WILLAMETTE FISHERIES SCIENCE REVIEW
COPEPODS AND CONVEYANCE

Session Organizer/Moderator: Rachel Neuenhoff
Fish Biologist – US Army Corps of Engineers
Portland District
12 March 2019

US Army Corps of Engineers ®
Portland District

U.S.ARMY

CONVEYANCE STRATEGIES

2008 BiOp – Safe Passage and sustainable populations

OMET
COP
Fish Benefit Workbook
Life Cycle Modeling

Preferred Alternative for Willamette Basin:
Two way trap and haul

FISH PASSAGE PRIORITY: COUGAR DAM

US Army Corps of Engineers®
Portland District

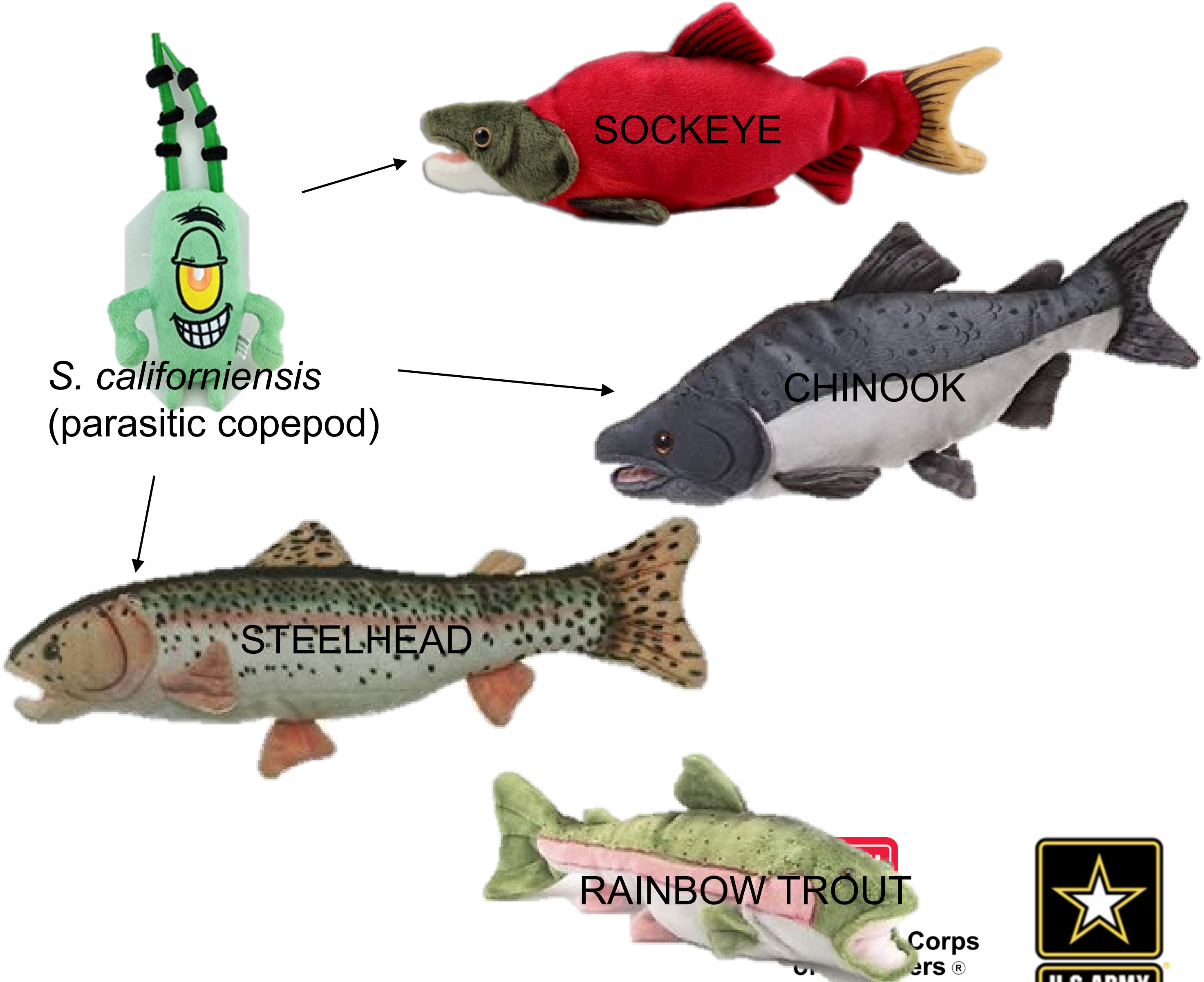
U.S.ARMY

FISH PASSAGE PRIORITY: DETROIT

US Army Corps of Engineers ®
Portland District

U.S.ARMY

EVIDENCE OF BIOLOGICAL IMPACTS FROM COPEPODS



EVIDENCE OF BIOLOGICAL IMPACTS FROM COPEPODS

- ↓ Hemoglobin
- ↓ Hemocrit
- ↑ Antigenic response
- ↓ Ion exchange

EVIDENCE OF BIOLOGICAL IMPACTS FROM COPEPODS

- ↓ Hemoglobin
- ↓ Hemocrit
- ↑ Antigenic response
- ↓ Ion exchange
- ↓ Swimming Performance

Journal of Aquatic Animal Health 30:81–89, 2018

ISSN: 0899-7659 print / 1548-8667 online
DOI: 10.1002/aah.10010

ARTICLE

Swimming Endurance in Juvenile Chinook Salmon Infected with *Salmincola californiensis*

Crystal L. Herron*
Department of Fisheries and Wildlife, Oregon State University, 104 Nash Hall, Corvallis, Oregon 97331, USA

M. L. Kent
Department of Microbiology, Oregon State University, 226 Nash Hall, Corvallis, Oregon 97331, USA

C. B. Schreck
Department of Fisheries and Wildlife, Oregon State University, 104 Nash Hall, Corvallis, Oregon 97331, USA

Abstract

Juvenile Chinook Salmon *Oncorhynchus tshawytscha* moving downstream through tributaries of the upper Willamette River basin can spend months in reservoirs created by dams. While residing in the reservoirs, they often obtain heavy infections of the freshwater parasitic copepod *Salmincola californiensis*. The physiologic effect these parasites have on salmonids is poorly understood. We developed a method to infect juvenile Chinook Salmon in a laboratory with the copepodid stage of *S. californiensis*. Infected