Deducing effects of mammalian predation

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“Probably the commonest death for many animals is to be eaten by something else”

--Charles Elton 1927

Photo: Florian Graner

"Whatever else may be said of predation, it does draw attention."

--Paul Errington 1947.

Goals and Objectives

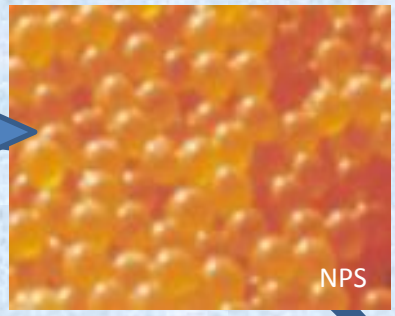
Highlight key predator/prey concepts for subsequent discussions of managing predation effects on sockeye salmon in the Lake Ozette ecosystem.

- Key factors influencing mammalian predation effects on prey
- Are there lessons from local studies of otter movements in the Elwha ecosystem?

Salmon Life Cycle

spawning

incubation



freshwater rearing

outmigration

marine

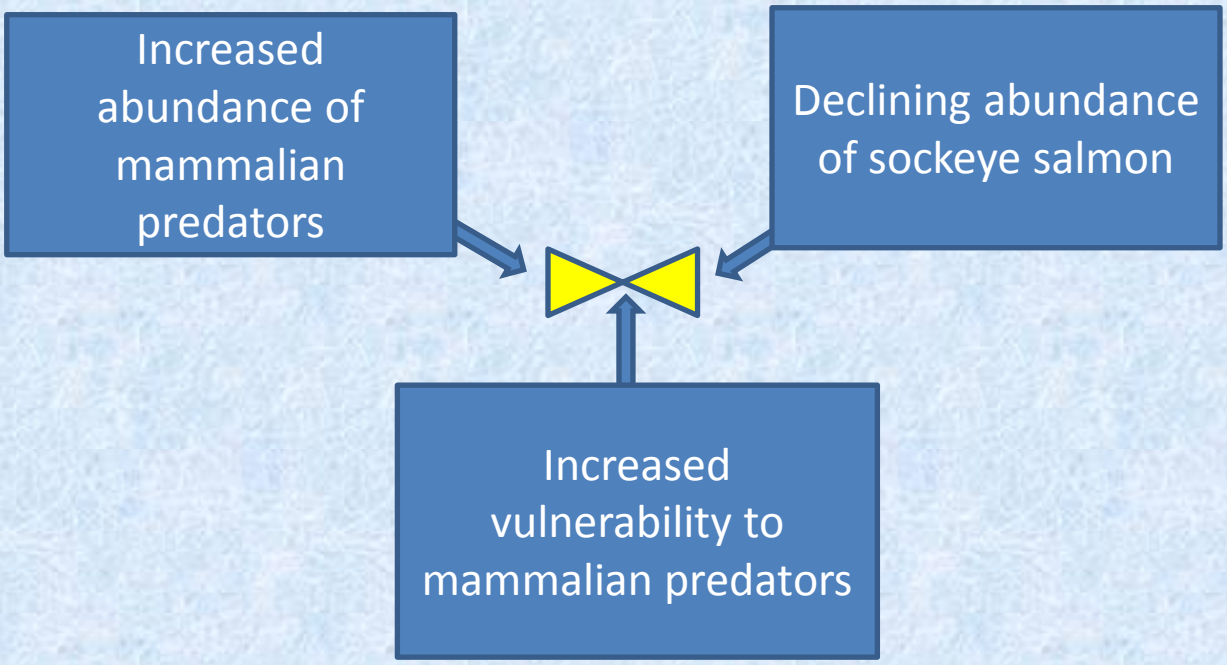
river

freshwater holding

symbolizes predation rate
At each life stage

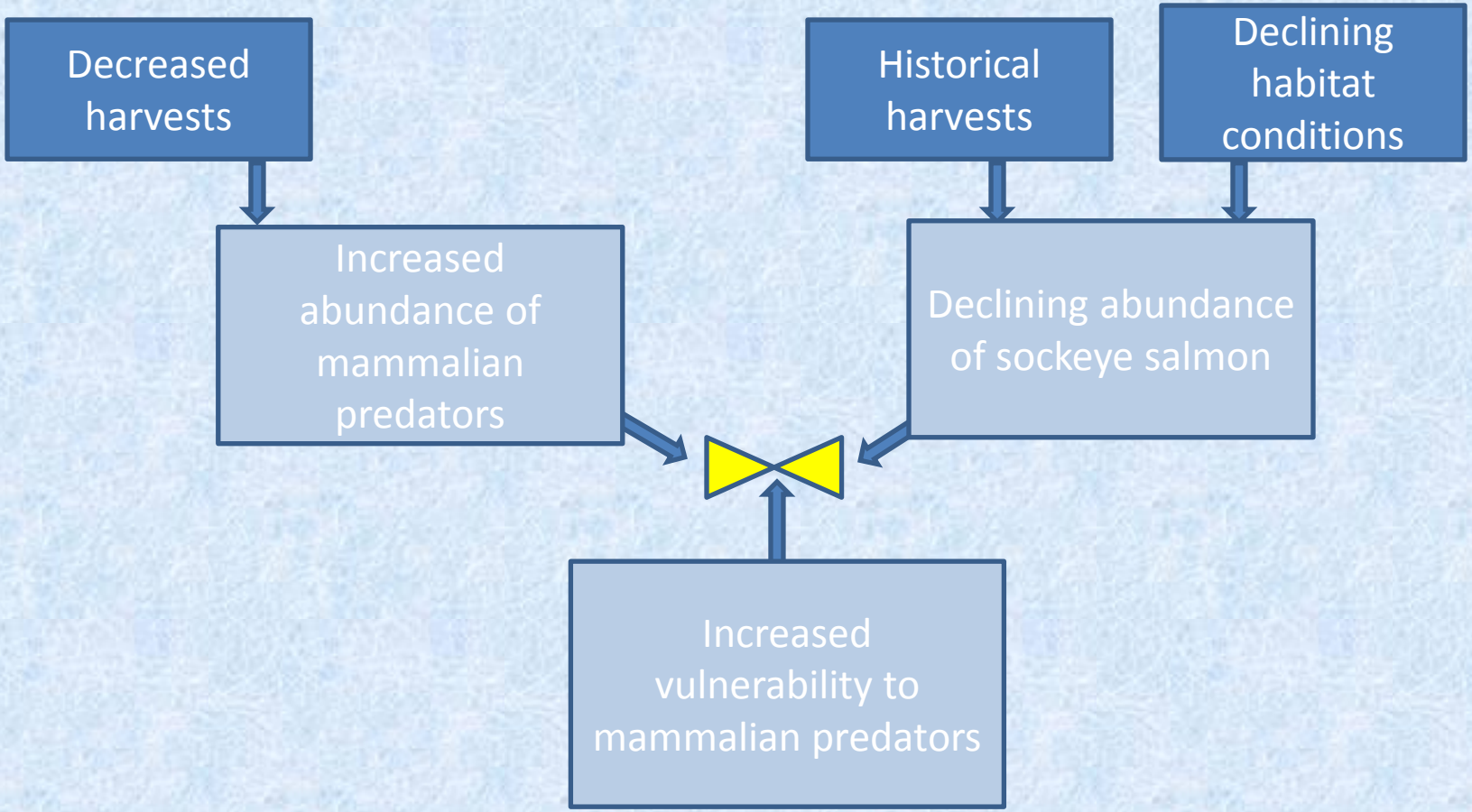
Factors Affecting Predation Rate

(Summarized from Lake Ozette Sockeye Limiting Factors Analysis)



