

Kootenai Valley Resource Initiative

20Mar2023

Nathan Jensen

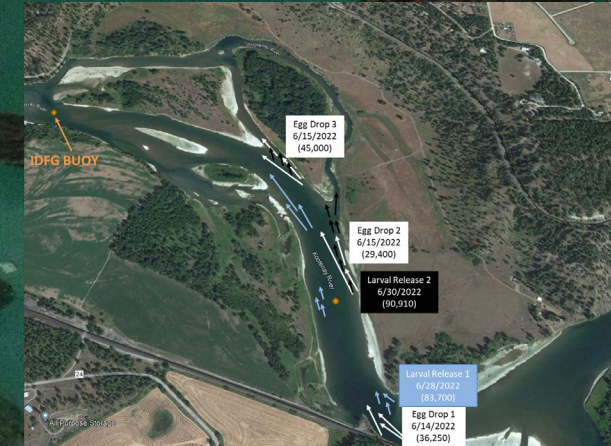
njensen@kootenai.org

208-597-4241



General Outline

- Background
- Conservation Aquaculture
- Fish Restoration
- Release Strategies
- Release Numbers
- Outcomes=>>>IDFG



Background ca.1990 to 2023

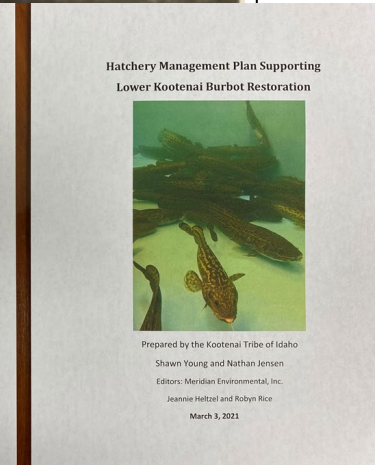
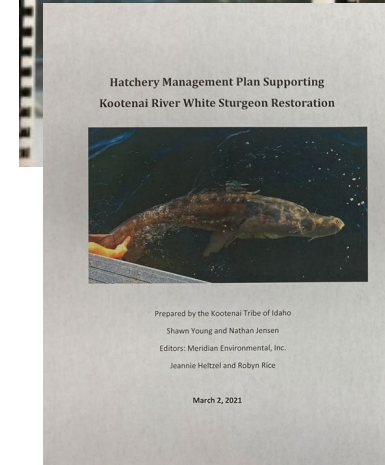
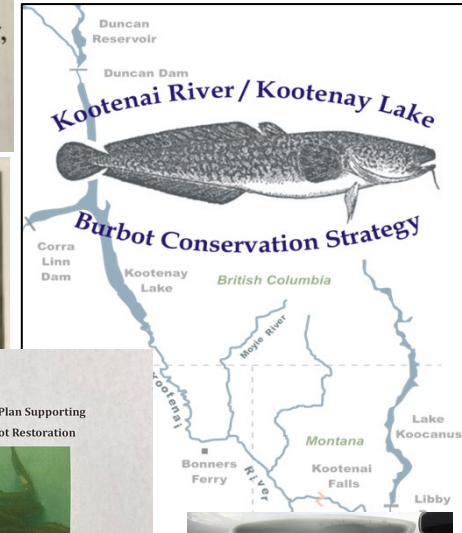
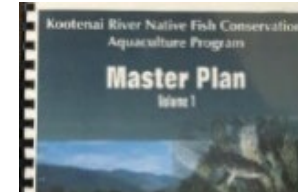
- 1990 KTOI Sturgeon aquaculture 'Experimental'
- 1992 Burbot fishing closed, Sturgeon releases on
- 2000 Paragamian et al. Burbot collapse
- 2003 Uofl Burbot aquaculture development
- 2005 MOU signed; conservation strategy completed by stakeholders
- 2012 Master planning process complete
- 2015 KTOI hatchery 2 operational
- 2019 Burbot fishery re-opens
- 2020-2023 Sturgeon population restructuring, early life stage releases now a part of Conservation Aquaculture program...

**Burbot Restoration in the Kootenai River Basin:
Using Agency, Tribal, and Community Collaboration to
Develop and Implement a Conservation Strategy**

SUSAN C. IRELAND* AND PATRICIA N. PERRY

**Collapse of Burbot Fisheries in the Kootenai River,
Idaho, USA, and Kootenay Lake,
British Columbia, Canada**

VAUGHN L. PARAGAMIAN AND VINT WHITMAN



1988



2015

Conservation Aquaculture

1. What is Conservation Aquaculture (Bing search last week)?

The image shows a Bing search result for the query "define conservation aquaculture". The search bar at the top shows the query and the Microsoft Bing logo. Below the search bar, there are navigation options: ALL, CHAT, IMAGES, VIDEOS, MAPS, NEWS, and MORE. The search results show "About 240,000 results" and "Any time" filter. A blue oval highlights the first search result, which is a definition of conservation aquaculture. The definition states: "Anders (1998) first coined 'conservation aquaculture' as the 'use of aquaculture for conservation and recovery of endangered fish populations.' This definition is somewhat narrow in scope and reflects the perception of aquaculture and conservation nearly two decades ago." Below the definition, there is a citation: "Aune, Kelley E. Froehlich, Rebecca R. Gentry, Benjamin S. Halpern, Benjamin S. Halpern" and "Publish Year: 2017". The citation is followed by a link to a ScienceDirect article: "Conservation aquaculture: Shifting the narrative and paradigm of ..." with the URL "www.sciencedirect.com/science/article/pii/S0006320717307565". Below the search results, there is a "People also ask" section with three questions: "What are the benefits of conservation aquaculture?", "What is the definition of aquaculture?", and "What is aquaculture? - National Oceanic and Atmospheric Administration". To the right of the search results, there is a "Related people" section with three profiles: Christopher Hills, Michael A. Rice, and Shirley Jeffrey. At the bottom right, there is a snippet of text: "The ocean covers more than 70 percent of the Earth's surface, yet capture fisheries and a small marine aquaculture sector produce only two percent of the global food supply."

Microsoft Bing

define conservation aquaculture

ALL CHAT IMAGES VIDEOS MAPS NEWS MORE

About 240,000 results Any time Open links in new tab

Anders (1998) first coined 'conservation aquaculture' as the "use of aquaculture for conservation and recovery of endangered fish populations." This definition is somewhat narrow in scope and reflects the perception of aquaculture and conservation nearly two decades ago.

Aune, Kelley E. Froehlich, Rebecca R. Gentry, Benjamin S. Halpern, Benjamin S. Halpern

Publish Year: 2017

Conservation aquaculture: Shifting the narrative and paradigm of ...

www.sciencedirect.com/science/article/pii/S0006320717307565

Was this helpful?

People also ask

What are the benefits of conservation aquaculture?

One potential reward specific to conservation aquaculture is the reduced introduction of non-native fouling species, which include parasites and pathogens associate...

Conservation aquaculture as a tool f... journals.plos.org/plosone/article?id...

What is the definition of aquaculture?

What is aquaculture? Aquaculture is the breeding, rearing, and harvesting of fish, shellfish, algae, and other organisms in all types of water environments. VIDEO: What is...

What is aquaculture? - National Oce... oceanservice.noaa.gov/facts/aquac...

Related people

Christopher Hills Michael A. Rice Shirley Jeffrey

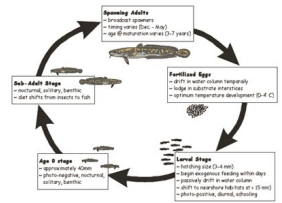
The ocean covers more than 70 percent of the Earth's surface, yet capture fisheries and a small marine aquaculture sector produce only two percent of the global food supply.

Conservation Aquaculture

1. What is Conservation Aquaculture?
2. Froehlich et., al. 2017...."Anders (1998) first coined 'conservation aquaculture' as the "use of aquaculture for conservation and recovery of endangered fish populations." This definition is somewhat narrow in scope and reflects the perception of aquaculture and conservation nearly two decades ago. Although a useful starting point, it does not echo the evolving conservation approaches. In redefining conservation aquaculture, we draw on (but do not limit ourselves to) the definitions of each term:

conservation represents "a careful preservation and protection of something; planned management of a natural resource to prevent exploitation, destruction, or neglect" (Merriam-Webster, 2017), while aquaculture is defined as "the cultivation of aquatic organisms, especially for food" (Merriam-Webster, 2017, NOAA Fisheries, 2017)."

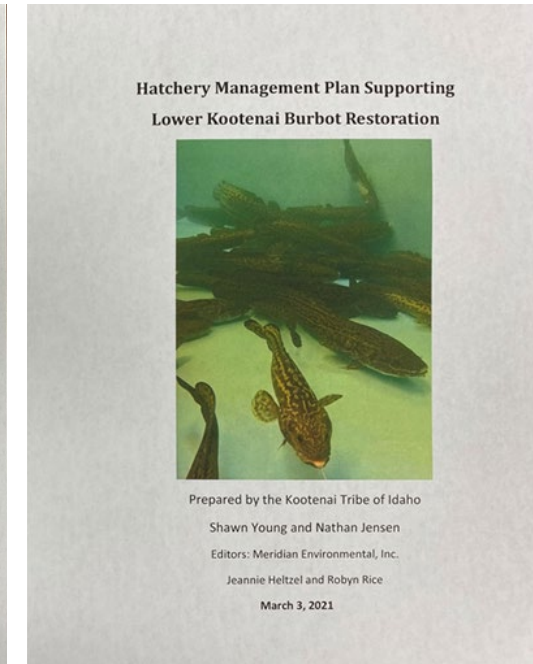
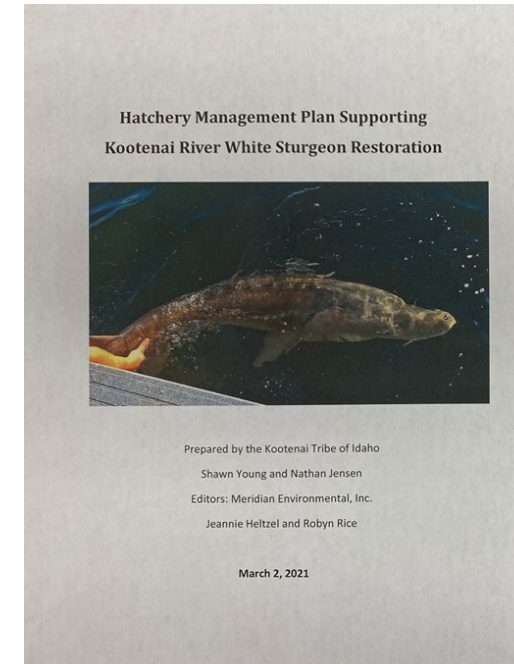
- Conservation
- Recovery
- Research
- Stewardship
- Covenant
- Economics
- Fisheries...