and uninfected fish were subjected to a swimming challenge to ascertain swimming endurance. Severity of gill damage was assessed using a dissecting microscope. Juvenile Chinook Salmon naturally infected with *S. californiensis* in Cougar Reservoir, Oregon, were also challenged and compared with their lab-infected counterparts. Copepod infection greatly impaired the swimming ability of laboratory fish, and the naturally infected fish were entirely incapable of swimming at low velocity. Chinook Salmon collected in the wild were more heavily infected than the laboratory fish and had trouble surviving collection and transport to our laboratory. The intensity of infection and severity of gill damage were positively correlated with diminished swimming ability, suggesting that heavy infection with copepods impairs gas exchange and osmotic regulation, which likely results in diminished fitness and decreased survival of infected fish.

Juvenile Chinook Salmon *Oncorhynchus tshawytscha* are listed as “threatened” under the U.S. Endangered Species Act (NMFS 1999) and, along with other salmonids, can become heavily infected with the freshwater parasitic copepod *Salmincola californiensis* while they pass through reservoirs that were created by dams in the Willamette River basin in Oregon (Monzyk et al. 2015). *Salmincola californiensis* occurs along the west coast of North America from mid-California into British Columbia and in Japan (Sutherland and Wittrock 1985; Johnson and Heindel 2001; Modin and Veek 2002; Nagasawa and Urawa 2002; Bowker et al. 2012; Monzyk et al. 2015). While moving to the ocean from the Willamette River basin, juvenile salmon may pass through multiple reservoirs, which presents multiple infection points and, hence, sparks management concern. *Salmincola californiensis* specifically infects salmonids including Cutthroat Trout *O. clarkii*, kokanee *O. nerka*, and Rainbow Trout *O. mykiss*, but is most commonly found on Chinook Salmon at high levels of infection (Monzyk et al. 2015). The physiological