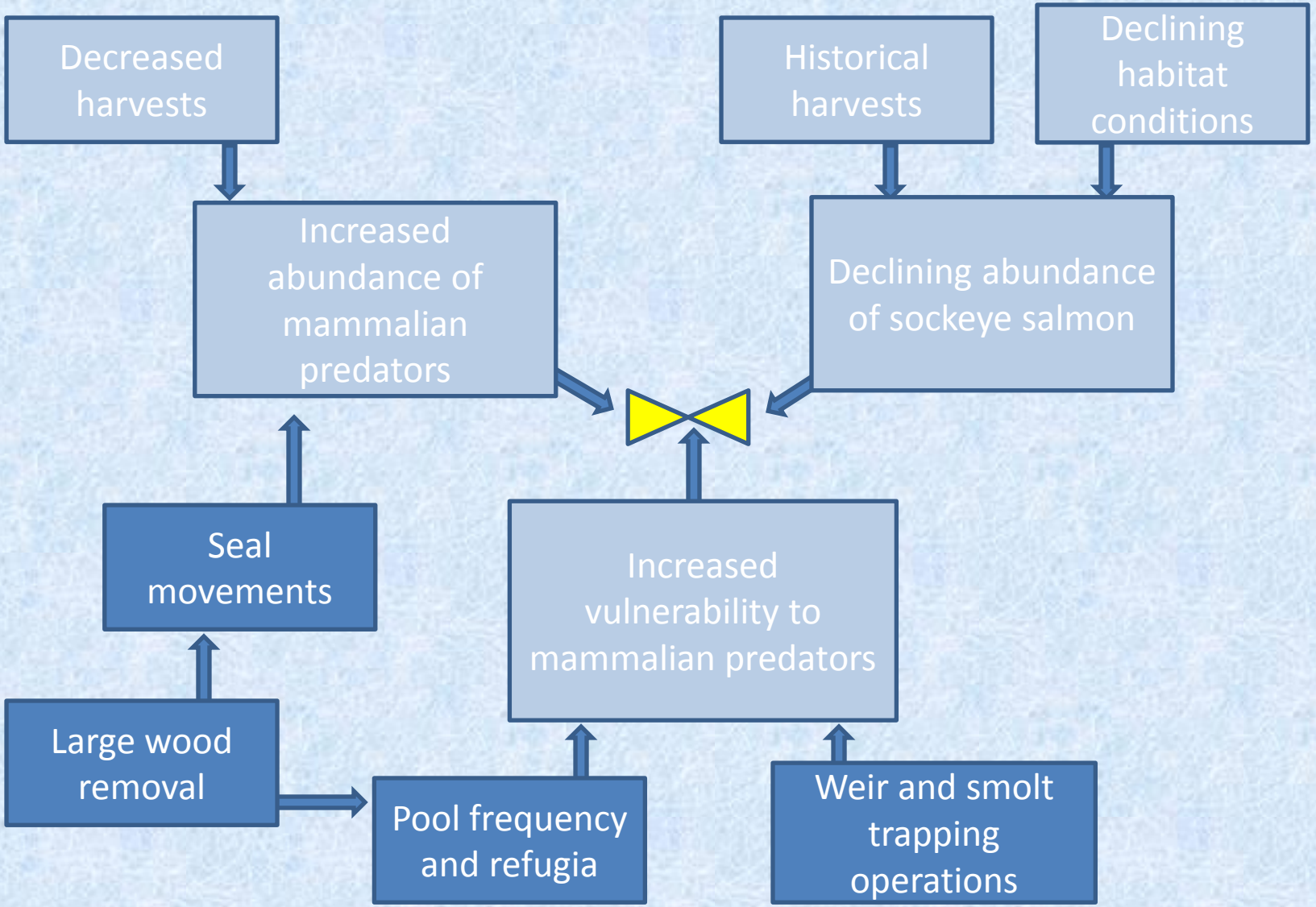
Factors Affecting Predation Rate

(Summarized from Lake Ozette Sockeye Limiting Factors Analysis)



Factors Affecting Predation Rate

(Summarized from Lake Ozette Sockeye Limiting Factors Analysis)



