November 5, 2019

MEMORANDUM

TO: **Council Members**

FROM: **Erik Merrill, Independent Science Manager, and Nancy Leonard, ISAB Ex Officio**

SUBJECT: **ISAB Review of the Upper Columbia United Tribes' (UCUT) Fish Passage and Reintroduction Report**

BACKGROUND:

Presenters: Stan Gregory, ISAB Chair, and Tom Quinn, ISAB member

Summary: In response to the Council's July 2019 request, the Independent Scientific Advisory Board (ISAB) reviewed the Upper Columbia United Tribes' (UCUT) *Fish Passage and Reintroduction Phase 1 Report: Investigations Upstream of Chief Joseph and Grand Coulee Dams* (Reintroduction Report) and supporting documents. The Reintroduction Report was a broad analysis of key decision factors and potential outcomes to determine whether reintroduction of any of the historically present species of salmon and steelhead is feasible. The Council asked the ISAB to answer a set of questions about the strengths, data uncertainties, and limitations of each element of the UCUT's report.

Brief answers to the Council's questions

1. *Strengths, data uncertainties, and limitations of each element of the UCUT's report and critical gaps in the analyses*

    a. *Donor stock and risk assessment*

The Reintroduction Report prioritized donor stocks for reintroduction and concluded that summer/fall Chinook salmon is the preferred lineage for Chinook salmon in the blocked area. Kokanee from Lake Roosevelt and sockeye salmon from the Okanogan River are the highest ranked sources for sockeye. However, concerns about the abundance of kokanee and whether they would develop an anadromous life history led to a preference for Okanogan sockeye. The ISAB finds the process and recommendations for donor sources to be scientifically credible. Research, monitoring, and evaluation programs are needed to identify responses of donor sources and consequences of hatchery stocking, competition, predation, passage mortality, and other factors.

- *Disease risks*

  Future assessments of disease risk should consider possible interactions between water quality, disease resistance, and other factors such as predator avoidance. The ISAB advocates development of a parentage-based tagging (PBT) program for all adults released in the blocked area to identify donors with the greatest disease resistance and to assess other factors that influence the success of reintroduction.

- *Predation risks*

  The Reintroduction Report concluded that predation risk to juveniles of reintroduced salmon probably will be high overall but variable, depending on spatial and temporal overlap with potential predators. Numerous uncertainties about predators make more thorough evaluation critical in the next steps. Bioenergetic models could improve the understanding of the role of fish predation, especially by nonnative northern pike, on survival of introduced salmonids. Future effects of expanding populations of nonnative predators and a warming and changing climate also should be assessed. Non-fish predators—such as birds, mammals, including pinnipeds—should be considered in the assessment of risks to reintroduced salmon and included in the life cycle models.

b. Habitat assessments

The Reintroduction Report's habitat assessments identified both current available habitat within the blocked area as well as habitat conditions above existing barriers that could be restored in the future. Data were provided in a format allowing consideration of reintroduction either solely within the United States or within the combined areas in the U.S. and Canada above Chief Joseph and Grand Coulee dams. The Report did not rely on future production from the

Canadian portion of the basin but provided an assessment of Chinook salmon capacity in the Transboundary Reach.

The habitat assessments provided a reasonable set of hypotheses about the capacity of the habitat in the blocked area to support juvenile and adult salmonids, but the Fish and Wildlife Program will require additional information for future decisions. Overall, the estimates of potential adult capacities for both Chinook and sockeye salmon had wide ranges and included great uncertainty about habitat relationships and other factors, such as predation, fish passage, and survival in the lower Columbia River and ocean.

The ISAB commends the Reintroduction Report authors for considering the potential effects of climate change on reintroductions, which should be considered in future planning and implementation. Ocean survival of anadromous salmonids in the face of climate change is one of the most critical uncertainties facing reintroduction efforts but was not addressed in the Reintroduction Report. The discussion of climate change considered only the positive effects related to the lower thermal stress in the blocked area compared to warmer regions of the Columbia River. The Report did not consider climate-related factors that could negatively affect survival, such as interactions with other salmonid stocks, pathogens, lower river migration, or predators throughout the system.

c. *Life-cycle modeling*

The Life Cycle Model provides a framework for integrating information on potential habitat and reproductive capacity and for identifying data gaps. The model is simple to use and update. It provides a useful tool to inform decision making. However, the model is deterministic and incorporates little or no stochasticity, density dependence, or regime shifts in ocean productivity.

Outputs of the model are directly influenced by numerous uncertainties, which include a wide range of estimates of habitat availability and variation in adult spawner capacity. Use of the lower end of the distribution of estimated habitat and spawner capacity in applications of the LCM would be more conservative and precautionary. Sensitivity analysis should be expanded to evaluate the model and consequences of using estimates of the lower range of habitat and spawner capacity.

d. *Adult and juvenile fish passage*

The Reintroduction Report explored five possible options for adult passage and concluded that any of them could be used to pass adult salmon upstream over the two dams. The proposed interim adult passage approaches appear to be reasonable. Collecting and passing juvenile salmon downstream over Chief

Joseph Dam and especially over Grand Coulee Dam represents a much greater challenge. At Grand Coulee Dam, fluctuations of reservoir levels would make passage for both life stages difficult. The passage assessment did not consider consequences of total dissolved gas supersaturated water, which may reduce survival and limit passage alternatives.

- *Costs*

  The Reintroduction Report did not assess the costs of upstream and downstream passage options for salmon and steelhead. Specific donor stocks and passage systems have not been selected, thus only broad preliminary estimates of cost can be developed currently. More specific design elements and cost analysis will be possible after preliminary experiments and cultural releases of adult fish are completed. Future cost estimates would inform decisions about timing, combinations of actions that could be more effective than the individual actions on their own, and risks associated with the sequential, experimental nature of the reintroduction program. Incremental actions and numerous uncertainties make it important to incorporate cost analyses in the initial stages of the reintroduction effort.

2. *In sum, how well do the report and its supporting documents address the biological and physical elements of Phase 1, as described in the Council's Fish and Wildlife Program?*

   The 2014 Fish and Wildlife Program (Northwest Power and Conservation Council 2014-12) identifies several key steps in a phased approach to reintroduction of anadromous fish above Chief Joseph and Grand Coulee dams to mainstem reaches and tributaries in the United States (P. 85). The Program specifically calls for 1) evaluation of information from passage studies at Grand Coulee and Chief Joseph dams and other blockages, 2) assessment of habitat availability, suitability and salmon survival potential above Grand Coulee, and 3) investigation of the scientific feasibility and possible cost of upstream and downstream passage options for salmon and steelhead. The Reintroduction Report addressed all these elements, except for cost of passage options, and provided a general proof of concept. The Report additionally evaluated donor stocks, disease risks, predation, and climate change, which are not specifically included in the reintroduction tasks identified in the Fish and Wildlife Program.

   While it is reasonable to expect that reintroduction could be successful to some extent, there is great uncertainty about the numbers of adults that will return and the types of management that will be required to maintain them. A strategic plan for future steps and an adaptive management process will be needed to address these uncertainties. The ISAB encourages the UCUT and the Council to make decisions

conservatively or with caution because of the very wide ranges of estimates of capacity and habitat availability. While the ISAB recommends careful development of future decisions and actions, it is clear the UCUT and their collaborators put a lot of thought and effort into this assessment and make the fundamental issues and management alternatives accessible to many stakeholders.

Numerous individuals and institutions assisted the ISAB with this report. Their help and participation are gratefully acknowledged. The ISAB especially appreciated the August 2019 site visit to the blocked Upper Columbia River Basin—Grand Coulee and Chief Joseph Dams, reservoirs, and tributaries—and the chance to hear from a wide range of tribal leaders; tribal, state, and federal scientists and fish managers; and Council members and staff.

The full ISAB report is available online (ISAB 2019-3).




