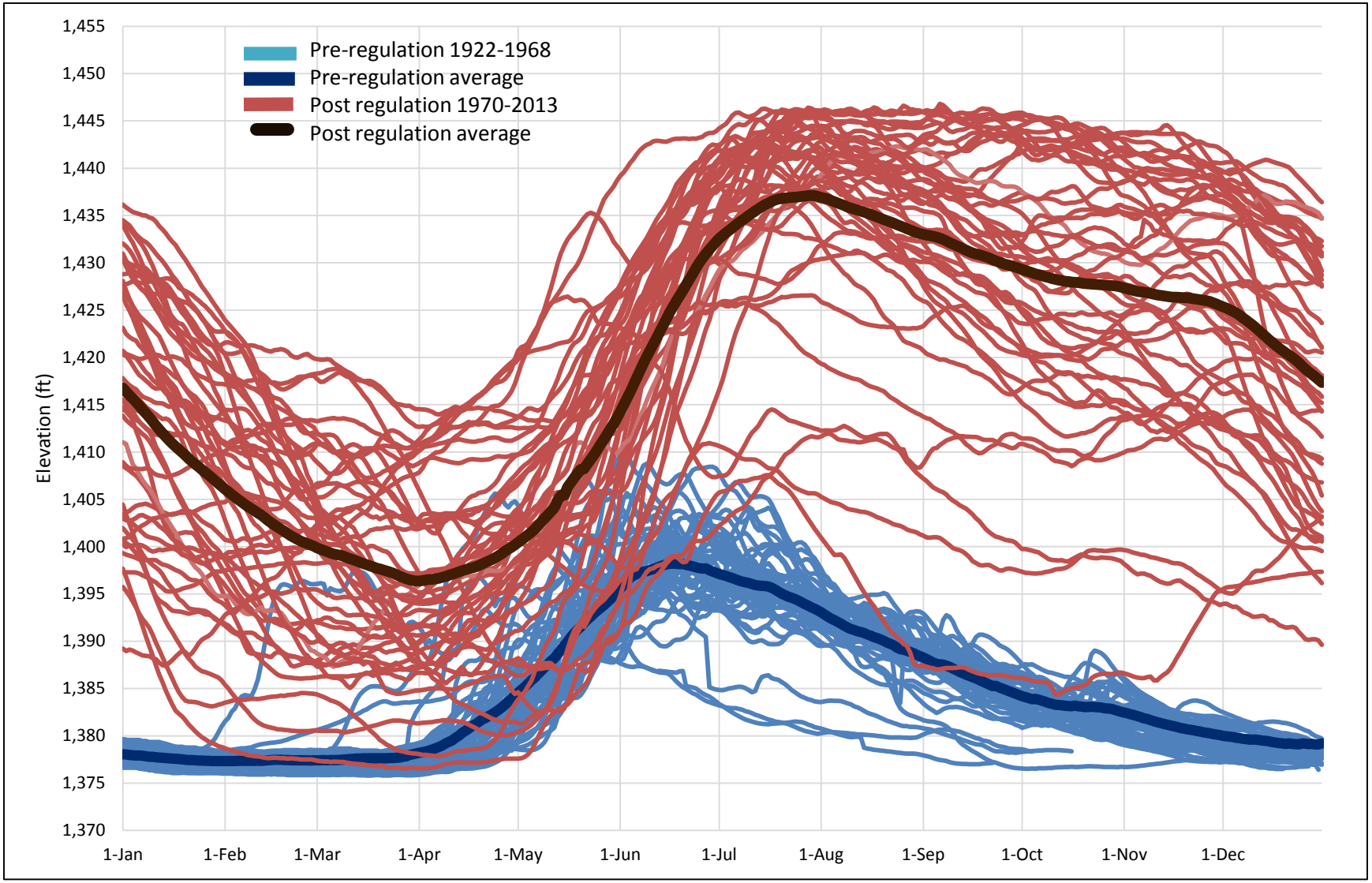


Information Sources

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

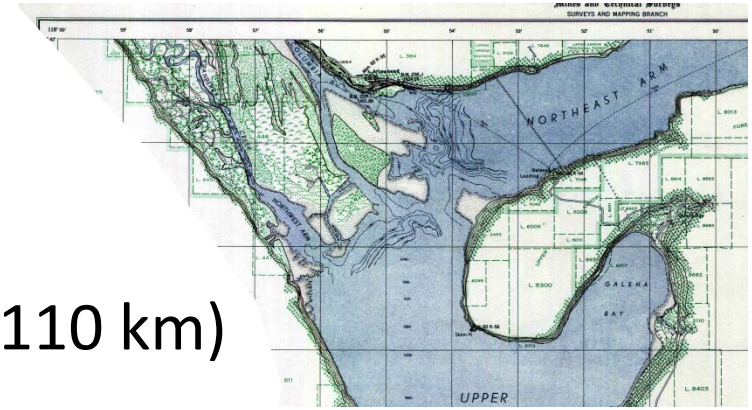


Arrow Lakes Pre and Post Regulation



Dam Footprint Impacts - Examples

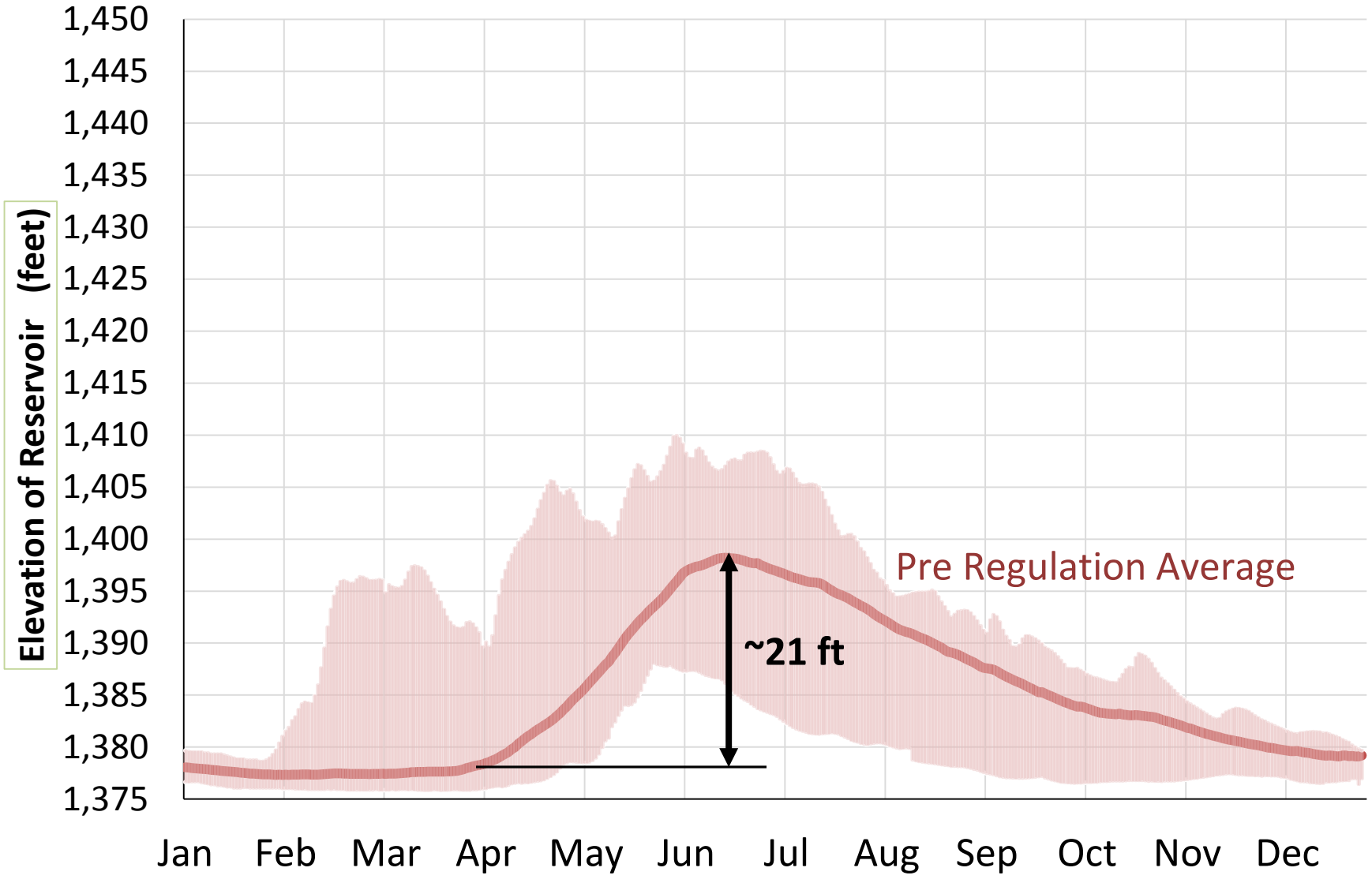
- Ecosystems and Habitat
  - Lakes 34,992 ha
  - Wetlands/ Ponds 3,535 ha
  - Rivers/Floodplains 8,849 ha (110 km)
  - Streams 52 ha (93 km)
  - Uplands 3844 ha
- Farmland/ Orchards
  - 2,300 ha of active agricultural lands
  - 260 farmsteads
- Numerous rural communities and infrastructure



