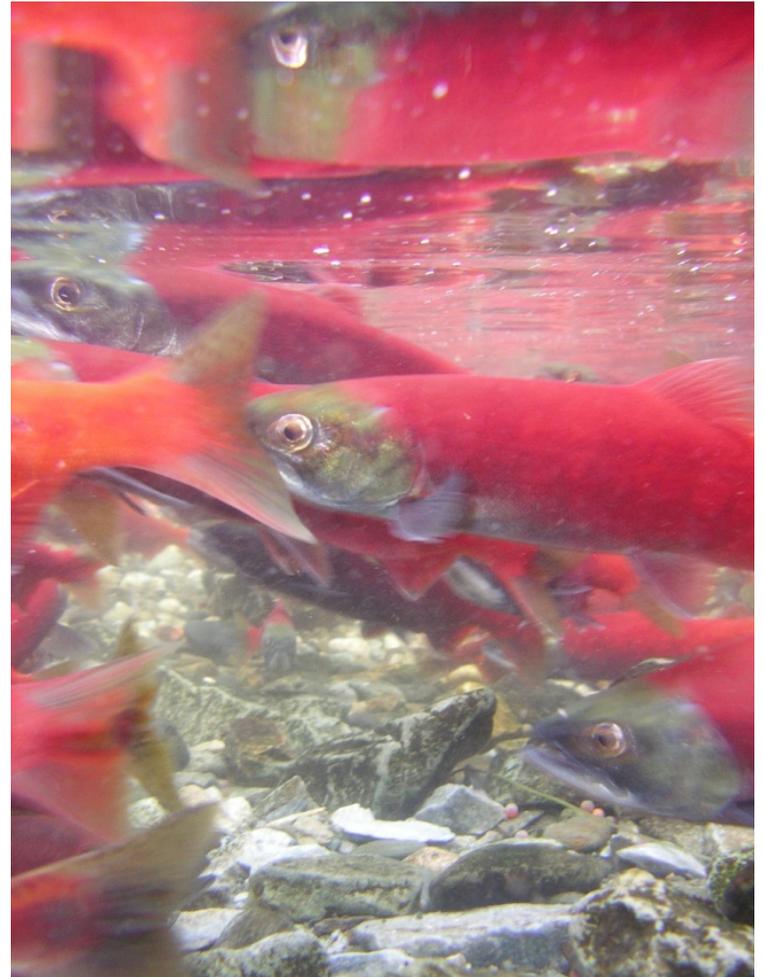




Kootenay Lake Kokanee and other Fish – 2017 Status

**Friends of Kootenay Lake
5th Annual Kootenay Lake Summit
November 2017**

Matt Neufeld and Jeff Burrows
BC Fish and Wildlife – Nelson



Outline – Kootenay Lake Fish 2017

1. Kootenay Lake Kokanee – the basics
 - what are they? why are they here? life cycle?
2. Importance of Kokanee – a keystone species
3. Kokanee Status **and Key Recovery Actions**
4. Other fish:
 - Gerrard Rainbow Trout
 - Bull Trout
 - Burbot and White Sturgeon
5. Summary and Questions

Local Kokanee: the basics

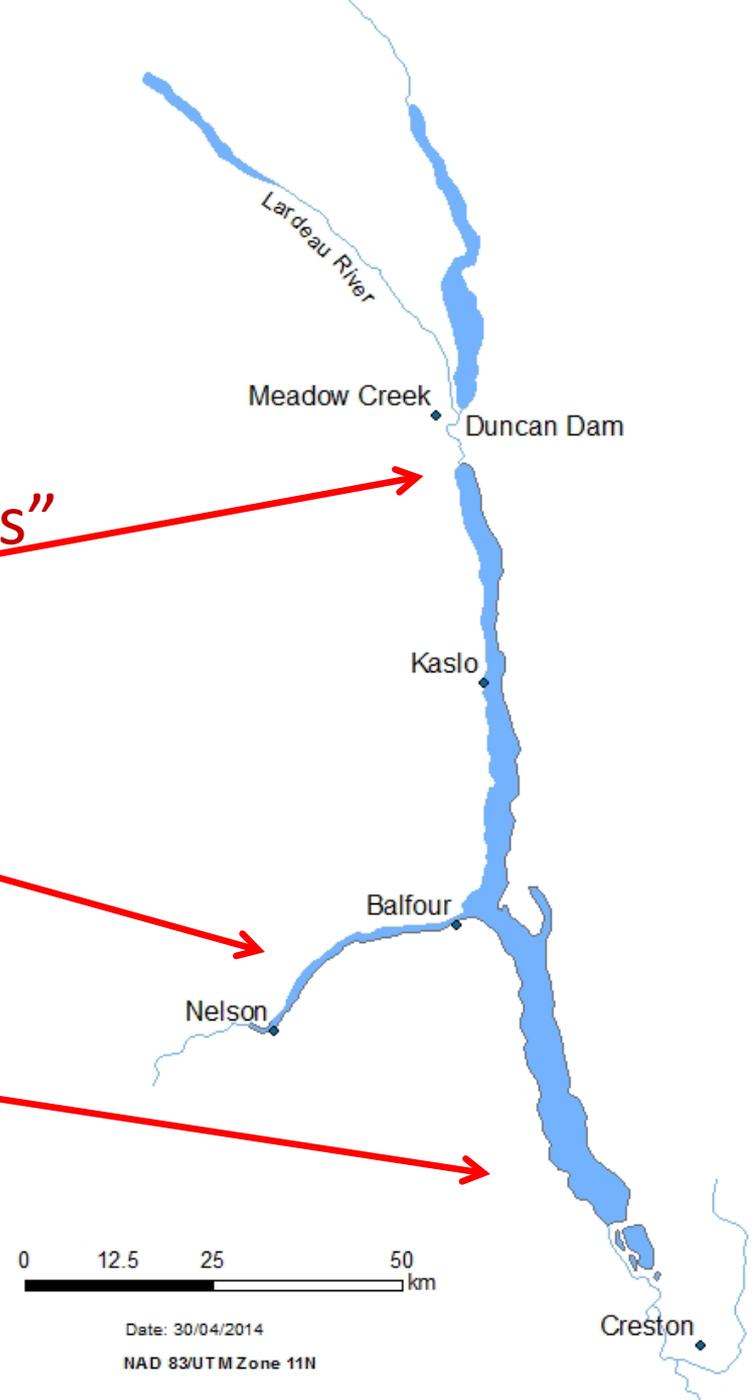
- Kokanee are landlocked sockeye salmon: *Oncorhynchus nerka*
- Present in Kootenay Lake since glaciers melted (~9000 to 12000 years ago)
- Sockeye salmon (and many other fish) colonized Kootenay Lake when it was much larger due to melting glaciers
- Sockeye then, that did not emigrate to Pacific for feeding, became kokanee
- Soon after, as large glaciers melted, Kootenay Lake became much smaller and Bonnington Falls appeared (about 9000 years ago)
- These falls blocked access to the ocean and isolated kokanee from sockeye – since then only the kokanee form of the species is in Kootenay Lake
- Instead of crustaceans in the Pacific Ocean, kokanee eat crustaceans in lakes: mature size depends on feeding conditions