KTOI Conservation Aquaculture Program Goals

1. Prevent extinction of Endangered White Sturgeon
2. Rebuild/maintain the Burbot population

- Preserve wild gene pool(s) using native broodstock and/or in-basin population(s)
- Strive to create 'healthy' age-class structure
- Restore natural recruitment
- Identify bottlenecks to recovery
- Adaptive management



Hatchery Management Plans updated annually
“Living Documents...”

KTOI Con Aqua – Burbot Phase Example

Production Targets (from NPCC Step 2 document)

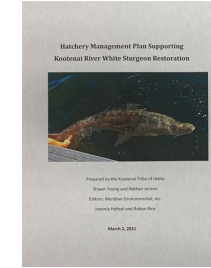
Metrics	Phase 1 2004-2008	Phase 2 2009-2013	Phase 3 2014-2018	Phase 4 2019+
Donor Source	Moyie Lake	Moyie Lake	Moyie Lake	Moyie Lake
% Broodstock from Donor Source	100	100	50-100	0-100
% KR Natural-origin Broodstock	0	0	0-50	0-100
Families Produced	-	Up to 36	Up to 60	Up to 60
Larvae Release	-	0-350,000	TBD	TBD
Age-0+ to 6 mo. old Juveniles Released	-	5,000-20,000	20,000-100,000	Up to 125,000
Age-1 Released	-	100-500	TBD	TBD
Minimum Number Mature Adults (Ages 4+)	-	-	2,500	17,500
Minimum Number of Spawning Areas	-	-	3	3
Natural Recruitment	-	Possible	Probable	Significant

Phase 5 2021+
Kootenai River
100% from river now
300
Family Groups
Yes, releasing larvae
Yes, releasing juveniles
No Age-1 Releases
~50,000 harvestable
?
Low level observed

KEY POINTS: Change is a good thing; adaptive management is key to success.

KTOI Con Aqua – Sturgeon Phase Example

Year class	Rearing facility	Release number		Mean total length (mm) (SD)	Mean weight (g) (SD)	Release season & year
		Tagged	Untagged			
1990	KT	14	0	457 (53)	321 (112)	Summer 1992
1991	KT	104	0	255 (17)	66 (13)	Summer 1992
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1995	KT		0	582 (40)	863 (198)	Summer 1999



Cut 20 yrs...



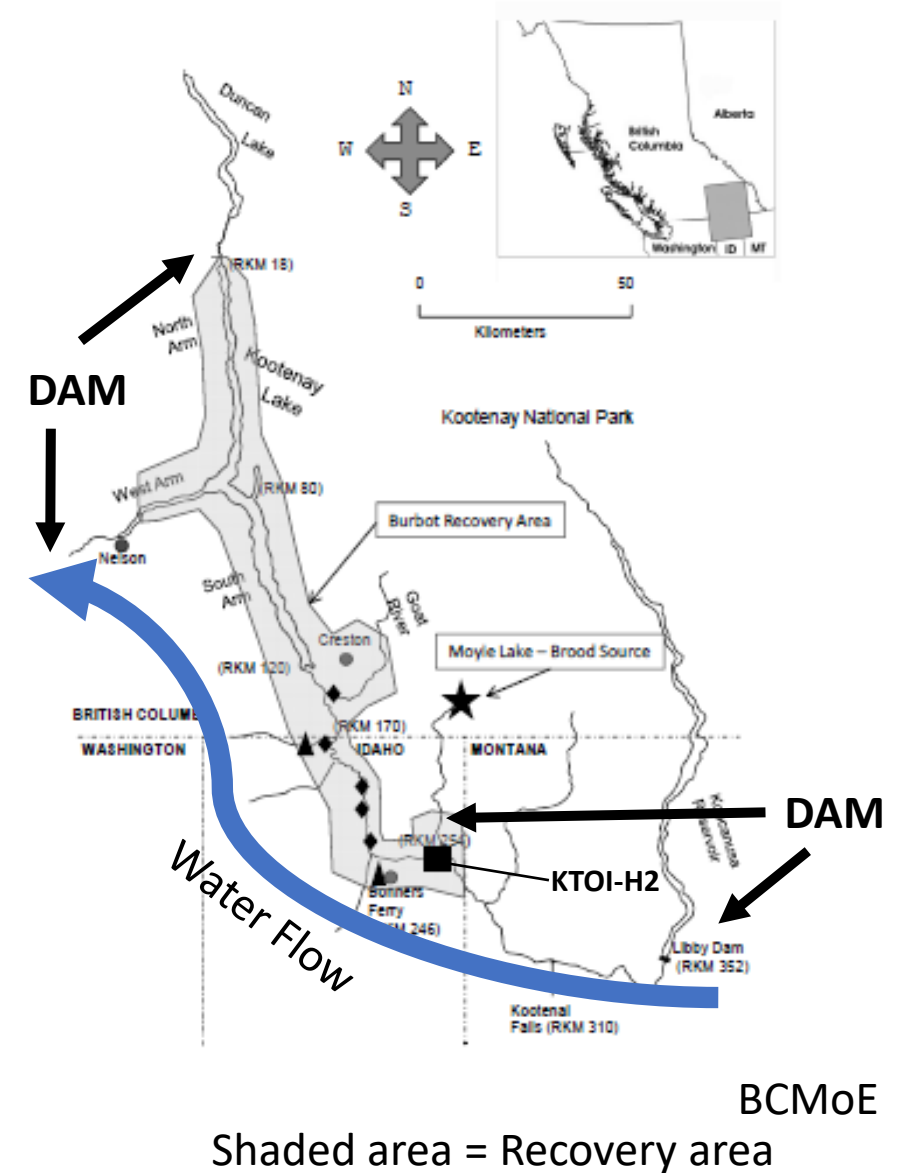
Mature Hatchery Fish – IDFG 2020

Year class	Rearing facility	Release number		Mean total length (mm) (SD)	Mean weight (g) (SD)	Release season & year
		Tagged	Untagged			
2015	TR	0	Minimize hatchery impacts 6,350	--	< 20	Spring 2016
2015	TR	95	0	251 (38)	61 (30)	Fall 2016
2016	TR	1,408	0	207 (26)	33 (15)	Spring 2017
2016	TR	0	2,480	--	< 20	Spring 2017
2016	TR	563	0	212 (40)	40 (30)	Summer 2017
2016	TR	84	0	217 (20)	40 (21)	Fall 2017
2017	TR	3,301	0	230	57	Spring 2018
2017	TR	0	2,273		< 30	Spring 2018
2017	KT	2,749	0	250	75	Fall 2018
2017	KT	0	655	-	< 30	Fall 2018
2018	TR	7,891	0	267	75	Spring 2019
2018	TR	0	3,087	-	< 30	Spring 2019
2018	KT	4,131	0	264	82	Fall 2019
2019	TR	2,162	0	203	58	Spring 2020
2019	KT	0	0			
2020	No Year Class – Research only due to COVID-19					
Subtotal		187,181	128,727			
Total		315,908				