Review of Upper Columbia United Tribes' Fish Passage and Reintroduction Phase 1 Report: Investigations Upstream of Chief Joseph and Grand Coulee Dams (Reintroduction Report)

INDEPENDENT SCIENTIFIC ADVISORY BOARD
ISAB 2019-3 NOVEMBER 1, 2019

ISAB Review of the Upper Columbia United Tribes' Fish Passage and Reintroduction Report

REPORT TO THE

NORTHWEST POWER AND CONSERVATION COUNCIL

NOVEMBER 1, 2019

Independent Scientific Advisory Board
for the Northwest Power and Conservation Council,
Columbia River Basin Indian Tribes,
and National Marine Fisheries Service
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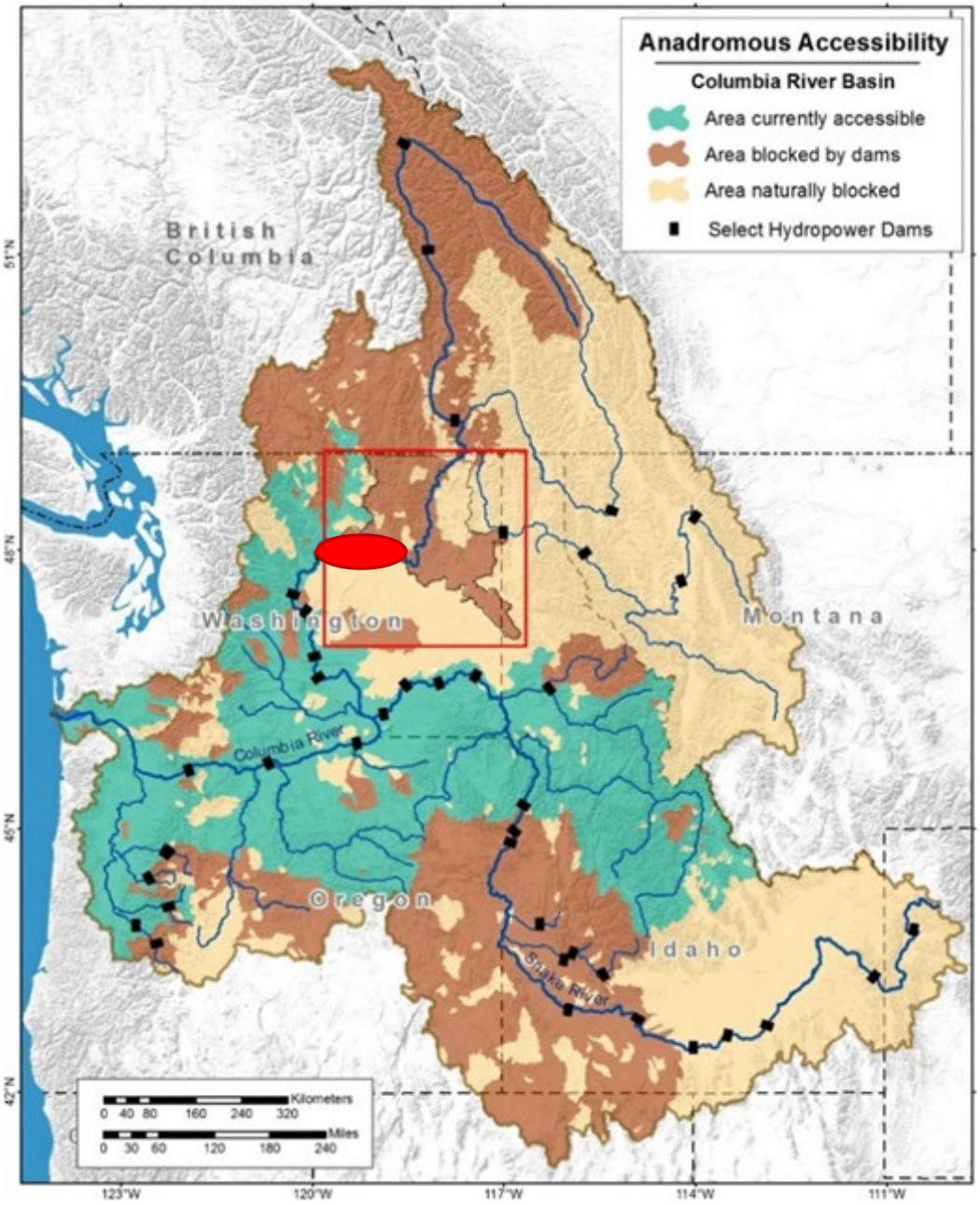
Anadromous Accessibility
Columbia River Basin
Area currently accessible
Area blocked by dams
Area naturally blocked
Select Hydropower Dams
British Columbia
Washington
Montana
Oregon
Idaho
Columbia River
Snake River
Kilometers
0 40 80 160 240 320
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123°W
120°W
117°W
114°W
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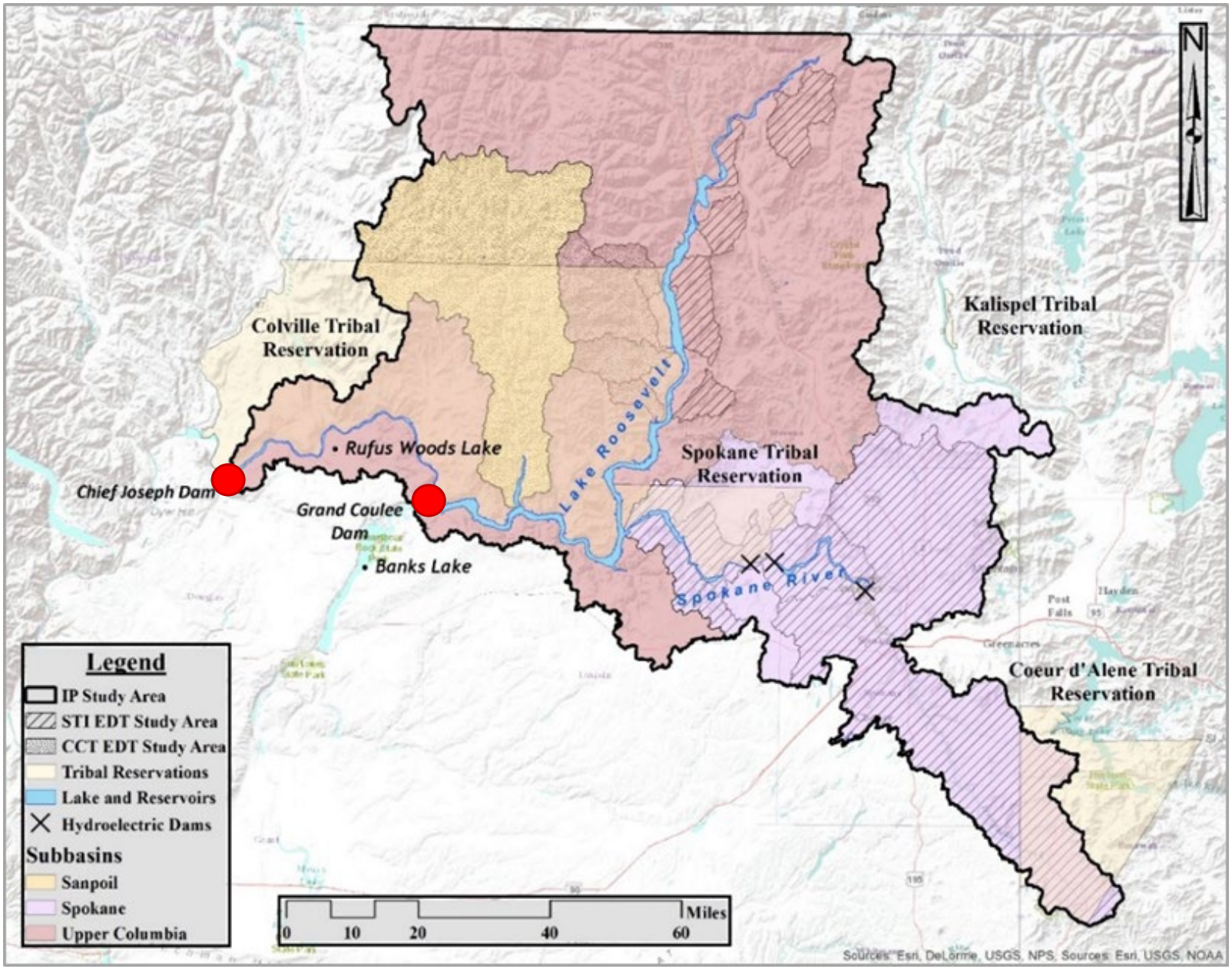

Colville Tribal Reservation
Kalispel Tribal Reservation
Spokane Tribal Reservation
Coeur d'Alene Tribal Reservation
Rufus Woods Lake
Chief Joseph Dam
Grand Coulee Dam
Banks Lake
Lake Roosevelt
Spokane River
N
Legend
IP Study Area
STI EDT Study Area
CCT EDT Study Area
Tribal Reservations
Lake and Reservoirs
Hydroelectric Dams
Subbasins
Sanpoil
Spokane
Upper Columbia
0 10 20 40 60 Miles
Sources: Esri, DeLorme, USGS, NPS, Sources: Esri, USGS, NOAA

ISAB Conclusions

The 2014 Fish and Wildlife Program identifies several key steps:

- Evaluation of passage information for Grand Coulee and Chief Joseph dams and other blockages
- Assessment of habitat availability, suitability and salmon survival potential in the blocked area
- Investigation of the scientific feasibility and possible cost of passage options

ISAB Conclusions

The Reintroduction Report addressed all of these elements except for cost analysis.

