

A lake is the landscape's most beautiful and expressive feature.

It is Earth's eye; looking into which the beholder measures the depth of his own nature.

Henry David Thoreau

A Valuable State Asset, The Soul of a Community

Washington State possesses one of the most iconic state capitol landmarks in the United States - Capitol Lake. The Lake lends a unique spiritual beauty to the state capitol campus, city and county, literally reflecting and enhancing the magnificence of all. Tens of thousands love to visit and use this area annually. Their lives are enriched.

But, the positive effects of Capitol Lake extend beyond aesthetics and social health. They also include economic, recreational, sediment control efficiencies, bat sustenance, sea level rise flooding mitigation, and Chinook salmon production. Chinook salmon - the preferred food for our Southern Resident endangered orca pods.

Very little has been written regarding the Lake's hidden value as a salmon rearing system. Such a system was not possible before the Lake and its associated salmon ladder systems were created. Through the work of many scientists, we now have a better understanding as to why this system works so well and why it works even better when the Lake is properly maintained. A purpose of this paper is to explain why some scientists think this is the case.

Capitol Lake or Estuary Habitat Strengths Appear To Be Equal For Our Hatchery Chinook Run.

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Introduction

For decades an abundance of information regarding the fall hatchery Chinook run in the Deschutes River has circulated through our community. Much of this information appears to be questionable as it has inferred that Capitol Lake has a deleterious effect on this salmon run when compared to an estuary. Many community members and public officials have been led to believe these unsubstantiated claims are factual.

The purpose of this paper is to provide the community and elected officials with well researched information regarding the relationship between Capitol Lake and its hatchery Chinook run. We believe that objective readers will conclude that Capitol Lake has little or no net deleterious effect on its Chinook run. Although not a claim of this paper, when marine predation and Budd Inlet toxicity to these fish is considered, Capitol Lake could be considered advantageous when compared to riverine and estuarine conditions.

Focus has been given to the Chinook species here because of its critical importance (80%) to the diet of Puget Sound's ESA endangered Orcas . Chinook salmon are the preferred prey of Southern Resident Killer Whales.¹ Consequently, the #1 goal of the Southern Resident Orca Task Force is to increase Chinook abundance.²

¹ NOAA Fisheries, www.fisheries.noaa.gov/species/killerwhales

² Southern Residence Orca Task Force, November 16, 2019. Cascadia Consulting Group.

Brief Background:

In 1954, the State and Olympia community modified the Deschutes watershed to create the first salmon run above Tumwater Falls, producing more salmon than at any time throughout recorded history. The introduction of fish ladders, concrete baffles, electric motors, steel fences, piping, pens and pumps provided the infrastructure for the highly successful hatchery Fall Chinook run. About 4 years before these modifications were made Capitol Lake had been created primarily for its aesthetic and recreational value to the community as a whole. Both of these amenities – the infrastructure for the new hatchery Chinook run and Capitol Lake itself - have worked in concert to make the Deschutes urban watershed area exceedingly valuable to virtually everyone in the Thurston County community.

More recently, proponents of an estuary have claimed that Capitol Lake is harmful to our hatchery Chinook salmon run and have demanded that the Lake be re-converted to an estuary. We find their reasoning to be lacking in factual support.

The fishing community (gillnetters and non-tribal sport fisherpersons) has been and is currently benefitting from the salmon run utilizing Capitol Lake as a rearing habitat and an in-migrating escapement conduit. “Returns to the river of marked and unmarked hatchery fish have been exceptionally good.”³ (Note, this was 1955 and is relative to the era.)

Importantly, but not part of this paper, the entire community and state are benefitting from the vast array of other qualities of the Lake - aesthetic, social cohesion, economic, financial, etc. The Lake appears to have served as an optimizing management strategy for all. By sharing the Lake with everyone, the

³ Engstrom-Heg R. T. 1955, *Environmental relationships of young Chinook Salmon in Capitol Lake and the Deschutes River System*. Washington Department of Fisheries, Olympia, Washington. 76pp

strategy serves the fishing community and the entire community in a balanced fashion.

Current knowledge regarding rearing juvenile Chinook in a lake environment is incomplete:

Some proponents of the elimination of Capitol Lake have claimed that lakes in general are harmful to Chinook salmon production. However, according to Koehler and other researchers, “Little is known about use of lacustrine (lake) habitats by juvenile ocean-type Chinook salmon.....To better manage existing populations and aid in designing recovery strategies for ocean-type Chinook salmon using lacustrine environments, basic information on the ecology of juvenile Chinook salmon rearing in this habitat is needed.”⁴

Note the plural nature of “populations” and “environments”, which suggests the applicability of these research findings to other lakes nurturing juvenile Chinook salmon.

Juvenile Chinook can and do thrive in a lake environment:

The above study concluded the following: “Lake residence is a rare life history for ocean-type Chinook salmon (e.g. Burger et. al. 1985) but our results suggest that the juvenile Chinook salmon can feed and grow well in this habitat.”⁵

“Further east, Chinook are a particularly important game fish in the Great Lakes, where their abundance is maintained by large-scale artificial propagation.”⁶

⁴ M. Koehler, K. Fresh, D. Beauchamp, J. Cordell, C. Simenstad, D. Seiler *Diet and Bioenergetics of Lake-Rearing Juvenile Chinook Salmon in Lake Washington*, 2006. Transactions of the American Fisheries Society 135: 1580-1591. 1581 pp) p. 1581

⁵ (Koehler and others, p. 1587

⁶ Behnke, Robert. Trout and Salmon of North America, 2002, Chanticleer Press.