US Army Corps of Engineers ®
Portland District

U.S.ARMY

EVIDENCE OF BIOLOGICAL IMPACTS FROM COPEPODS

- ↓ Hemoglobin
- ↓ Hemocrit
- ↑ Antigenic response
- ↓ Ion exchange
- ↓ Swimming Performance

Is the preferred trap and haul alternative, biologically feasible?

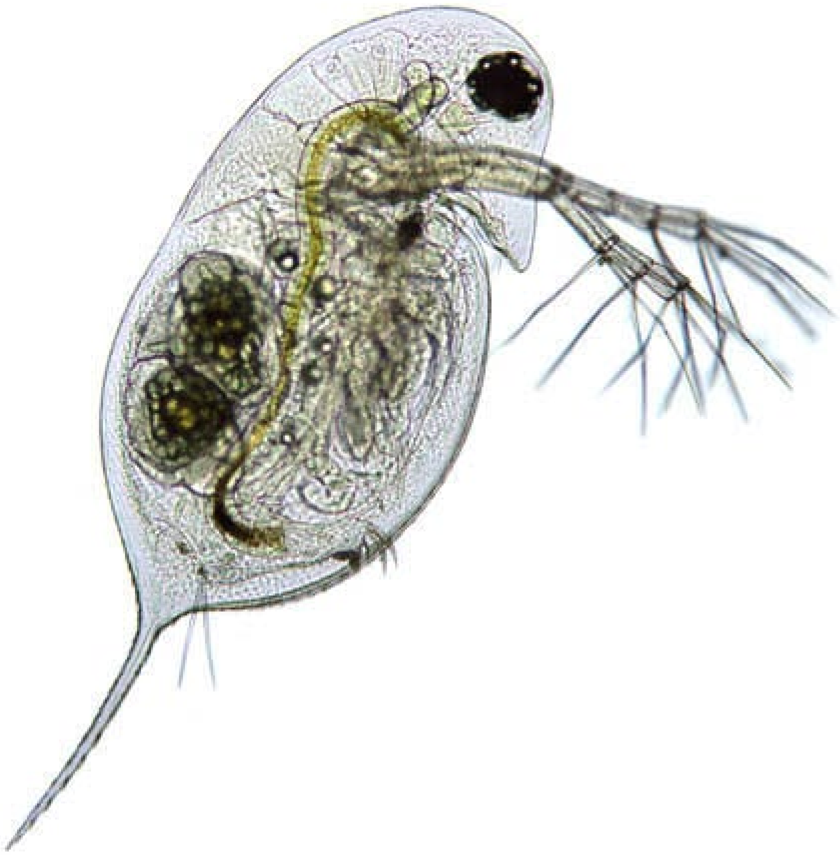
EVIDENCE OF BIOLOGICAL IMPACTS FROM COPEPODS

DECLINES IN SWIMMING PERFORMANCE

US Army Corps of Engineers ®
Portland District

U.S.ARMY

"YOU STUDY PLANKTON NOW…"



Life Cycle of *Salmincola californiensis* (Dana 1852) (Copepoda: Lernaeopodidae)

Z. Kabata

Fisheries Research Board of Canada
Pacific Biological Station, Nanaimo, B.C.