HMP 2001

Program Considerations

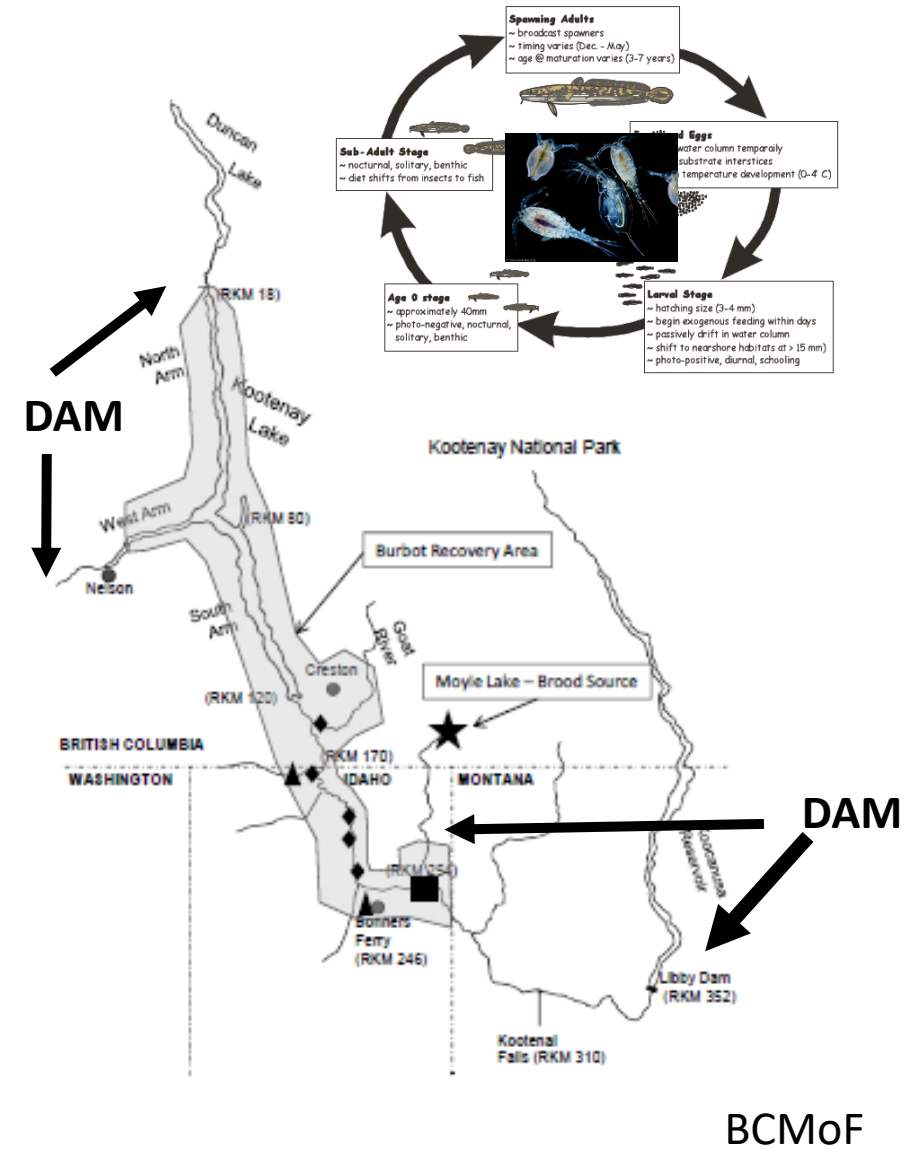
1. Large recovery area with limited areas to work in
2. Donor stocks (genetic considerations)
3. Adult broodstock captures are coordinated with IDFG (critical to success of program)
4. Permitting (transport, release(s), etc.)
5. Disease susceptibility (SPF Cert., OIE, AFS Bbook)
6. Fish life cycles (Sturgeon and Burbot overlap)
 - Burbot larvae also require live feeds
 - Sturgeon have Two facilities/crews



KTOI Fish Restoration

Some challenges:

1. Studies have shown very low abundance of plankton (Larval fish food)
2. Other Agency/Department priorities:
 - Ducks vs. Fish?
 - Fish vs. Cottonwood Trees?
 - Frogs vs. Fish? , etc...
3. KTOI now employs a “Diversified Release Strategy” that requires more coordination/communication
4. Hydrooperation Coordination?

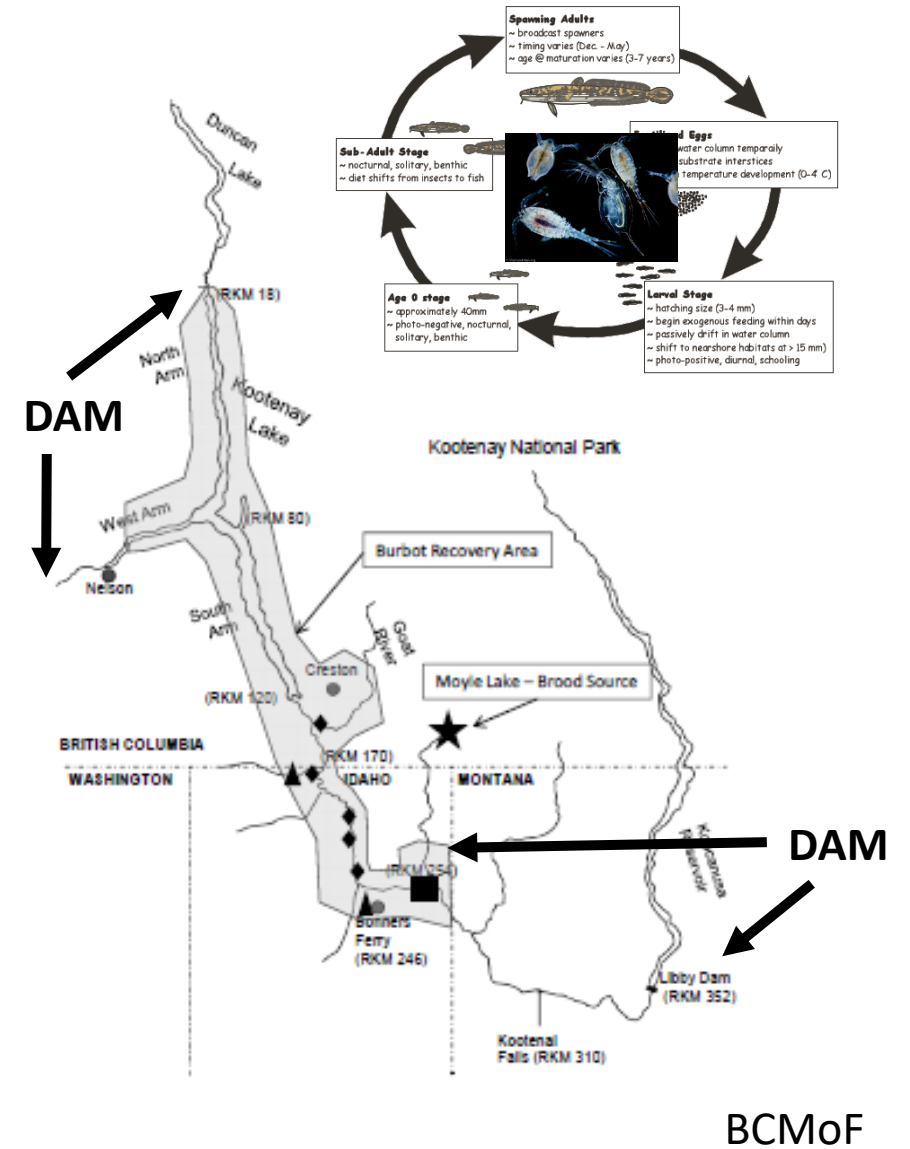


Shaded area = Recovery area

KTOI Fish Restoration

Some general considerations:

1. Other species may be considered in restoration efforts alongside with habitat restoration program(s)
2. Releasing hatchery fish in habitat restoration areas
3. Each release effort (#s) needs to be “enough” to support population rebuilding...
 - ex. lots of eggs vs. few juveniles
 - ex. 2017 released 7M larvae in a cold high flow river condition = no survival

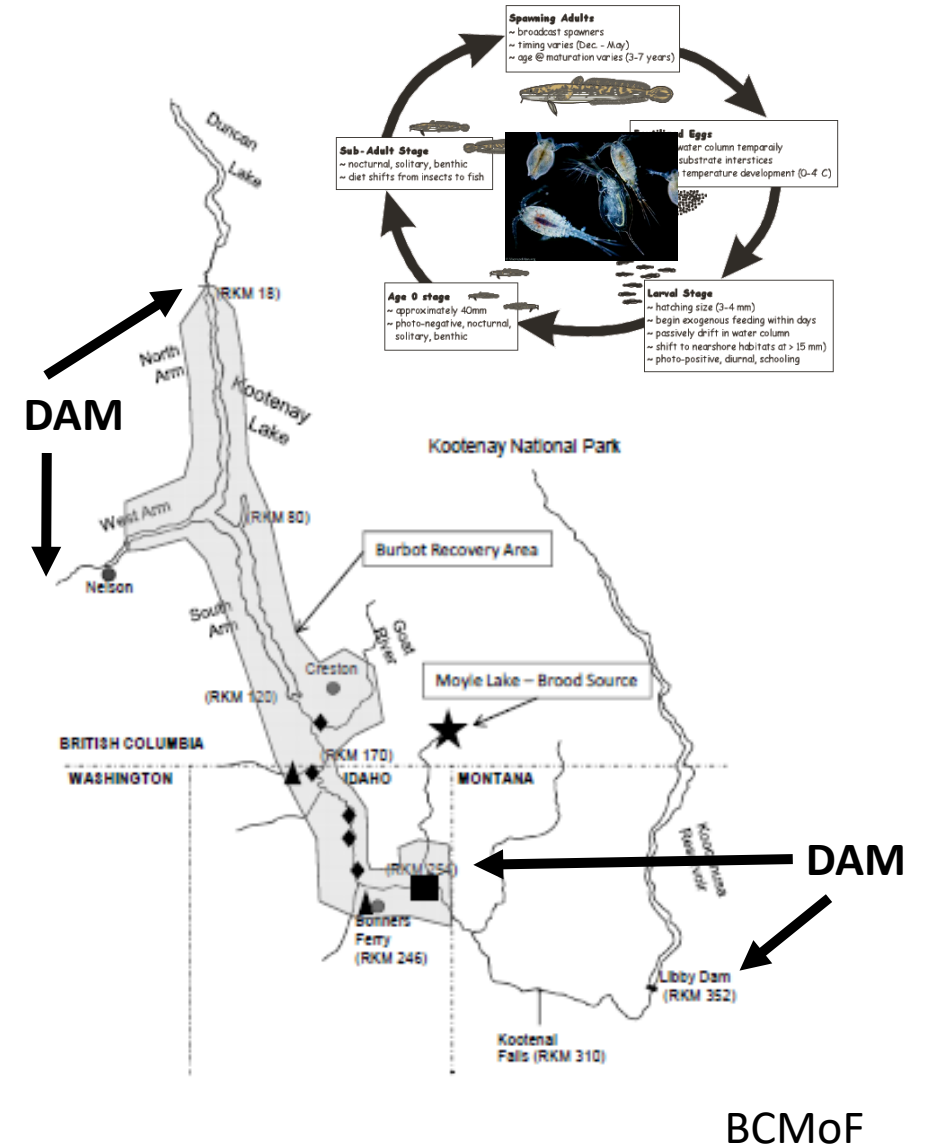


Shaded area = Recovery area

KTOI Fish Restoration

Other general considerations:

