October 2, 2018

MEMORANDUM

TO: **Fish and Wildlife Committee members**

FROM: **Stacy Horton**

SUBJECT: **Understanding the distribution and sources of invasive northern pike in the Columbia River basin**

BACKGROUND:

Presenter: Kellie Carim is an Aquatic Research Biologist at the National Genomics Center for Wildlife and Fish Conservation in Missoula, Montana. Her research focuses on using genetic tools and information to inform conservation and management of freshwater species in North America.

Summary: Dr. Carim will present results of environmental DNA analysis showing the distribution of invasive northern pike in the Columbia River basin, and results of genetic analyses identifying the source populations contributing to the invasion in Washington. Together, this information will be used to monitor the spread of northern pike and their response to suppression efforts over time, as well as inform targeted efforts to prevent continued introductions from outside sources.

Relevance: The Council's 2014 Fish and Wildlife Programs' third highest emerging priority calls for expanded management of predators, and for an aggressive response where non-native and invasive species may impact program effectiveness. Information presented by Dr. Carim may help the Council focus on policy solutions to suppress invasive northern pike and prevent future invasions.

Workplan: Addresses the updated 2018 Fish and Wildlife Division Workplan

More Info: https://www.fs.fed.us/research/genomics-center/

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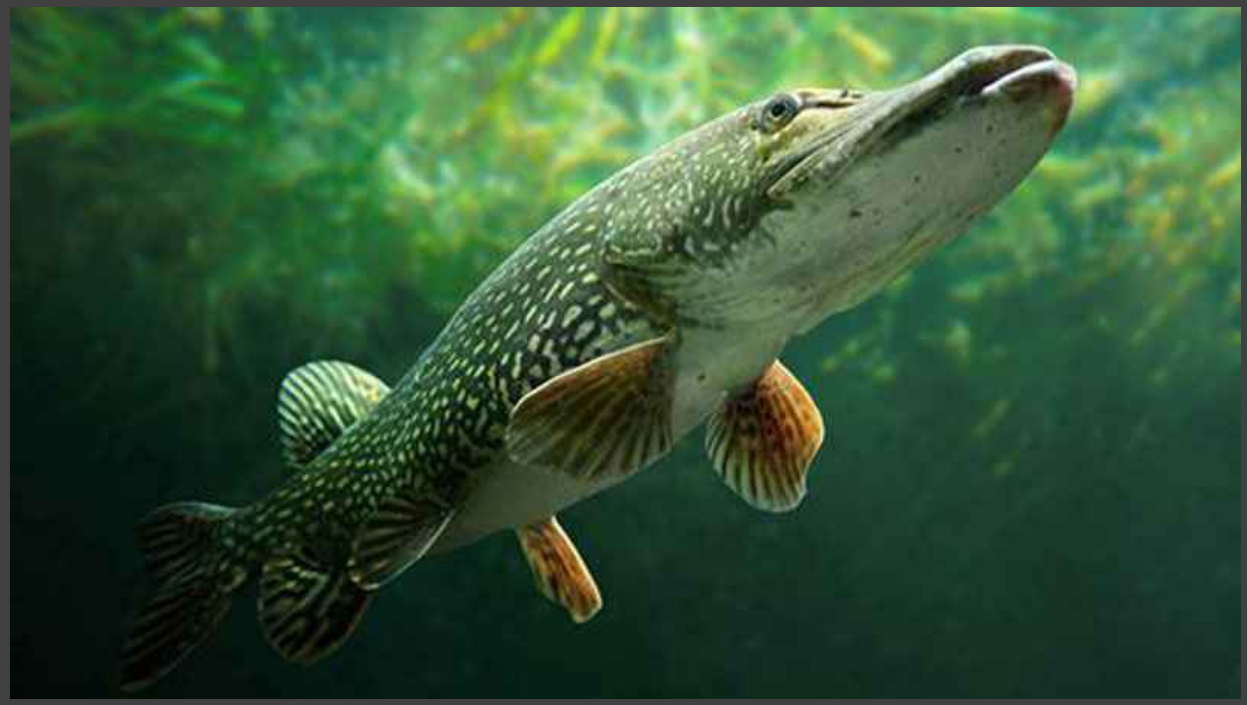
Understanding the Distribution and Sources of Pike in the Columbia River Basin



K.J. Carim[1], H. McLellan[2], L. Miller[3], L. A. Eby[4], M. K. Young[1], M. K. Schwartz[1], V. Dupuis[5]

1 National Genomics Center FOR WILDLIFE AND FISH CONSERVATION

2 The Confederated Tribes of the Colville Reservation 1872

3 MNDNR

4 Wildlife Biology The University of Montana

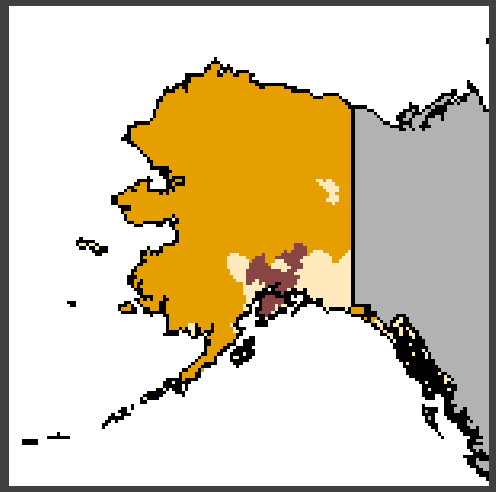
5 Salish Kootenai College Education • Leadership • Wisdom

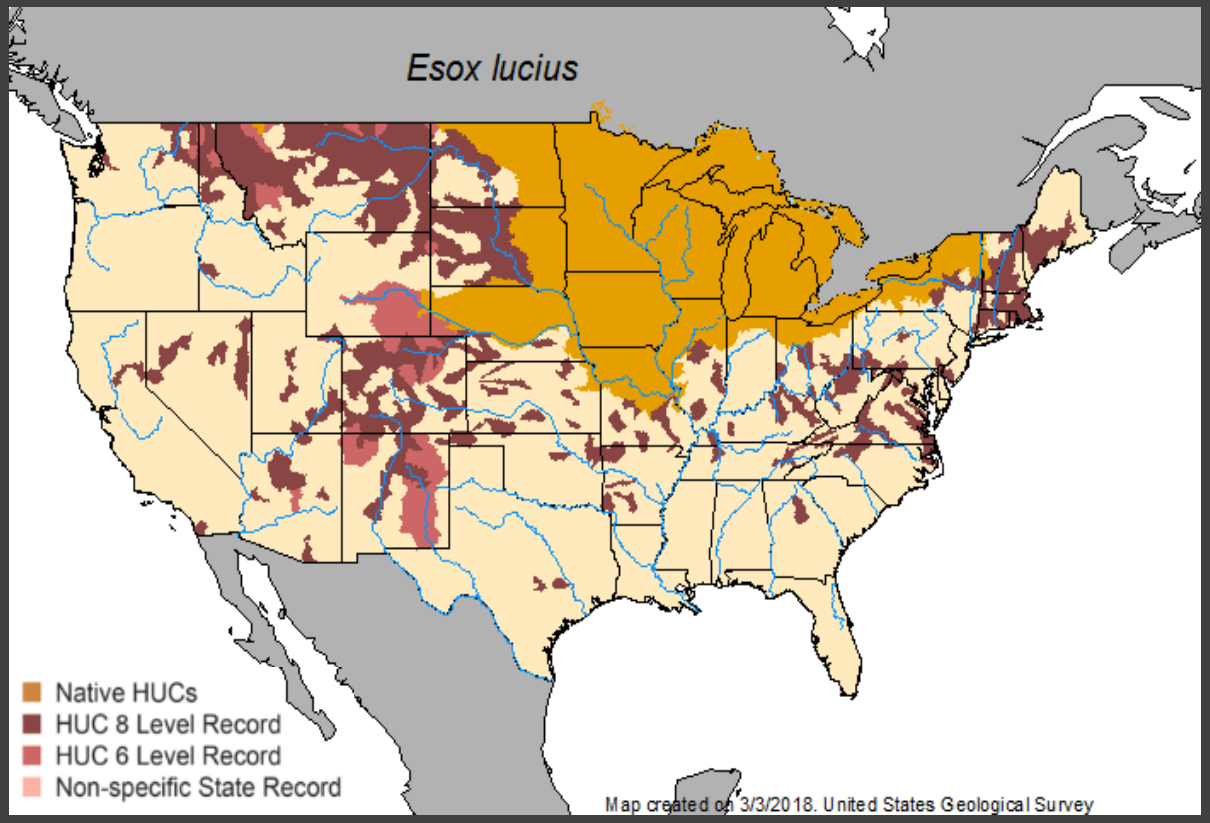
Northern Pike (*Esox lucius*) Background

- Broadly distributed across northern Hemisphere
- Prefer shallow areas with emergent vegetation
- Top predators and can consume fish up to 75% of body size