The following excerpt is from “Diet and Bioenergetics of Lake-Rearing Chinook Salmon in Lake Washington”. “Despite the heavily altered nature of Lake Washington and the relatively short time Chinook salmon have used this system, feeding and growth performance of juvenile salmon in littoral habitats of Lake Washington were comparable to those for Chinook salmon rearing in estuarine and riverine environments. (e.g. Healey 1982; Simenstad et. al. 1982; Rondorf et. al. 1990; Miller and Simenstad et. al. 1997; Duffy 2003).....”⁷

Similarities should be noted: Capitol Lake like Lake Washington, has been used for only a short time by chinook salmon. Both are urbanized lakes. Juvenile Chinook populations in both lakes enter and leave within similar seasons (approximately March –July). Both Chinook juvenile populations predominately consume chironomid pupae and Daphnia spp. Thus, findings by Koehler et al. regarding juvenile Chinook in Lake Washington could well be relevant to this species in Capitol Lake. (Engstrom-Heg 1955, Koehler et al. (2006).

According to Thurston County Health Department data, bottom water in Capitol Lake is well oxygenated throughout the year, this includes April – July (the Chinook juvenile rearing period) and during the return period, July through September, when these fish return (mostly September).⁸ “The deep portions of the lake are kept well aerated by the inflow of river water which, being colder and heavier than the lake water, follows the bottom of the old channel during the summer months.”⁹

⁷ Koehler, and others p.1589

⁸ Milne, D. H. 2015 Capitol Lake: The Healthiest Lake in Thurston County. 17 pp. Available on CLIPA’s website, www.savecapitollake.org/documents/healthiest-lake.html

⁹ Engstrom-Heg. p. 4

It should be noted that maintenance dredging of the Lake as well as riparian planting along the Deschutes River will further improve temperature and oxygen conditions in Capitol Lake.¹⁰

Capitol Lake insects support bats, Chinook and Coho

Aquatic insects, an important source of food for juvenile Chinook (and our ecologically valuable Yuma and Little Brown bat populations), thrive in conjunction with Capitol Lake in great part due to the freshwater Lake's uniquely high benthic (bottom) oxygen content. According to both Koehler and Engstrom-Heg, juvenile Chinook reared in Lake Washington and Capitol Lake prefer Chironomidae and Daphnia sp. as primary food sources. Capitol Lake, of course, has significant populations of both.¹¹

It is interesting to note that (regarding coho salmon) "The contents of the stomachs of 38 silver [coho] of the 1953 and 1954 broods, mostly from the Percival Cove area, revealed the diet of these fish to be substantially the same as that of the Chinook salmon."¹² This observation may have important ramifications for establishing a future sustainable coho run.

Regarding the release of juvenile Chinook salmon into Capitol Lake, Robert Engstrom-Heg, fisheries biologist, has stated "The data do not indicate that the conversion of Capitol Lake to freshwater had any great effect on survival, either for better or worse."¹³ (The lower Deschutes River just above Tumwater Falls was used as a brood stream from 1946-1950, thereby allowing comparison of survival rates before and after construction of Capitol Lake.¹⁴)

¹⁰ Capitol Lake Alternatives Analysis, pp 31 -32

[http://des.wa.gov/sites/default/files/public/documents/About/CapitolLake/21-CapitolLake AlternativesAnalysisFinalReport\(July2000\).pdf](http://des.wa.gov/sites/default/files/public/documents/About/CapitolLake/21-CapitolLake%20AlternativesAnalysisFinalReport(July2000).pdf)

¹¹ Engstrom-Heg, p. 38

¹² Engstrom-Heg, p. 39

¹³ Engstrom, Heg, p. 11

¹⁴ Engstrom-Heg, p. 7

Engstrom-Heg continues, “The data...show growth of Chinook salmon in Capitol Lake to be extremely rapid, greatly exceeding that attained by fish of the same stock held in hatcheries.”¹⁵ These conclusions appear to corroborate the conclusions of M. Koehler and others.

According to Mr. Wayne Daley, Sr. Fisheries biologist, “I do not believe that turning the lake into a mudflat will enhance or improve the existing salmon and trout populations of the watershed. The restricted flow of water into the area above 4th street will not provide the typical flushing that would occur in an undisturbed estuary.”¹⁶

Interestingly, Deschutes River Fall Chinook escapement for 2017 numbered over 30,000 (probably 33,000). This compares favorably with averages of about 10,000 over the last several years.¹⁷

Loss of shoreline vegetation will reduce Chinook habitat quality.

It seems likely that Capitol Lake’s massive overhanging shoreline vegetation will be almost totally destroyed due to the salinity increases of an estuary. This canopy currently offers shade and protection from predators, so valuable for Chinook juveniles. Loss of this vegetation or access to it will reduce habitat quality.

Removing the tide-lock will allow toxins now in Budd Inlet to infiltrate Capitol Lake basin endangering Chinook and by extension, Southern Resident orcas.

Budd Inlet has furans, dioxin, and other toxic hydrocarbons which are currently prevented from infiltrating Capitol Lake basin by the tide-lock.¹⁸ More than a

¹⁵ *Engstrom-Heg, p.77*

¹⁶ Daley, Wayne, Sr. Fisheries Biologist. Opinion letter, March 21, 2011. <http://www.savecapitollake.org/documents/impact-on-fisheries.html>

¹⁷ Pylon, Lee. Washington Department of Fish and Wildlife. Pers. Comm. May, 2018

dozen cautionary and advisory warning signs issued by the Thurston County Health Department populate the shores of lower Budd Inlet warning humans to keep themselves and pets away from the water. Showering is advised after contact with either sand or water from this area.



Priest Point Park signage referencing Ellis Cove

Advisory reads: “Water and Soil Pollution. Shower after contact with sand or water from this area.”

Thus, sensitive juvenile Chinook salmon that spend April, May, June and possibly July developing in Capitol Lake basin are spared exposure to these toxins during that time period. It seems logical that harbor seals, sea otters, cormorants, (ESA endangered) orcas, and other predators benefit from this barrier.