1. This is a multi-phase, transboundary, multi-agency program (KTOI, BC, MFWP, IDFG, USACE, USFWS, USDA, CFIA, Uofi, KVRI, BPA)
2. Tag/release strategies (Co-manager agreements)
3. Post-release survival, M&E (IDFG, BCMOF, KTOI)
4. Spontaneous Autopolyploidy (SA) in the river (chromosome abnormality of Sturgeon)



Shaded area = Recovery area

KTOI Rearing Strategies – Sturgeon Ploidy (2021YC)

Code	Tested	12N	Ploidy	Fate
3F82	30	10	33%	Test/Sort
F954	30	0	0%	Release
629B	30	8	27%	Test/Sort
2B94	30	0	0%	Release
6015	30	0	0%	Release
AC62	150	1	0.6%	Release
49F6	30	1	3%	Release
18C4	30	1	3%	Release
A788	30	2	7%	Release
60B9	30	15	50%	CULL
2F14	30	0	0%	Release
1B31	30	25	83%	CULL
49A9	30	9	30%	Test/Sort
E5C5	30	17	56%	CULL
Totals	540	89	Ave 16%	

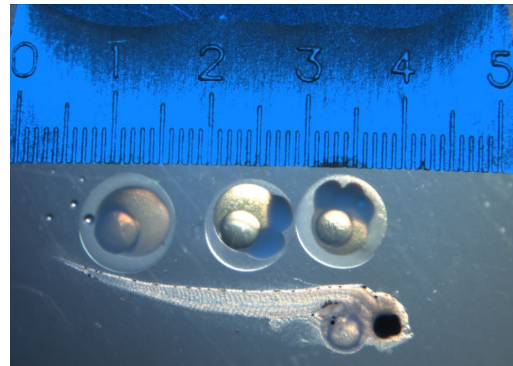
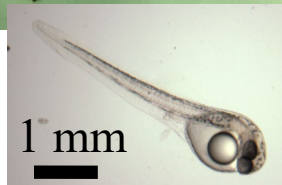
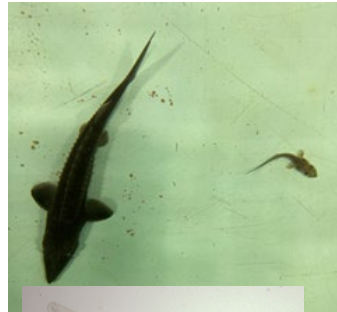


Table 6. In KTOI 2022 Hatchery Management Plan for KRWS

KTOI Rearing Strategies

1. KTOI only raises fish from Egg to Juvenile (no rearing to maturity)
2. Juveniles: 3mo, 6mo, 8mo
 - (egg take dependent)
3. 10-11mo for WST (Accelerated growth, release in SPRING!...)

Life Stages	Sturgeon*	Burbot
Fertilized eggs	Yes	Yes
Eyed Eggs	No	Yes
Pre-feeding Larvae (Yolk-sac Larvae*)	Yes	Yes
Feeding Larvae	Not yet	Yes
Juveniles (3 mo)	No	Maybe
Juveniles (6 mo)	No	Maybe
Juveniles (8 mo)	No	Maybe
Juveniles (11 mo)	Yes	No
Adult	No	No



KTOI Release Strategies

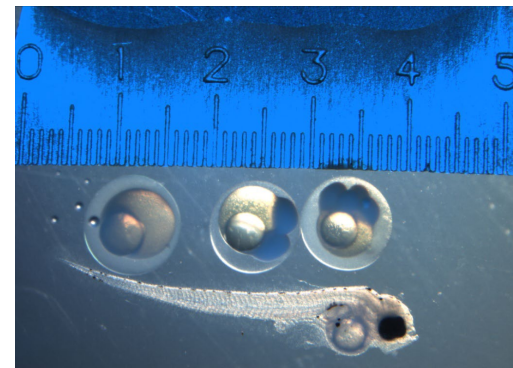
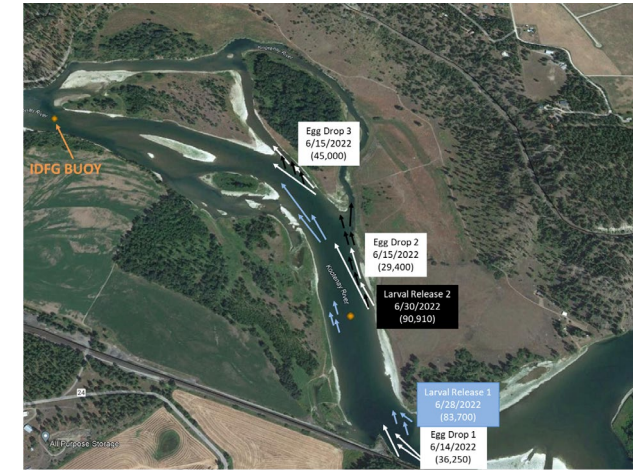
1. Release near cover to aid in transition
2. Release in “Family Groups” to support RM&E studies
3. Parental Based Tagging (PBT)



Littoral zones



Open water

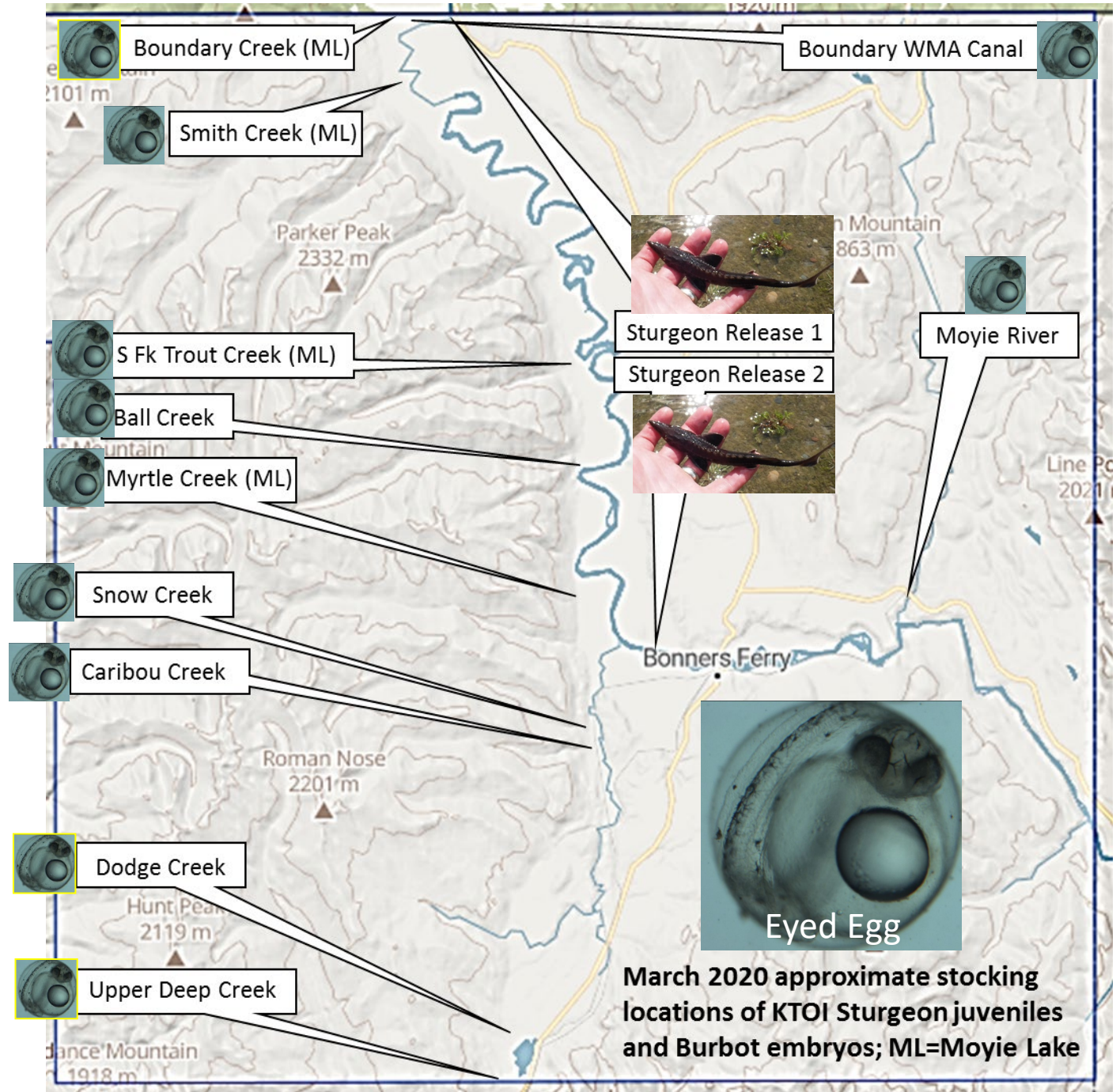


Multiple Life Stage Releases (PBT!)