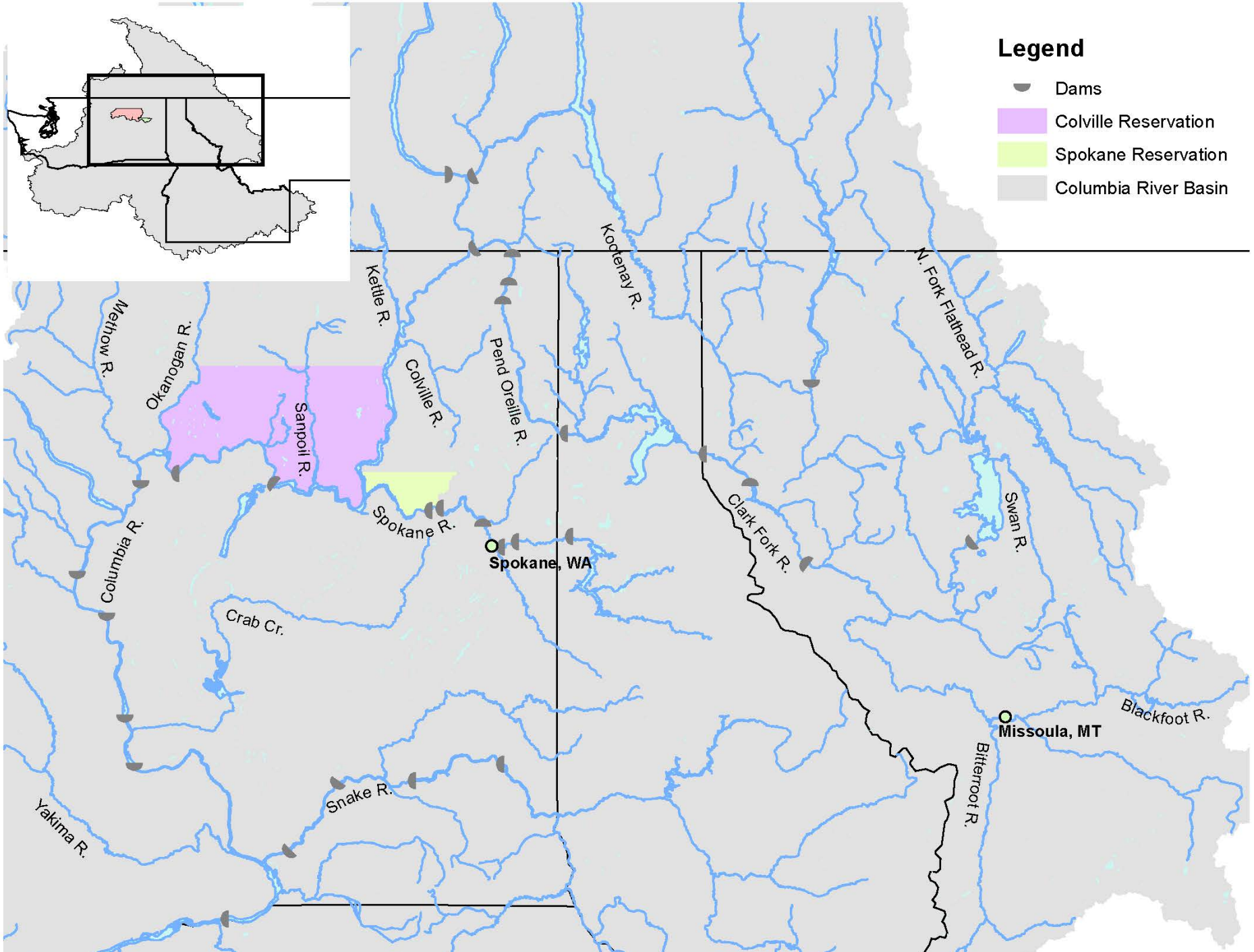
Photos: Wikipedia Commons, Paul Vecsei

Native and Introduced Range of Northern Pike





Maps: USGS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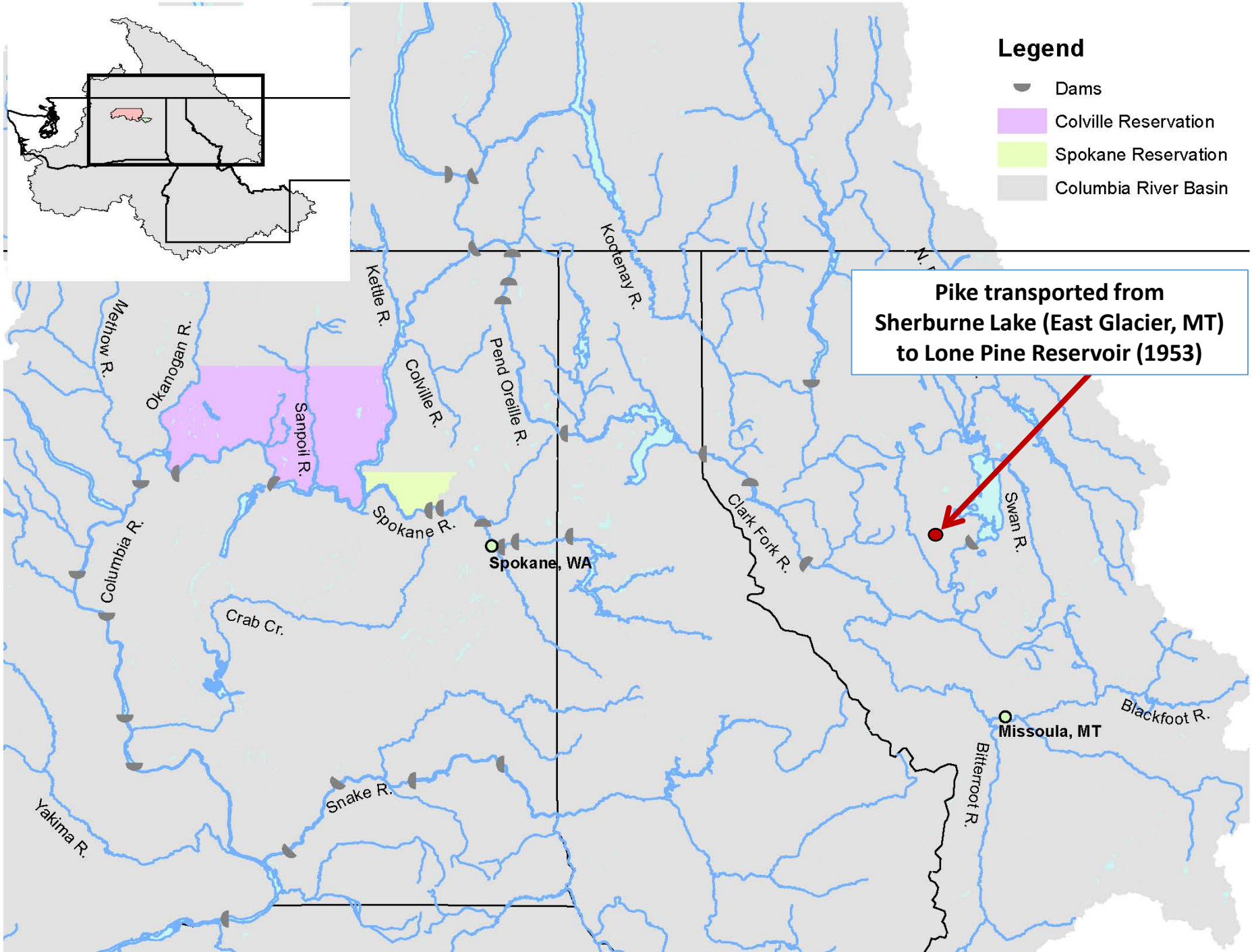
Dams
Colville Reservation
Spokane Reservation
Columbia River Basin
Kettle R.
Kootenay R.
N. Fork Flathead R.
Methow R.
Okanogan R.
Sanpoil R.
Colville R.
Pend Oreille R.
Spokane R.
Spokane, WA
Clark Fork R.
Swan R.
Columbia R.
Crab Cr.
Missoula, MT
Blackfoot R.
Bitterroot R.
Snake R.
Yakima R.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Dams
Colville Reservation
Spokane Reservation
Columbia River Basin
Pike transported from
Sherburne Lake (East Glacier, MT)
to Lone Pine Reservoir (1953)
Methow R.
Okanogan R.
Kettle R.
Kootenay R.
Sanpoil R.
Colville R.
Pend Oreille R.
Spokane R.
Spokane, WA
Columbia R.
Crab Cr.
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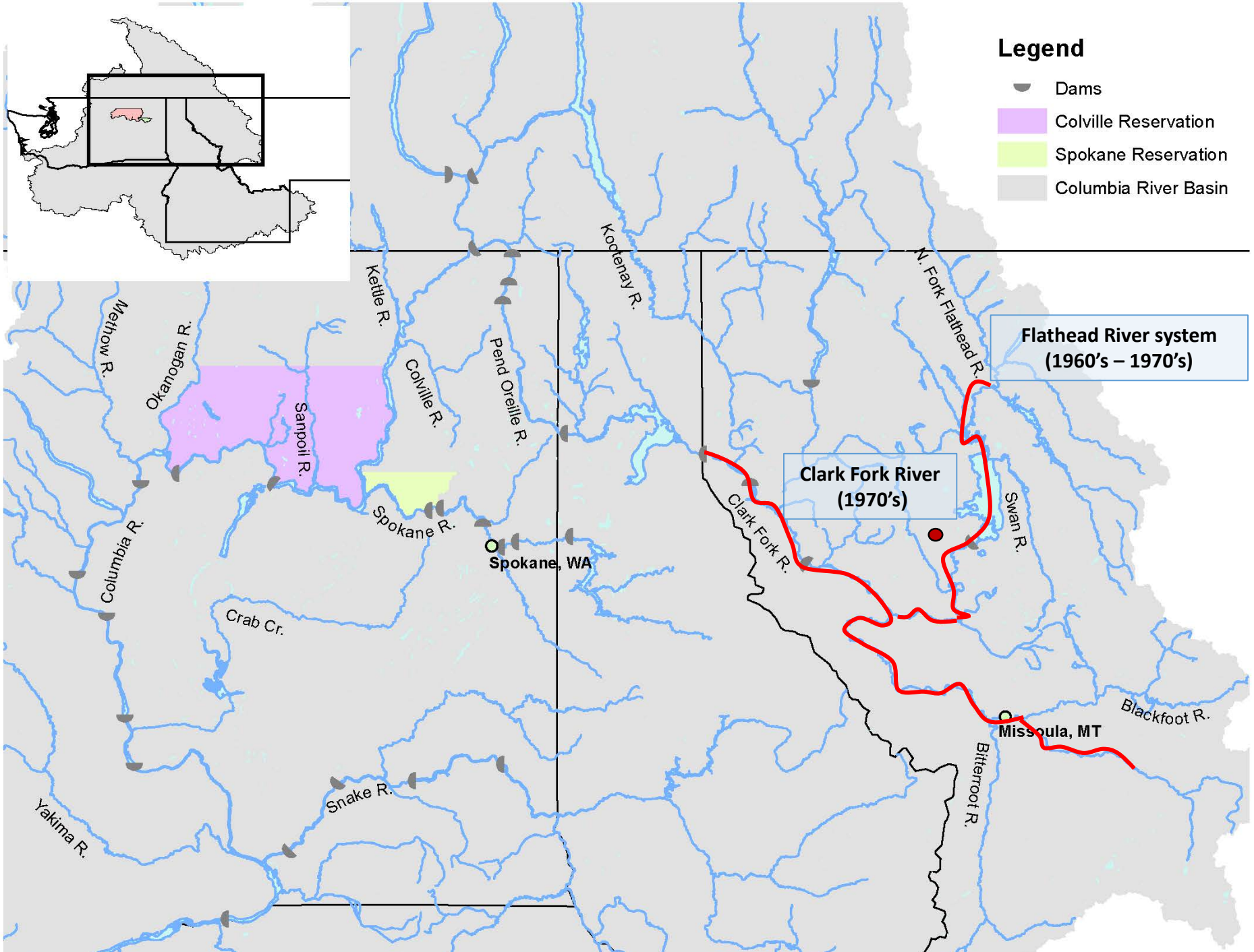
Missoula, MT
Blackfoot R.
Bitterroot R.
Snake R.
Yakima R.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Dams
Colville Reservation
Spokane Reservation
Columbia River Basin
Flathead River system
(1960's – 1970's)
Clark Fork River
(1970's)
Methow R.
Okanogan R.
Kettle R.
Kootenay R.
N. Fork Flathead R.
Sanpoil R.
Colville R.
Pend Oreille R.
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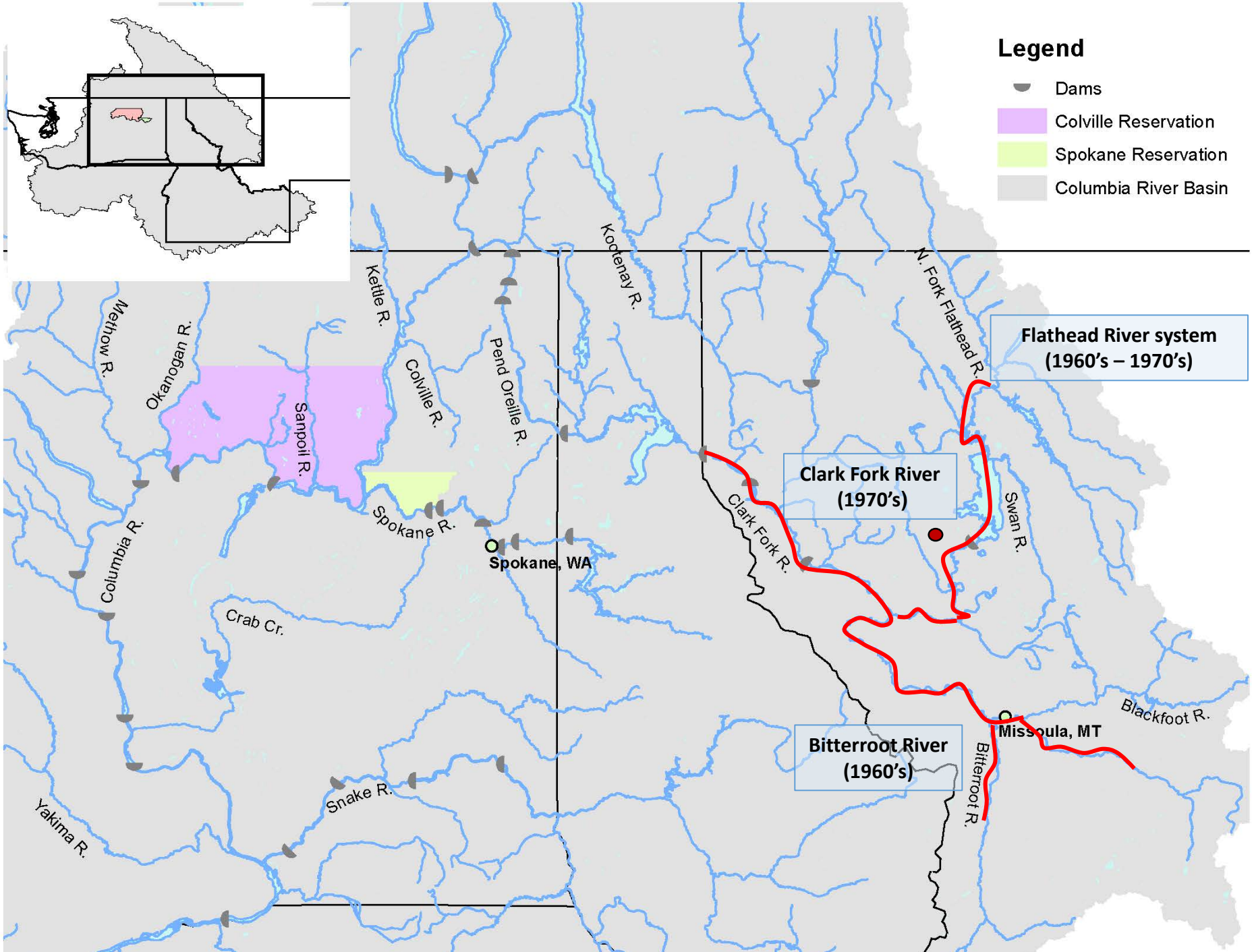
Yakima R.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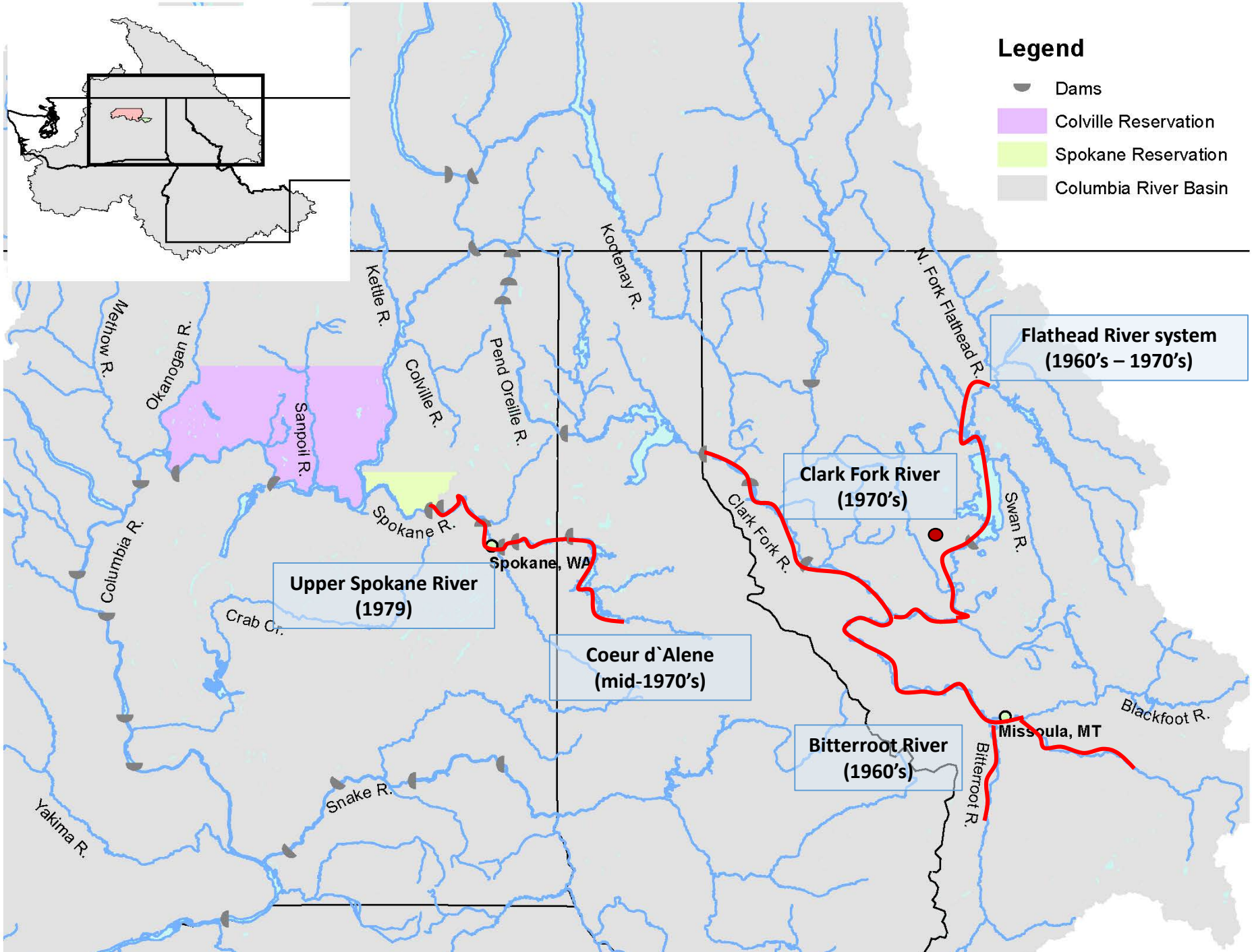
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Flathead River system