Kokanee: more basics

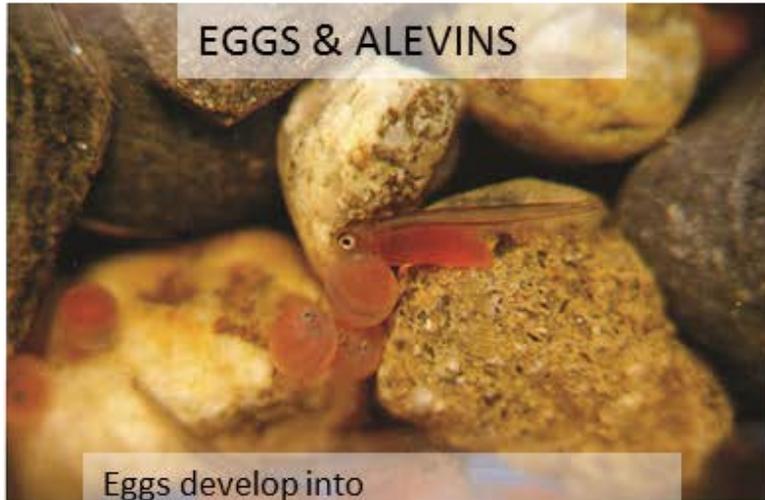
- In the lake kokanee school together for protection from predators, and efficiently feed on microscopic crustaceans (“zooplankton”)
- Kokanee mature at 2 to 5 years old (South and West Arm kokanee at 3, North Arm at 4)
- Females dig depressions in the gravel (redds) in which they lay 200 - 1000 eggs that a male (or males) fertilize
- Fall spawners, die after spawning

Types of Kootenay Lake Kokanee

- Over 10000 years, local adaptations occurred
- Today we know of 4 “stocks”
- North Arm
- West Arm
 - Stream
 - Shore
- South Arm



Kokanee Life Cycle



EGGS & ALEVINS

Eggs develop into alevins during the winter.



FRY

By spring the alevins have matured into fry, about 25 mm long, and are ready to leave the spawning channel (imprinting).



ADULT SPAWNERS

Adult spawners return to streams or suitable shoreline locations to deposit their eggs.