The Report additionally included:

- Evaluation of donor stocks
- Disease risks
- Predation
- Climate change

Major Assessments

Donor stock selection

Disease risk

Predation risk

Habitat

Life cycle model

Passage alternatives

Cost

Donor Stock Selection

Donor Stock Selection

The process and recommendations for donor sources are scientifically credible.

RME programs will be needed to identify responses of donor sources and consequences of other factors.

Donor Stock Selection

Preferred lineages in the blocked area

- Summer/fall Chinook salmon from the upper Columbia River
- Kokanee from Lake Roosevelt or sockeye salmon from the Okanogan River

Concerns

- Abundance of kokanee
- Ability of kokanee to develop anadromous life history

Steelhead

IHNV (infectious hematopoietic necrosis virus) is virulent for steelhead, and the primary control strategy is pathogen avoidance.

Reintroduction of anadromous steelhead was rejected because of the high risk of transmitting IHNV to redband trout.

Steelhead

If steelhead are reintroduced, resident redband trout would be a preferred donor source because they likely are ancestrally related to steelhead in the upper Columbia River.

Redband trout from the Sanpoil River have been detected in the Columbia River estuary.

- Potential capacity for downstream migration

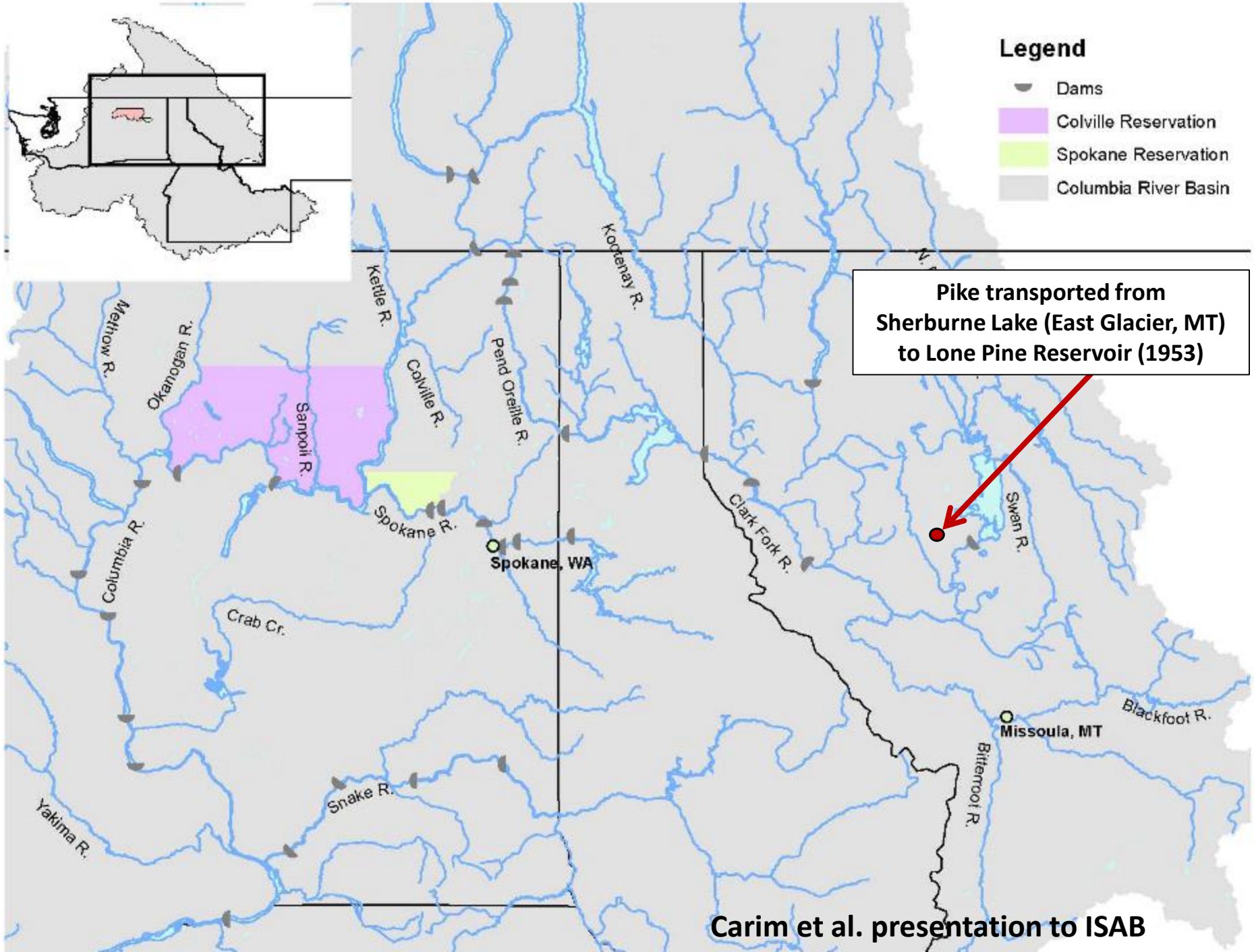
Disease Risk

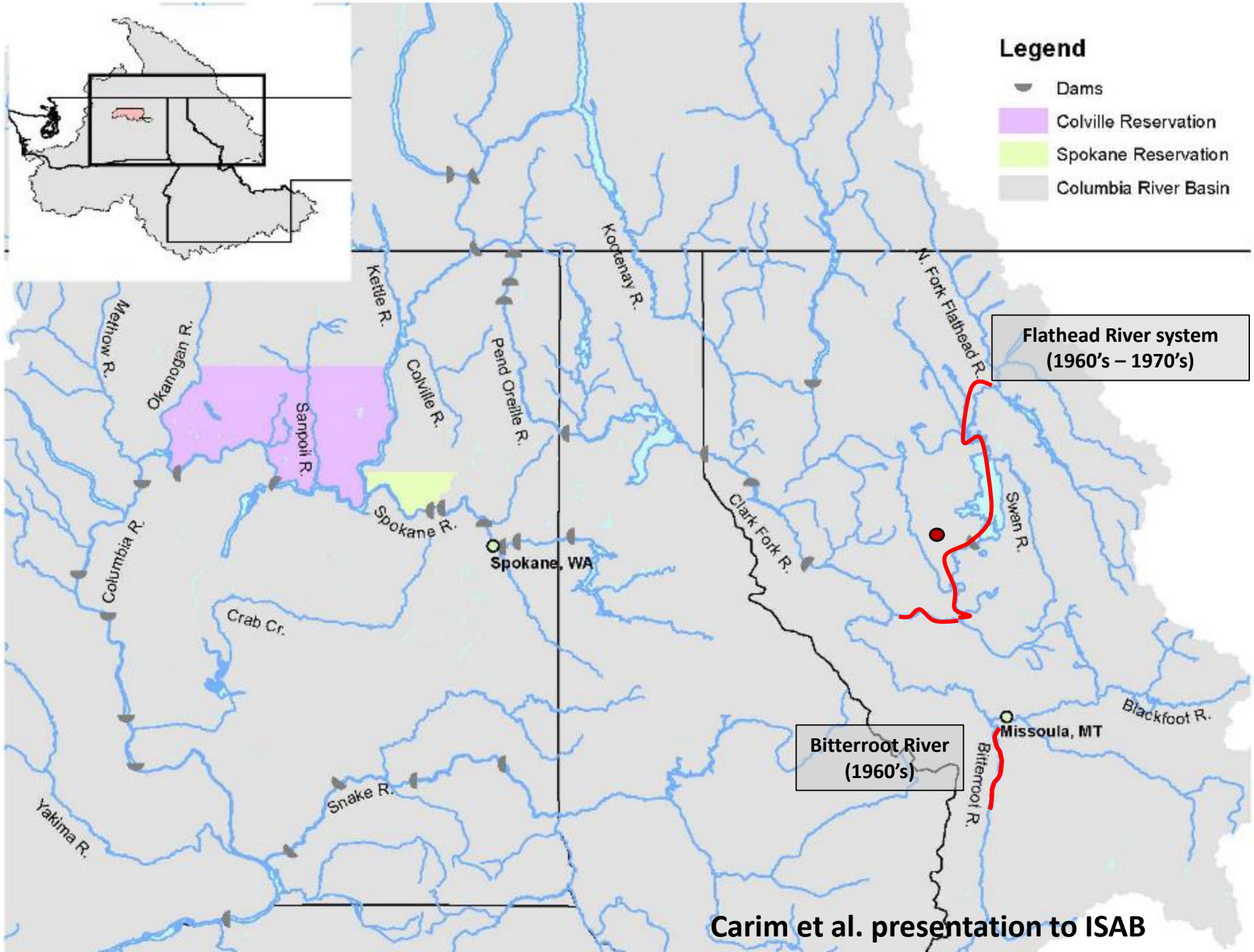
Future assessments should consider:

- Water quality
- Disease resistance
- Other factors such as predator avoidance

The ISAB recommends a parentage-based tagging program to identify donors with the greatest disease resistance and other factors that influence success.