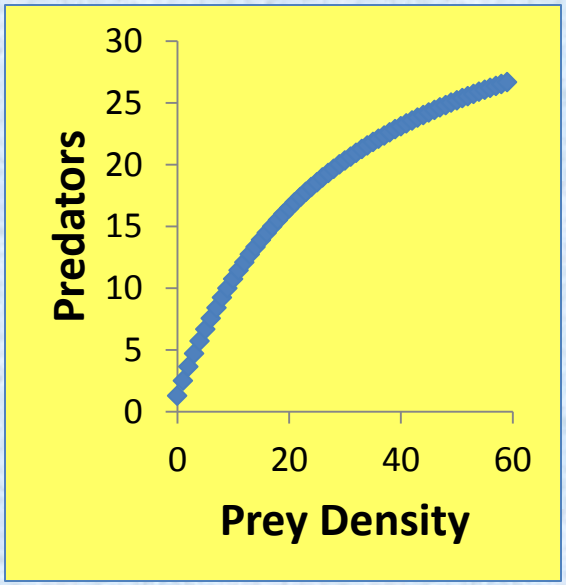
Can we build on this?

- Some considerations from theory
- Implications of predator movement

Numbers of Predators

(aka: Numerical Response of Predators to Prey Density)

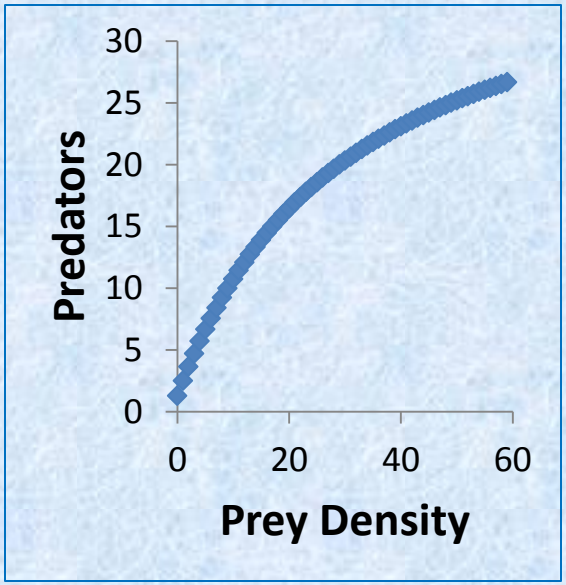
Note: All axis quantities are hypothetical (not based on actual data)



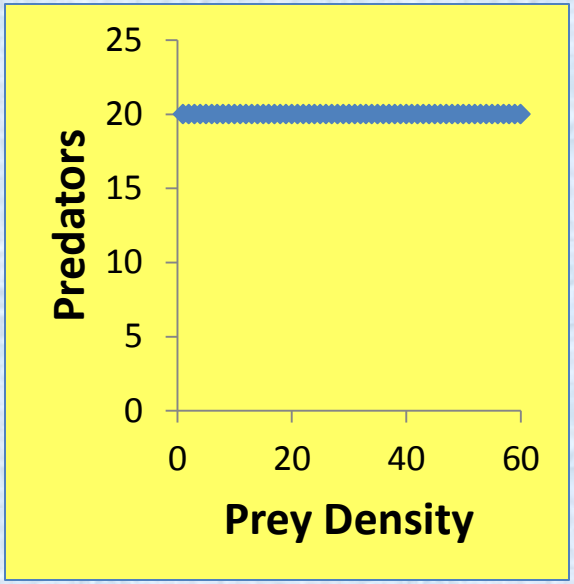
Specialized Predator
and/or
Single Prey

Numbers of Predators

(aka: Numerical Response of Predators to Prey Density))



Specialized Predator
and/or
Single Prey

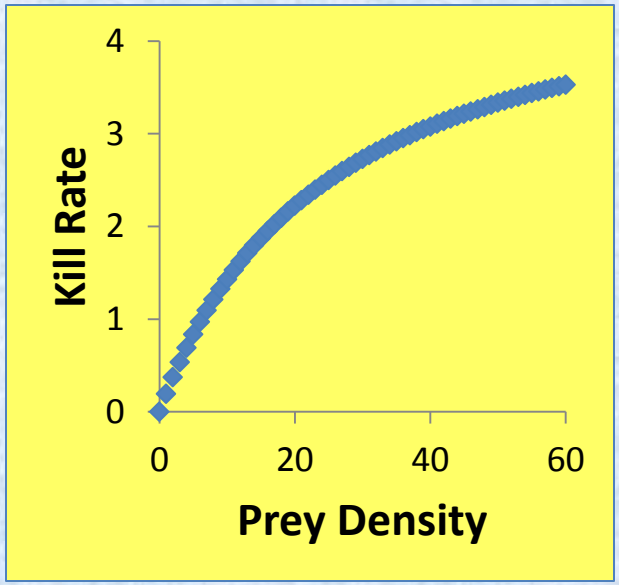


Generalized Predator
and/or
Multiple Prey

Kill Rate

(N prey killed/predator/day)