FRY AND JUVENILES

Fry and juveniles feed and mature in Kootenay Lake

Kokanee importance – a keystone species





Large fish and their anglers



Endangered Species

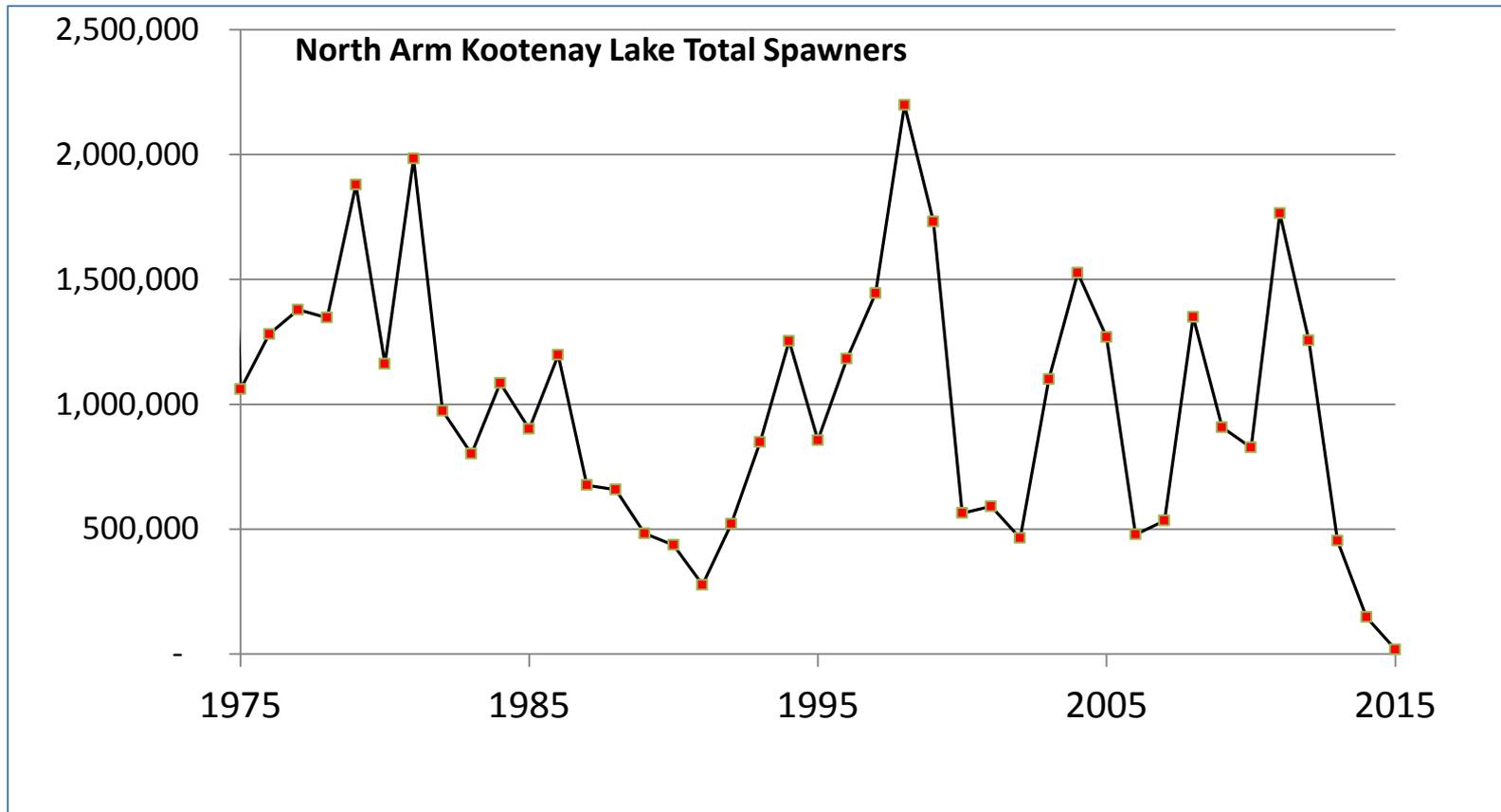


Other beneficiaries

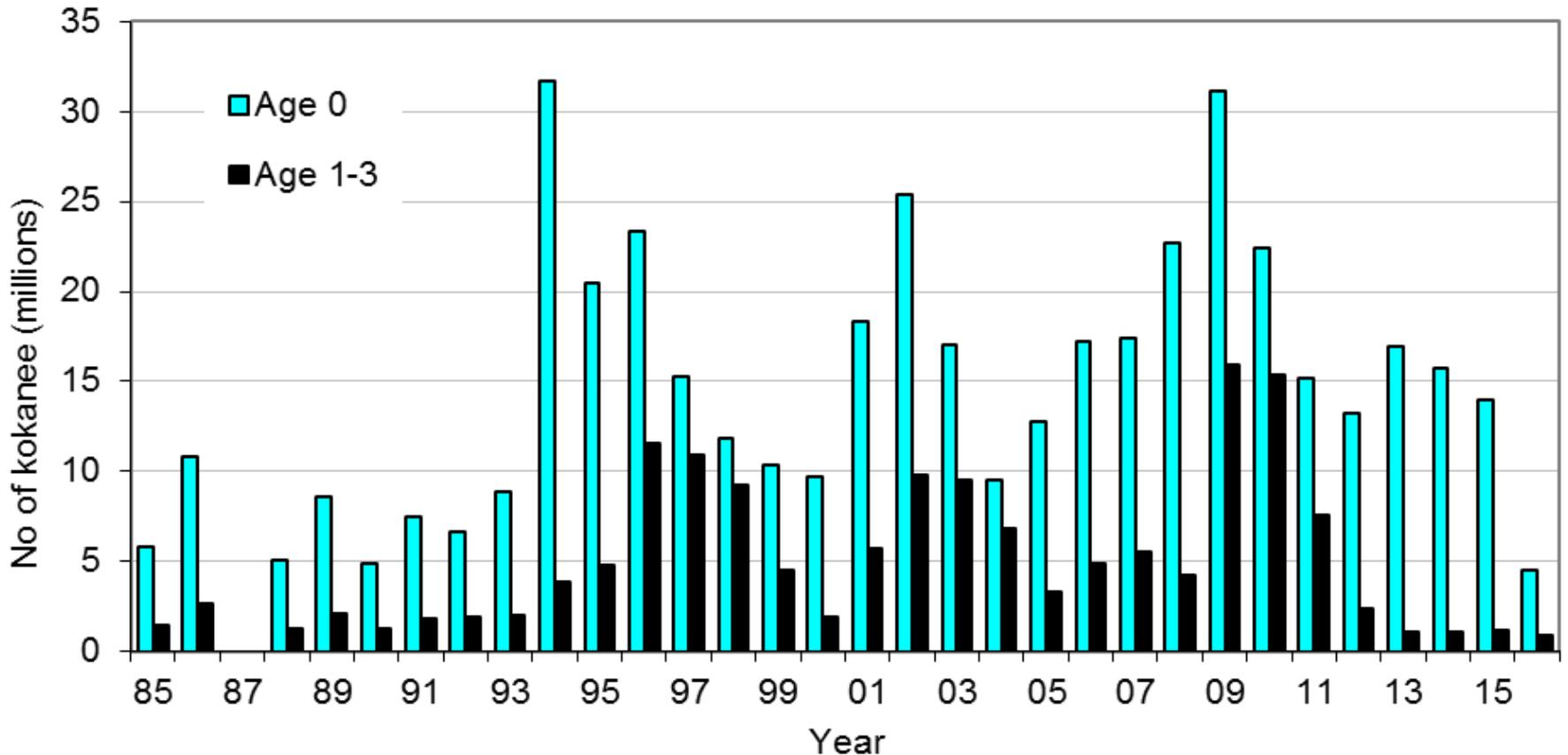
- Kingfisher, blue herons, gulls, ravens, crows, turkey buzzards, eagles, American dippers and many other birds
- Otters, raccoons, grizzly bears and other mammals
- Sculpin, whitefish, and many other fish
- Fungus and bacteria decompose dead kokanee, which releases nutrients to streams and adjacent riparian areas, benefitting plants (algae, trees, etc)
- Nutrients from these kokanee provide nutrients at the base of the food web help feed young rainbow trout and bull trout that rear in these streams; and some ends up back in the lake to add to lake productivity

North Arm Kokanee spawners

Year	Spawners
2015	18000
2016	41000
2017	12000



Main Lake Kokanee: in-lake September survey



Preliminary 2017 results – 10 million fry; 500,000 1 to 3 year olds

South Arm Kokanee spawners

Year	Crawford	Boulder	Goat	Summit	Midge
2006	0	0	0	1	
2007	8	0	0	0	
2008	0	0	0	0	
2009	22	0	187	114	
2010	0	0	0	0	
2011	575	0	274	203	
2012	57	3	1441*	315	
2013	2	0	100	1	
2014	0	0	34	3	
2015	36	0	235	10	
2016	260*	0*	2386*	14*	158*
2017	504*	0	59*	0	378*

* = entire tributary counted to barrier; others are spot counts

West Arm spawners

Year	Kokanee Creek	Redfish Creek	Other Creeks	Shore spawners	Total
2007	7,429	8,364	1,748	238	17,779
2008	11,450	15,198	8,336	520	35,504
2009	14,671	13,246	4,688	2,718	35,322
2010	8,236	13,220	3,572	115	25,143
2011	4,798	6,347	3,735	738	15,618
2012	13,953	4,259	4,109	2,078	24,398
2013	18,962	19,747	5,181	0	43,890
2014	5,008	5,903	2,439	345	13,695
2015	6,104	1,260	1,571	1,108	10,042
2016	5,786	1,416	1,119	933	9,253
2017	14,400	5,653	2,508	4,168	26,729

Does not include harvest!