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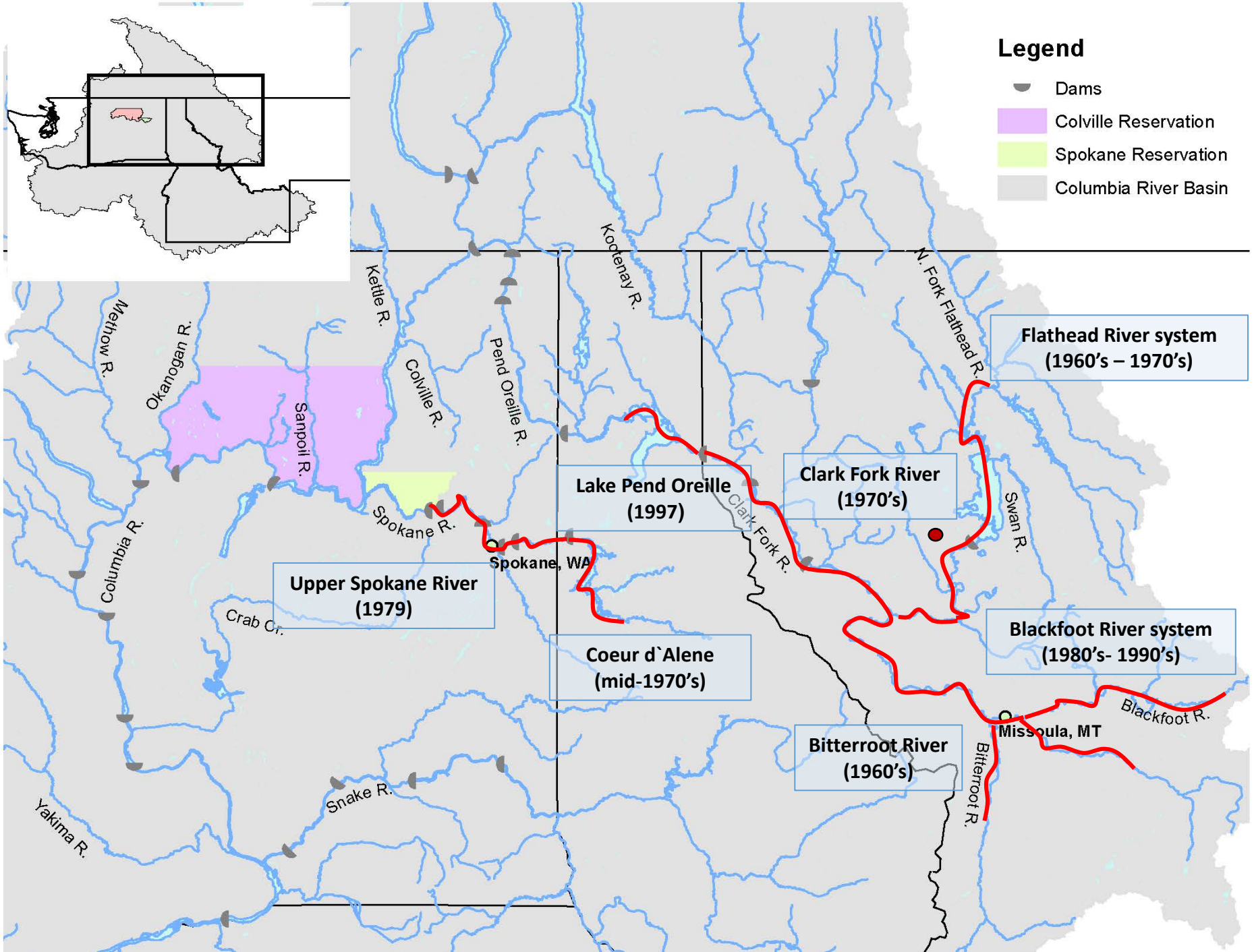
Clark Fork River
(1970's)
Clark Fork R.
Swan R.
Spokane R.
Spokane, WA
Upper Spokane River
(1979)
Columbia R.
Crab Cr.
Coeur d`Alene
(mid-1970's)
Missoula, MT
Blackfoot R.
Bitterroot River
(1960's)
Bitterroot R.
Snake R.
Yakima R.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Colville R.
Pend Oreille R.
Flathead River system
(1960's – 1970's)
Lake Pend Oreille
(1997)
Clark Fork River
(1970's)
Clark Fork R.
Swan R.
Spokane R.
Spokane, WA
Columbia R.
Upper Spokane River
(1979)
Crab Cr.
Coeur d`Alene
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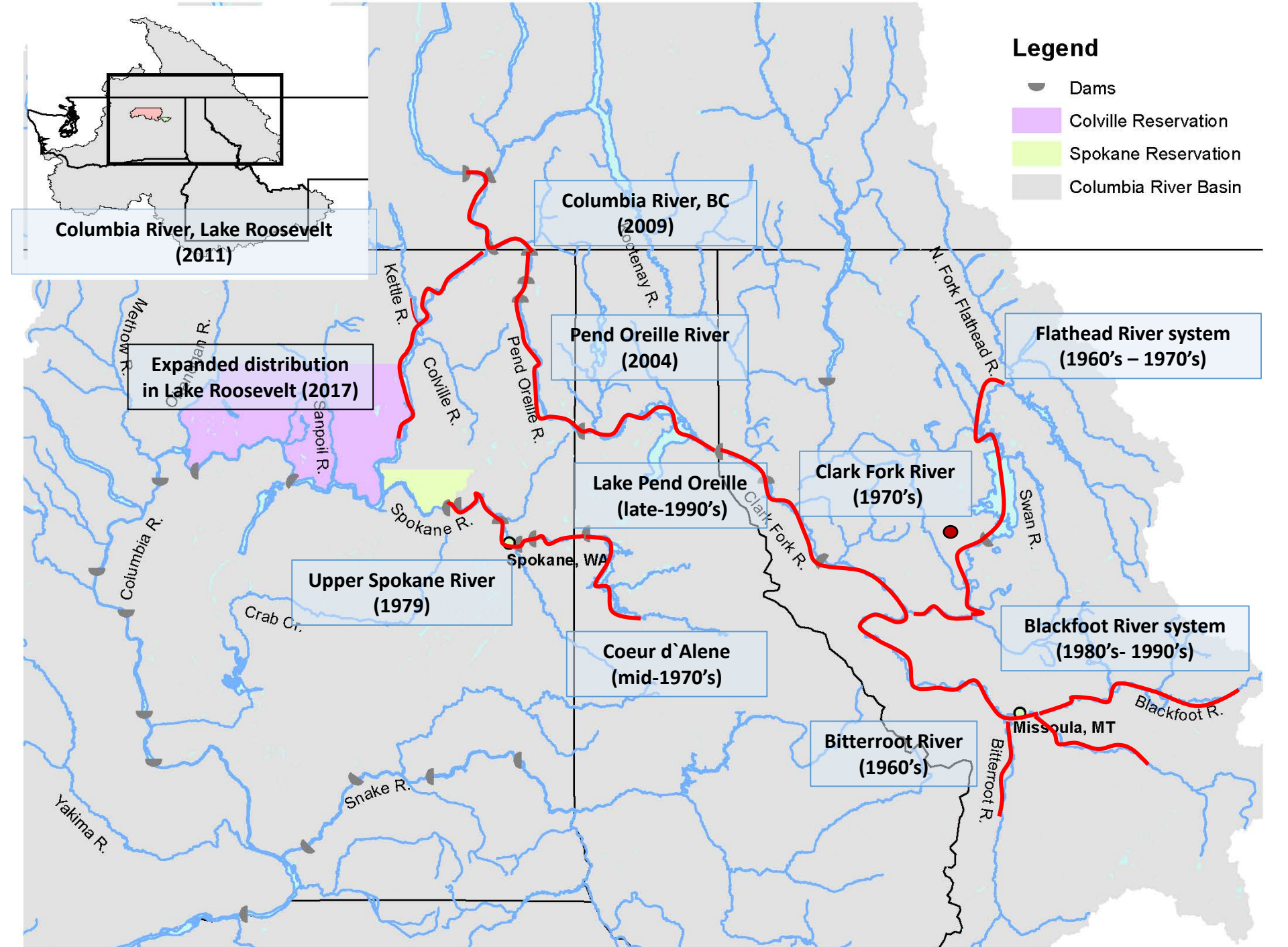
Blackfoot River system
(1980's- 1990's)
Blackfoot R.
Missoula, MT
Bitterroot River
(1960's)
Bitterroot R.
Snake R.
Yakima R.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Dams
Colville Reservation
Spokane Reservation
Columbia River Basin
Columbia River, Lake Roosevelt (2011)
Columbia River, BC (2009)
Expanded distribution in Lake Roosevelt (2017)
Pend Oreille River (2004)
Flathead River system (1960's – 1970's)
Lake Pend Oreille (late-1990's)
Clark Fork River (1970's)
Upper Spokane River (1979)
Coeur d`Alene (mid-1970's)
Blackfoot River system (1980's- 1990's)
Bitterroot River (1960's)
Spokane, WA
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Kettle R.
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Swan R.
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Bitterroot R.
Snake R.
Yakima R.