Predation Risk


Legend
Dams
Colville Reservation
Spokane Reservation
Columbia River Basin
Pike transported from
Sherburne Lake (East Glacier, MT)
to Lone Pine Reservoir (1953)
Kettle R.
Kootenay R.
Methow R.
Okanogan R.
Sanpoil R.
Colville R.
Pend Oreille R.
Spokane R.
Spokane, WA
Columbia R.
Crab Cr.
Clark Fork R.
Swan R.
Missoula, MT
Blackfoot R.
Bitterroot R.
Snake R.
Yakima R.
Carim et al. presentation to ISAB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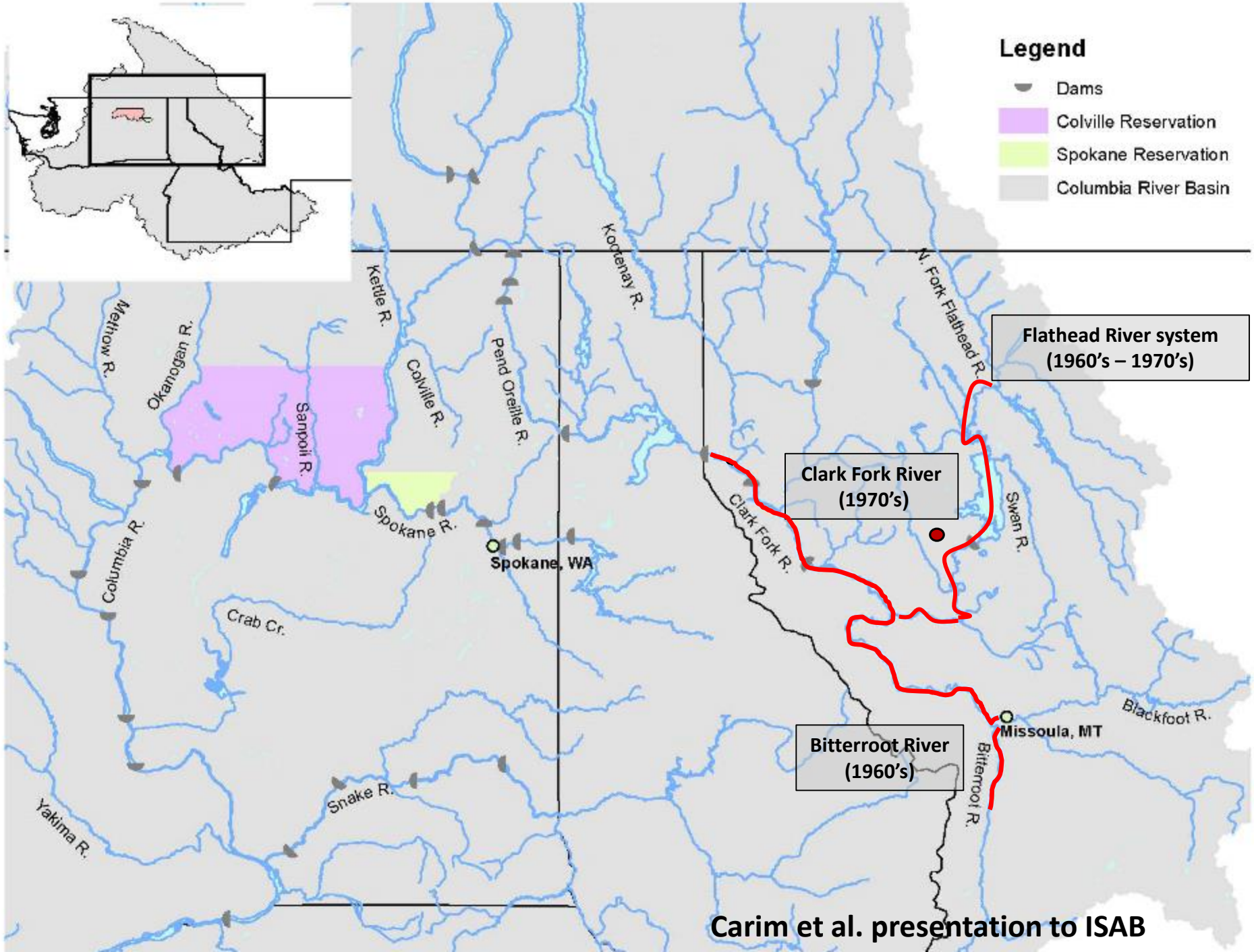
Dams
Colville Reservation
Spokane Reservation
Columbia River Basin
Kettle R.
Kootenay R.
N. Fork Flathead R.
Methow R.
Okanogan R.
Sanpoil R.
Colville R.
Pend Oreille R.
Flathead River system
(1960's – 1970's)
Swan R.
Clark Fork R.
Spokane R.
Spokane, WA
Columbia R.
Crab Cr.
Blackfoot R.
Missoula, MT
Bitterroot River
(1960's)
Bitterroot R.
Snake R.
Yakima R.
Carim et al. presentation to ISAB