Kootenay Lake Kokanee Status - **2017**

Stock	2017 Status
South Arm Kokanee	Functionally extinct for decades, Midge Creek remnant (400) ? Total of 1500 spawners
North Arm Kokanee	Temporarily collapsed; 12,000
West Arm Shore Spawners	Small but persisting spawning population; 4000
West Arm Stream Spawners	Varying abundance, but stable; 23,000

West Arm harvest = 8800

Main Lake harvest = 0

Main Lake Kokanee

Key Recovery Actions

- Primary recovery tools available to managers
 - supplementation of Kokanee eyed eggs and/or fry
 - ensure that lake conditions support Kokanee survival through continued nutrient additions
 - sport fishing regulations that support recovery objectives.
 - 2015 Main Lake kokanee daily quota = 0
 - 2015 Rainbow trout daily quota = 4 (1 > 50 cm)
 - 2018 ?
- Kokanee spawner triggers:
 - Kokanee Spawners; > 65,000-140,000 limited benefit to kokanee stocking and re-opening of kokanee harvest possible

2015-17 Kokanee Supplementation



- 17 million eggs – fall transplants
- 800 thousand spring fry released

Eyed egg transplants

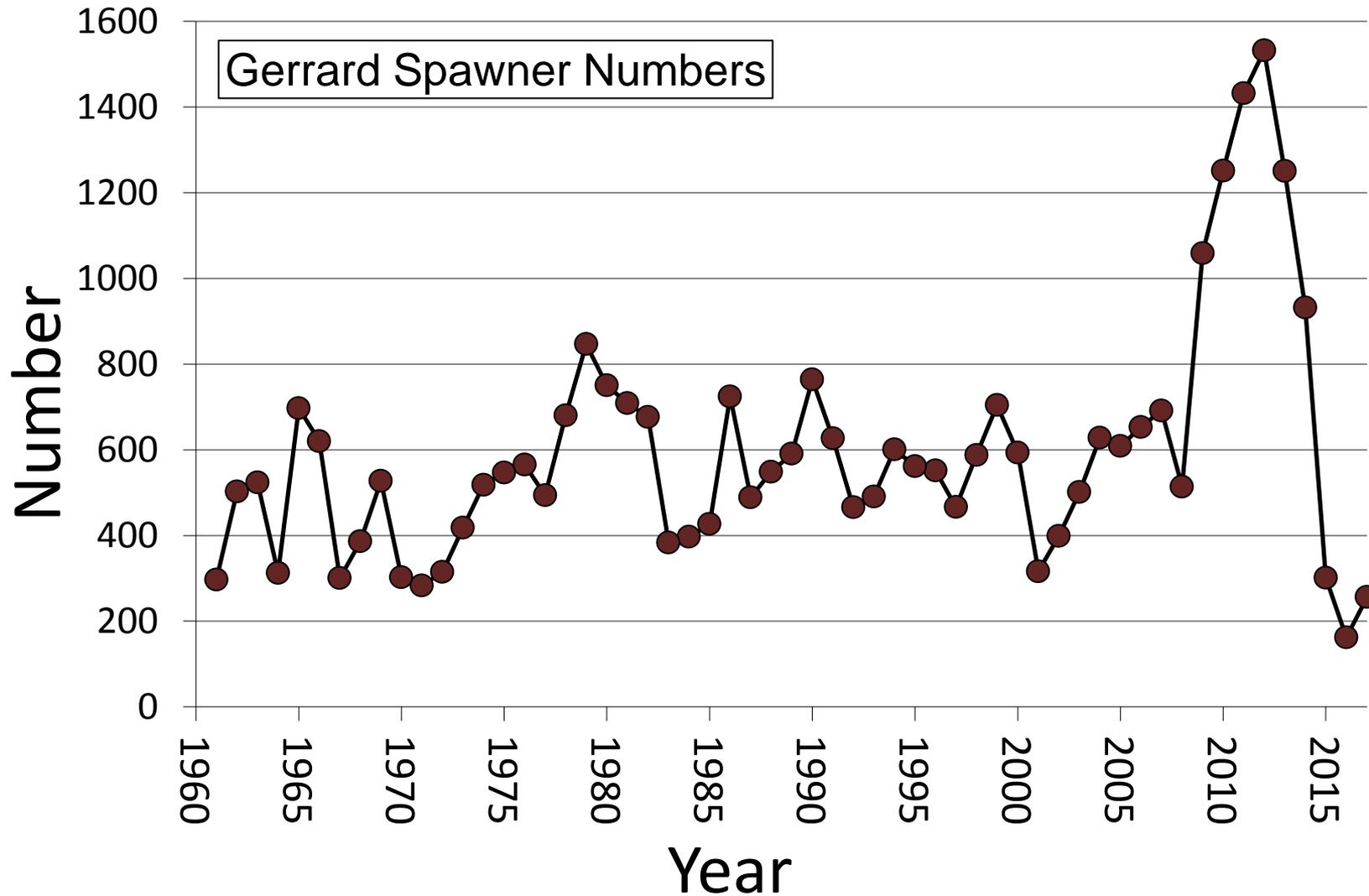


Crawford Creek – Nov 2, 2017

150,000 kokanee eggs



Gerrard rainbow trout



Gerrards are 80% of all rainbow trout in Kootenay Lake, even now

Kootenay Lake Bull Trout Status

Year	Bull trout spawners
2011	4200
2013	3300
2015	1150
2017	2700



Joel Sartore/National Geographic Stock
with Wade Fredenberg

Recovery of white sturgeon and burbot

- International habitat and recovery partnership
 - Idaho Fish and Game, BC Ministry, Kootenai Tribe of Idaho and Montana Fish Wildlife and Parks
 - Bonneville Power Administration – funding and Libby Operations (US Corps of Engineers)
 - University of Idaho, UC Davis, and others – research partners
- White sturgeon – federally listed as endangered
- Burbot – international conservation agreement
- Recovery needs
 - Recruitment failure – egg to juvenile survival failure
 - Hatchery supplementation until addressed