26 pound female Pike from Lake Roosevelt, Columbia River - 6/7/17

Photo: Holly McLellan

Management of Invasive Northern Pike

Information Needs:

1) Monitor invasion for early detection of expanding populations

2) Identify source of invading fish for targeted management

Photo: MN Dept. of Natural Resources

Management of Invasive Northern Pike

Information Needs:

1) **Monitor invasion for early detection of expanding populations**

2) Identify source of invading fish for targeted management

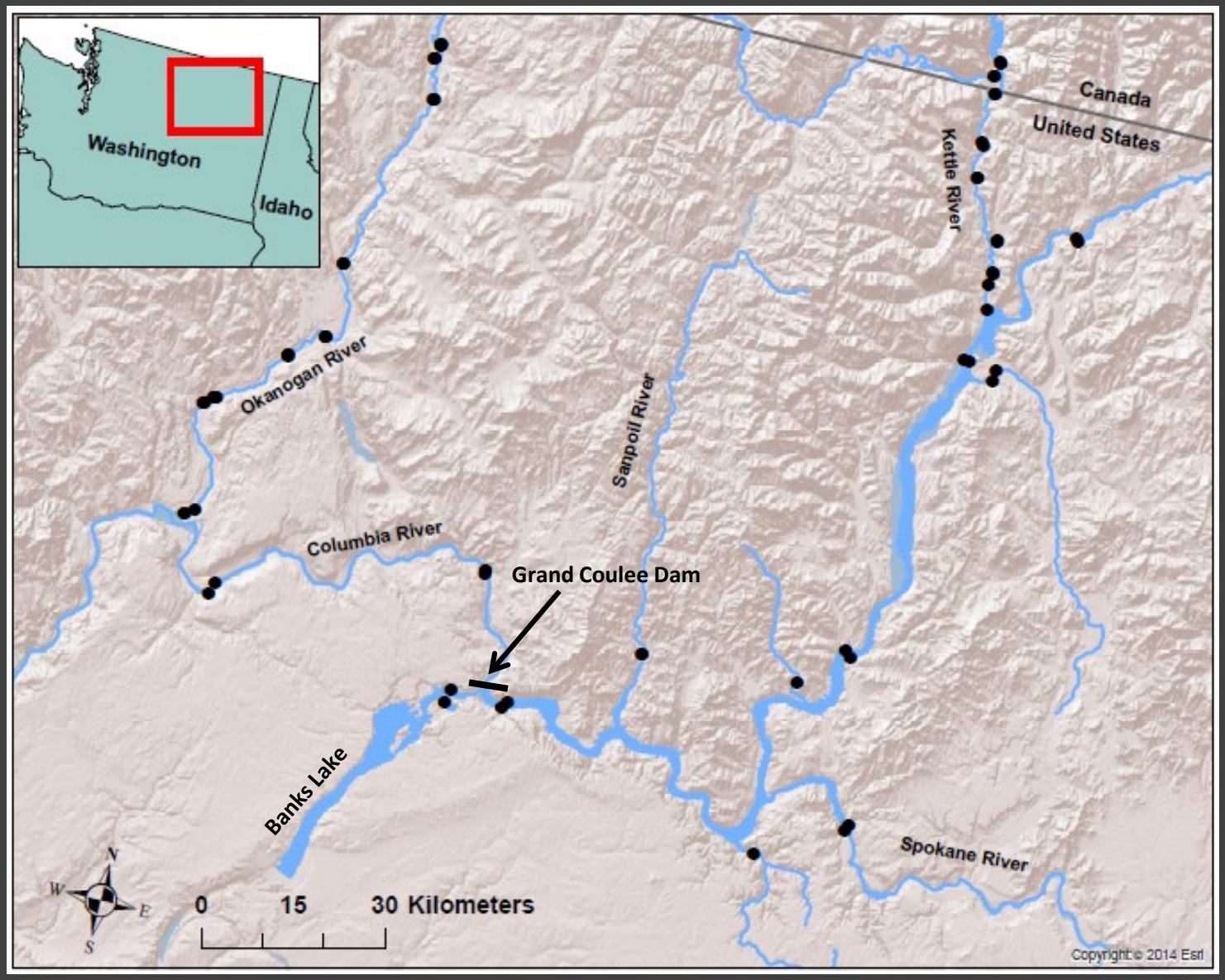
Photo: MN Dept. of Natural Resources

Environmental DNA for Monitoring Northern Pike in the Columbia River Basin

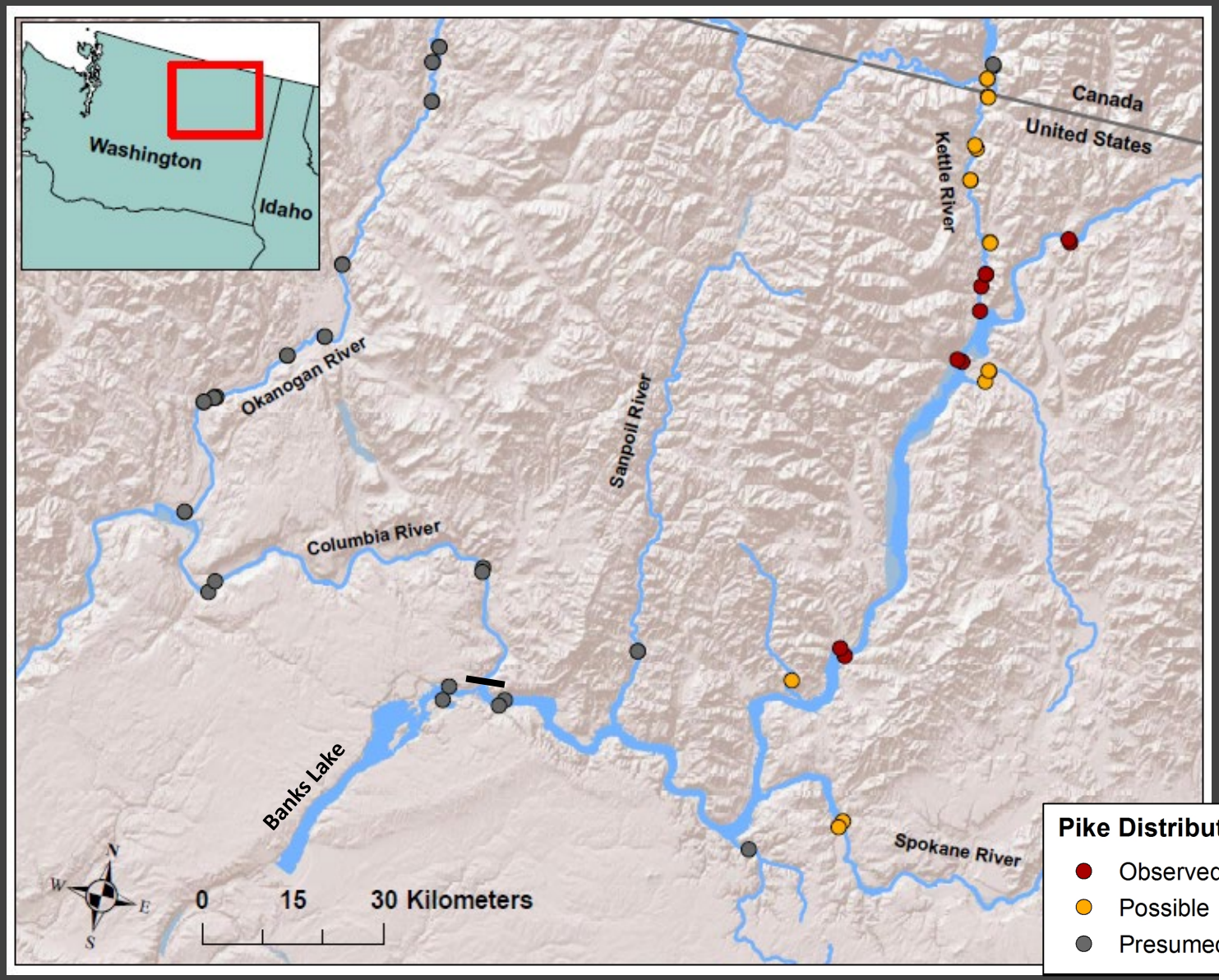
eDNA techniques are highly sensitive:

A single copy of DNA can be detected!