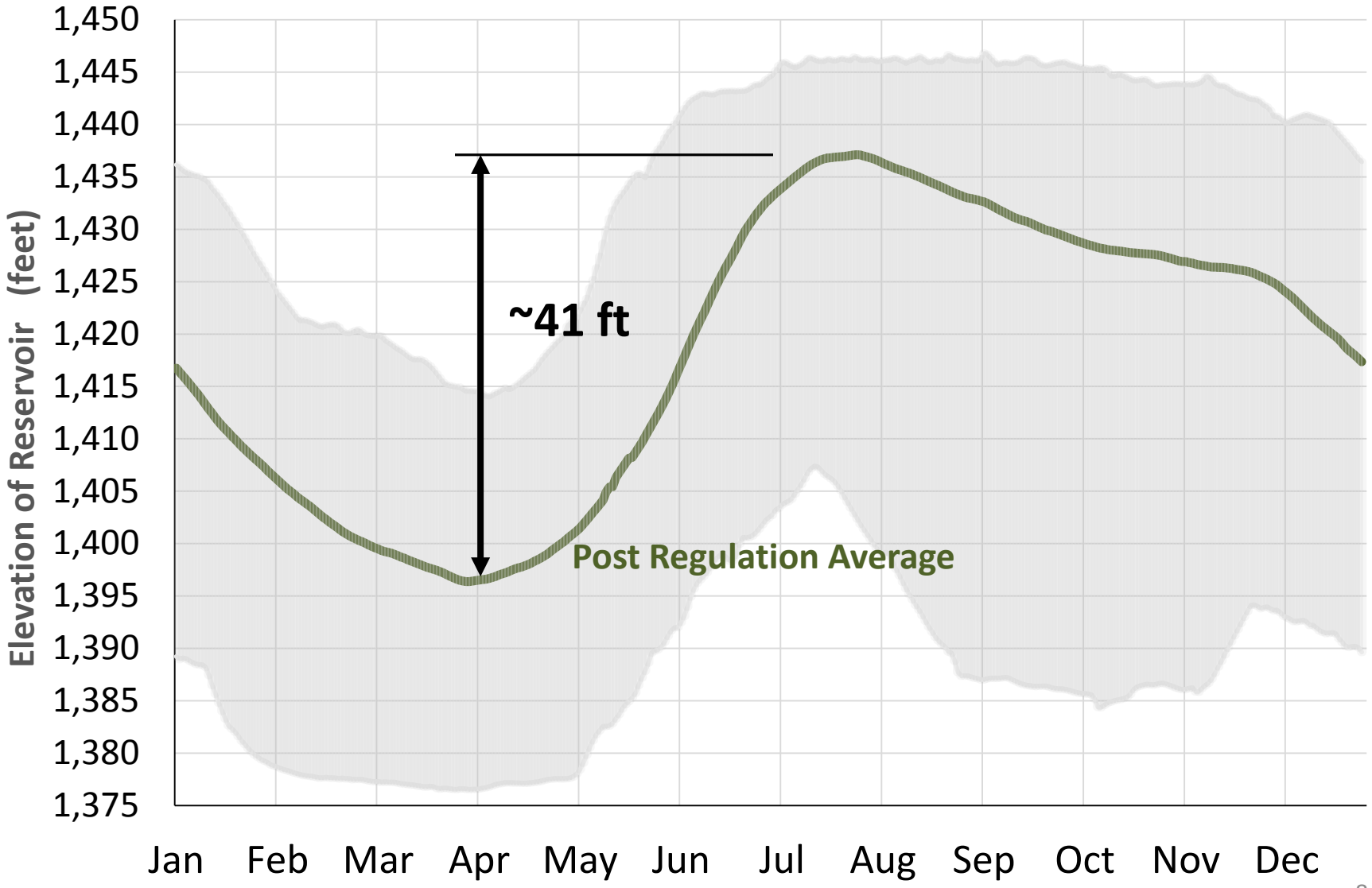
C. Spicer

From: Utzig and Schmidt 2011 and Penfold 2012

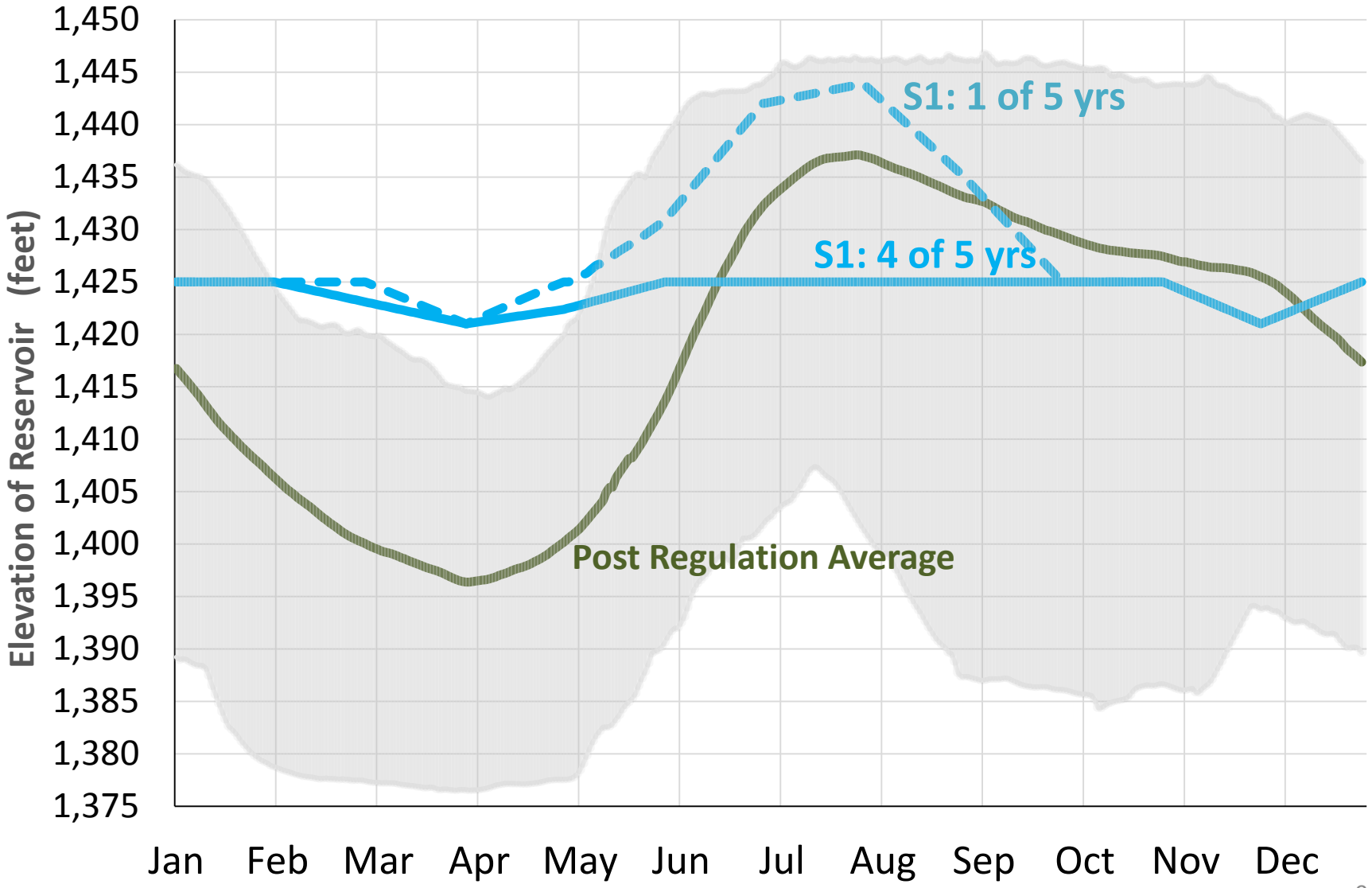
Pre Regulation Hydrograph