The Southern Resident Orca Task Force Report and Recommendations of November 16, 2018 makes clear that PCB’s, PBDE’s, PAH’s, and CEC’s (contaminants of emerging concern) present serious threats to Chinook and

¹⁸ Capitol Lake Alternatives Analysis.

[http://des.wa.gov/sites/default/files/public/documents/About/CapitolLake/21-CapitolLake AlternativesAnalysisFinalReport\(July200\).pdf](http://des.wa.gov/sites/default/files/public/documents/About/CapitolLake/21-CapitolLake%20AlternativesAnalysisFinalReport(July200).pdf)

Southern Resident orcas.¹⁹ According to that report and the Department of Ecology website, it appears that most if not all these contaminants are found in Budd Inlet. Chris Wilke, Director of Puget Soundkeepers has stated that Budd Inlet is significantly contaminated and is of serious concern to that watchdog organization.²⁰

An important quote from the Task Force Report is: “Adult Chinook Salmon are a major source of persistent toxic chemicals to Southern Resident Orcas.”

The toxin infiltration threat appears to have been under-investigated by those conducting the decision making process.

Cost benefit ratios for the tide lock removal project appear to be relatively poor.

Engstrom-Heg’s assessment that “The data do not indicate that the conversion of Capitol Lake to freshwater had any great effect on survival, either for better or worse.” is important for this reason: Although not a controlled experiment, the assessment suggests that (unlike removal of the Elwha dams) removing the tide lock would likely yield no significant increase in fish production. The **hundreds of millions of dollars** saved by retaining the Lake and continuing with the Lake Management Plan could protect funding to improve other more productive rearing and spawning areas in Puget Sound.

One example: according to then Thurston County Commissioner Bud Blake, Thurston County-owned fish barrier culverts total 336 and block many miles of natural spawning grounds. It is possible that most or all of these spawning grounds could be recovered using money from the above savings. Note, these culvert restorations will likely benefit coho, chum, cutthroat and perhaps steelhead. Less likely Chinook.

¹⁹ Southern Resident Orca Task Force Report and Recommendations, November 16, 2019. Cascadia Consulting Group.

²⁰ Wilkie, Chris, Lecture, Thurston County League of Women Voters Public Forum, April 2, 2019.

Another example: We must understand that stormwater is the #1 cause of pollution in Puget Sound and pavement is the #1 contributor to that source.²¹ Urban Runoff Mortality Syndrome is now widely recognized.²² Effectively addressing this problem is terribly expensive, but nevertheless is a critically important future public investment.

This cost benefit position is reportedly supported by the PSNERP decision of March, 2013 to de-couple (remove) the Deschutes Estuary Restoration Project from its funding list.^{23 24 25}(See various emails from WDFW managers Margen Carlson and Theresa Mitchell) and Washington State Senator Karen Fraser. The last two persons had verbal contact with Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) administrators regarding this decision. (Available upon request, Jack Havens, bikeandfish@comcast.net).

An overlooked but serious cost of re-conversion is the physical risk associated with a mudflat in our urban area (as warned by Thurston County Health Department signage). In late March of 2017 a man was rescued by Olympia Fire Department after becoming entrapped in the mud of the tidal mudflats near Priest Point Park.²⁶ Presumably a less fortunate outcome might have ensued with a rising tide had rescuers not been alerted.

²¹ Wilkie, Chris. Lecture, League of Women Voters Symposium, April 2, 2019.

²² Wilkie, Chris. Lecture, League of Women Voters Symposium, April 2, 2019.

²³ Carlsen, Margen, Deputy Assistant Director – Habitat, Washington Department of Fish and Wildlife pers. communication email April 24, 2015. (Available by contacting Jack Havens at bikeandfish@comcast.net.)

²⁴ Mitchell, Theresa C., Puget Sound Nearshore Ecosystem Restoration Project, Washington Department of Fish and Wildlife – Habitat Program. Pers. Communication April 27, 2015

²⁵ Fraser, Senator Karen @leg.wa.gov. email July 9, 2015.
<http://sdc.wastateleg.org/fraser/contact/>

²⁶ *The Olympian*, Amelia Dickson, 4/1/17, “Olympia Firefighters rescue man from tidal flats near Priest Point Park”

In addition to toxicity induced disease, predation on Juvenile Chinook in an estuary appears to have been inadequately researched.

The importance of predation on Chinook juveniles in Lake Washington has been stressed by researchers as follows: “....increasing the amount of food available to the juvenile Chinook salmon in Lake Washington will not materially contribute to improve the status of this population. Efforts to rebuild Chinook salmon populations in this basin should therefore focus on the influence of other lake related factors, such as predation, disease, and other life stages.”²⁷

Regarding Capitol Lake, marine predation below the 5th Avenue tide gate is recognized as a problem for migrating salmon in this run.²⁸ However, re-converting Capitol Lake to an intertidal mudflat will quadruple the number of marine water compression points (bottlenecks caused by the railroad trestle, Deschutes Parkway bridge, I-5 bridge and fish ladder at Tumwater Falls) available to predators such as harbor seals, otters, herons and cormorants. Regarding predation in Capitol Lake itself, Engstrom-Heg states the following: “Predation upon young salmon in the lake is probably negligible”.²⁹ It should be noted that Capitol Lake lacks northern pikeminnow (*Ptychocheilus oregonensis*) which is a significant predatory fish in Lake Washington.³⁰

It is noteworthy that the author has heard no discussion from estuary proponents regarding the threat to juvenile Chinook from increased predation or toxicity posed by removal of the tidelock.

Fifth Avenue salmon viewing platform: a valuable, unique outreach investment not easily replicated with an estuary.