(aka: Functional Response of Predator Kill Rate to Prey Density

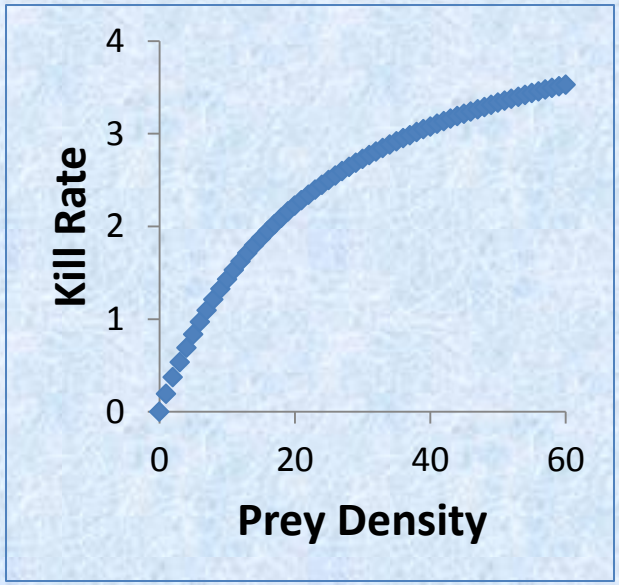


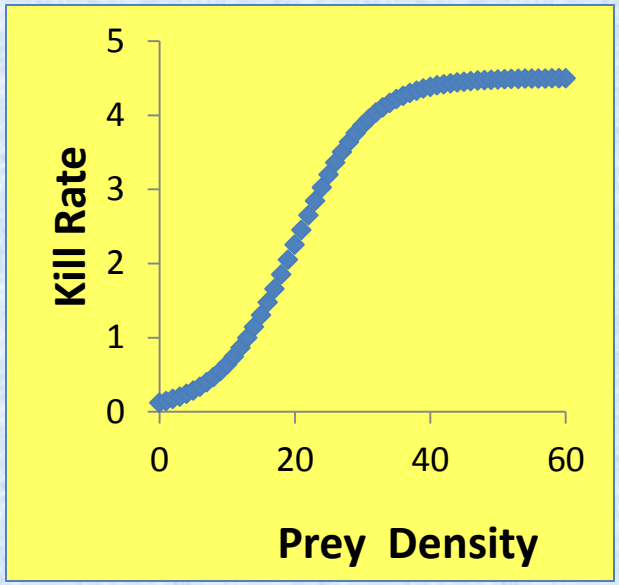
Simple System
and/or
Single Prey

Kill Rate

(N prey killed/predator/day)

(aka: Functional Response of Predator Kill Rate to Prey Density)



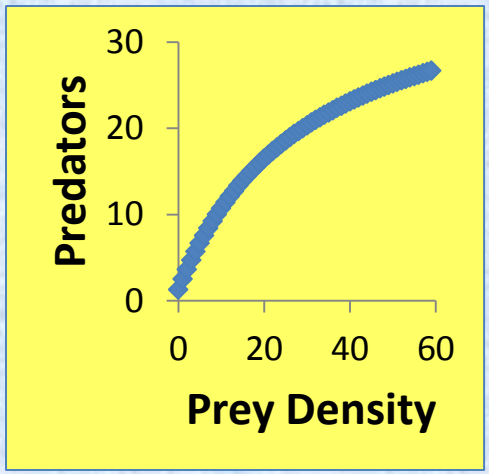


Simple System
and/or
Single Prey

Prey Switching
and/or
Prey Refugia
(i.e., reduced predation
efficiency at low prey density)

Predation Rate ( )

(% of prey population killed)