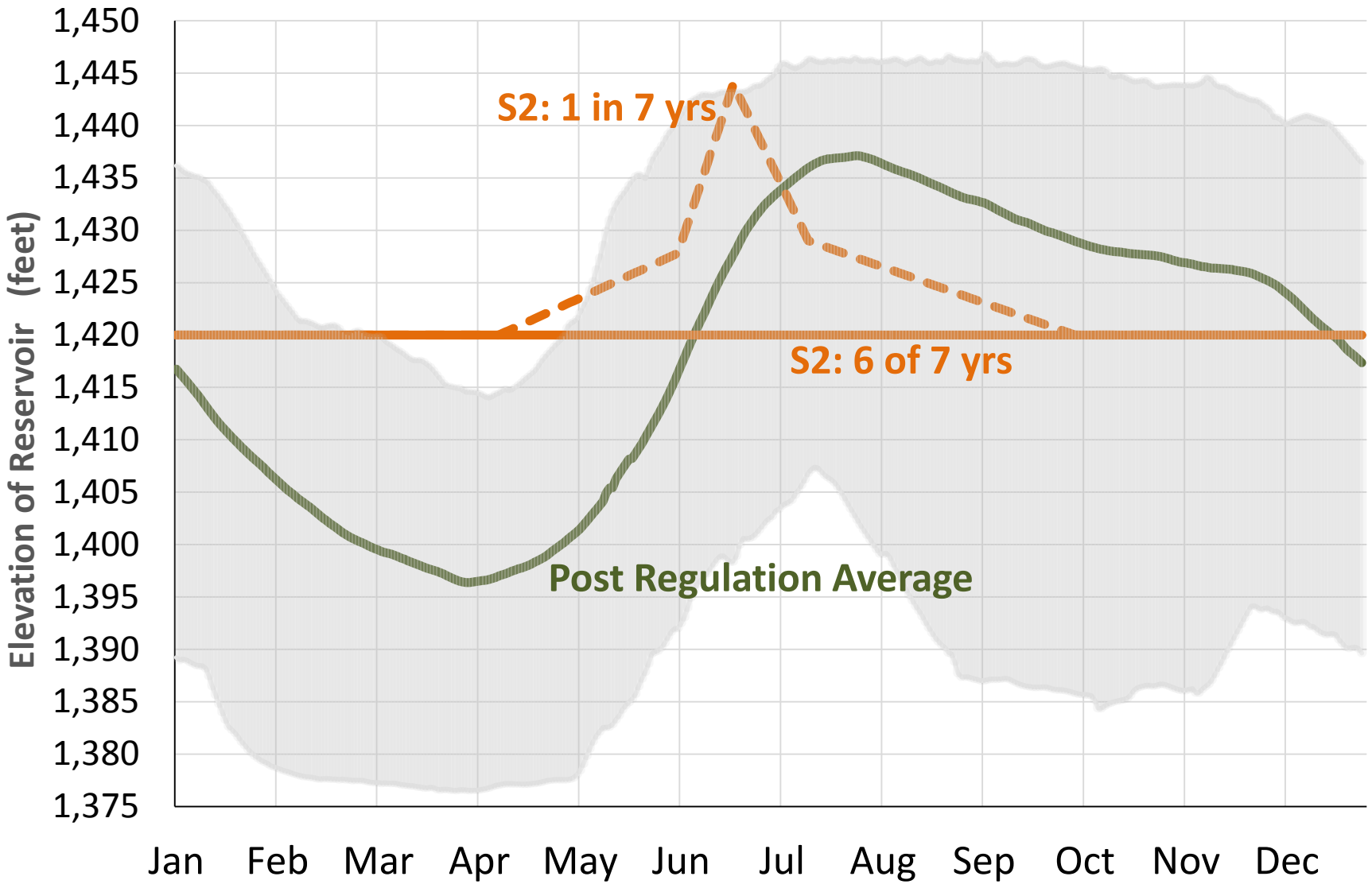
Post Regulation Hydrograph



Scenario 1


1,450
1,445
1,440
1,435
1,430
1,425
1,420
1,415
1,410
1,405
1,400
1,395
1,390
1,385
1,380
1,375
Elevation of Reservoir (feet)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
S1: 1 of 5 yrs
S1: 4 of 5 yrs
Post Regulation Average