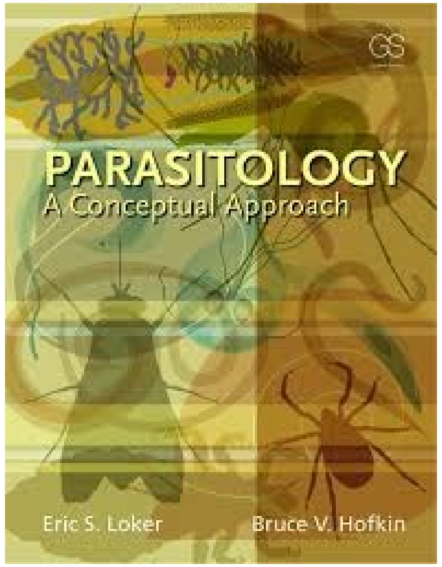
and B. Cousens

Department of Zoology
University of Victoria, Victoria, B.C.

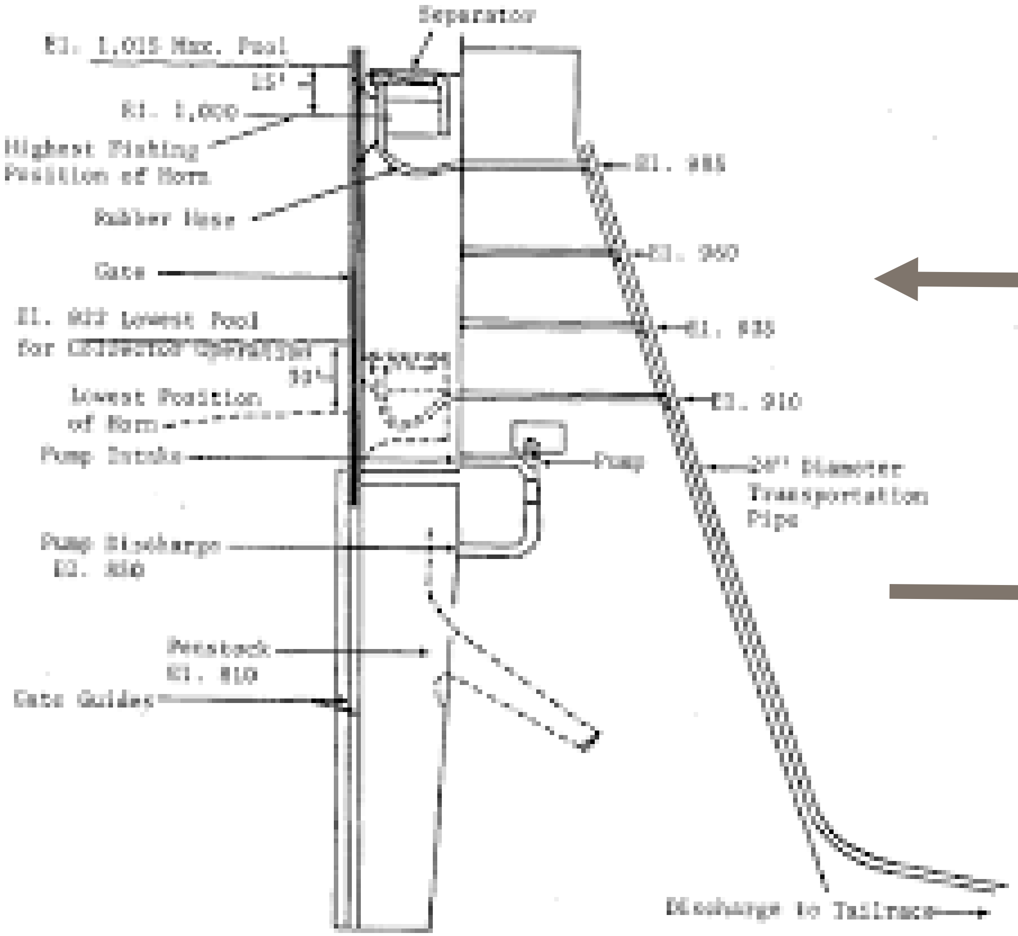
Kabata, Z., and B. Cousens. 1973. Life cycle of *Salmincola californiensis* (Dana 1852) (Copepoda: Lernaeopodidae). J. Fish. Res. Board Can. 30: 881–903.