Example Release 2020

Burbot eyed-egg and Sturgeon Juvenile releases:

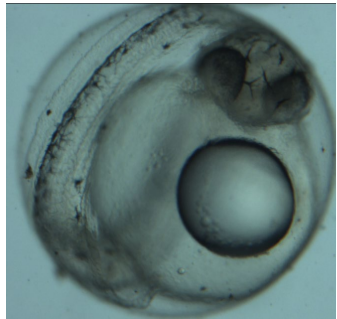
- Result of PANDAMNIT! Shutdown...
- Example of adaptive management and flexibility needed for program to proceed
- Note two egg sources...last year for Moyie Lake (~28M released)
- ~2100 Juvenile Sturgeon (2019 YC) Released



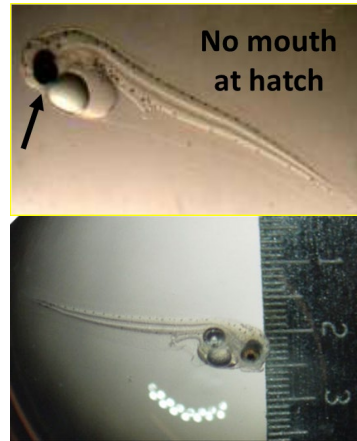
Early life releases now a major component of program - Burbot

1. Being used as tool to support:

- Annual production
- Habitat evaluations
- Investigate Recruitment bottlenecks



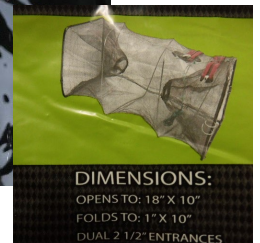
Egg/embryo releases



Pre- and post-feed larvae released



Select habitat locations



DIMENSIONS:
OPENS TO: 18" X 10"
FOLDS TO: 1" X 10"
DUAL 2 1/2" ENTRANCES

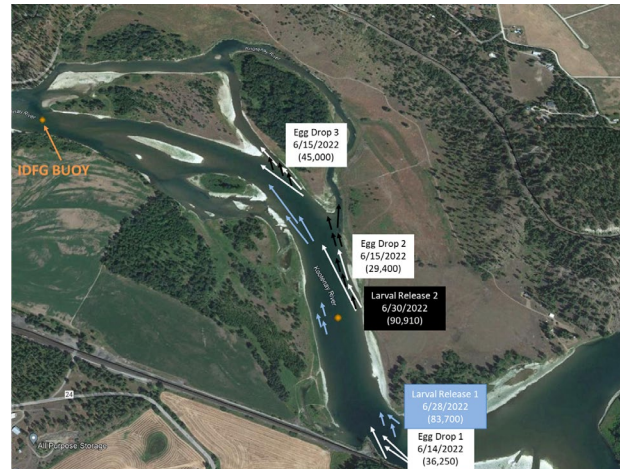
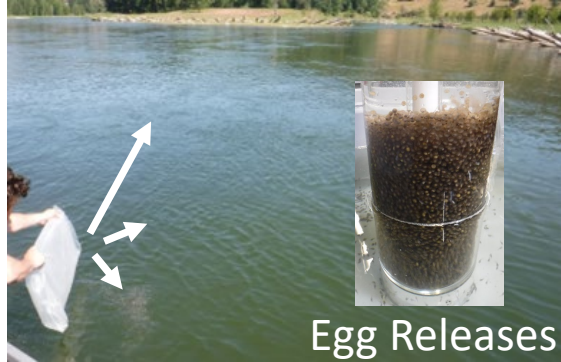
KTOI minnow trap surveys and IDFG M&E program used to verify survival using Parental Based Tagging (PBT)

2. Fertilized egg releases now part of program

Early life releases now a major component of program - Sturgeon

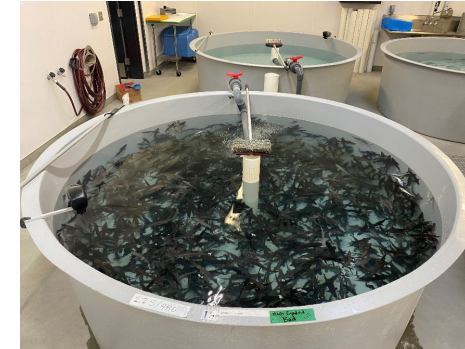
1. Being used as tool to support: *NEW IN 2022*

- Annual production
- Habitat evaluations
- Investigate recruitment bottlenecks



Release Eggs and Larvae in Critical Habitat –
Kootenai River

Cull Tank Example



Release Tank Example
(High Graded, Accelerated Growth)



Select* juveniles going to Lake (BC),
pending in 2023

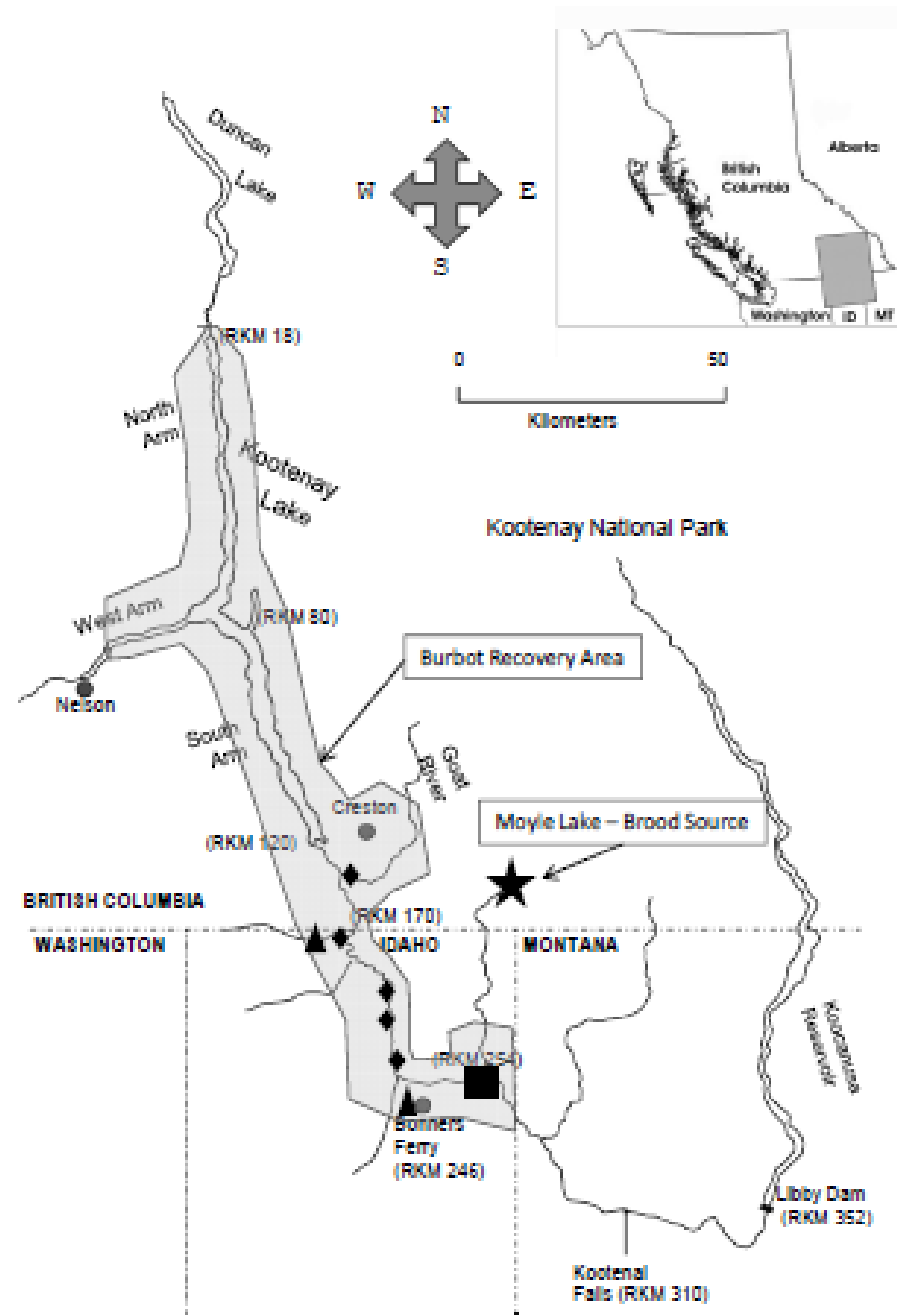
*Select includes “high graded, low 12N Ploidy...”