Scenario 2


1,450
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1,410
1,405
1,400
1,395
1,390
1,385
1,380
1,375
Elevation of Reservoir (feet)
S2: 1 in 7 yrs
S2: 6 of 7 yrs
Post Regulation Average
Jan
Feb
Mar
Apr
May
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Jul
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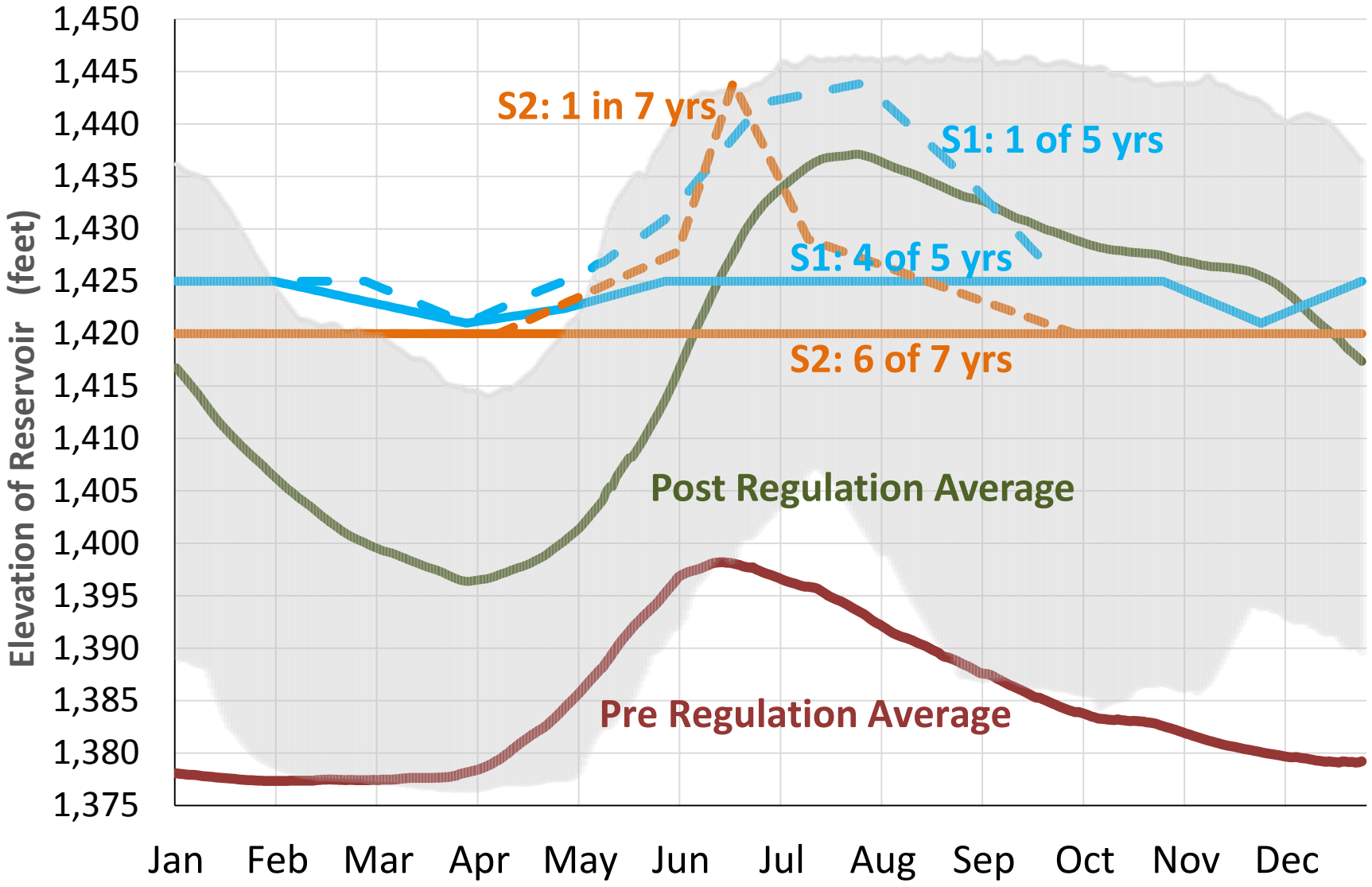
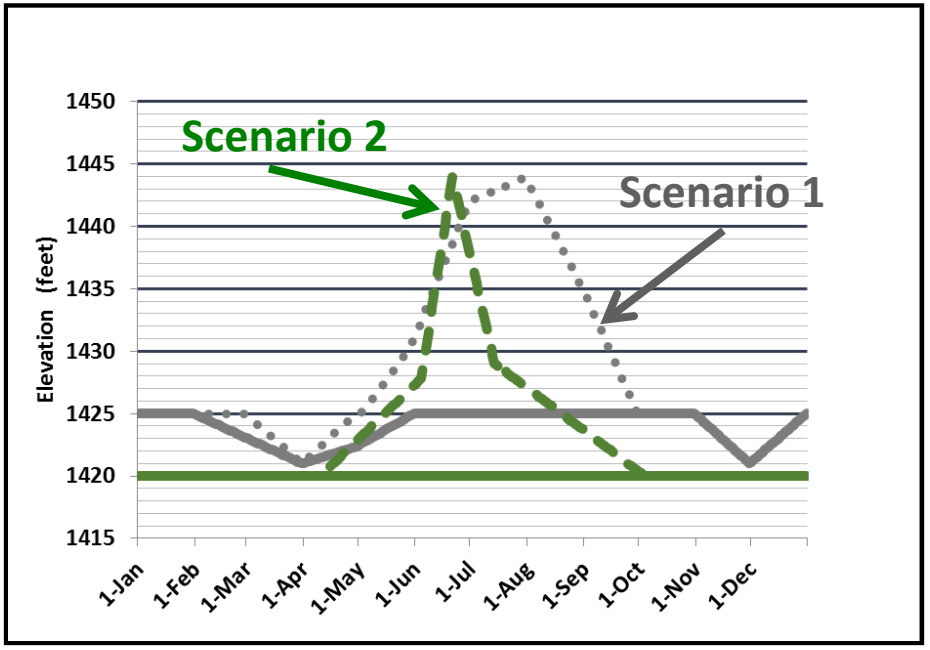
Sep
Oct
Nov
Dec