A description is given of the life cycle of *Salmincola californiensis* (Copepoda: Lernaeopodidae), studied by continuous observation of developing parasites and by intermittent examination of infected sockeye salmon (*Oncorhynchus nerka*). The cycle consists of six stages: copepodid (free-swimming), four chalimus stages (attached by second maxillae to frontal filament), and adult (attached by bulla). The copepodid settles on the fish and uncoils its frontal filament. Each successive chalimus stage reattaches the filament during moulting, but chalimus IV breaks off, searches for the site of final attachment, and excavates an implantation cavity for the bulla. The male cycle is similar but its chalimus IV is of shorter duration and soon moults into the male adult, actively searching for the female. Morphology of all stages is described in detail. Some comments are made on life cycles in Caligoida.

Kabata Z., and B. Cousens. 1973. Life cycle of *Salmincola californiensis* (Dana 1852) (Copepoda: Lernaeopodidae) J. Fish. Res. Board Can. 30: 881–903.



MULTI-FACETED PROBLEM



VOLITIONAL HIGH HEAD BYPASS

FISH HEALTH UNCERTAINTIES

MULTI-FACETED PROBLEM

VOLITIONAL HIGH HEAD BYPASS

- Design parameters (Document)
- Alternative Development (EDR)
- Alternatives/Design Charrette
- Recommended Design (EDR)

Infection levels observed in wild

Field study design & ability to infect

FISH HEALTH UNCERTAINTIES

- Fish health under alternative conveyance
- Hypothesis testing (fish stress)
- Model to evaluate stress metrics & mortality
- Model alternative conveyance under stress

FIELD BASED LAB BASED

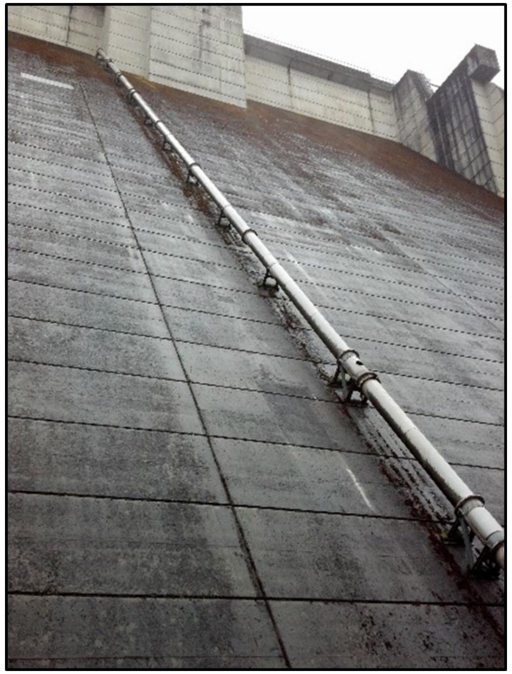
US Army Corps of Engineers ®
Portland District

U.S.ARMY

BIOLOGICAL EFFECTS AND FISH HEALTH UNCERTAINTIES

Model Framework:

1. Infection protocol
2. Holding stress
3. Swimming performance
4. Ecology and infection risk
5. Alternative conveyance
6. **Decision support**



FEASIBILITY & FISH SAFETY CRITERIA

BIOLOGICAL EFFECTS FROM COPEPODS

Oregon State University

FISH STRESS AND INFECTION RISK UNDER TRAP AND HAUL ALTERNATIVE

US Army Corps of Engineers ®
Portland District

U.S. ARMY

STRUCTURED DECISION MAKING AND DECISION SUPPORT

SDM Workshop (1-2 days, mid-April):
-Conveyance decision set
-Objectives
-Alternative hypotheses
-Metrics
-Data gaps and information needs
-Stakeholder involvement and creative brainstorming