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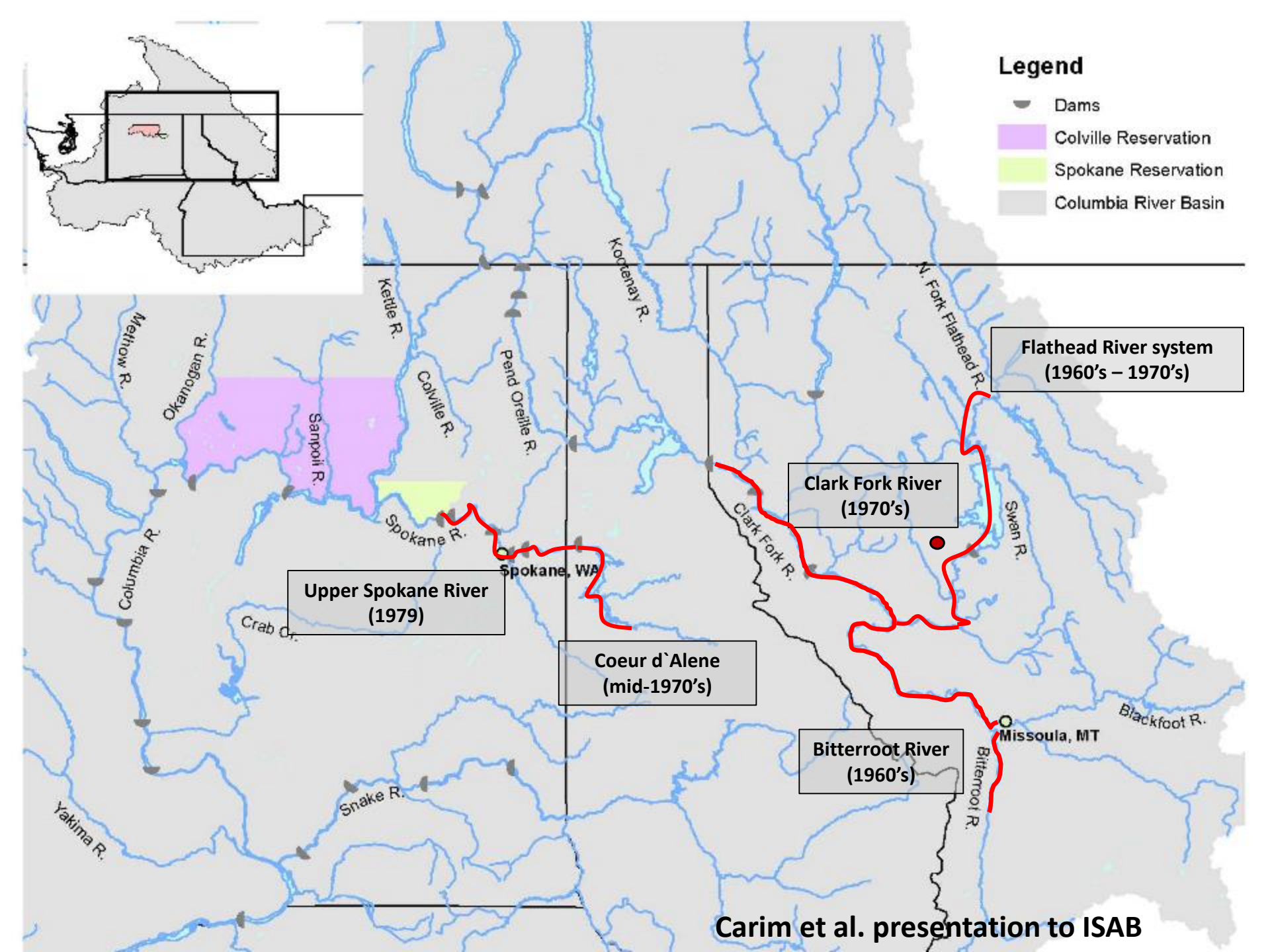
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(1970's)
Clark Fork R.
Swan R.
Spokane R.
Spokane, WA
Upper Spokane River
(1979)
Columbia R.
Crab Cr.
Coeur d`Alene
(mid-1970's)
Missoula, MT
Blackfoot R.
Bitterroot River
(1960's)
Bitterroot R.
Snake R.
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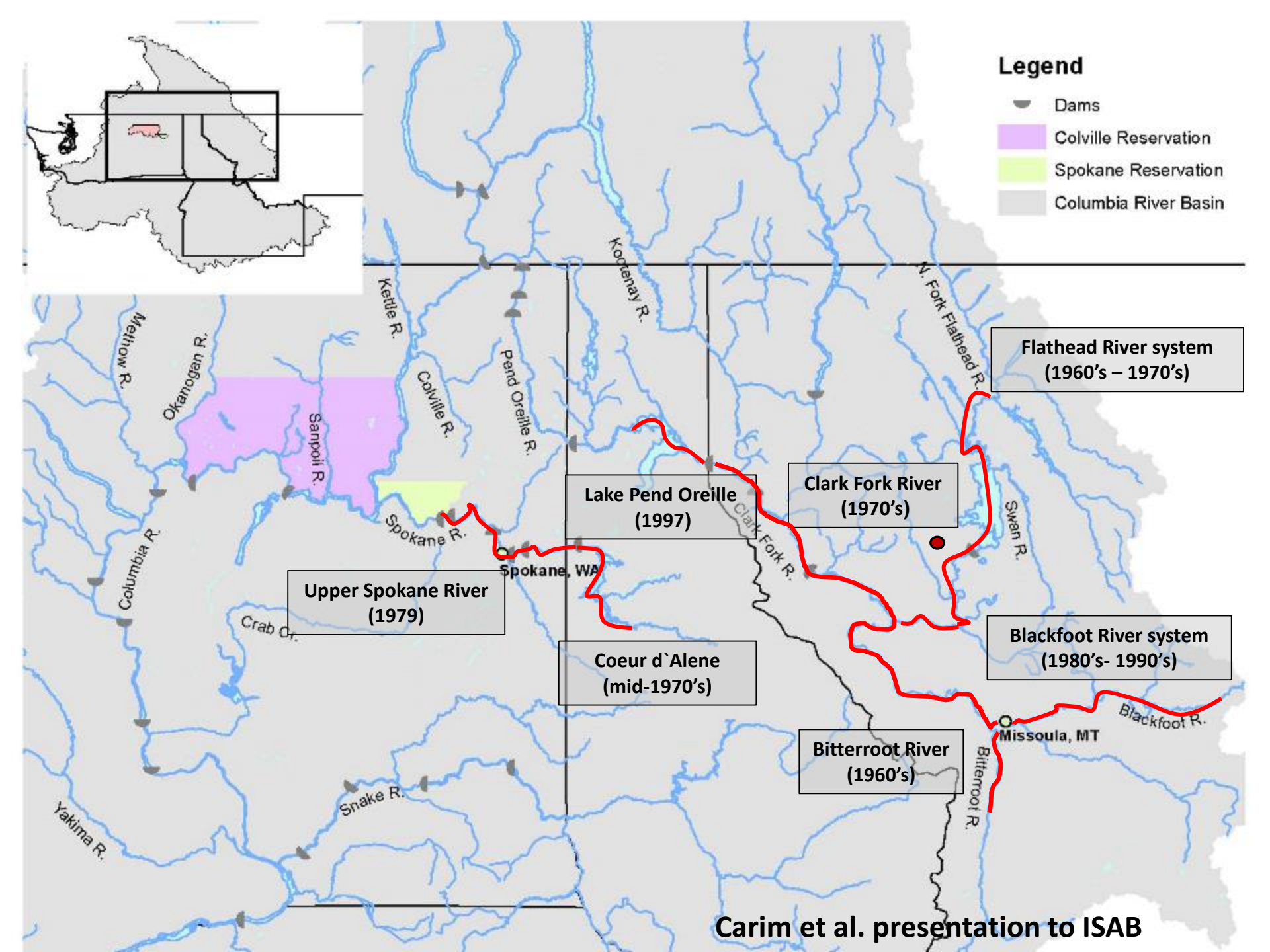
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Missoula, MT
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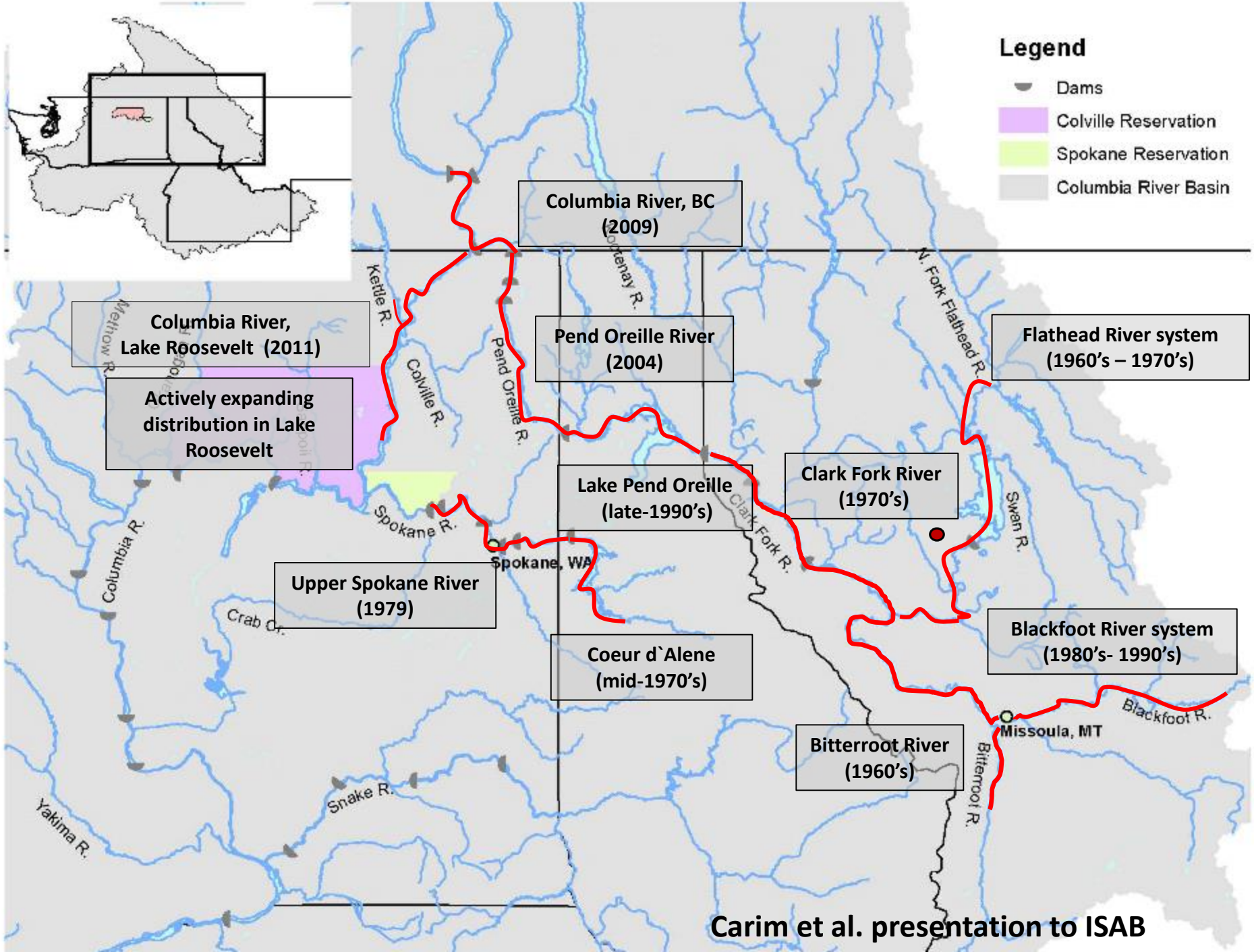
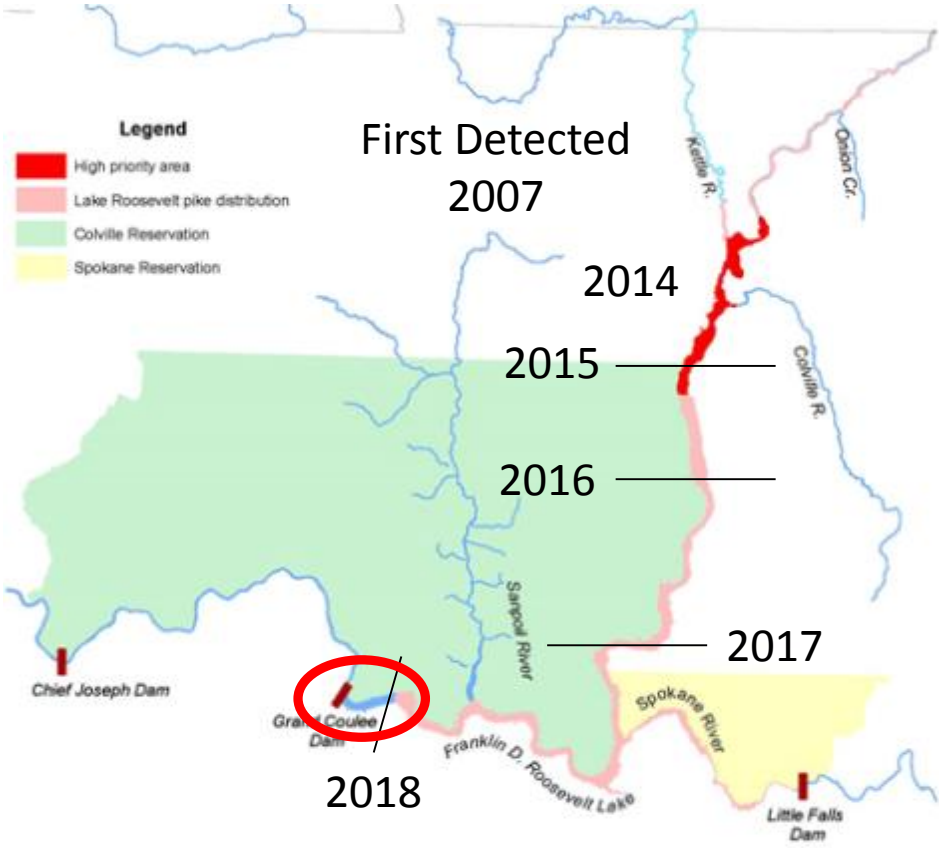
Flathead River system
(1960's – 1970's)
Clark Fork River
(1970's)
Lake Pend Oreille
(1997)
Upper Spokane River
(1979)
Coeur d`Alene
(mid-1970's)
Blackfoot River system
(1980's- 1990's)
Bitterroot River
(1960's)
Carim et al. presentation to ISAB