Scenarios 1 & 2



Reservoir Operations



Scenario 1

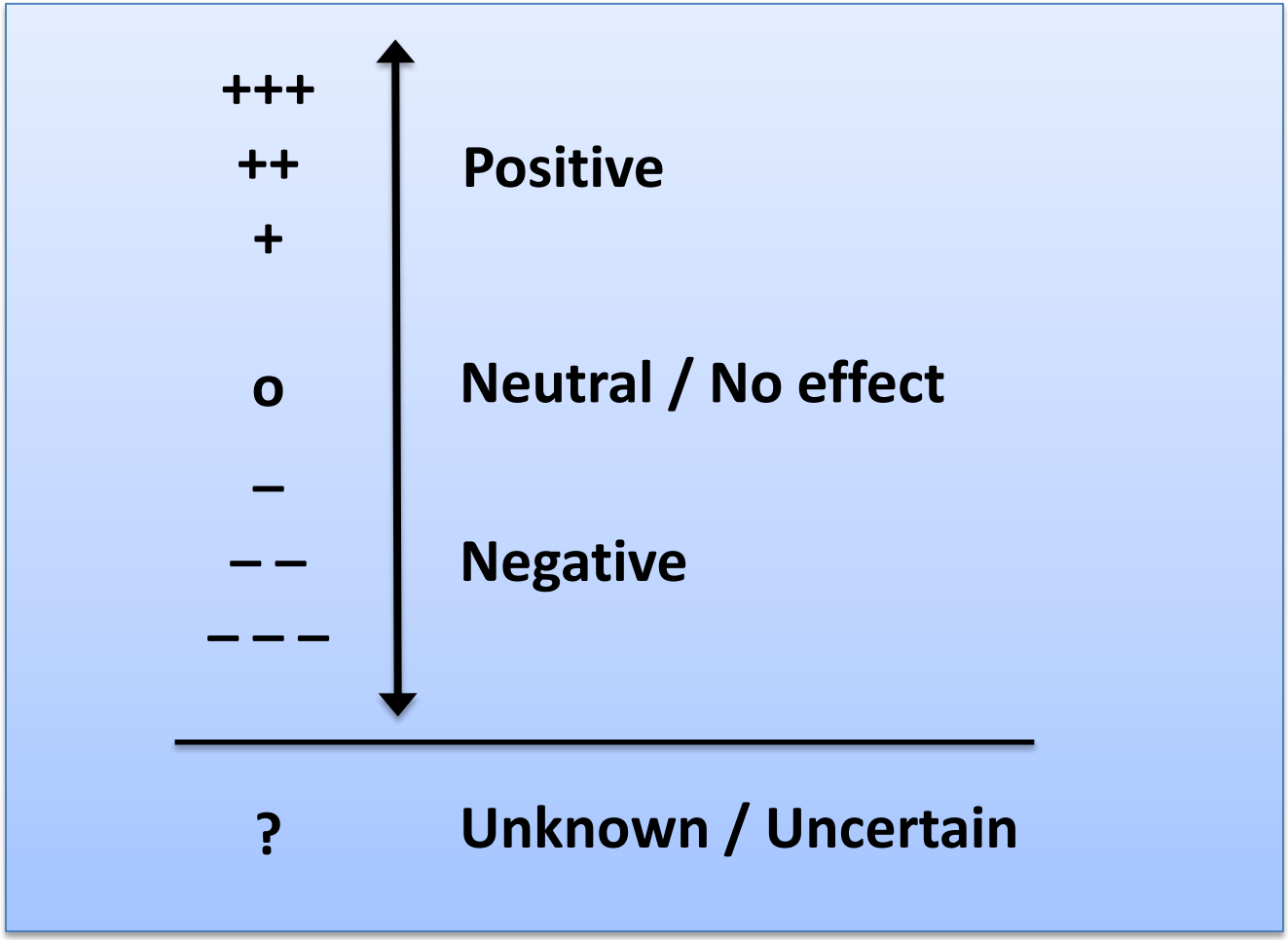
- reservoir generally held at approx. 1,425’
- dips to approx. 1,421’ in spring and late fall
- fills to 1,444’ at freshet in 1 of 5 years on average
- empties slowly over a couple months or more