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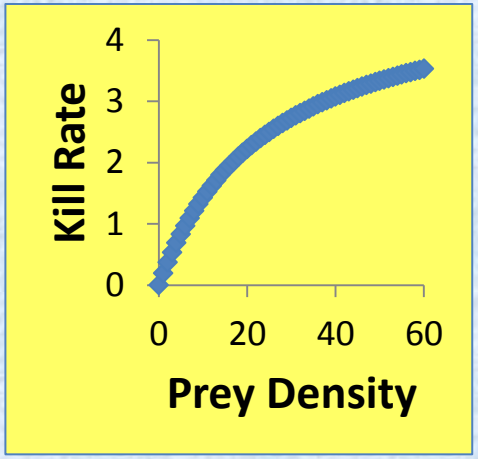

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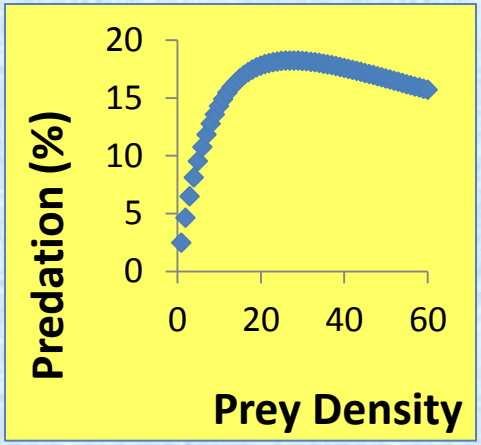
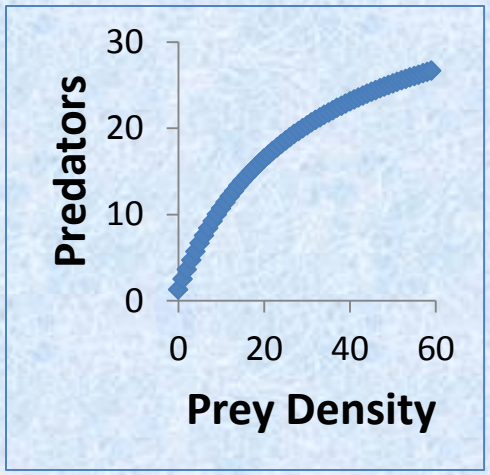


(÷ prey numbers)

Predation Rate ( )

(% of prey population killed)



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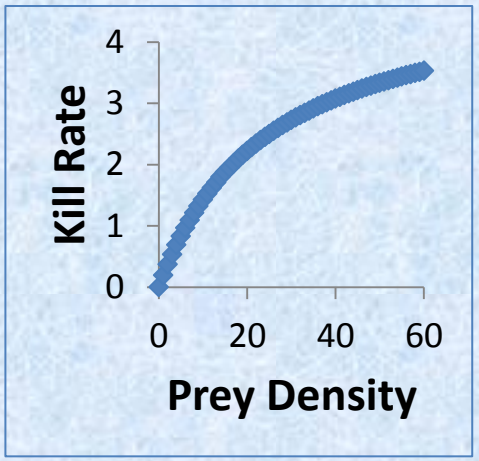