²⁷ Koehler and others, p.1589

²⁸ Capitol Lake Alternatives Analysis, June, 2009, 21, 23, 25 pp
[http://des.wa.gov/sites/default/files/public/documents/About/CapitolLake/21-CapitolLake AlternativesAnalysisFinalReport\(July2009\).pdf](http://des.wa.gov/sites/default/files/public/documents/About/CapitolLake/21-CapitolLake%20AlternativesAnalysisFinalReport(July2009).pdf)

²⁹ Engstrom-Heg, p.42 and p. 78

³⁰ Beecher, Hal. Personal written communication.

The Fifth Avenue salmon viewing platform is close to downtown and spans the narrow outflow and fish ladder from Capitol Lake into Budd Inlet. The popular viewing platform represents a valuable outreach investment for community education and enrichment, recognized as an integral part of salmon enhancement. Each year, thousands of pedestrians walking to and from the Olympia downtown use this structure to learn about salmon life history and predation. Docents from Stream Team (funded by Lacey, Olympia, Tumwater and Thurston County) use this structure to teach many hundreds if not thousands of people the unique characteristics of our Chinook salmon. A close-up, bird's eye view of returning Chinook in a populated area would not be easily replicated with an estuary.

Capitol Lake removal represents questionable civic planning philosophy:

In addition to the already existing fish producing infrastructure as mentioned above, concrete and steel buildings and pond infrastructure for a new fish hatchery is being funded for the riparian area of the Deschutes River at Pioneer Park independently of the Capitol Lake issue “including whether or not the Fifth Avenue dam is removed.”³¹ Biological waste nutrients will likely enter this watershed from this hatchery to some degree. Funding is being requested and supported by WDFW and the Squaxin Island Tribe.

Community members must ask why we should accept the man-made hatchery structures while the major proponents of the new hatchery oppose Capitol Lake in no small part because it is “not natural”. This begs the question, Should the demands of the fishing community take priority over the needs and values of the community at large?

Estuary advocates have opposed dredging and plant harvesting Capitol Lake:

According to the Capitol Lake Alternatives Analysis – Public Review Draft and

³¹ Unsworth, Jim, PhD, Director Washington Department of Fish and Wildlife, letter of April 18, 2017.

other experts, these fish would unquestionably benefit from dredging and aquatic plant harvesting Capitol Lake because of:

- a) cooler temperatures contributing to higher Lake and Budd Inlet DO (dissolved oxygen),
- b) fewer aquatic weeds and algae thus higher subsequent DO in Budd Inlet,

With these findings in mind, it would seem beneficial to our Chinook juveniles if Capitol Lake would be dredged according to the original plan of every 5-10 years. The Lake was last dredged partially in 1986 and is at least 3 decades overdue. The most recent claim is that dredging must be matched with the management plan selected. However, dredging the Lake must occur under any management scenario. It does seem likely, however, that the lack of dredging (and harvesting aquatic weeds) reduces aesthetic appeal to most and contributes to an impression that “the Lake must be unhealthy”.

Strategic harvesting of aquatic plants is performed in many lakes but has been rejected for Capitol Lake. Adequate explanation for this rejection using documented and verified facts may very well not exist.

Other Assertions Which Lack Factual Support

Assertion: The dam kills fish:

Fact: The 5th Avenue tide-lock is not a dam and does not have either a turbine or spillway, characteristics considered almost totally responsible for juvenile salmon mortality in the nine Columbia River and Snake River dams.³²

³² Montgomery, David R. *King of Fish – The Thousand Year Run of Salmon*, 2003. Westview Press. 186 pp

Assertion: The Lake produces directional disorientation for the salmon:

Fact: Dams of the Snake and Columbia are accused by some of reducing river current speed causing salmon juveniles to become directionally disoriented over the course of hundreds of miles. Such claims that Capitol Lake is similarly detrimental appear to be without foundation. The two mile stretch from Tumwater Falls to the 5th Avenue tide lock has a relatively high flow which could technically qualify it as a river.³³ “Exchange of water {in Capitol Lake} is much more rapid than in most lakes.” (brackets added).³⁴

Assertion: Stray juveniles are excluded from rearing in Capitol Lake:

Fact: Seining studies performed by the Squaxin Island Tribe have shown that a relatively high percentage of Chinook juveniles residing in Budd Inlet in the summer originate in watersheds other than the Deschutes and Nisqually and might use estuarine waters extended into Capitol Lake basin. This is an interesting finding and must be acknowledged.

The following must be considered: 1. The relative numbers of these stray juveniles would likely be exceedingly small compared to the relatively large numbers rearing in Capitol Lake. Also, we don't know what percentage of their natal run these fish represent. That percentage is likely to be relatively small. 2. If our goal is to increase absolute numbers of Chinook, this could be accomplished by increasing fry numbers placed in Capitol Lake (assuming rearing capacity will allow). 3. If our goal is to increase genetic diversity, adding fry from the remote watersheds to Capitol Lake would help to accomplish that outcome. 4. We must consider that should an estuary be re-established, the number of stray juveniles who might use it may be smaller than the increased number of juvenile deaths brought about by the increased compression points of the estuary (discussed on page 9) reducing total juvenile Chinook numbers. (More research is needed.) 5. The same argument applies to the serious threat posed by Budd Inlet contaminants which are currently separated from Chinook juveniles by the tidelock. 6. Employing the Percival Creek Extension (discussed on page 16) could

³³ Personal communication with Robert Holman and John DeMeyer

³⁴ Engstrom-Hegg, p 4

facilitate the movement of these “foreign” Chinook juveniles into a smaller estuary which the extension would create.

Noted researcher Dr. Hal Beecher, PhD fisheries biologist, has stated regarding the issue of fish from other rivers, “I think that (stray juveniles from other watersheds) is a really weak argument for removing the lake.”