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: o

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

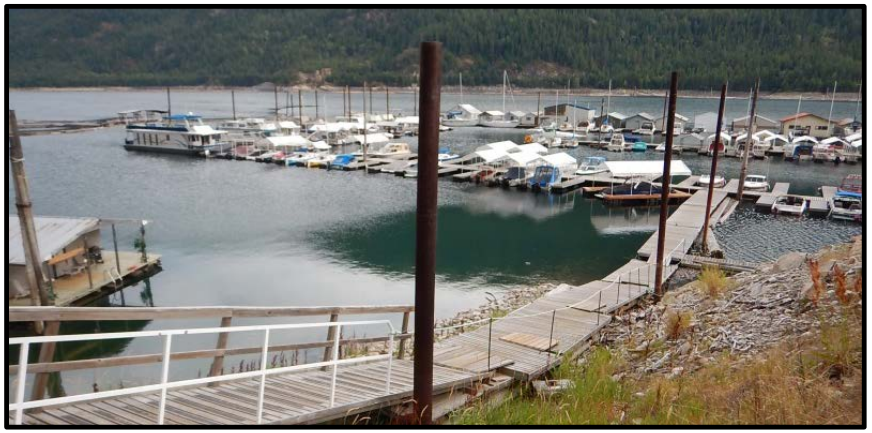
- main concern is boat ramps that are accessible at all elevations
- some launches now not available at extreme low water
- no strong preference for specific elevation
- slight aversion to very low and very high elevations

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: +/o

⇨ S2 Evaluation: +/o



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

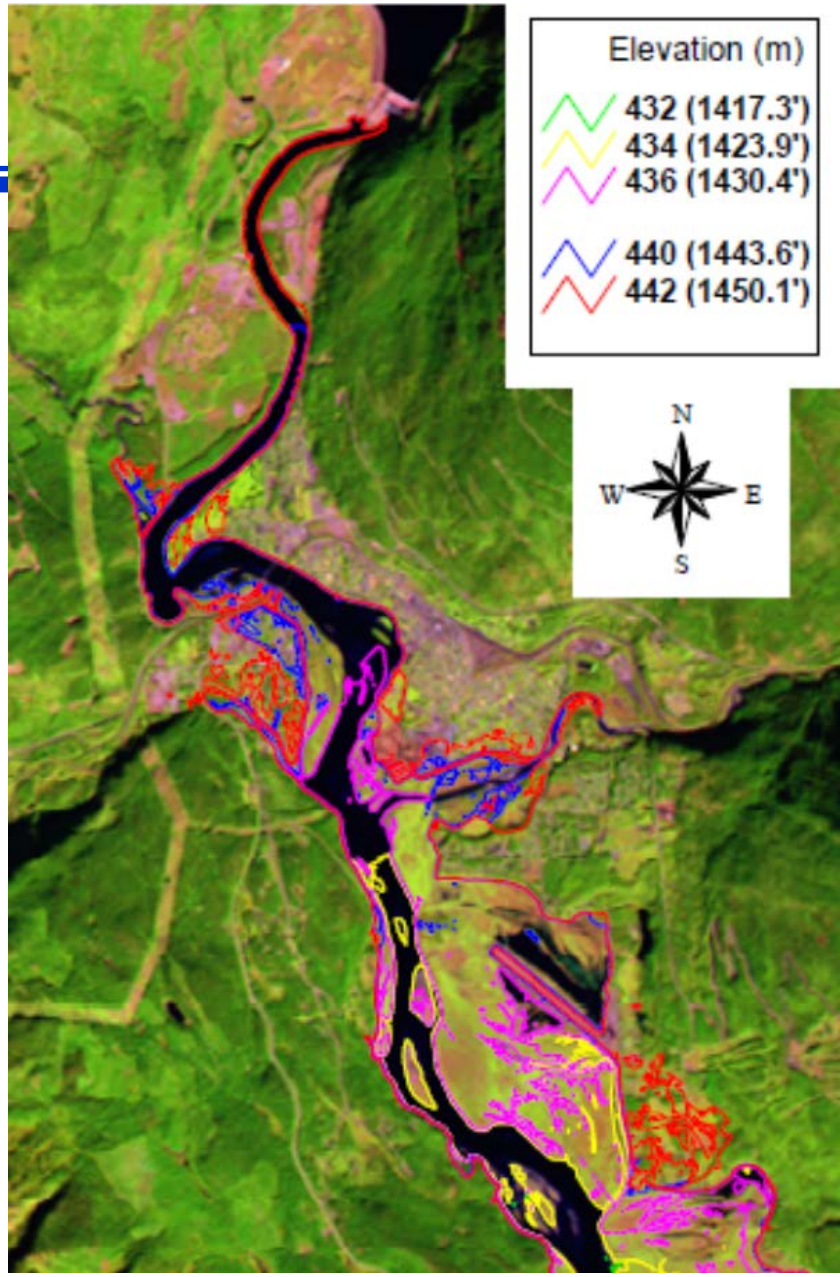
Conclusions

		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



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January 2016

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