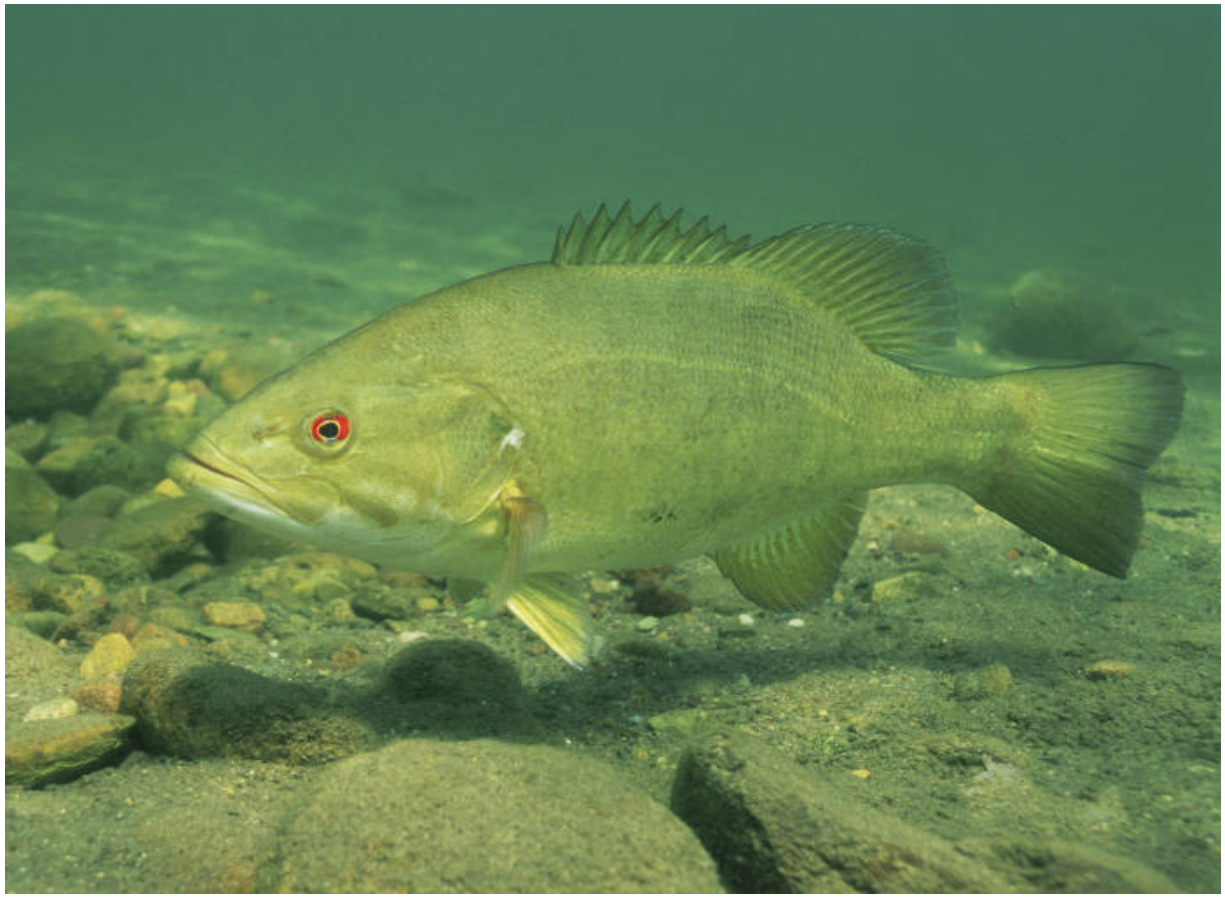


Carim et al. presentation to ISAB

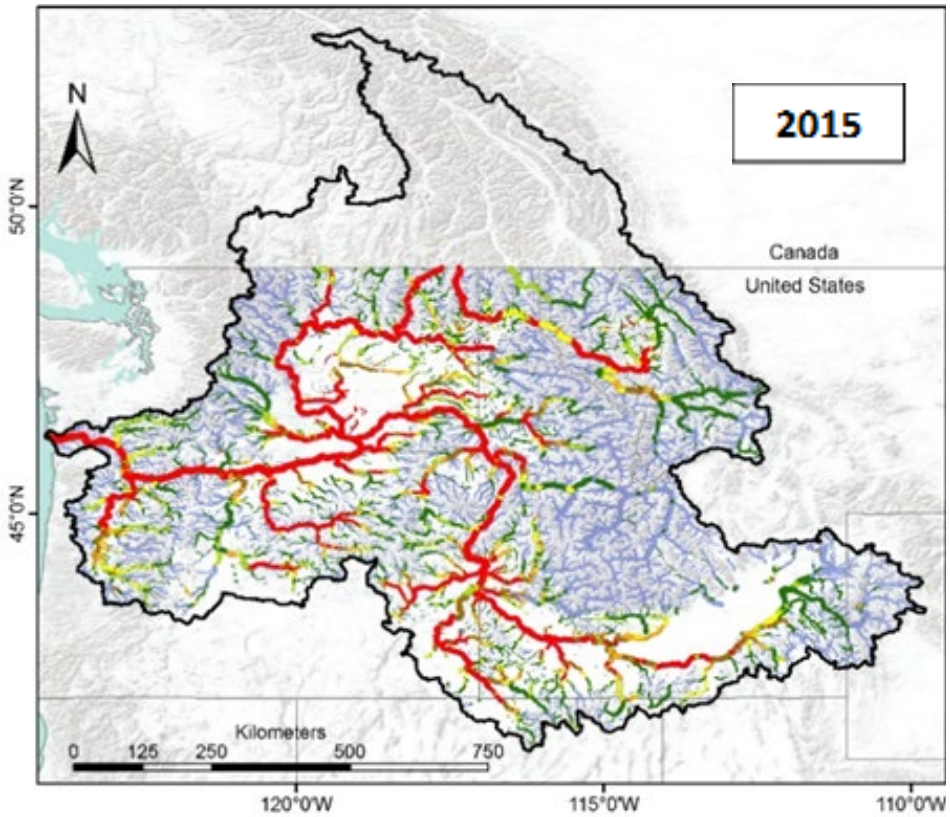
Northern Pike Distribution Lake Roosevelt