2. Egg/Sac-Fry releases began in 2022

3. Culling, high grading, SA removal, limited release numbers

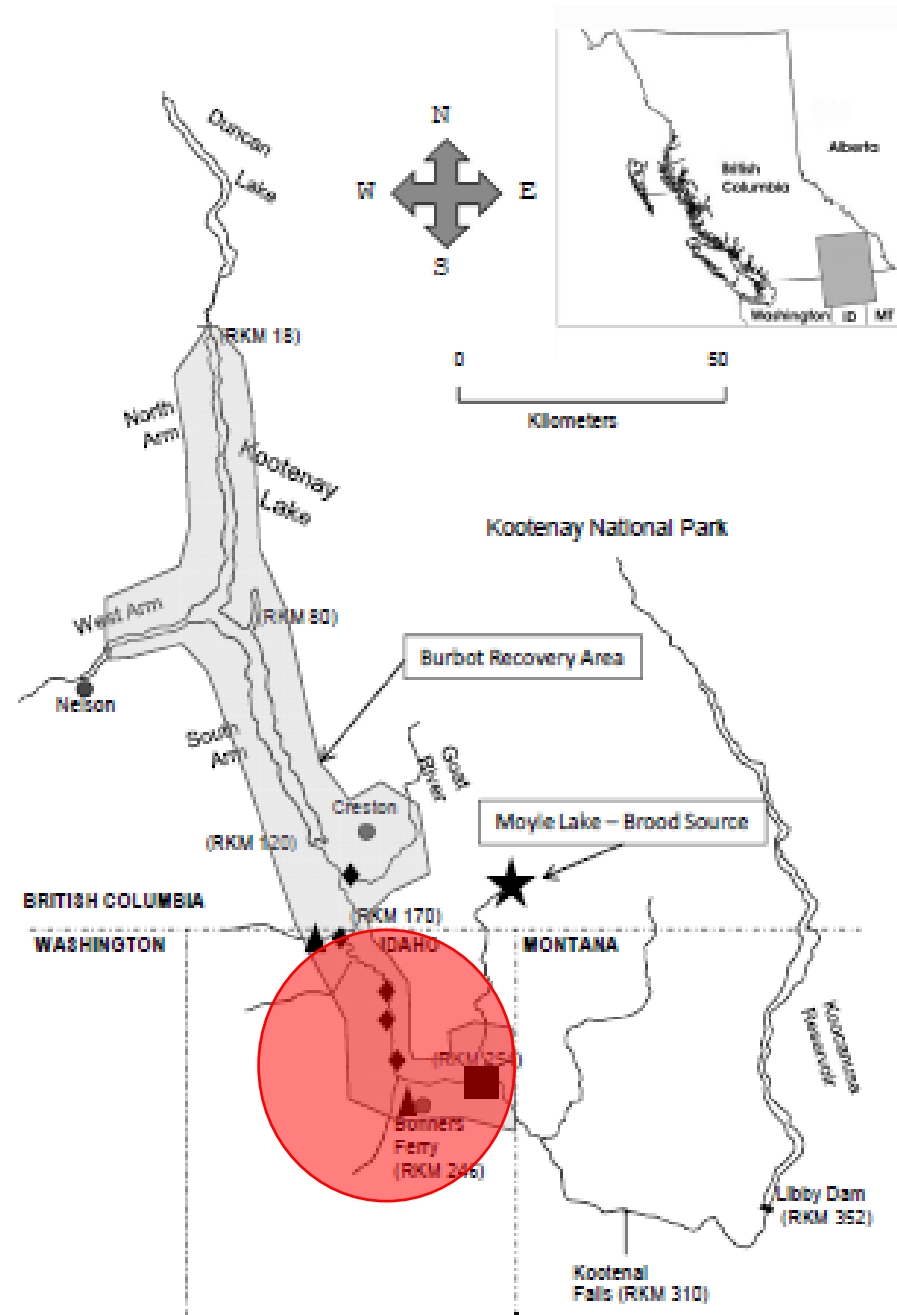
Recovery area and Release areas

*Note disproportion of recovery area in Ca compared to US...No shade in MT



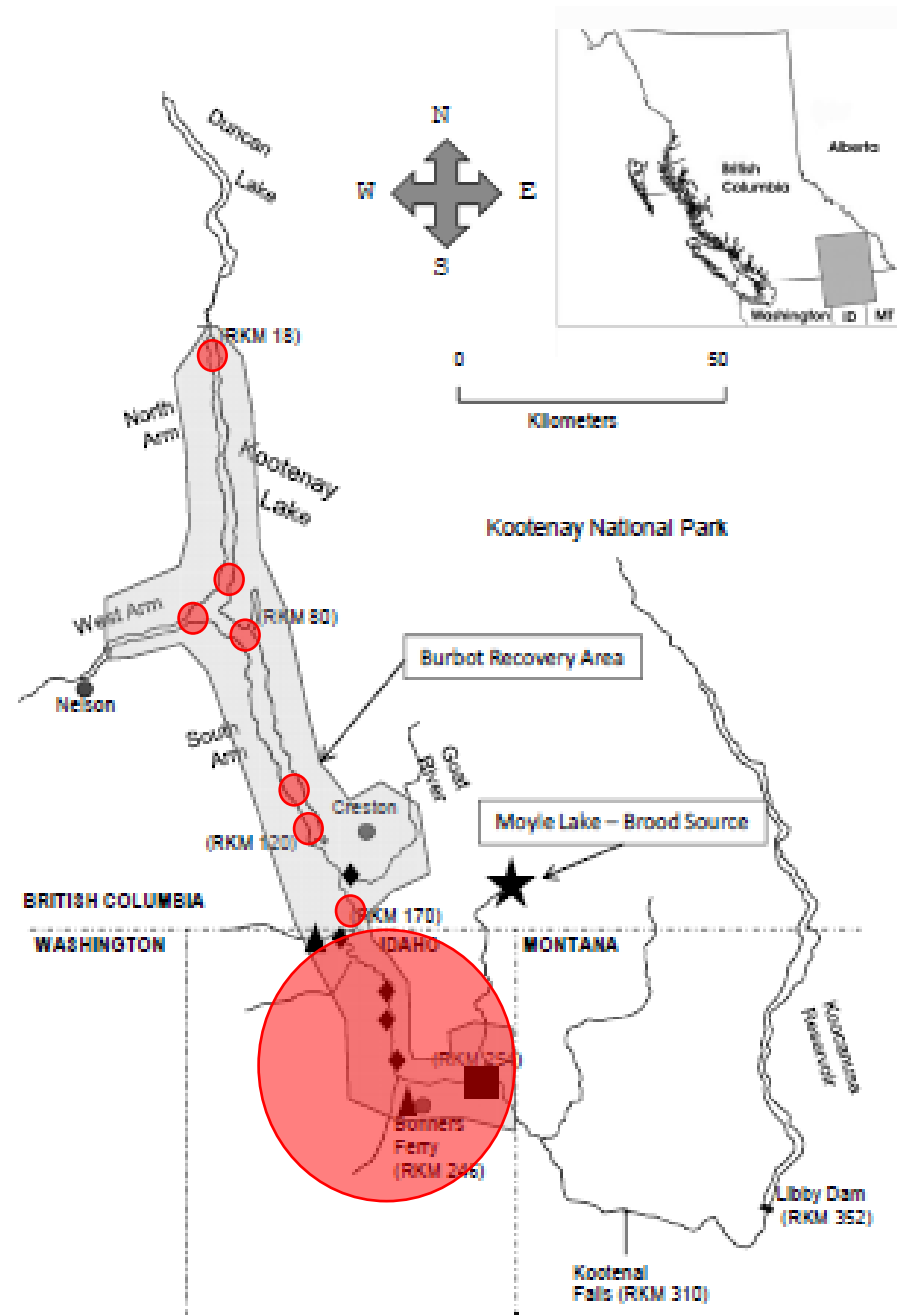
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Recovery area and Release areas

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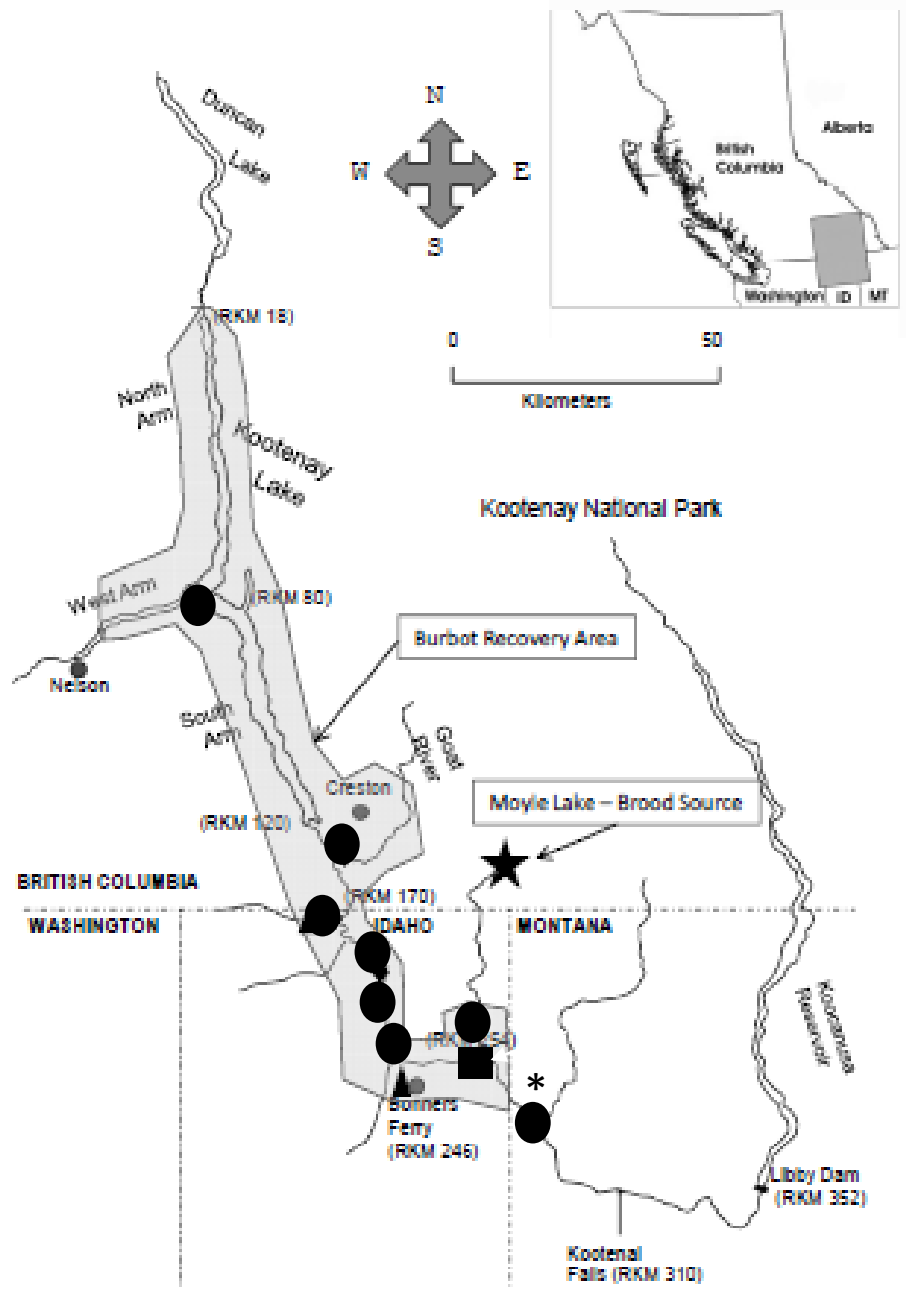