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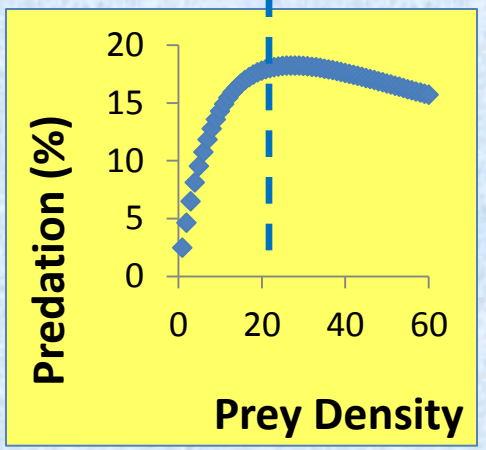
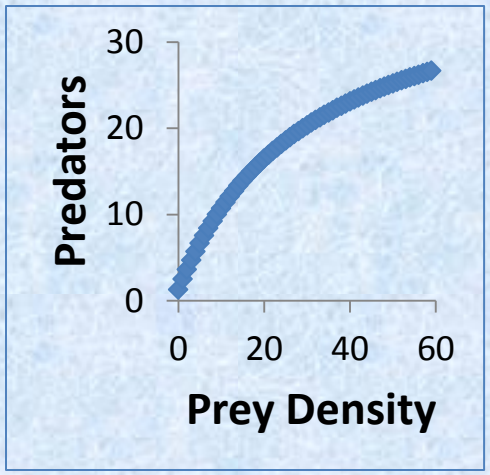
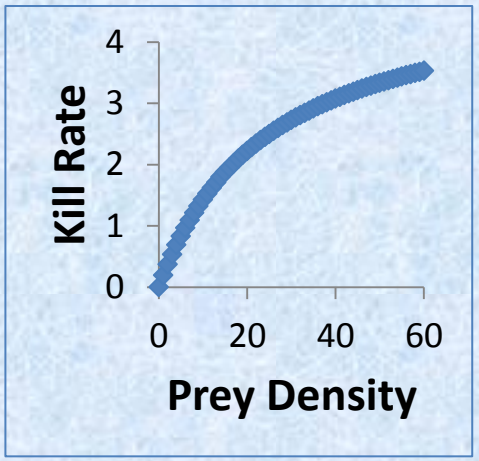


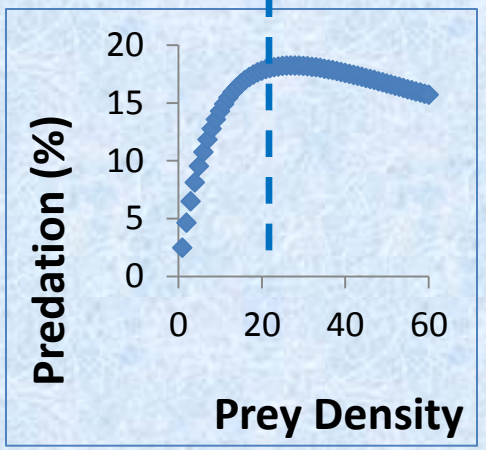
(÷ prey numbers)

Predation Rate ( )

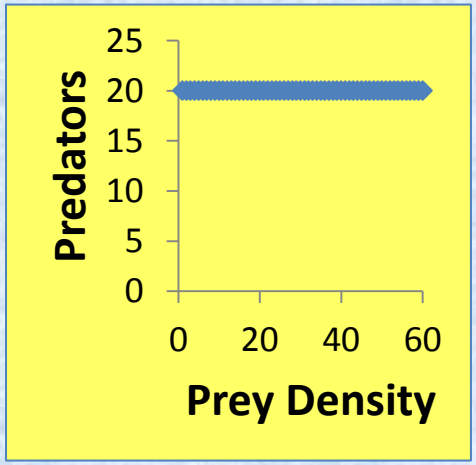
(% of prey population killed)

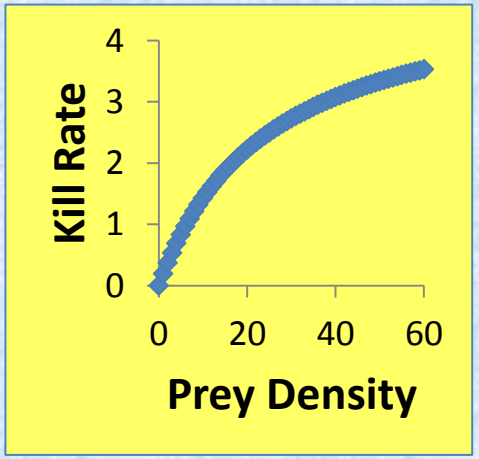


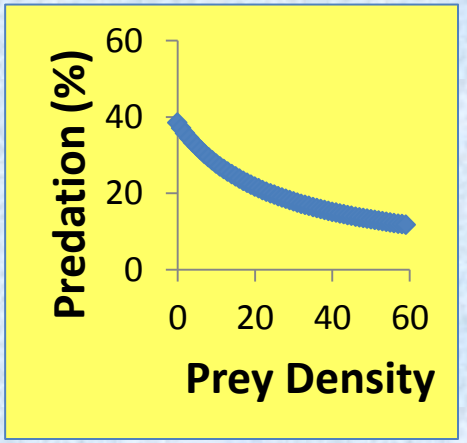




(÷ prey numbers)