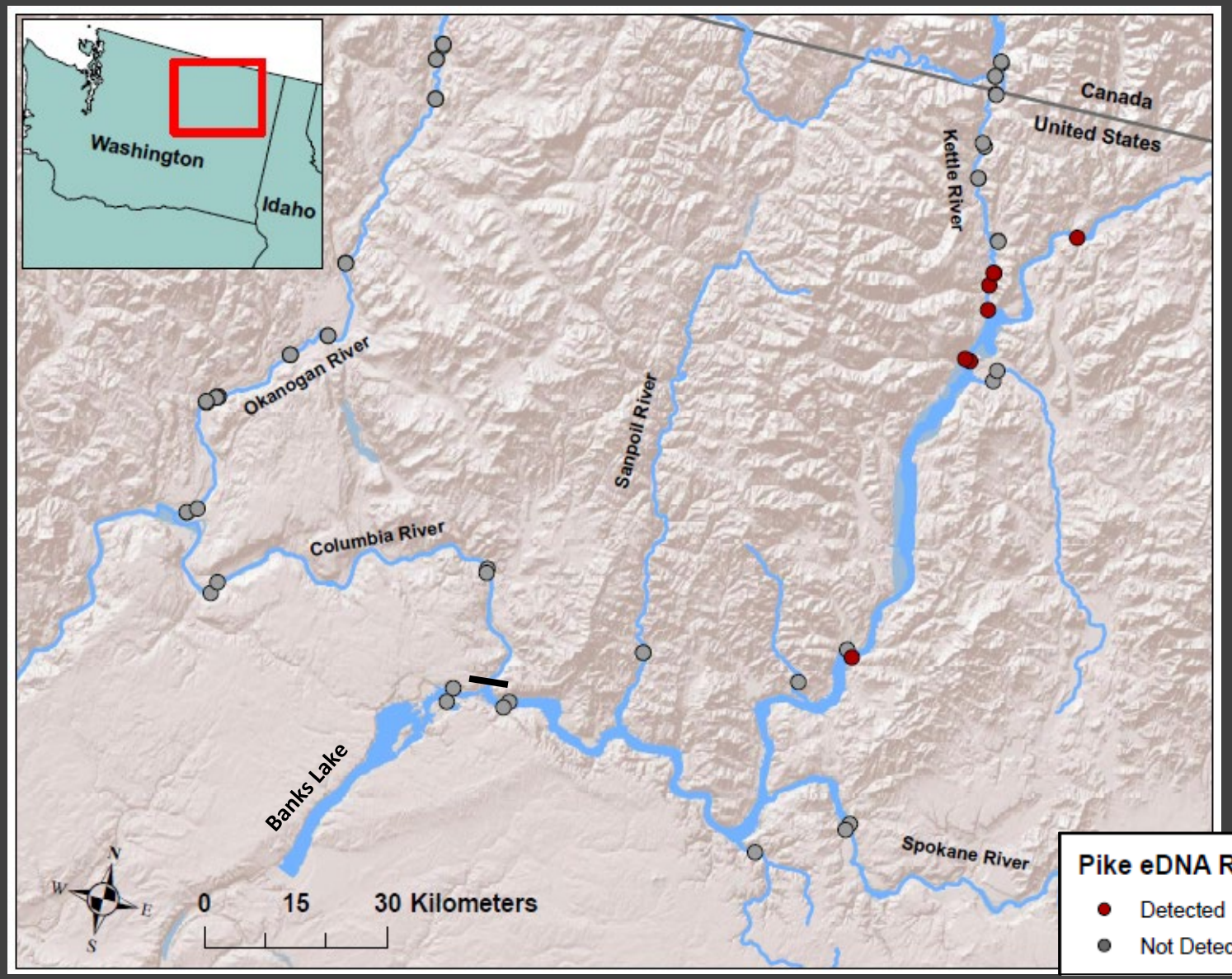
30 eDNA Sampling Locations – Sept. 2017



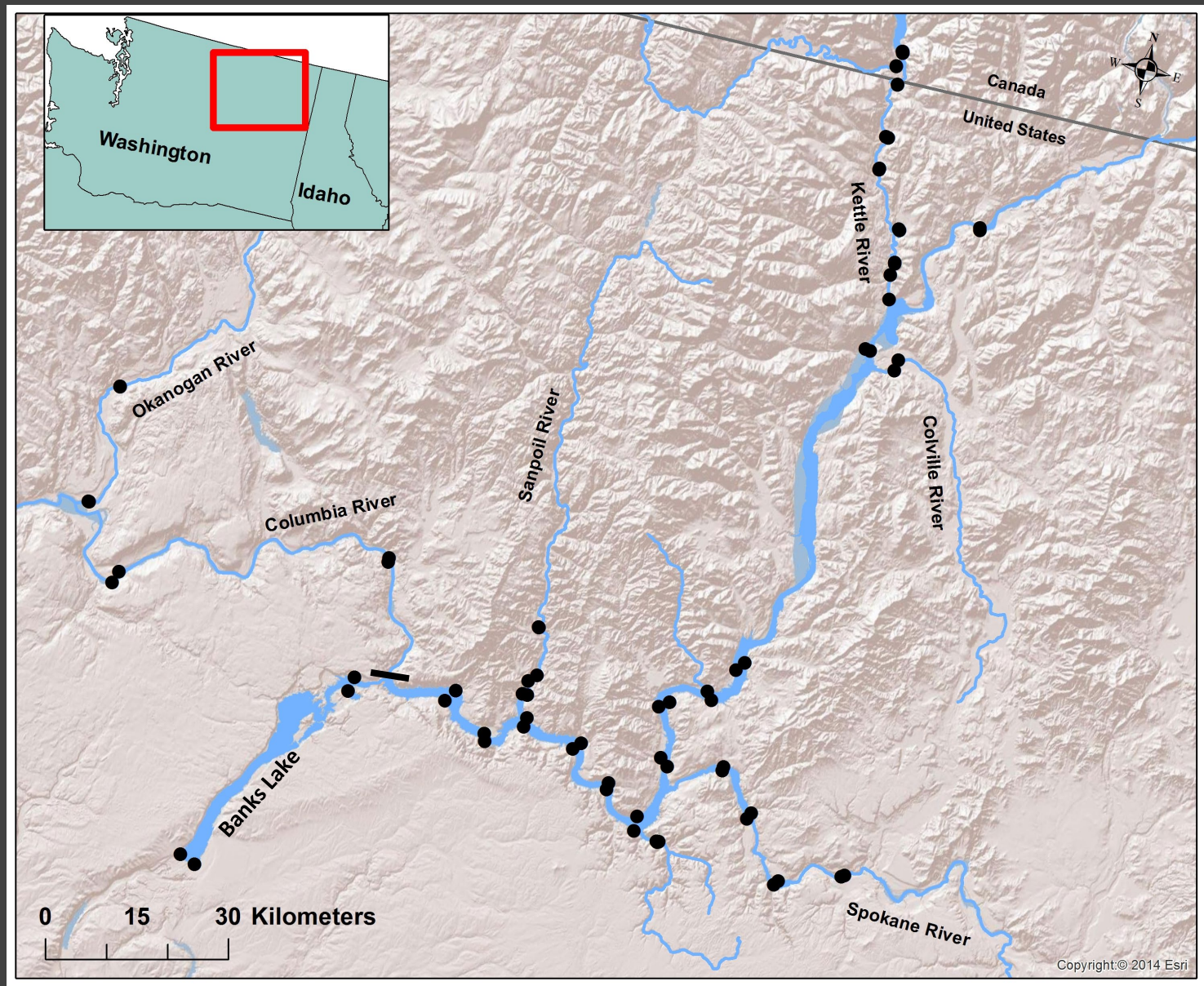
Known Distribution of Northern Pike – Aug. 2017



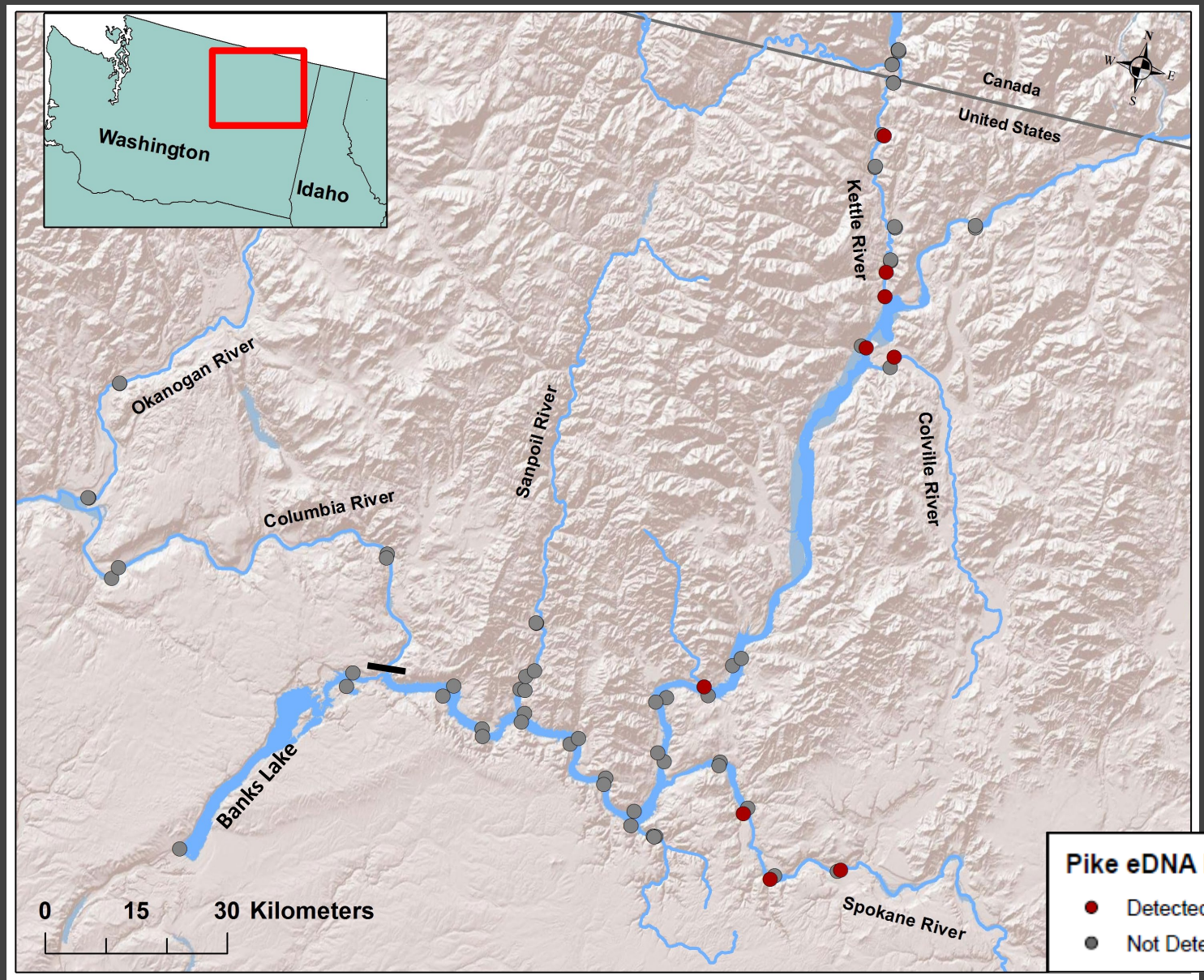
Pike detected at 6 locations;
Consistent with live observations



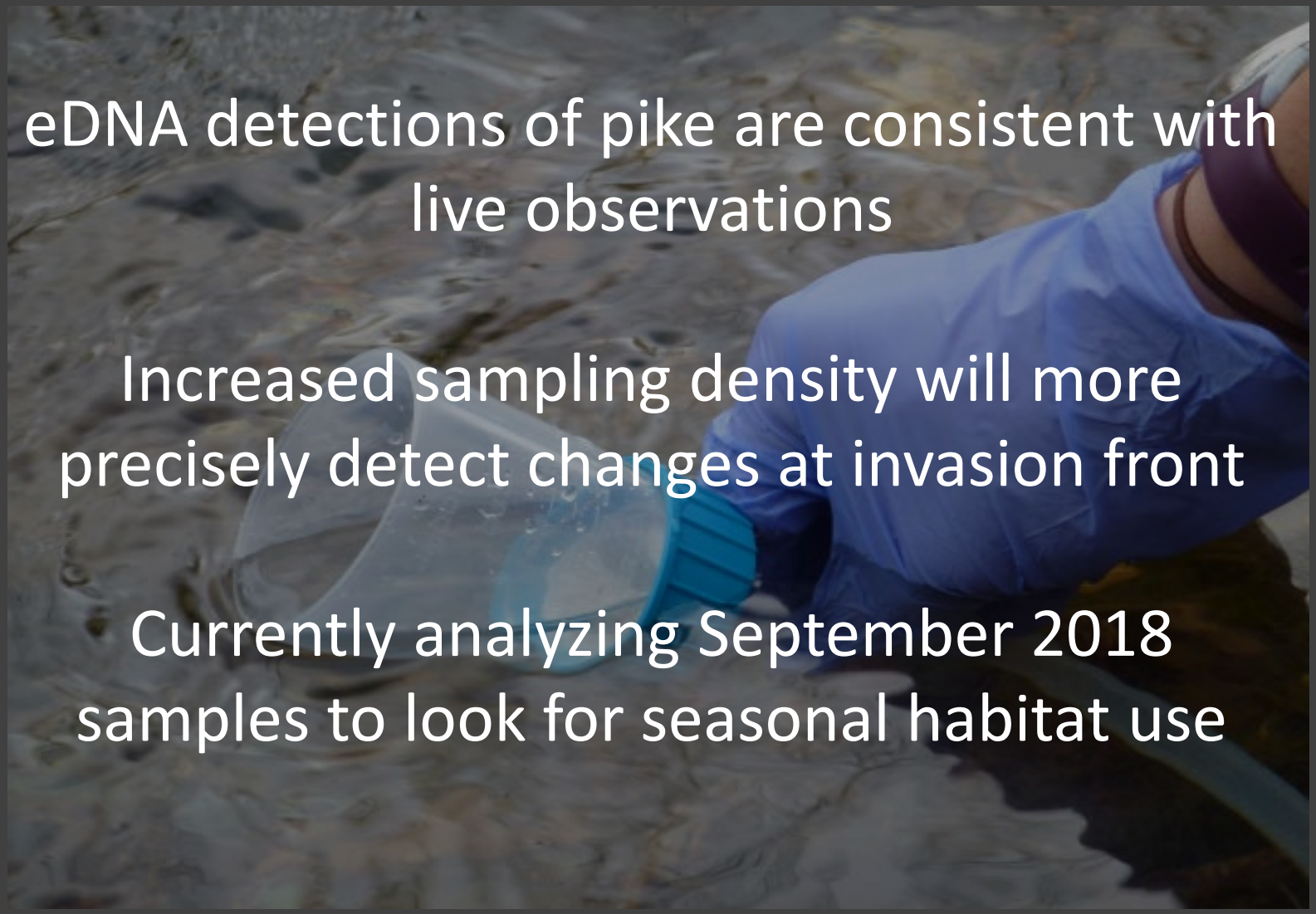
May – early July 2018 :
Increased sampling density Lake Roosevelt



Spring 2018 Results: New detections in Kettle River, Lake Roosevelt and Spokane River



Conclusions and Next Steps



eDNA detections of pike are consistent with live observations

Increased sampling density will more precisely detect changes at invasion front

Currently analyzing September 2018 samples to look for seasonal habitat use

Management of Invasive Northern Pike

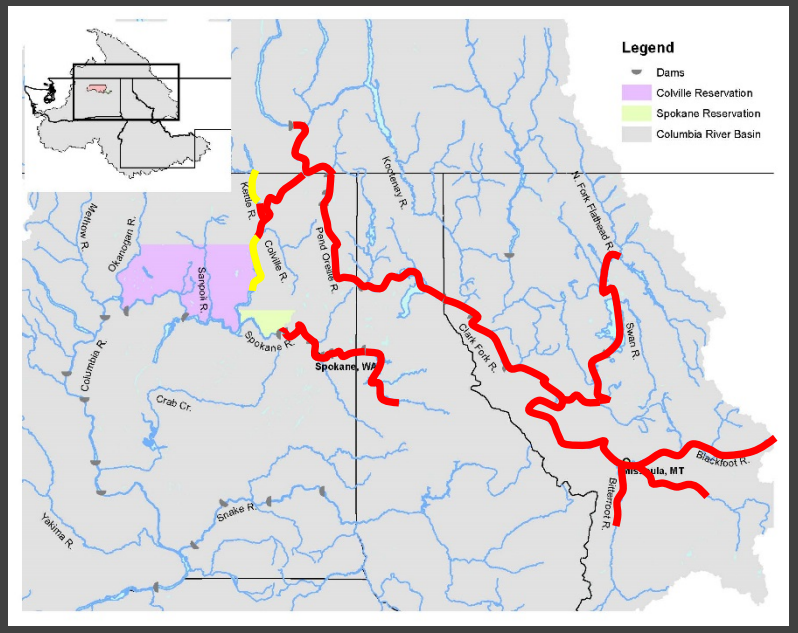
Information Needs:

1) Monitor invasion for early detection of expanding populations

2) **Identify source of invading fish for targeted management**

Photo: MN Dept. of Natural Resources

Where did pike in recently invaded areas come from?