Assertion: “High temperatures” in the Lake are harmful to salmon:

Fact: Regarding temperature in Capitol Lake, the following findings are revealing: “In general, lake temperatures are similar to river temperatures throughout fall, winter and spring months. In the summer, however, only those temperatures at the bottom of the lake in the river channel remained synonymous with river temperatures above, which reached a maximum of 63 degrees F.”³⁵. This suggests that a properly maintained Lake, periodically dredged, provides cool water for juvenile Chinook and access to cool channel water for returning adults. Also, see previous section (page 7) on “**Loss of shoreline vegetation**”.

Note: Under any proposed management plan, temperature elevations in the Capitol Lake basin will occur due to the effects of the Deschutes River and Black Lake. Both water bodies are listed for temperature violations under the Department of Ecology 303 (d) list. Capitol Lake is not.

Assertion: The “steep salinity gradient” is a problem for the Chinook:

Fact: With regard to the salinity gradient experienced by Chinook juveniles as they travel from freshwater of Capitol Lake to more brackish estuarial waters of Budd Inlet (and the reverse for returning adults), we must be reminded of Engstrom-Heg’s findings following the conversion of the intertidal mudflat to Capitol Lake:

³⁵ Engstrom-Heg, p. 13

“The data do not indicate that the conversion of Capitol Lake to freshwater had any great effect on survival, either for better or worse.”³⁶

It must be recognized that with dam removal, Chinook juveniles released from the planned hatchery at Pioneer Park or elsewhere on the Deschutes River will experience essentially the same salinity gradient at the base of Tumwater Falls. It is noteworthy that neither Koehler et. al. or Engstrom-Heg or Beecher mention a steep salinity gradient as a physiological problem for these juveniles.

The following table has been compiled by Hal Beecher, PhD Fisheries biologist to more easily understand relative advantages for Chinook of each management system, Capitol Lake or estuary.³⁷

Chinook salmon life-stage & season	Factor influencing salmon survival, growth, and production	Capitol Lake	Unimpounded estuary
Juvenile – Jan-Jun	Food supply	Chironomids. Engstrom-Heg (1955) indicated early Capitol Lake provided food supply that supported very good growth compared to other Puget Sound systems. Koehler et al. (2006) indicates high value of chironomids as food for young Chinook in Lake Washington. Chironomid population might have adjusted as Capitol Lake aged, so current data on Chinook salmon growth and/or chironomid abundance would be informative, but in absence of new data, the best information seems to suggest favorable feeding conditions in the lake.	Some chironomids in upper reach and Percival Cove; replaced by marine plankton in marine water.
	Predation	Fish-eating birds, cutthroat trout	Fish-eating birds, staghorn

³⁶ Engstrom-Heg, p. 11

		(relatively few)	sculpin (<i>Leptocottus armatus</i>), dogfish shark (<i>Squalus acanthias</i>),
	Dissolved oxygen (DO)	Tumwater Falls ensures near saturation.	Tumwater Falls ensures near saturation.
	Temperature	Temperature very similar under either management option.	Temperature very similar under either management option.
	Salinity	Fresh water	Salinity transition fluctuates with tide, but at highest extent only moves about a mile upstream, so that this is unlikely to be a physiological factor. It could be an ecological factor in influencing food supply and predators.
	Pollutants	Pollutants from automotive and other sources in the urban environment of Capitol Lake as well as agricultural inflow from the Deschutes watershed may be present, but data are needed to answer this. Pollutants from Budd Inlet are blocked.	Pollutants in sediments in Budd Inlet might be washed farther upstream with the tide, depending on the degree to which those pollutants are dissolved or suspended and moved into the estuary. Sampling the distribution and concentration of sediment pollution in different parts of Budd Inlet would be informative as would more detailed consideration of the chemistry and adsorption of the pollutants.
Juvenile – Jul-Aug	Food supply	<i>Daphnia</i> replace chironomids as a high-quality food for juvenile Chinook (Engstrom-Heg 1955; Koehler et al. 2006)	<i>Daphnia</i> in Percival Cove and closer to Tumwater Falls in pools; replaced downstream in tidal reach by other arthropods
	Predation	See above (Jan-Jun)	See above (Jan-Jun)
	Dissolved oxygen (DO)	See above (Jan-Jun). Higher temperature can reduce DO. DO is influenced positively by ratio of surface area to volume (S:V), which is high in the relatively shallow Capitol Lake.	See above (Jan-Jun). Higher temperature can reduce DO.
	Temperature	Although high S:V favors DO, it can also lead to greater heating when air temperature and direct solar radiation are a major factor in the hot months. Data from Engstrom-Heg (1955) suggest that temperatures remain acceptable for salmonids, with more preferred	Temperature would change little from Tumwater Falls.

		temperatures in the channel. Deposition and shallowing of Capitol Lake could have changed the temperature and DO conditions in Capitol Lake. Current data would be informative.	
	Salinity	See above (Jan-Jun)	See above (Jan-Jun)
	Pollutants	See above (Jan-Jun)	See above (Jan-Jun)
Returning adult – Aug-Sep	Food supply	NA	NA
	Predation	Harbor seals (<i>Phoca vitulina</i>) and California sea lions (<i>Zalophus californianus</i>) are excluded from Capitol Lake but prey on Chinook salmon waiting to enter the lake. Once in the lake, adult salmon are safe from these larger predators while the salmon try to find the entrance to the Tumwater Falls fishway. River otters (<i>Lutra canadensis</i>) could get access to salmon at the base of the falls, but I have not seen them there.	Harbor seals (<i>Phoca vitulina</i>) and California sea lions (<i>Zalophus californianus</i>) could have access to the base of the falls where salmon aggregate in high density. Seals and sea lions often ascend rivers many miles in pursuit of salmon – I have seen them far up the Fraser, they are well-known at Bonneville Dam, and they have been reported well up the Nisqually River. This could be a major predation opportunity where salmon have much less opportunity to avoid predators than they have in Budd Inlet below the bridges. River otters could also access salmon, but may be deterred by larger seals and sea lions.
	Dissolved oxygen (DO)	See above (Jul-Aug)	See above (Jul-Aug)
	Temperature	See above (Jul-Aug)	See above (Jul-Aug)
	Salinity	See above (Jan-Jun)	See above (Jan-Jun)
	Pollutants	See above (Jan-Jun)	See above (Jan-Jun)