Release Locations Continued

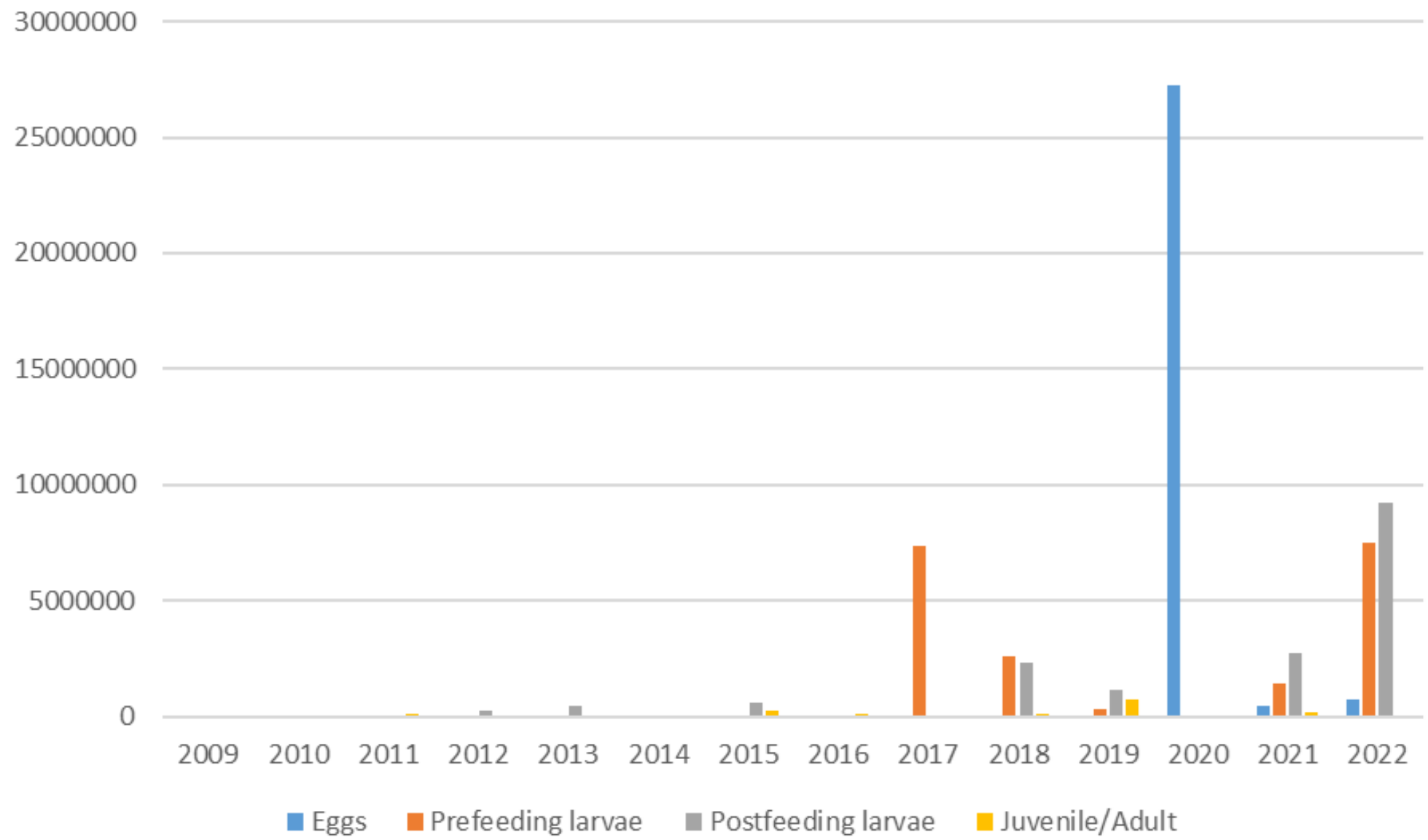
Primary Burbot/Sturgeon* Stocking Sites

- Kootenay Lake
- Goat River
- Boundary Cr (Porthill)
- Ferry Island
- Deep Cr
- Ambush Rock
- Moyie River

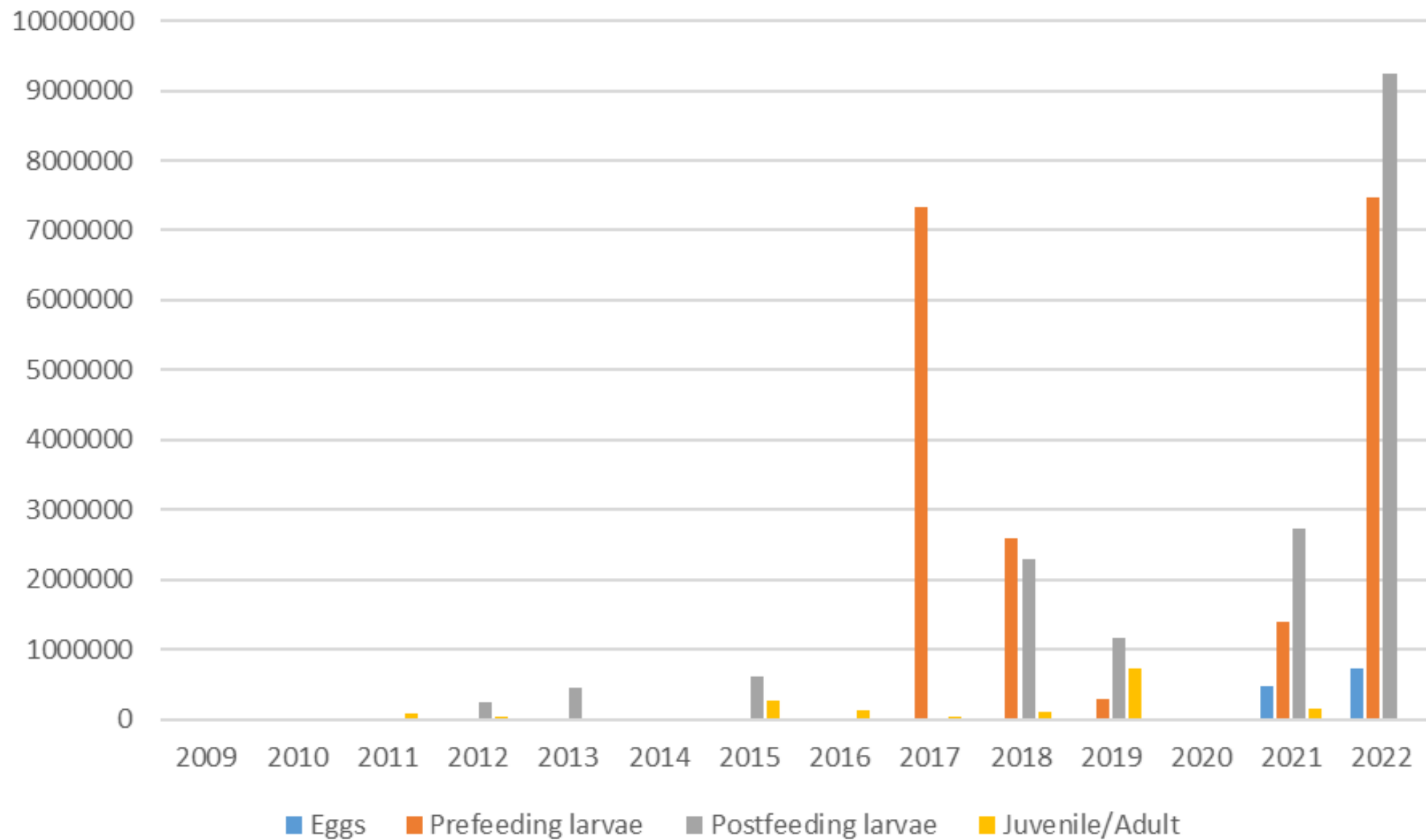
- Other/New: Off channel habitats, KTOI properties, habitat rehab. areas, KNWR?