Kootenay Lake burbot

Past

- 20,000 harvested a year (until mid 1970s)
- <100 by year 2000
- 2005 = International Burbot Conservation Agreement signed



Present

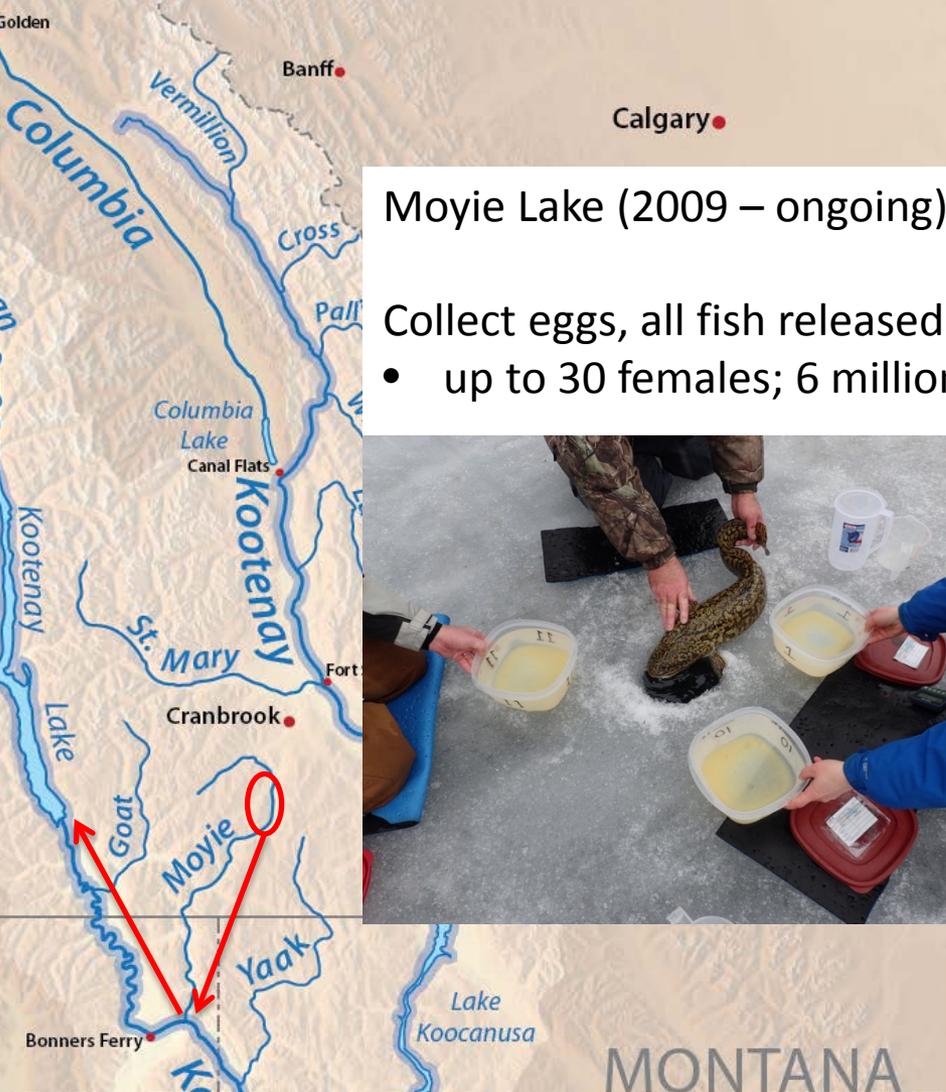
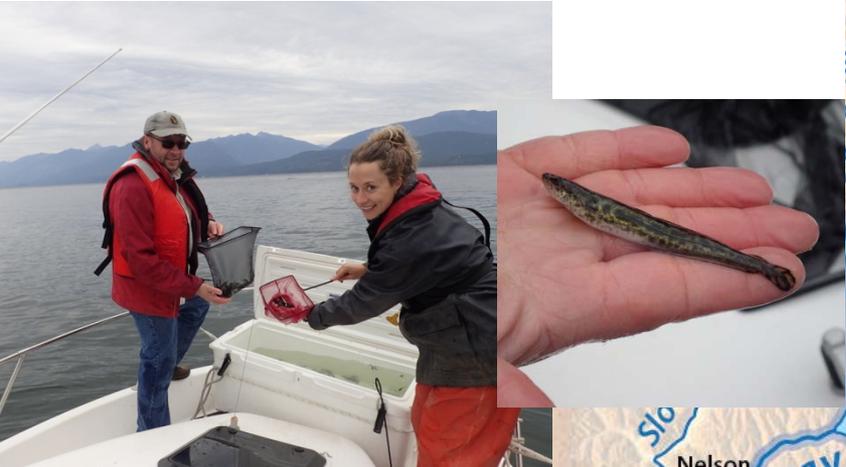
- No natural recruitment
 - Large adults captured at north end
- Hatchery program from Moyie Lake
 - > 90,000 juveniles released into Lake
 - River releases and monitoring ahead of Lake
 - potential for sport fishery in river
 - Hatchery fish in the Lake should be starting to show up in sampling and angling gear



Releases in BC and Idaho

BC FLNR and IDFG

- 90,940 into Kootenay Lake
(6 month +)



Mojie Lake (2009 – ongoing)