CLIPA's Managed Lake Options For Consideration

Coho Restoration Project:

With the exception of modest spawning in Percival Creek, there has likely never been significant sustainable spawning of native or wild salmon in the entire Deschutes River watershed, including the Capitol Lake basin. Again, this is primarily due to the existence of Tumwater Falls as an upstream migration barrier. (With the exception of limited numbers of chum, salmon do not spawn in saltwater.) Although Percival Creek's spawning habitat has been seriously harmed by human development in its upper reaches, CLIPA's proposed "Coho Habitat Restoration Project" in lower Percival Creek could help to provide a modest sustainable fishery for wild coho, and possibly steelhead and chum in this watershed. The plan is simple: provide ample woody debris and engineered log jams strategically in Percival Creek. WDFW should decide if adequate spawning habitat still exists in Percival Creek to support the cost of this project.

Percival Creek Extension Plan:

Percival Creek currently empties into Capitol Lake. Some have speculated that a direct access from Percival Creek to Budd Inlet could possibly benefit easier passage of juveniles and adults into and out of this waterway. A sinuous, meandering channel just west of the current north basin of Capitol Lake and emptying into the southwest corner of Budd Inlet could accomplish this. Tidal flows for improved ingress of stray juvenile salmon (from watersheds other than the Deschutes) for rearing might possibly be increased by this re-channeling. WDFW should evaluate the wisdom of this strategy.

A Community Dilemma

Our community is faced with the following dilemma: Much of the above information has not been shared with community members through the media or public forums.

Unfortunately, this author and others have heard the following scientifically unsupported claims at public meetings, discussions with estuary advocates, and interviews with citizens, including elected officials. These claims illustrate mischaracterization of Capitol Lake: “Capitol Lake dam is just like the Elwha dams.”, “Capitol Lake is suffocating our salmon.”, “Capitol Lake is the cause of the recent downturn of Chinook numbers in South Sound.”, “All dams are bad! They kill fish!”, “Capitol Lake is starving our salmon.”, “The toxicity of Capitol Lake has prevented the Tundra swans from returning.”, “The en masse die-off of sticklebacks is due to Capitol Lake.”, “Capitol Lake’s a cesspool.” “Get rid of that Lake, it spews its toxins into Budd Inlet every second!” “Cost is irrelevant!” These claims have circulated throughout our community for years.

The claims have been detrimental to the attainment of a well-reasoned decision on this issue. Obviously, when repeated enough times, they tend to become accepted as fact. Perhaps these claims have an enhanced appeal to many of us who are concerned about past environmental neglect in other areas.

Summary

This report does not propose that either management system, lake or estuary is superior in providing rearing for juvenile Chinook salmon. However, based upon the above findings, the following statements appear to be true:

“Little is known about use of lacustrine habitats by juvenile ocean-type Chinook salmon.” Juvenile Chinook can and do thrive in a lake environment (Lake Washington and Capitol Lake). Juvenile Chinook reared in Lake Washington and Capitol Lake prefer Chironomidae and Daphnia sp. as primary food sources - Capitol Lake has significant populations of both due to its exceedingly high benthic (bottom) oxygen content. “The data... show growth of Chinook salmon in Capitol Lake to be extremely rapid, greatly exceeding that attained by fish of the same stock held in hatcheries.” “The data do not indicate that the conversion of Capitol Lake to freshwater had any great effect on survival either for better or worse.” Aquatic insects, an important source of food for juvenile Chinook (and our community’s iconic Yuma and Little Brown bat population), thrive in conjunction with Capitol Lake in great part due to the freshwater Lake’s uniquely high benthic (bottom) oxygen content. Stripping the nearshore vegetation currently supported by freshwater Capitol Lake will degrade Chinook juvenile habitat. Removing the tide lock will allow toxins now in Budd Inlet to infiltrate Capitol Lake basin likely adversely affecting young juvenile Chinook salmon (and probably Southern Resident orcas). Predation on juvenile Chinook salmon in an estuary’s intertidal mudflat apparently has never been adequately researched in the Capitol Lake – estuary issue. Re-converting Capitol Lake to an estuary will likely quadruple the number of marine water compression points which are advantageous to predators of Chinook. These oversights could result in even more stress on our threatened Southern Resident orca population. Despite almost universal understanding that juvenile Chinook (and community aesthetics) would benefit from the strategic dredging and plant harvesting in Capitol Lake, such efforts have been opposed for decades

by those who prefer an estuary/intertidal mudflat, which would reduce the Lake's aesthetic appeal to almost everyone.

Many of these facts have not been shared with community members and public officials. These omissions and others may be contributing to a higher probability for poor decision-making.

Recommendations:

What can we do long term?

Determining which rearing environment is best for Deschutes River Chinook salmon will require a serious commitment of time and money to reduce uncertainties to a desirable level. "Studies to provide actual data to inform these uncertainties would require a series of years, as annual variation in most of the factors in the Capitol Lake-Budd Inlet area, not to mention the Pacific Ocean feeding and growing areas, can be considerable, with numerous factors interacting in complex ways."³⁸

What can we do now?

1. Certainly, resumption of water quality sampling in Budd Inlet and Capitol Lake could and should be accomplished relatively quickly and inexpensively. Persistent toxic hydrocarbons should be

³⁸ Beecher, Hal, personal written communication

included in this sampling (or assessed by hydrologic mixing modelling.)