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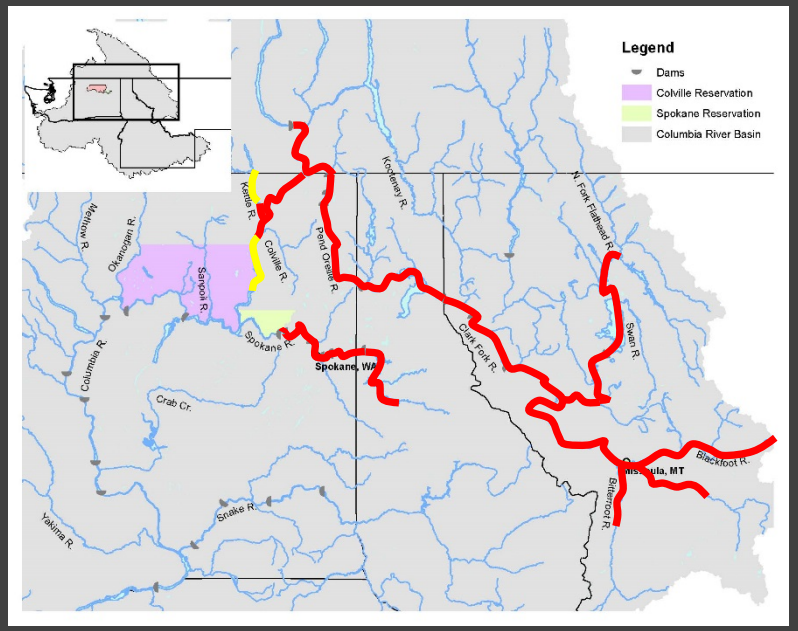
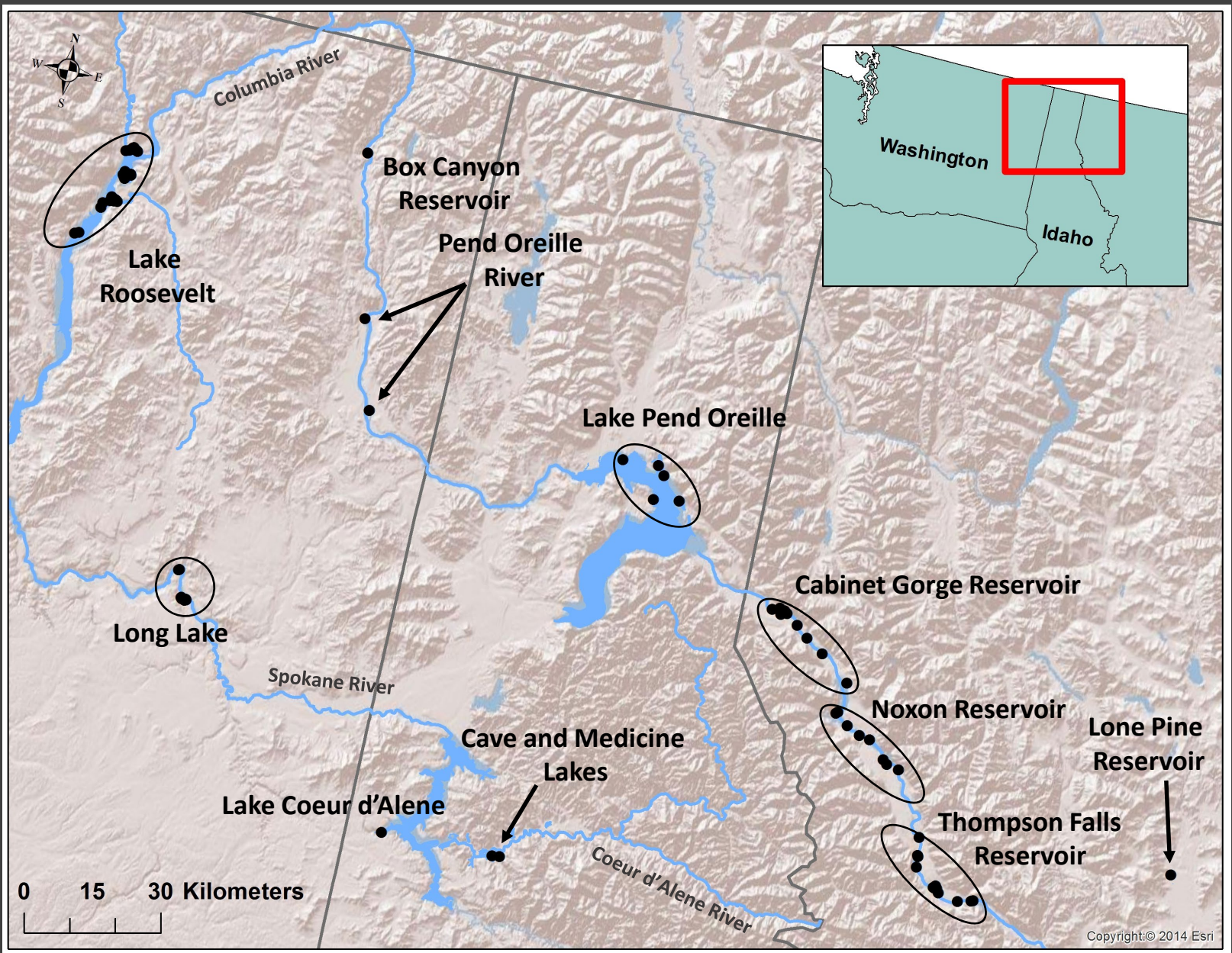


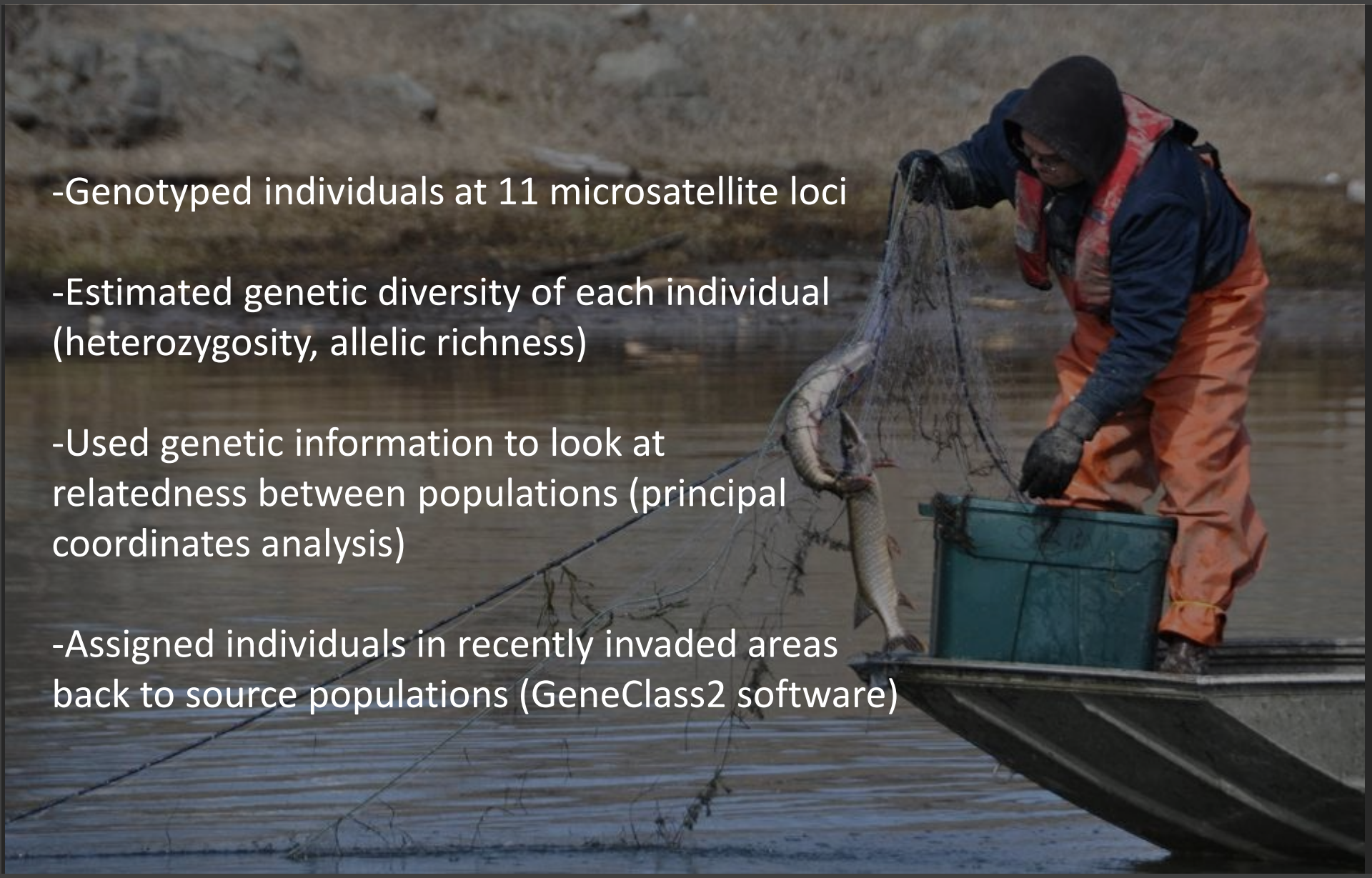
If pike are drifting downstream, we expect populations to be most closely related to the nearest neighboring population

If pike have been transported by people, we may not see a clear pattern of relatedness across the landscape, assignment to one source population

Collected samples from fish in 11 populations



Methods



-Genotyped individuals at 11 microsatellite loci

-Estimated genetic diversity of each individual (heterozygosity, allelic richness)

-Used genetic information to look at relatedness between populations (principal coordinates analysis)

-Assigned individuals in recently invaded areas back to source populations (GeneClass2 software)