Collect eggs, all fish released

- up to 30 females; 6 million eggs



Kootenai Tribe of Idaho

Twin Rivers Hatchery

Main target = 6 months old

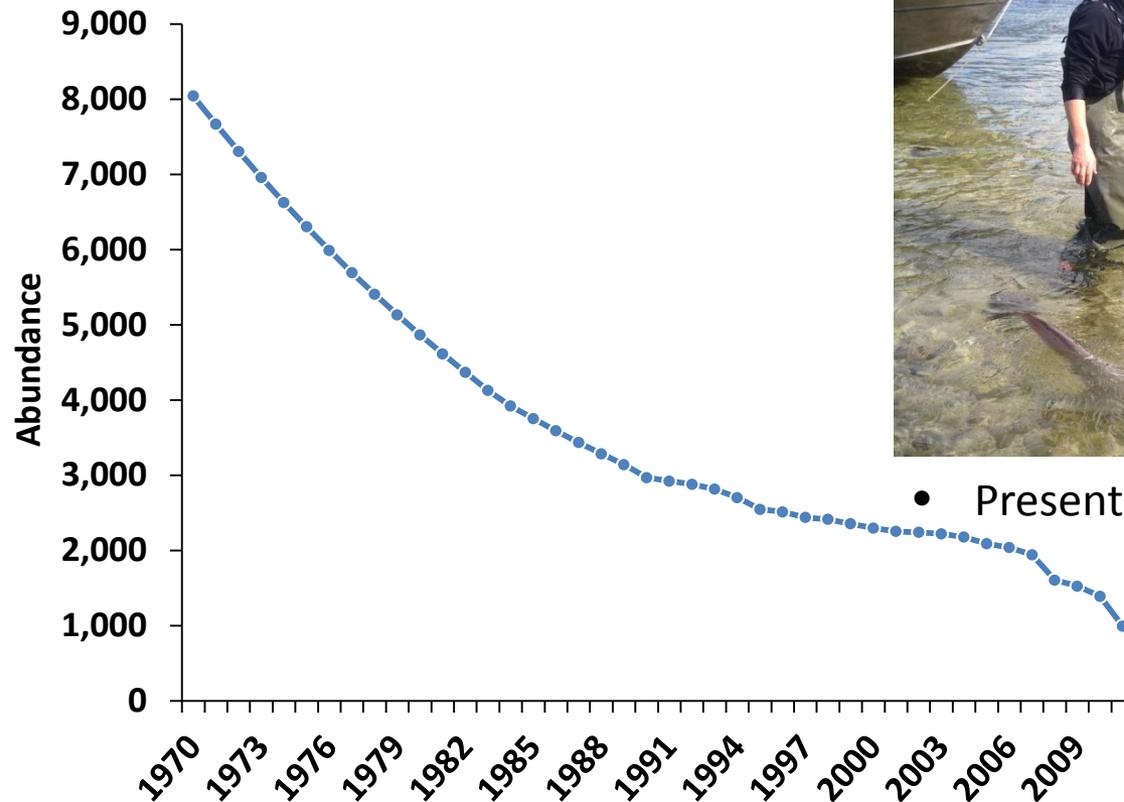
- ~2% egg to juv survival



Kootenay white sturgeon



White sturgeon wild adult abundance



• Present day = 1000 individuals

- Spawning age ~20-35 years, live over 80 years

White sturgeon – recovery actions

- Hatchery juveniles
 - Annual releases since early 1990s
 - ~290,000 released
 - Ongoing monitoring
 - Gill nets
 - >20,000 at large



- Addressing recruitment
 - Spawn near Bonners Ferry
 - Libby Flows – double peak in spring spawn
 - Limited by flood management
 - Habitat construction
 - Move sturgeon to better habitat
 - Build habitat where they spawn

No wild juveniles in nets to support a success - yet

Summary – Kootenay Lake Fish 2017

1. Kootenay Lake Kokanee – basic facts
2. Kokanee Status and Key Recovery Actions
 - Main Lake survival still too low
 - supplementation
 - restrict Kokanee, liberalize trout angling regulations
3. Other fish:
 - Gerrard Rainbow Trout 15% of peak
 - Bull Trout 65% of peak
 - Reduced abundance is one key to hastening kokanee recovery
 - Burbot and White Sturgeon – ongoing recovery

Kootenay Lake Questions



- Some slides for questions

Kootenay Lake Kokanee Status – IHN Virus

- Infectious hematopoietic necrosis virus (IHN) found for the first time in adult kokanee spawners at Meadow Creek in 2013 and again 2014 - 2017;
- West Arm stream spawners also infected
- Kokanee fry samples 2014 and Gerrard spawners testing indicated no viral infection
- Potential sources; migrating animal (e.g. birds), present in the past but undetected, introduced by a person/boat, or other possibilities.
- Disease (e.g. IHN virus) and parasites are rarely a major factor that affect wild population status- likely the case for Kootenay Lake:
 - no significant fish kills identified (2013 event, likely small impact -?)
 - adults have spawned successfully despite infection
 - egg to fry survival has remained normal (IHN typically kills fry)
 - levels of infected kokanee declining
 - rainbow trout not currently infected
- **IHN virus is not harmful to people**, and can't transfer to people by either touching or eating infected fish.

Kootenay Lake Kokanee Status – IHN Virus

- There is no practical way of completely controlling disease in wild fish populations
- We can limit virus at spawning channels where we have some control, and where practical
 - carcass removal
 - flushing
 - summer drying
 - kokanee testing will continue annually