2. Dredging the northern basin and strategically harvesting aquatic plants in the northern and middle basins could be performed to better assess the degree of positive effects of those neglected improvements.
3. Obtain neutral, third party reviews of the Coho Restoration Project and Percival Creek Extension Project.
4. Increase efforts to further restore the systemic health of the Deschutes River and Percival Creek with engineered logjams, use of woody debris, and riparian planting and possibly the creation of sediment traps.
5. Invest in treating stormwater outfall to Budd Inlet, Capitol Lake, Percival Creek, and the Deschutes River.

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Citations from Quotes

Citation #6 contains a quote from a secondary publication. The author did not read this entire publication but relied on the quote.

Review

3010 Capitol Blvd.

Olympia, WA 98501

2 October 2018

Note: On May 22, 2019 following minor revisions, Hal Beecher wrote, "Yes, you can still list me as a reviewer."

Dr. Jack Havens

Dear Dr. Havens:

A major focus of your paper is how Capitol Lake affects Chinook salmon (*Oncorhynchus tshawytscha*) in the Deschutes River (and, secondarily, in Percival Creek). A number of factors have been suggested as influencing Chinook salmon survival, growth, and production, and the paper addresses these and how they are influenced by Capitol Lake or estuarine habitat conditions. I suggest it might be useful to put these in table form, separating outmigrant (fry-juvenile-smolt) from returning adults.

Chinook salmon life-stage & season	Factor influencing salmon survival, growth, and production	Capitol Lake	Unimpounded estuary
Juvenile – Jan-Jun	Food supply	Chironomids. Engstrom-Heg (1955) indicated early Capitol Lake provided food supply that supported very good growth compared to other Puget Sound systems. Koehler et al. (2006) indicates high value of chironomids as food for young Chinook in Lake Washington. Chironomid population might have adjusted as Capitol Lake aged, so current data on Chinook salmon growth and/or chironomid abundance would be informative, but in absence of new data, the best information seems to suggest favorable feeding conditions in the lake.	Some chironomids in upper reach and Percival Cove; replaced by marine plankton in marine water.
	Predation	Fish-eating birds, cutthroat trout (relatively few)	Fish-eating birds, staghorn sculpin (<i>Leptocottus armatus</i>), dogfish shark (<i>Squalus acanthias</i>),
	Dissolved oxygen (DO)	Tumwater Falls ensures near saturation.	Tumwater Falls ensures near saturation.

	Temperature	Temperature very similar under either management option.	Temperature very similar under either management option.
	Salinity	Fresh water	Salinity transition fluctuates with tide, but at highest extent only moves about a mile upstream, so that this is unlikely to be a physiological factor. It could be an ecological factor in influencing food supply and predators.
	Pollutants	Pollutants from automotive and other sources in the urban environment of Capitol Lake as well as agricultural inflow from the Deschutes watershed may be present, but data are needed to answer this. Pollutants from Budd Inlet are blocked.	Pollutants in sediments in Budd Inlet might be washed farther upstream with the tide, depending on the degree to which those pollutants are dissolved or suspended and moved into the estuary. Sampling the distribution and concentration of sediment pollution in different parts of Budd Inlet would be informative as would more detailed consideration of the chemistry and adsorption of the pollutants.
Juvenile – Jul-Aug	Food supply	<i>Daphnia</i> replace chironomids as a high-quality food for juvenile Chinook (Engstrom-Heg 1955; Koehler et al. 2006)	<i>Daphnia</i> in Percival Cove and closer to Tumwater Falls in pools; replaced downstream in tidal reach by other arthropods
	Predation	See above (Jan-Jun)	See above (Jan-Jun)
	Dissolved oxygen (DO)	See above (Jan-Jun). Higher temperature can reduce DO. DO is influenced positively by ratio of surface area to volume (S:V), which is high in the relatively shallow Capitol Lake.	See above (Jan-Jun). Higher temperature can reduce DO.
	Temperature	Although high S:V favors DO, it can also lead to greater heating when air temperature and direct solar radiation are a major factor in the hot months. Data from Engstrom-Heg (1955) suggest that temperatures remain acceptable for salmonids, with more preferred temperatures in the channel. Deposition and shallowing of Capitol Lake could have changed the temperature and DO	Temperature would change little from Tumwater Falls.

		conditions in Capitol Lake. Current data would be informative.	
	Salinity	See above (Jan-Jun)	See above (Jan-Jun)
	Pollutants	See above (Jan-Jun)	See above (Jan-Jun)
Returning adult – Aug-Sep	Food supply	NA	NA
	Predation	Harbor seals (<i>Phoca vitulina</i>) and California sea lions (<i>Zalophus californianus</i>) are excluded from Capitol Lake but prey on Chinook salmon waiting to enter the lake. Once in the lake, adult salmon are safe from these larger predators while the salmon try to find the entrance to the Tumwater Falls fishway. River otters (<i>Lutra canadensis</i>) could get access to salmon at the base of the falls, but I have not seen them there.	Harbor seals (<i>Phoca vitulina</i>) and California sea lions (<i>Zalophus californianus</i>) could have access to the base of the falls where salmon aggregate in high density. Seals and sea lions often ascend rivers many miles in pursuit of salmon – I have seen them far up the Fraser, they are well-known at Bonneville Dam, and they have been reported well up the Nisqually River. This could be a major predation opportunity where salmon have much less opportunity to avoid predators than they have in Budd Inlet below the bridges. River otters could also access salmon, but may be deterred by larger seals and sea lions.
	Dissolved oxygen (DO)	See above (Jul-Aug)	See above (Jul-Aug)
	Temperature	See above (Jul-Aug)	See above (Jul-Aug)
	Salinity	See above (Jan-Jun)	See above (Jan-Jun)
	Pollutants	See above (Jan-Jun)	See above (Jan-Jun)

In most cases, what can be said is qualitative, not quantitative. There is nothing you have mentioned that makes a strong case that salmon production would increase significantly, if at all, with the conversion of Capitol Lake to a free-flowing estuary. Likewise, there is no clear case that salmon production would decrease. Studies to provide actual data to inform these uncertainties would require a series of years, as annual variation in most of the factors in the Capitol Lake-Budd Inlet area, not to mention in the Pacific Ocean feeding and growing areas, can be considerable, with numerous factors interacting in complex ways. By making conditions as favorable as possible in the terminal area, the fish will be in the best condition to survive the marine years, and allowing as many returning adults to spawn as there is suitable spawning (and subsequent incubation and rearing) habitat will increase the probability of good return. However, it is noteworthy that natural conditions did not allow a population of Chinook salmon to live in the Deschutes River, and only human intervention in our lifetime established this population.