General Results

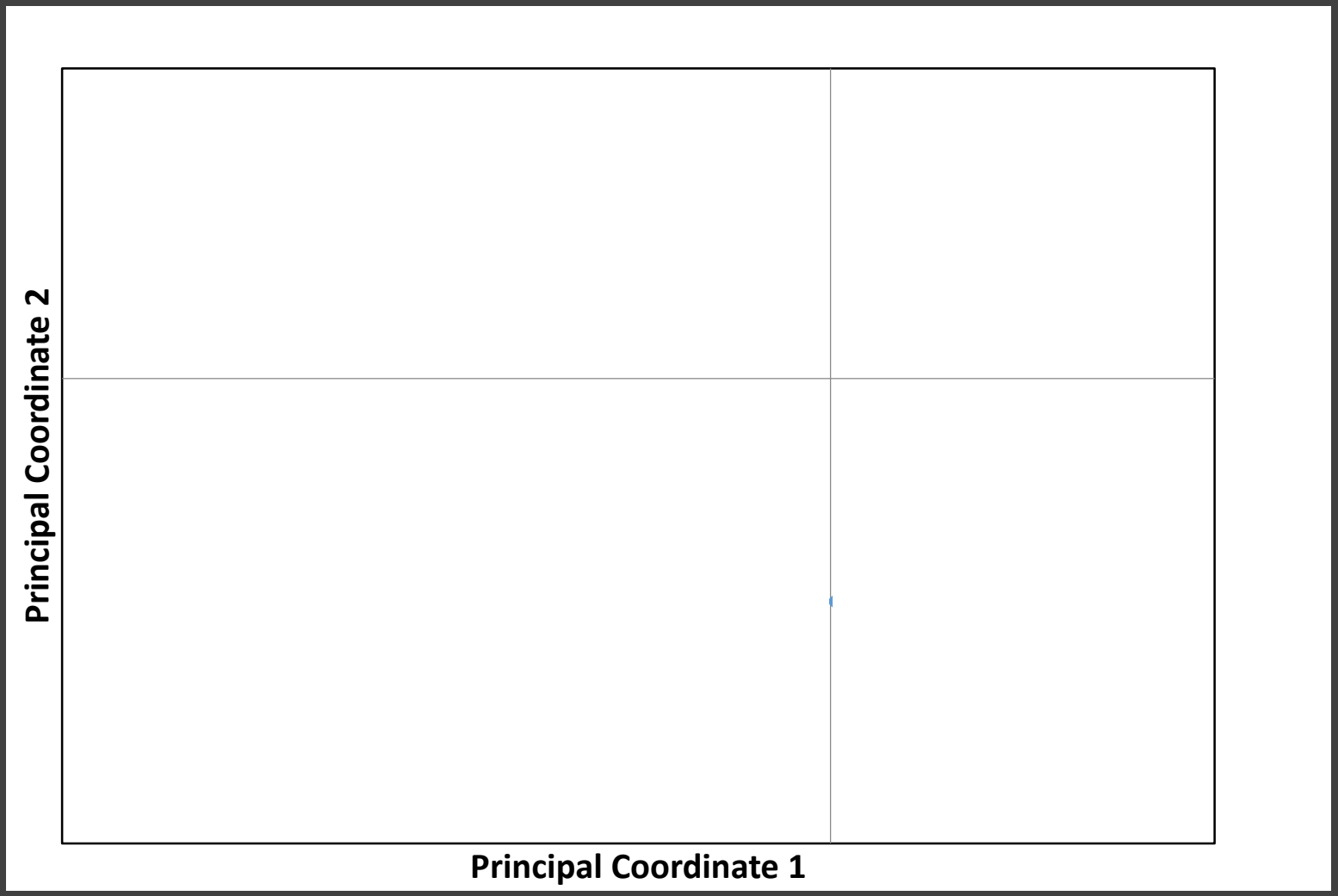
Upstream

Downstream

Sample Location	State	Population Description	# of Fish	Heterozygosity	Allelic Richness*
Lone Pine Reservoir	MT	Established	15	0.40	2.37
Thompson Falls Reservoir	MT	Established	25	0.51	2.82
Noxon Reservoir	MT	Established	25	0.50	2.69
Cabinet Gorge Reservoir	MT	Established	24	0.46	2.58
Lake Pend Oreille	ID	Established	25	0.39	2.29
Medicine Lake	ID	Established	13	0.46	2.69
Cave Lake	ID	Established	12	0.48	2.64
Coeur d'Alene Lake	ID	Established	27	0.45	2.54
Lake Spokane	WA	Established	27	0.41	2.32
Pend Oreille River	WA	Recent invasion	26	0.29	1.83
Box Canyon Reservoir	WA	Recent invasion	25	0.25	1.72
Lake Roosevelt	WA	Recent invasion	43	0.17	1.53

*corrected for sample size

How genetically similar are populations to one another?



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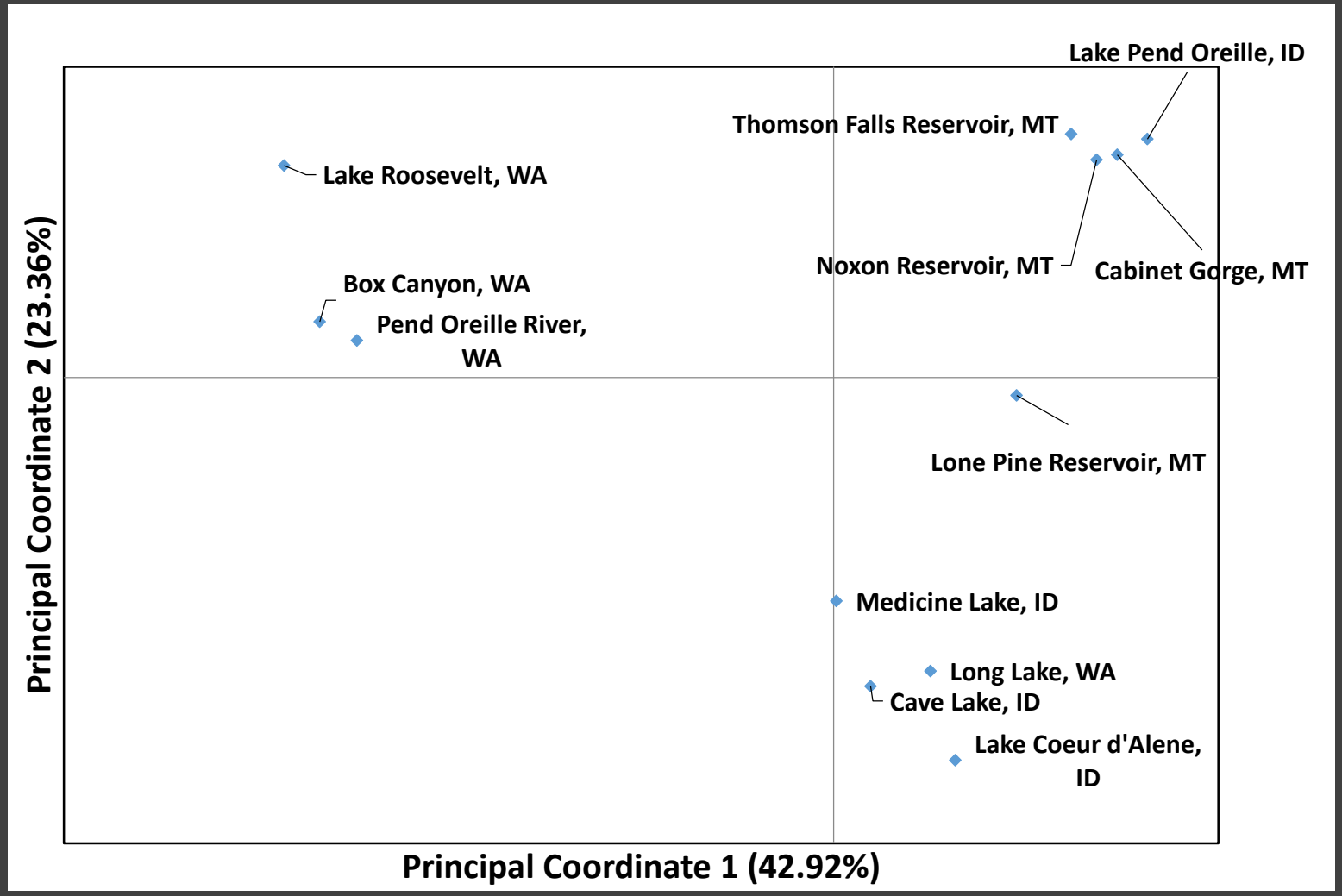


Relatedness of Northern Pike: Genetic Assignment

Relatedness of Northern Pike: Genetic Assignment

For each of the 104 fish in:

Pend Oreille River, Box Canyon Reservoir and Lake Roosevelt

Which is the most likely source population?

Thompson Falls Reservoir (MT)

Noxon Reservoir (MT)

Cabinet Gorge Reservoir (MT)

Lake Pend Oreille (ID)

Cave Lake/Medicine Lake (ID)

Lake Coeur d'Alene (ID)

Long Lake (WA)

Relatedness of Northern Pike: Genetic Assignment

For each of the 104 fish in:

Pend Oreille River, Box Canyon Reservoir and Lake Roosevelt

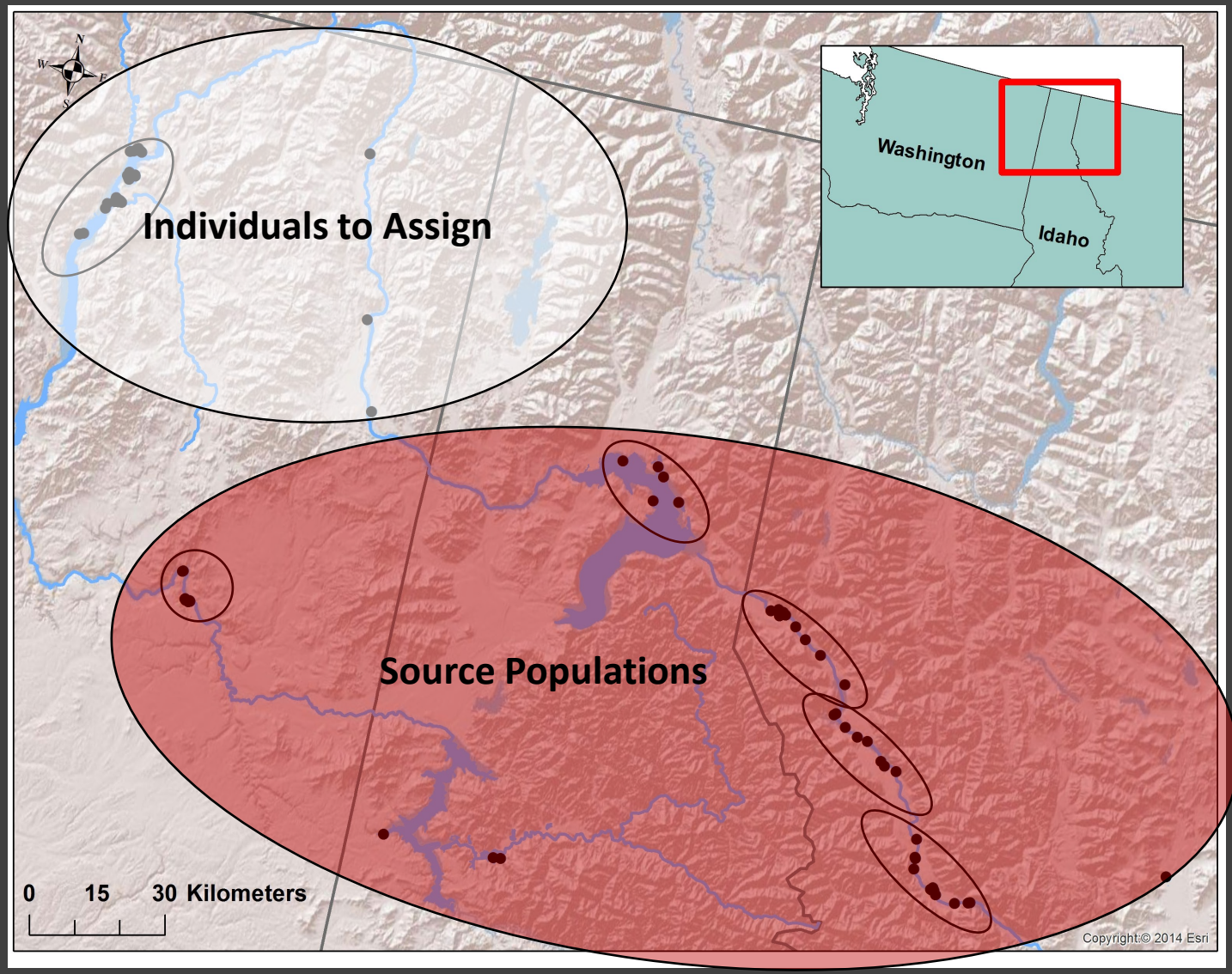
Which is the most likely source population?

Clark Fork/Pend Oreille

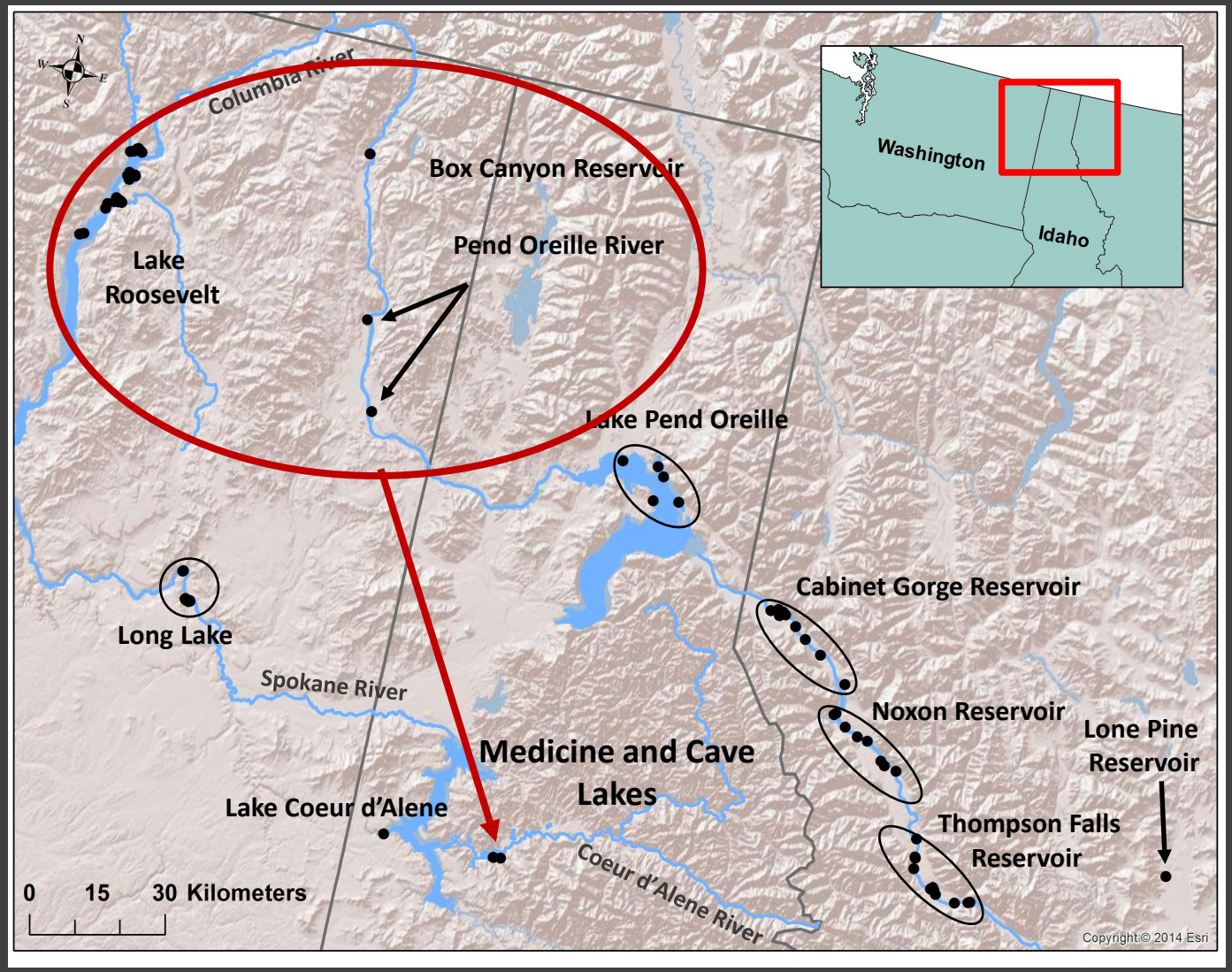
- Thompson Falls Reservoir (MT)
- Noxon Reservoir (MT)
- Cabinet Gorge Reservoir (MT)
- Lake Pend Oreille (ID)