Kokanee Spawning Channels

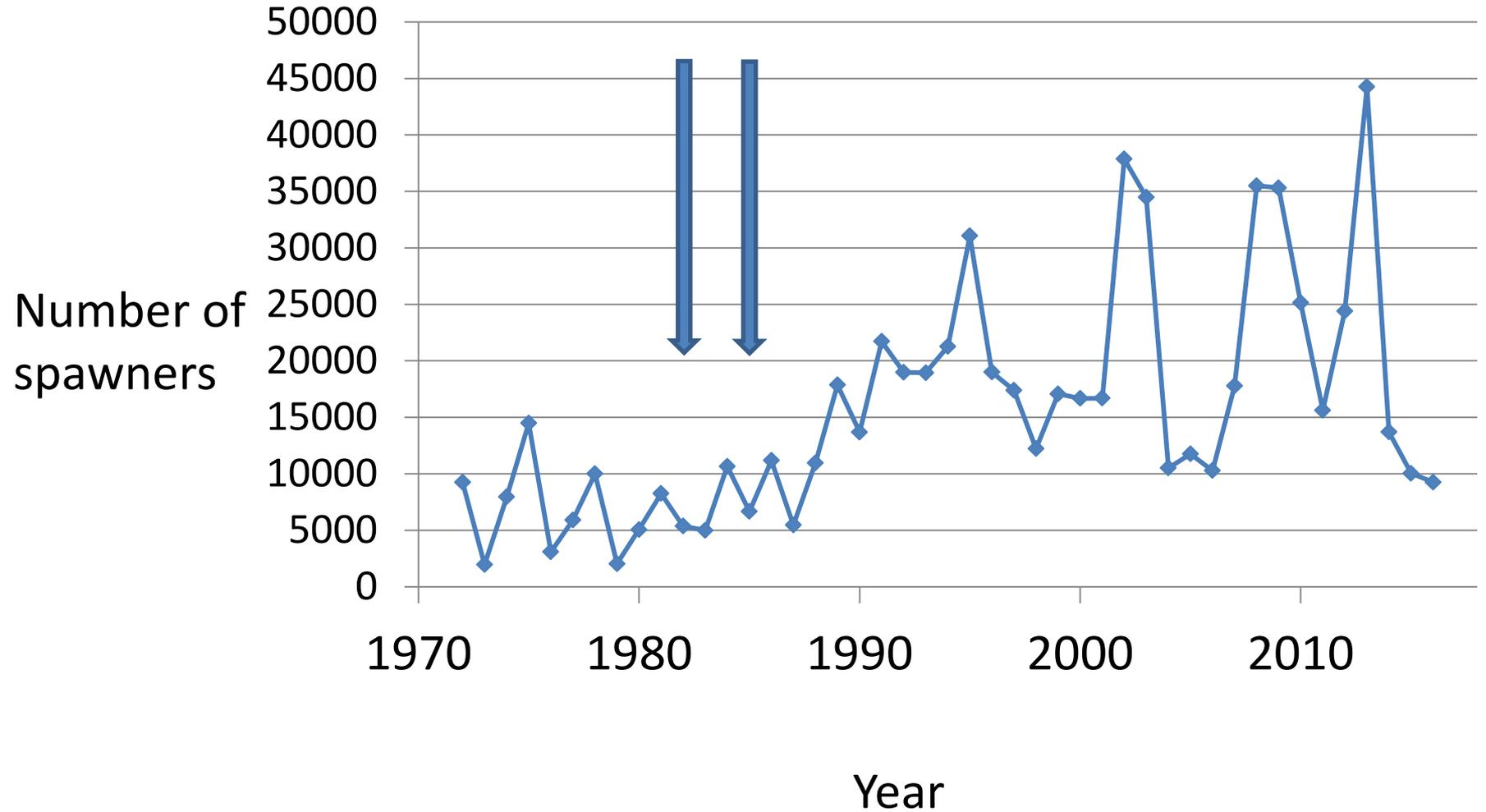
- Kokanee Creek, Redfish Creek and Meadow Creek
- Provide reliable spawning habitat for kokanee – we are able to control gravel size, clean annually, and deliver clean water
- Compensate for habitat impacts from humans over the last century (water control, riparian vegetation, food supply etc)
- Increase the egg incubation capacity and survival of eggs (from 5% to 80%)
- Significant benefits for anglers and the ecosystem

Kokanee Spawning Channels - Seasons

1. Fall – count fish in channel, collect biological data
2. Winter – flow maintenance, ice control
3. Spring – sample to estimate number of fry leaving spawning channels
4. Summer – clean gravel in channel for egg incubation



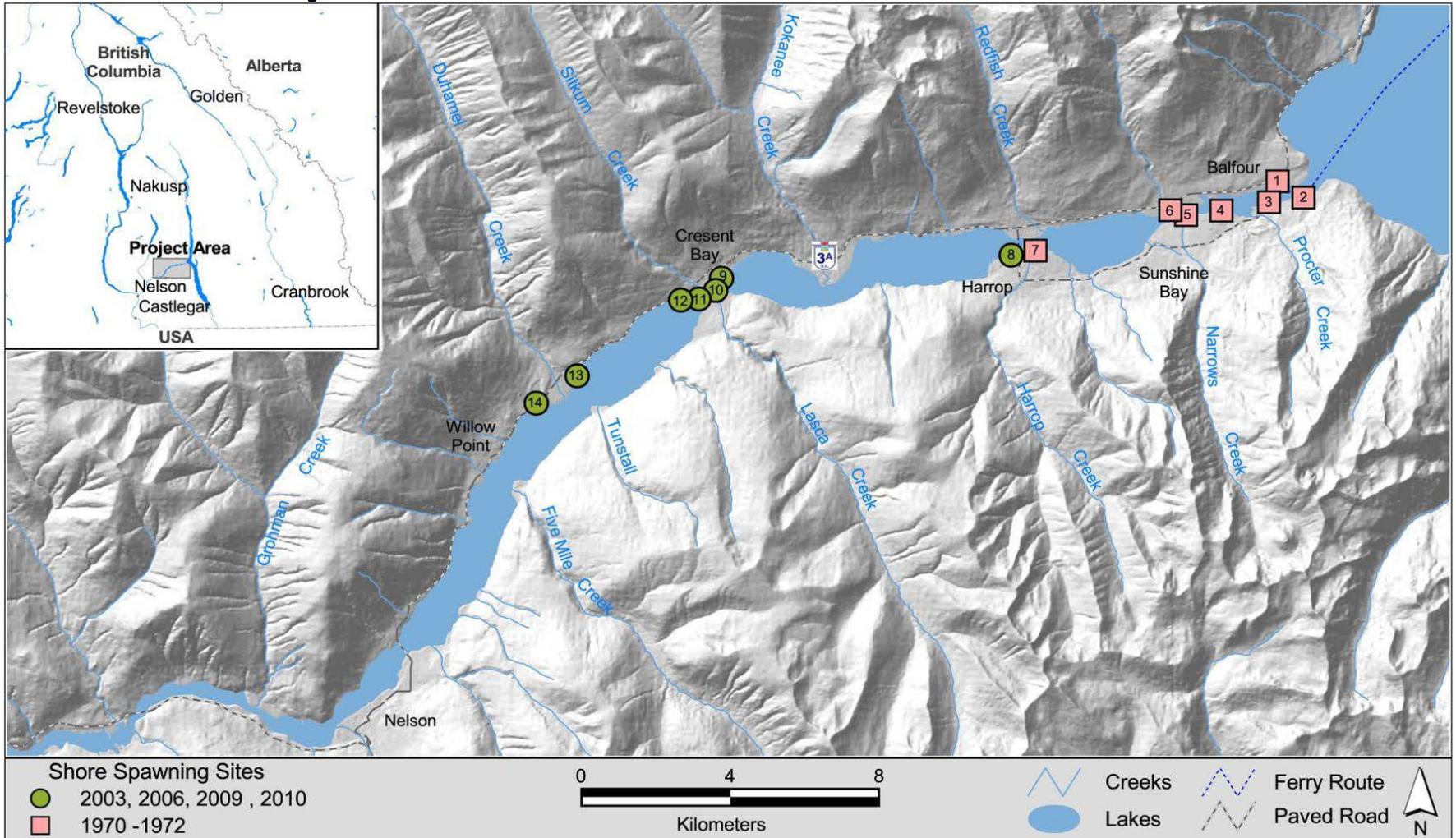
Kokanee Spawning Channels – West Arm Results