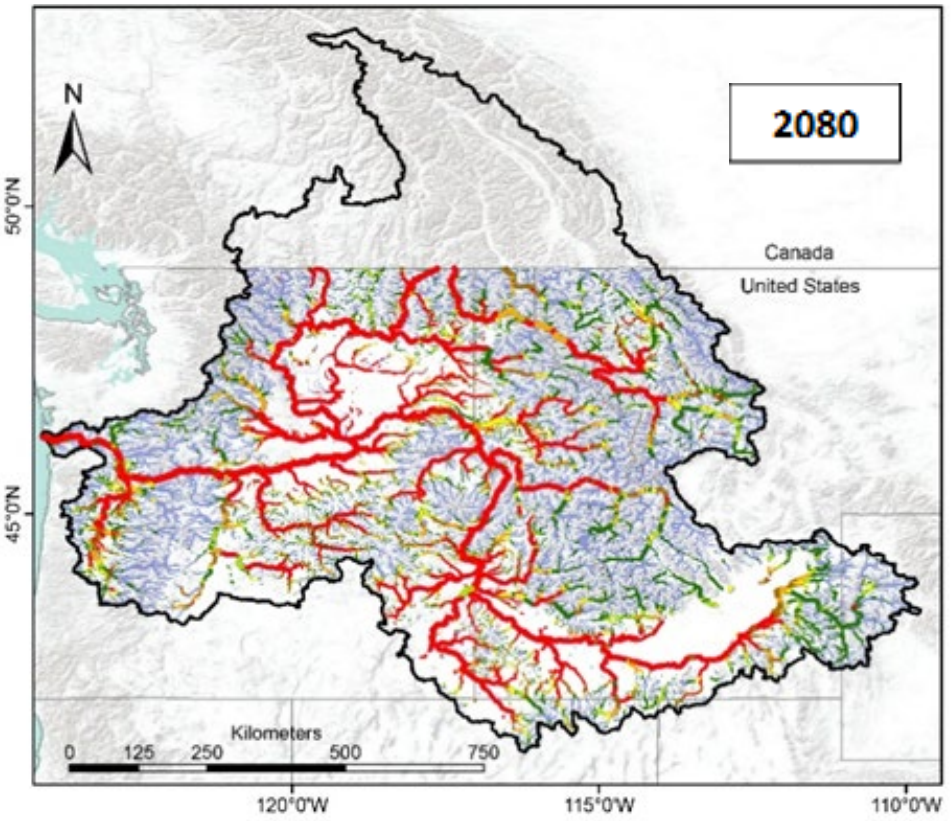


Smallmouth Bass



Smallmouth Bass Distribution





Rubenson and Olden 2019

Walleye

Piscivorous Birds

Sea Lions and Seals

Predation Risk

Predation risk to juveniles of reintroduced salmon will be high overall but variable

- Depends on spatial and temporal overlap with potential predators

Numerous uncertainties about predators make more thorough evaluation critical in the next steps.

Predation Risk

Bioenergetic models could improve the understanding of effects of predation on survival

- Especially by nonnative northern pike

Effects of expanding populations of nonnative predators and warming climate should be assessed.

Other predators—birds and pinnipeds—should be considered in risk assessment and life cycle models.

Habitat Assessments

Intrinsic Habitat Potential

Ecosystem Diagnosis and Treatment (EDT)

Large River Spawning Capacity

Sockeye Salmon Spawning Capacity

Lake Roosevelt Sockeye Salmon Rearing Capacity

Habitat Assessment

Sanpoil River

Habitat Assessments

The Report provided a reasonable assessment of the capacity of the habitat in the blocked area to support salmonids.

Additional information will be required for future decisions.

Habitat evaluations bounded potential capacity in the blocked area but provided only rough estimates.

Habitat Assessments

Estimates of potential adult capacities for both Chinook and sockeye salmon had wide ranges.

Great uncertainty about factors that affect plausible outcomes:

- Habitat relationships
- Predation
- Fish passage
- Survival in the lower Columbia River and ocean

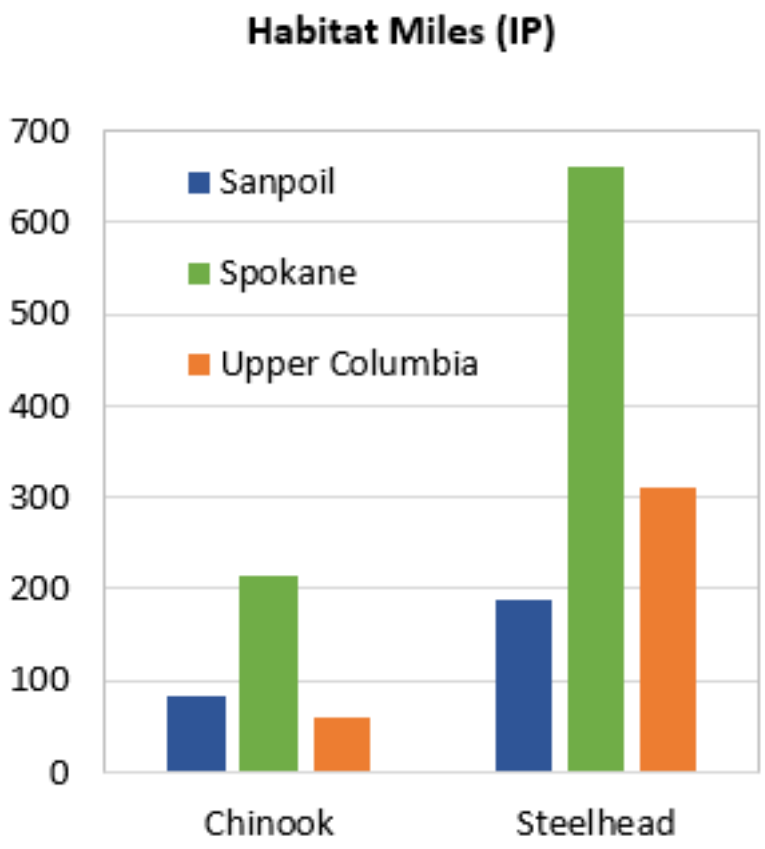
Spring Chinook Salmon

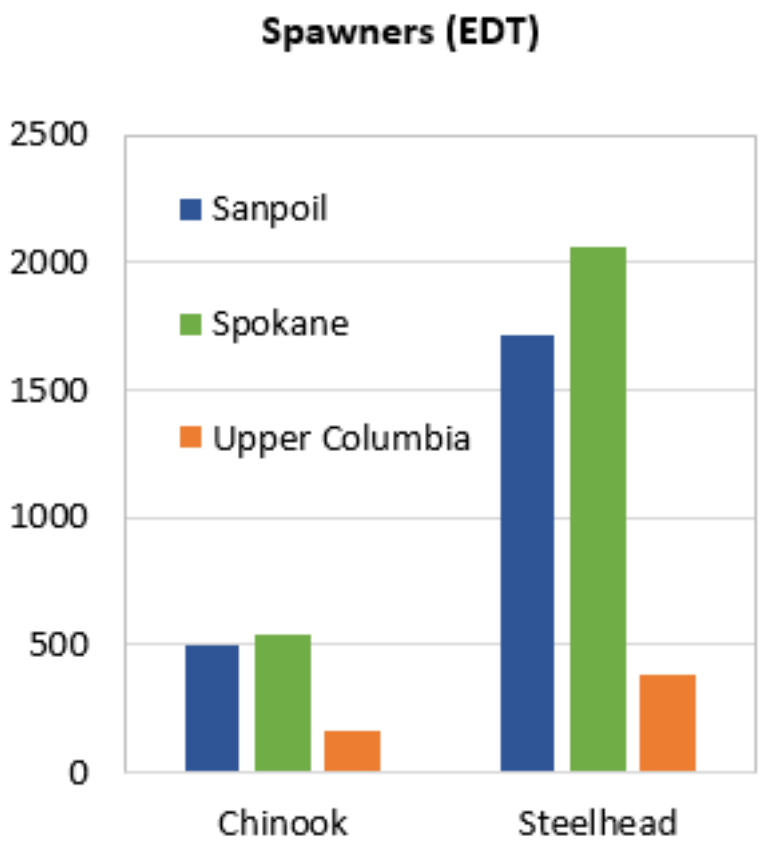
Method	Minimum	Maximum
Intrinsic Potential		356 miles
EDT	901 spawners	1,201 spawners

* Estimates include all habitat in the U.S. blocked area regardless of existing barriers.