Coeur d'Alene/Spokane

- Cave Lake/Medicine Lake (ID)
- Lake Coeur d'Alene (ID)
- Long Lake (WA)


Individuals to Assign
Source Populations
Washington
Idaho
0 15 30 Kilometers
Copyright:© 2014 Esri

For all 104 in recently invaded areas, Medicine Lake and Cave Lake are the most likely source

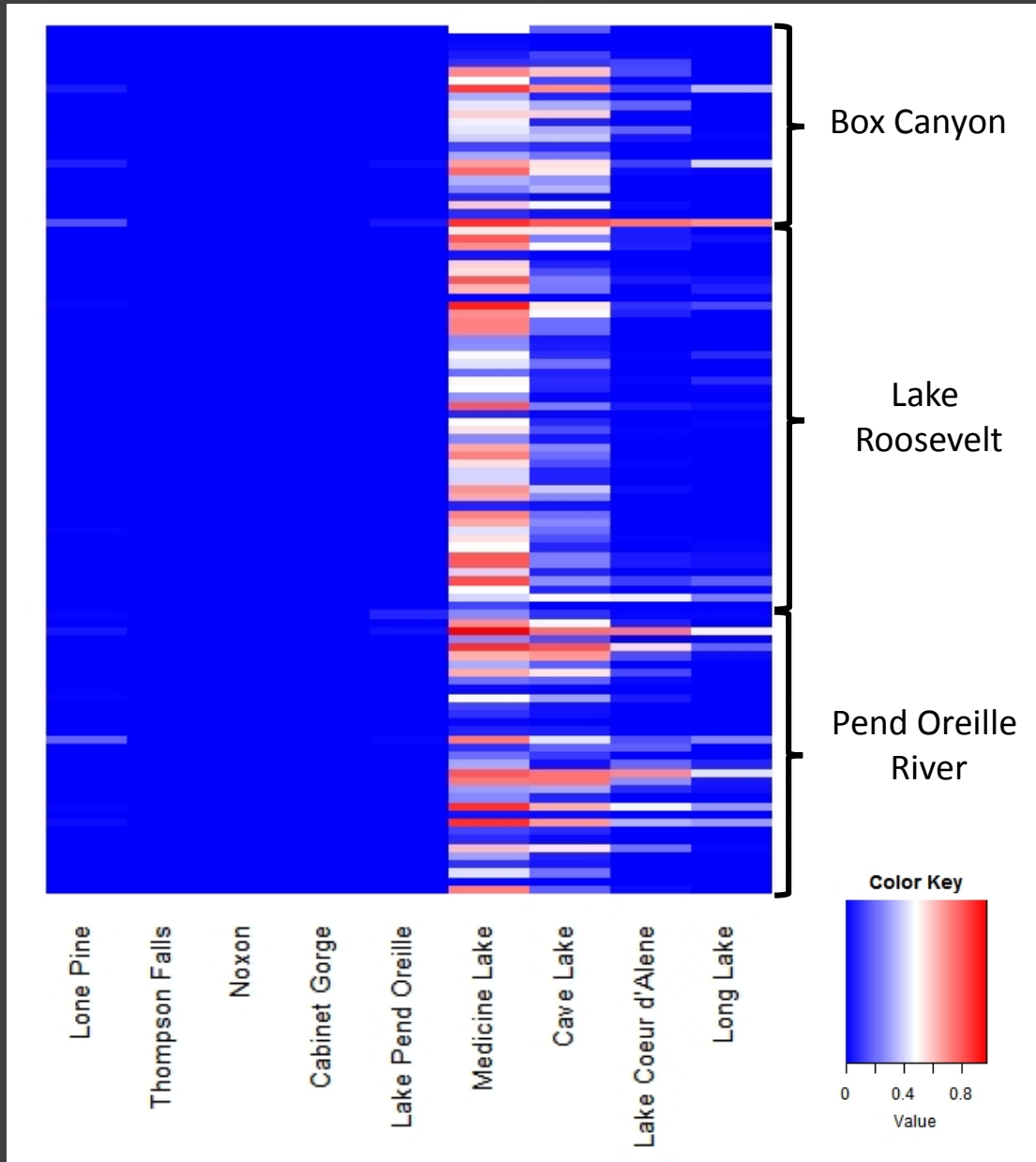


Assignment Probabilities by Individual Fish

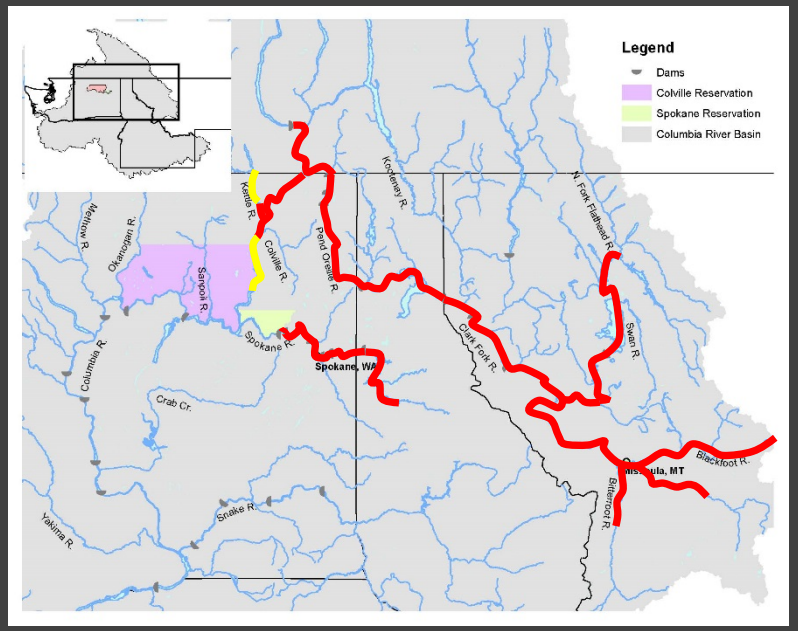
Medicine and Cave Lakes are most likely source for all fish

Assignment to most likely source ranged from 0.8% – 97%

We are likely missing other source populations



Where did pike in recently invaded areas come from?



If pike are drifting downstream, we expect populations to be most closely related to the nearest neighboring population

If pike have been transported by people, we expect no clear pattern of relatedness across the landscape, assignment to one source population

Conclusions

Results suggest pike in eastern Washington introduced illegally by human transport

Are there more source populations to consider?

→ Multiple sources?

→ Original source of fish in Coeur d'Alene/Spokane?

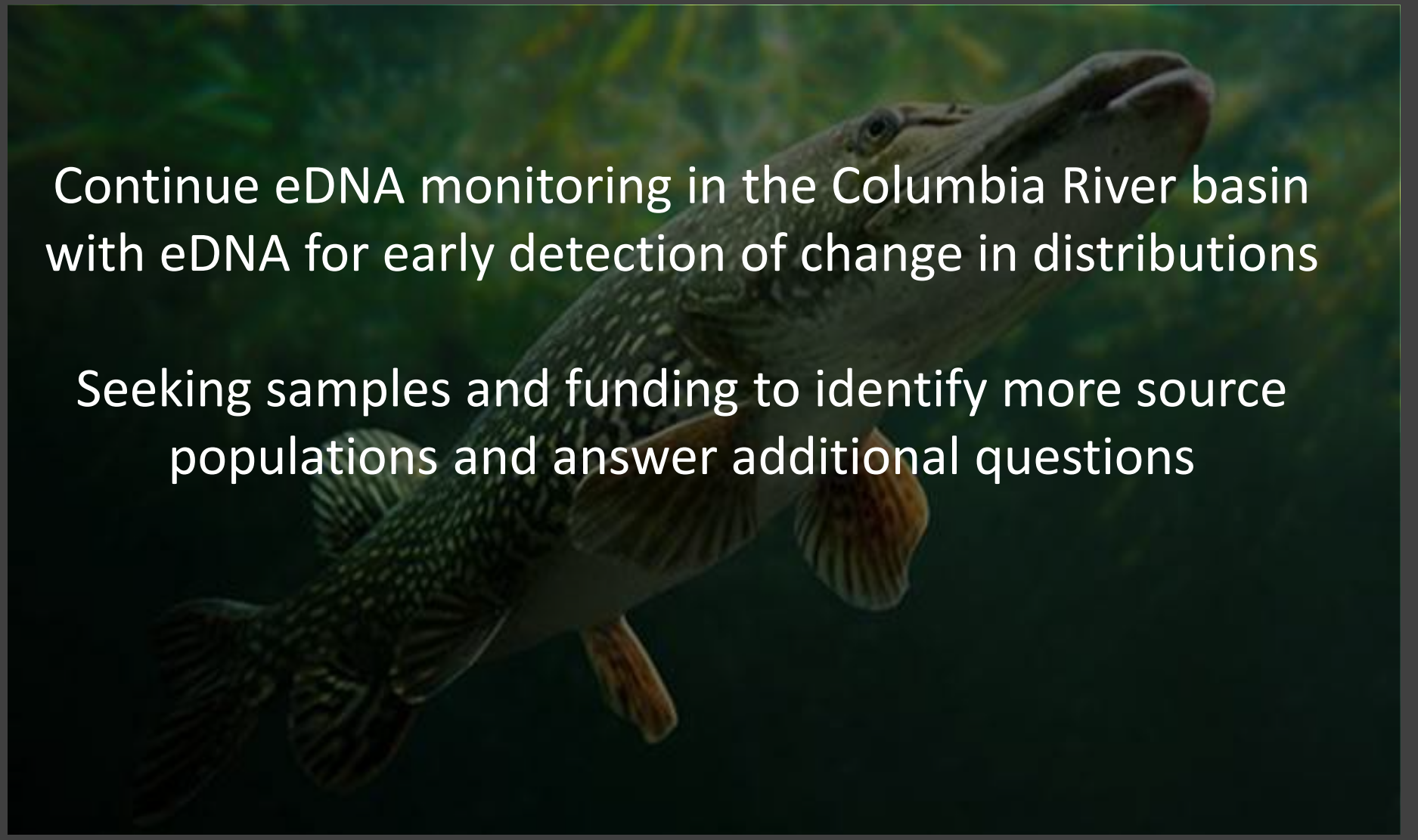
Low genetic diversity in recent invasions

→ No constant influx of invaders

Strong, strategic suppression could be successful

Managing people rather than fish may be the biggest challenge

Next Steps



Continue eDNA monitoring in the Columbia River basin with eDNA for early detection of change in distributions

Seeking samples and funding to identify more source populations and answer additional questions

Acknowledgements

Confederated Salish Kootenai Tribes
Craig Barfoot

Kalispel Tribe of Indians
Nick Bean
Jason Connor

Spokane Tribe of Indians
Elliot Kittel
Brent Nichols

Coeur d'Alene Tribe of Indians
John Firehammer

Montana Fish Wildlife and Parks
Matt Boyer
Ryan Kreiner
Dave Schmetterling

Idaho Fish and Game
Matt Corsi

U.S. Fish and Wildlife Service
Ann Grote

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