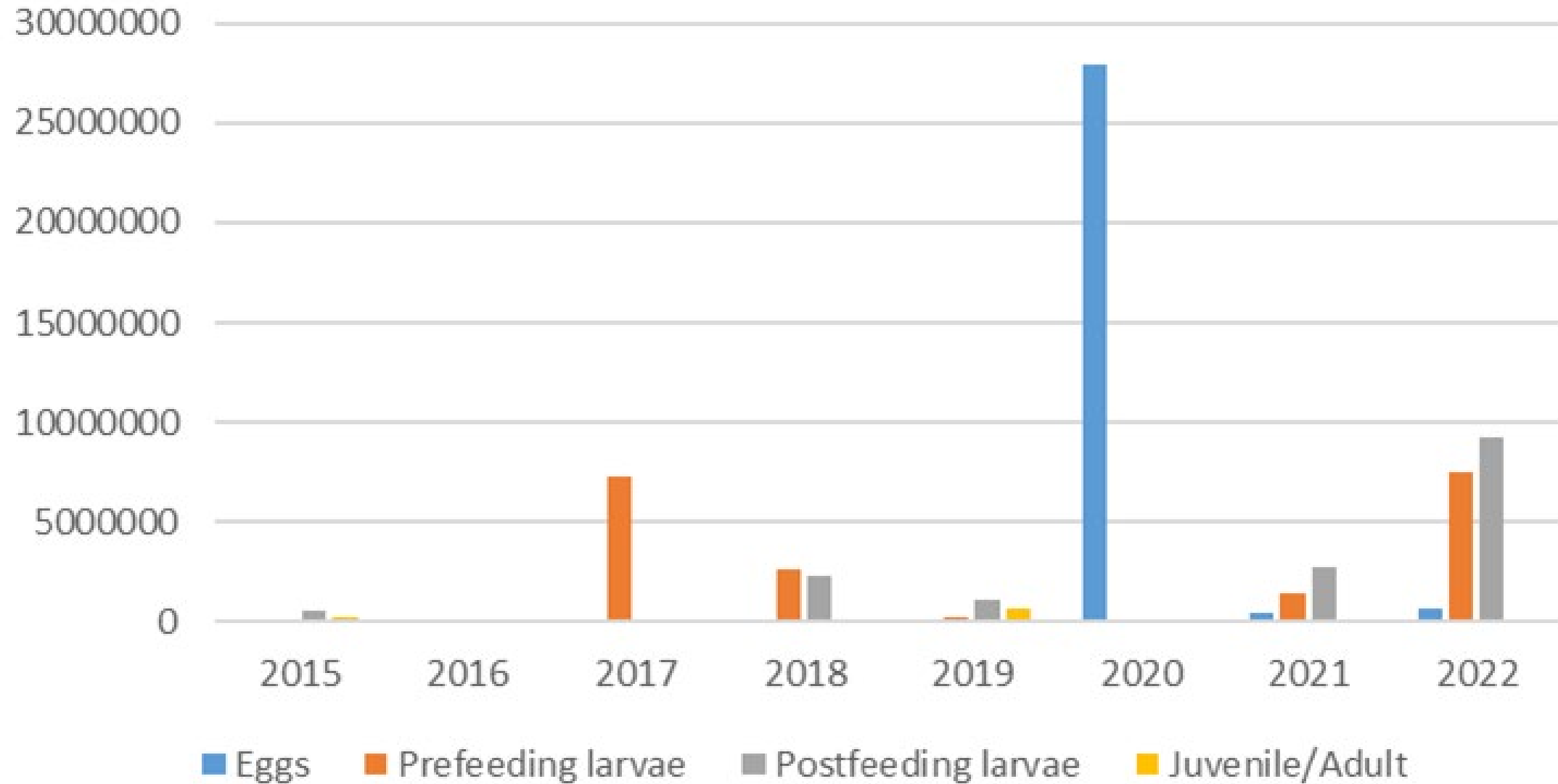
2009-2022 Burbot Releases



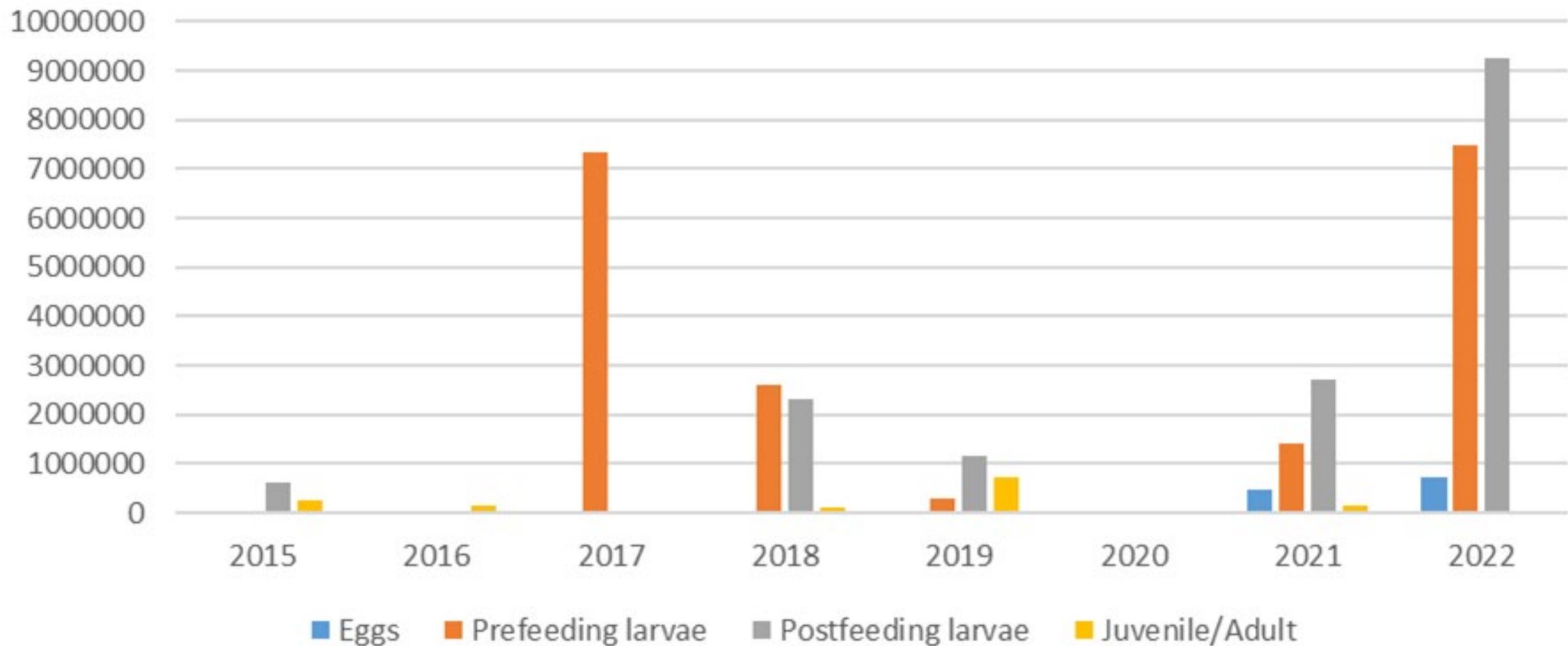
2009-2022 Burbot Releases (Pandemic Removed)



KTOI 2015-2022 Burbot Releases



KTOI 2015-2022 Burbot Releases (Pandemic Removed)



General Sturgeon Releases – over the decades

1. Multiple hatcheries

- KT (KTOI 1)
- KH (BC (no longer used))
- TR (KTOI 2)

2. Multiple rearing and release strategies

- Accelerated growth, High grading
- Larger size at release (Spring, with warming water)

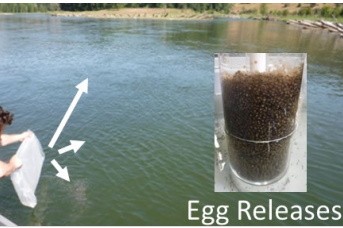
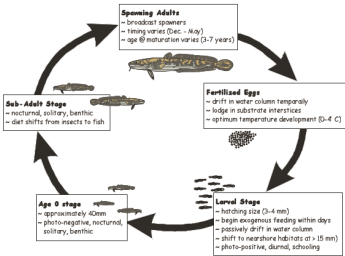
3. Marking and tagging varies

4. New reality - SA, in-river removals and production reduction...

Year class	Rearing facility	Release number		Mean total length (mm) (SD)	Mean weight (g) (SD)	Release season & year
		Tagged	Untagged			
1990	KT	14	0	457 (53)	321 (112)	Summer 1992
1991	KT	104	0	255 (17)	66 (13)	Summer 1992
1992	KT	123	0	483 (113)	549 (483)	Fall 1994
1995	KT	1,075	0	228 (27)	47 (17)	Spring 1997
1995	KT	884	0	344 (44)	148 (64)	Fall 1997
1995	KT	96	0	411 (68)	288 (138)	Summer 1998
1995	KT		0	582 (40)	863 (198)	Summer 1999
		25				
➡ Cut 1995-2000						
2000	KT	2,286	0	244 (39)	64 (31)	Fall 2001
2000	KH	1,654	0	240 (23)	58 (16)	Fall 2001
2000	KH	2,209	0	283 (29)	99 (30)	Spring 2002
2000	KH	30	0	365 (14)	195 (20)	Summer 2002
2000	KT	214	0	409 (54)	294 (110)	Fall 2002
2000	KT	907	0	333 (36)	193 (63)	Jan. 2003
2000	KT	10	0	558 (28)	88 (18)	Feb. 2004
2000	KT	3	0	662 (61)	425 (66)	Summer 2006
➡ Cut 2001-2015						
2015	KT	0	10,381	--	7	Spring 2016
2015	TR	14,450	0	233 (37)	54 (28)	Spring 2016
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			6,350			
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2019	KT	0	0			
2020	No Year Class – Research only due to COVID-19					
Subtotal		187,181	128,727			
Total		315,908				

Review of General RM&E Results of Hatchery Fish In-River

In-River	Sturgeon	Burbot
Post Release Survival	Yes	
Dispersal	Good	
Pop. Abundance	Good?	Supports Fishery
Pop. Structure	Multiple year classes represented	
Growth	Variable	Good
Spawning	Fish maturing, some spawning	
Recruitment	Unknown	Low level
Genetics	Maximizing broodstock contributions in-hatchery	



Again, now have PBT – game changer for post release RM&E...

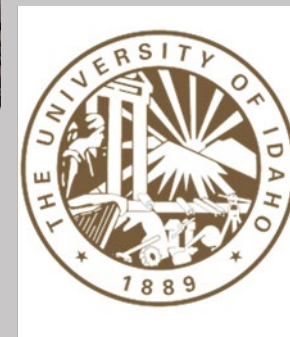
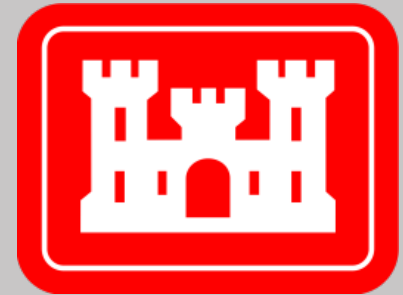
Future topics....

KTOI programs will continue to monitor ecosystem and hatchery-reared fish response to:

- Hydro-operations alternatives
- Large-scale physical habitat restoration and nutrient addition
- Pollutants in the system - Dr. Shawn Young....



Kootenai Valley Resource Initiative
Kootenai Tribe of Idaho Fisheries and Wildlife Program
Bonneville Power Administration (FUNDING)
Northwest Power and Conservation Council
BC Ministry of Forests, Lands & Natural Resource Operations
Idaho Department of Fish and Game
Montana Fish Wildlife and Parks
United States Army Corps of Engineers
United States Fish and Wildlife Service
United States Geological Survey
Idaho Department of Environmental Quality



Ministry of Forests,
Lands & Natural
Resource Operations