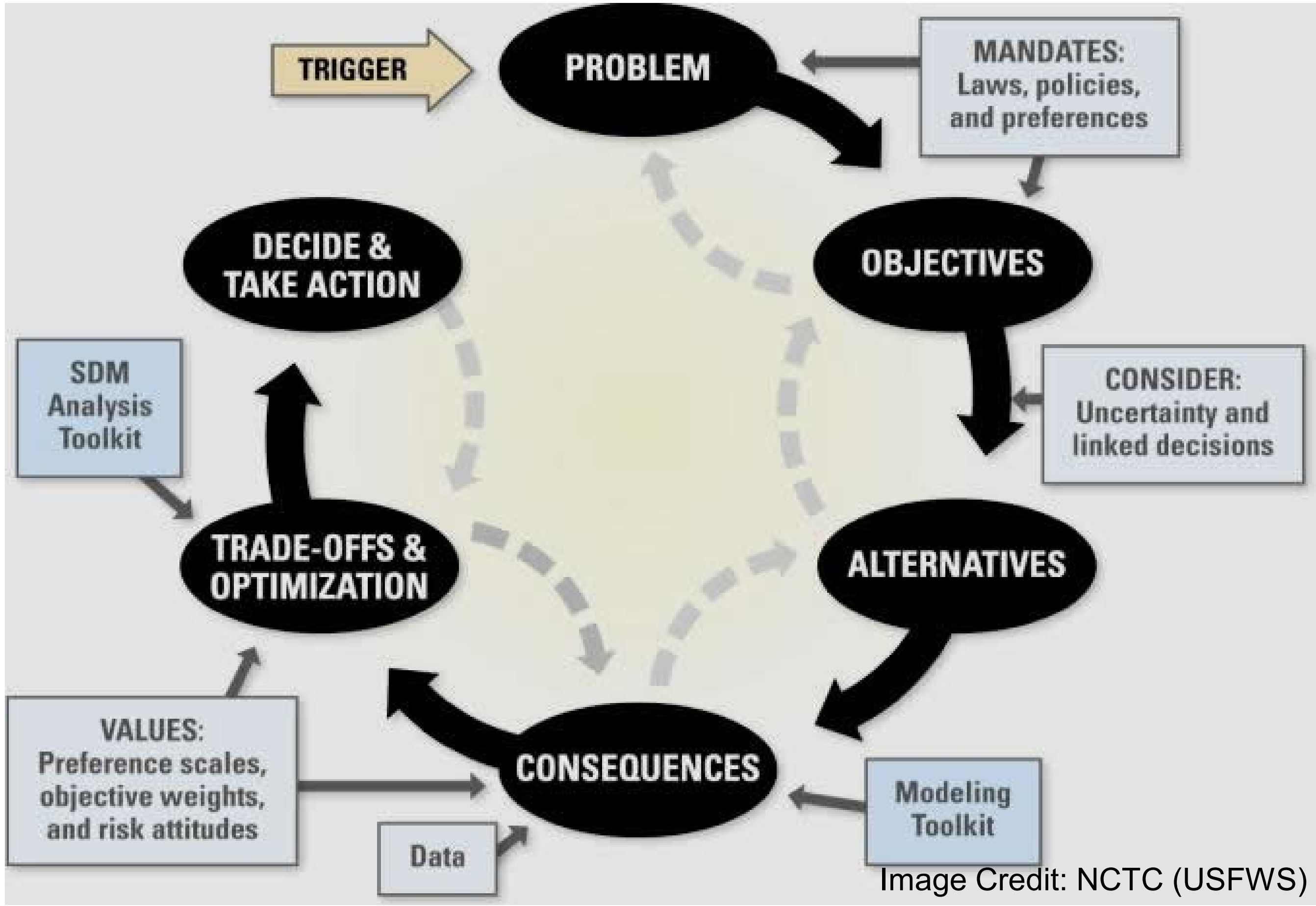


Image Credit: NCTC (USFWS)

US Army Corps of Engineers ®
Portland District

U.S.ARMY

USACE CONTACT INFORMATION:

Rachel Neuenhoff
Rachel.D.Neuenhoff@usace.army.mil

Rich Piaskowski
Richard.M.Piaskowski@usace.army.mil