Shore spawners - abundance

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2007	7,429	8,364	1,748	238	17,779
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2013	18,962	19,747	5,181	0	43,890
2014	5,008	5,903	2,439	345	13,695

Shore spawners - distribution



Irvine, R.L., G.F. Andrusak, and H. Andrusak. 2012.

Assessment of Lake Levels and their Variation on the Recruitment of Shore Spawning Kokanee Fry within the West Arm of Kootenay Lake. Report prepared for Columbia Operations Fisheries Advisory Committee.

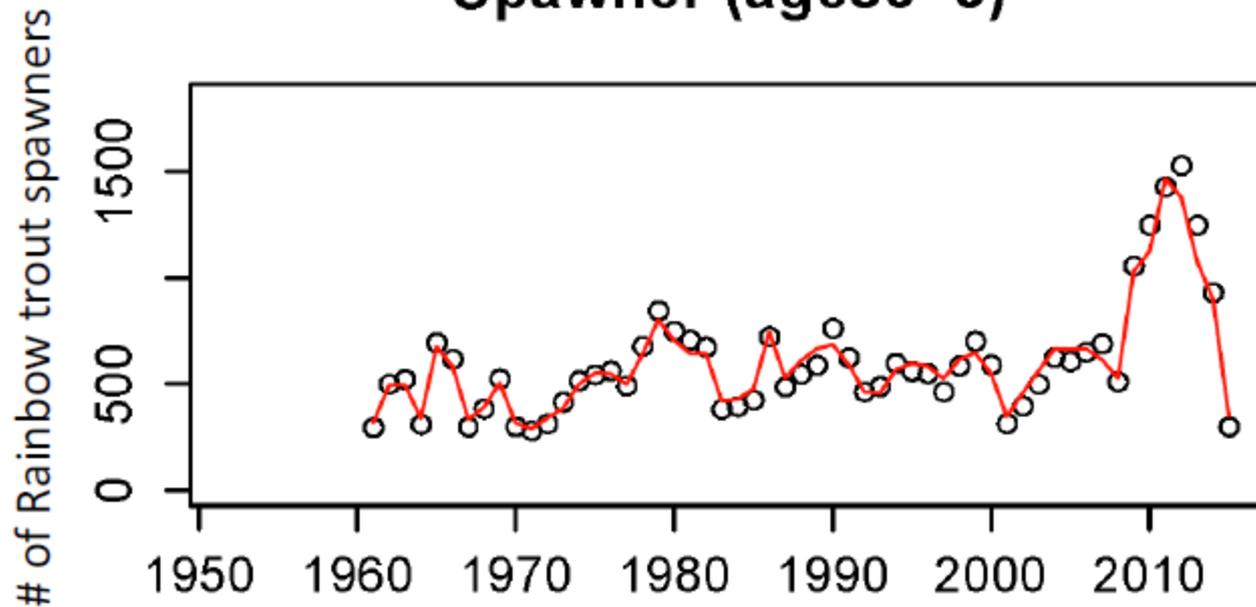
West Arm Shore Spawner

Conservation

- A. Veale and M. Russello, UBC-O 2015: “Kootenay Lake West Arm shore-spawning kokanee are genetically distinct from neighboring stream-spawners ... ”
- Pragmatic reason to conserve and protect shore spawners: water temperature may remain suitable
- Significant protection measure – hydro utilities implemented in 2012 and again in 2015 kokanee shore spawner lake level reductions (from normal) in fall, to reduce redd dewatering and stranding of embryos in spring
- Results: (report for COFAC, Andrusak and Andrusak 2013)
 - 2012 shore spawners experienced 35% dewatered redds
 - Compare to: ~80% since 2003 and 12% pre-development 1928-1932

Modelling

Model 8 fits to spawner counts in the Lardeau River Spawner (ages 6-8)



Modelling

Management implications

1. **Reestablishment of trophy rainbow trout will require**
 - Rebuilding of kokanee
 - Control of RT fishing effort
2. **Rebuilding of kokanee can be facilitated by**
 - Nutrient addition in north arm
 - Annual spawning channel maintenance
 - Planting of kokanee eggs or fry
3. **Heavy kokanee fry stocking + full retention of < age 4 RT most effective to rebuild both KO and RT - most scenarios**
 - 5 mil KO eggs/yr - about 10 yr recovery for RT
 - Other options give 20+ yr recovery for RT
4. **Level of nutrient addition could strongly influence both KO and RT recovery**
5. **High survival of RT may cause system instability**
 - Too much nutrient addition?
 - Regulations too conservative?