Intrinsic Potential

EDT





* Estimates include all habitat in the U.S. blocked area regardless of existing barriers.

Summer/Fall Chinook Salmon

Method	Minimum	Maximum
EDT	9,278 spawners	12,138 spawners
Large River	1,975 redds	25,386 redds

Sockeye Salmon

Method	Minimum	Maximum
Spawning Habitat	34,066 spawners	216,078 spawners
Lake Roosevelt Rearing	12 million smolts	48 million smolts

Climate Change

The ISAB commends the Reintroduction Report for considering the potential effects of climate change.

The Report emphasized the positive effects of climate change.

Other factors related to climate changes could negatively affect survival:

- Interactions with other stocks of salmon
- Pathogens
- Survival during lower river migration
- Predators throughout the system

Climate Change

Ocean survival of anadromous salmonids in the face of climate change is one of the most critical uncertainties facing reintroduction efforts.

Ocean survival was not addressed in the Reintroduction Report.

Genomic adaptation of inland Columbia River stocks appears to be more associated with environmental conditions along migration routes than conditions at natal spawning sites.

Climate Change

Anthropogenic factors—migration barriers, habitat degradation, hatchery influence—have reduced the adaptive capacity of most steelhead and salmon populations.

Enhancing adaptive capacity is essential to mitigate for the increasing threat of climate change.

Life Cycle Model

The Life Cycle Model provides a framework for integrating information on potential habitat and reproductive capacity and for identifying data gaps.

The model is simple to use and update.

It is a useful tool for managers to explore uncertainties about fisheries and hydrosystem management.

Life Cycle Model

The model is deterministic and incorporates little or no stochasticity or density dependence.

The model does not acknowledge interannual variation or regime shifts on ocean productivity.

Life Cycle Model

Outputs of the model are directly influenced by the numerous uncertainties:

- Wide range of estimates of habitat availability
- Variation in adult spawner capacity

Decisions based on the lower end of the distribution of estimated capacity would be more conservative and precautionary.

Sensitivity analysis should be expanded.

Passage Alternatives

Chief Joseph Dam

Passage Alternatives

Adult Passage

- Trap and Haul
- Fish Ladders
  Collector
- Fish Elevators and Locks
- Natural Fishway Channel
- Whooshh Salmon Cannon

Juvenile Passage

Trap and Haul

Floating Surface

Passage Alternatives

Fish Ladder at Chief Joseph Hatchery

Passage Alternatives

The Reintroduction Report explored five possible options for adult passage, and concluded that any of them could be used to pass adult salmon upstream over the two dams.

Passage Alternatives

The proposed interim adult passage approaches appear to be reasonable.

Collecting and passing juvenile salmon downstream over Chief Joseph Dam and especially over Grand Coulee Dam represent a much greater challenge.

Fluctuations of reservoir levels at Grand Coulee Dam would make passage for both life stages difficult.

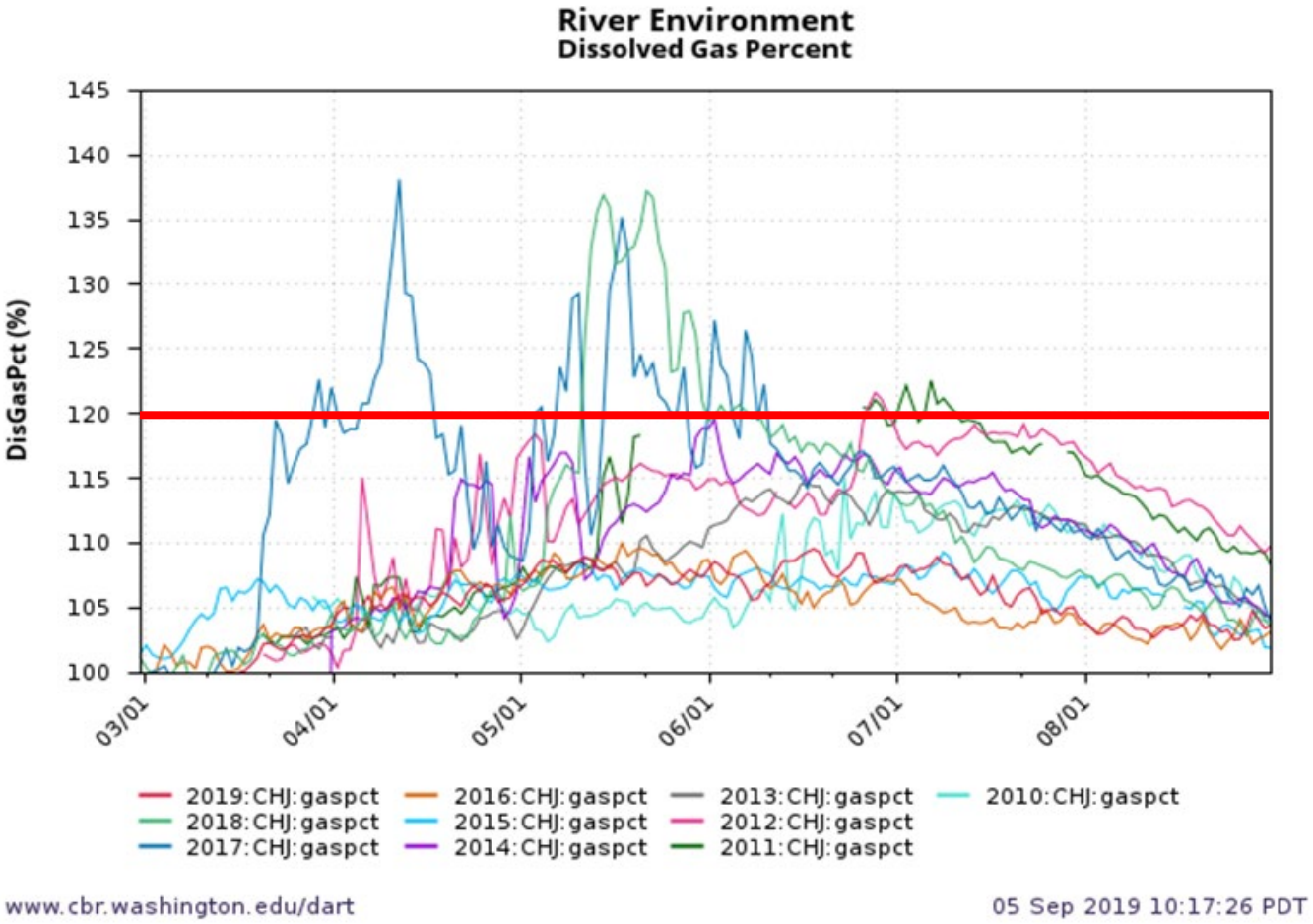
Passage Alternatives

The consequences of total dissolved gas supersaturated water were not considered in passage assessment but may reduce survival and limit passage alternatives.

John Day Dam fish ladder

Total dissolved gas measured in the forebay of Chief Joseph Dam

March – August 2010-2019



Cost

Costs of passage options for salmon and steelhead were not assessed because specific donor stocks and passage systems have not been selected.

Cost

More specific design elements and cost analysis will be possible after preliminary experiments and tribal releases of adult fish are completed.

Cost

Future cost estimates would inform decisions:

- Timing
- Effective combinations of actions
- Risks given the experimental nature of the program

The incremental actions and large number of uncertainties make cost analyses important in the early stages.

ISAB Conclusions

Though it is reasonable to expect that reintroduction could be successful to some extent, there is great uncertainty about the numbers of adults that will return and the management that will be required to maintain them.

ISAB Conclusions

A strategic plan for future steps and an adaptive management process will be needed.

The ISAB encourages the UCUT and the Council to make decisions with caution because the estimates of capacity and habitat availability are very imprecise.

ISAB Conclusions

The UCUT and their collaborators put a great deal of thought and effort into this assessment, and make the fundamental issues and management alternatives accessible to tribal members, many stakeholders, the Council, and BPA.