In the Introduction, you mentioned the critical importance of Chinook salmon in the diet of the resident orcas (*Orcinus orca*). Wikipedia cites National Marine Fisheries Service (2008). "[Recovery Plan for Southern Resident Killer Whales \(*Orcinus orca*\)](#)" (PDF). National Marine Fisheries Service, Northwest Region, Seattle, Washington as a source for diet information.

Note that mustelid predation is from river otters (*Lutra canadensis*), which I have watched catching adult steelhead and which, despite the name, occur in Puget Sound and Straits (abundant in San Juan Islands). Sea otters (*Enhydra lutris*) live on the outer coast and the most inland I have seen one was Neah Bay; they eat mollusks, crustaceans, and echinoderms, although if they found a dying adult salmon they might eat it.

Where discussing a situation with the lower dam removed to make a more connected estuary, I suggest using the term estuary more, as calling it a tidal mudflat sounds more derogatory (e.g, p.3). It's certainly appropriate to state that a significant feature of an estuary is tidal mudflat.

You mentioned tundra swans (*Cygnus columbianus*) on Capitol Lake during winter. My experience with them there is limited even though during much of the 1980s I ran around Capitol Lake regularly (roughly weekly), always watching what waterfowl were present. I do not recall seeing them until quite recently, I believe since 2010, and definitely since 2005.

You also mentioned three-spined stickleback (*Gasterosteus aculeatus*) mortality as being attributed by some to the dam creating Capitol Lake. In Wydoski & Whitney (1979; Inland Fishes of Washington, University of Washington Press, Seattle and London; there is a 21st century edition of this book, but I don't have it) these sticklebacks are reported to die following breeding in the spring. They can be abundant in fresh and saltwater, so a post-spawning mortality might be quite noticeable. Attributing such mortality to blocked migration would require considerable evidence. A quick Google search turned up an article (Jolanta Morozinska-Gogol, 2015, Changes in the parasite communities as one of the potential causes of decline in abundance of the three-spined sticklebacks in the Puck Bay, *Oceanologia* 57 (3): 280-287) from Poland (this is a circumpolar species) about mortality associated with parasite load. That's a subject where you are the expert.

Other minor comments

On p. 4 in the last full paragraph, delete the "[like Capitol Lake]" and "Brackets added" and instead add a following sentence, such as "Capitol Lake, like Lake Washington, has been used for only short time by Chinook salmon and findings by Koehler et al. (2006) may be relevant to Capitol Lake as well as to Lake Washington, given the similarity of diets in the two lakes (Engstrom-Heg 1955, Koehler et al. 2006)."

On p. 7, the discussion of county-owned fish barrier culverts is relevant to salmon and trout in general (as well as lampreys and sticklebacks), but the preference of Chinook salmon for larger streams, as you mention elsewhere, means that most culvert improvement will benefit coho, chum, cutthroat, and perhaps steelhead, but Chinook are less likely to be benefitted by them. The state and county have legal obligations to improve fish passage at these, so that financial obligation exists.

On p. 8, you cite Engstrom-Heg (1955) as stating predation is negligible in the lake. It might be worth pointing out that Capitol Lake lacks northern pikeminnow (*Ptychocheilus oregonensis*) that is a significant predatory fish in Lake Washington (Koehler et al 2006) as well as in the Columbia River (where there has been a bounty fishery for this native minnow).

On p. 10, you mention less predator shielding with dredging. Given the scarcity of predators in Capitol Lake, is this relevant. I presume you are referring to sit-and-wait ambush predators (fish), rather than fish-eating waterfowl. If you are talking about waterfowl, then vegetation may shield the young salmon.

On p. 11, Daphne should be *Daphnia*. I suspect that was a spellcheck action. (I always thought that a company based in Washington state should have programmed its spellcheck in WORD to accept Walla Walla!)

On p. 13, you point out that salmon do not spawn in saltwater. Chum salmon are borderline. I see them spawning in areas of Hood Canal streams that are reached by high tides.

On p. 14, you accidentally omitted quotation marks around the sentence about spewing toxins.

(In the same paragraph is the quote about all dams are bad. There was a time in the 1990s when, as a WDFW employee [or WDG or WDW, depending on year], I worked with USFWS, ODFW, NMFS, and Umatillas to consider getting the Corps to add a dam to the Walla Walla basin in Oregon to store water to release for fish when irrigators had taken all the river water. Other solutions were eventually found through extensive negotiations.)

I think trying to put some order instead of just sentiment into the issue is very commendable. Obviously there are a lot of uncertainties. Getting more certainty would be a major undertaking (although some water quality sampling may be relatively inexpensive and quick), but given the costs of existing options, better understanding will certainly improve the discussion and inform the decision-making.

Sincerely,

Hal A. Beecher, Ph.D.

From: Hal Beecher [mailto:halbeecher@comcast.net]
Sent: Wednesday, October 03, 2018 12:09 PM
To: bikeandfish@comcast.net
Subject: Capitol Lk

Jack - I think I forgot to address that issue of fish from other rivers. I think that is a really weak argument for removing the lake. The percentage of fish from those rivers (primarily Nisqually, I assume) would be a small percentage of the production of those rivers, with percentage diminishing as distance from Budd Inlet increases.

Hal