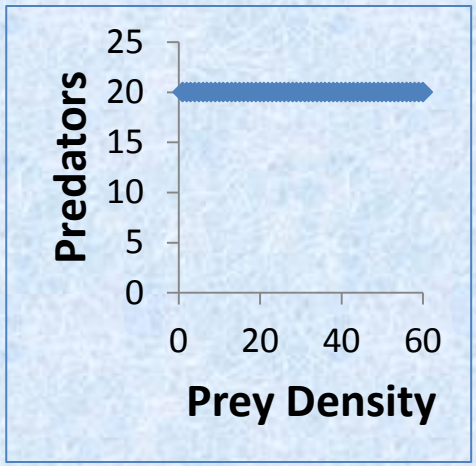




Predation depensatory

Predation Rate ( )

(% of prey population killed)



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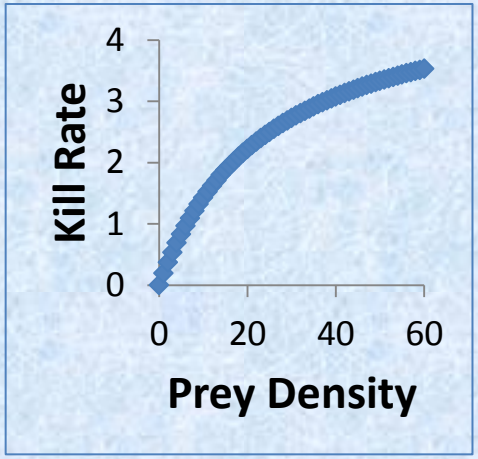

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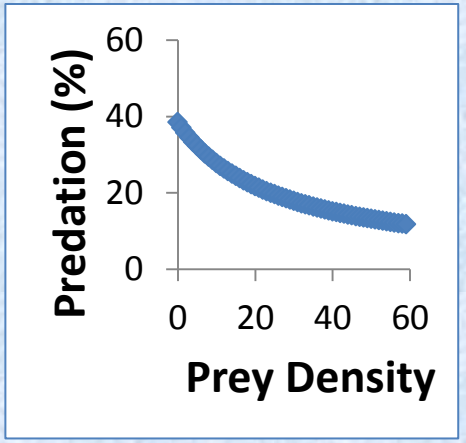
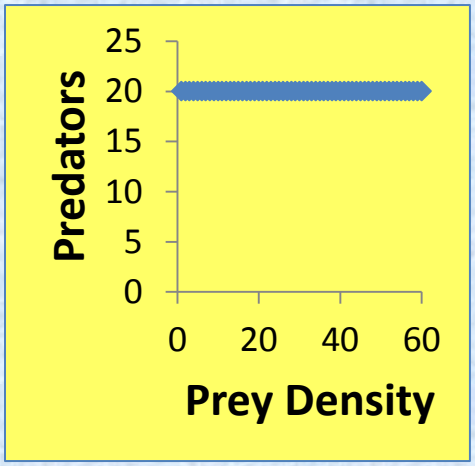


(÷ prey numbers)



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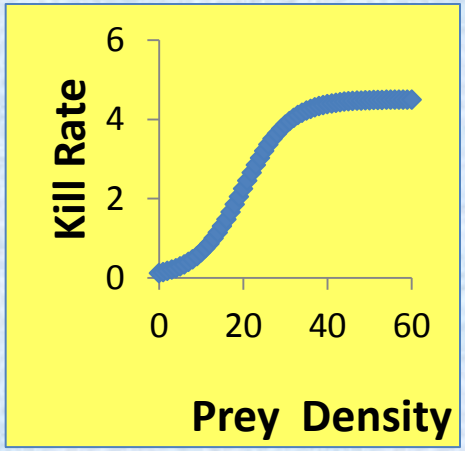

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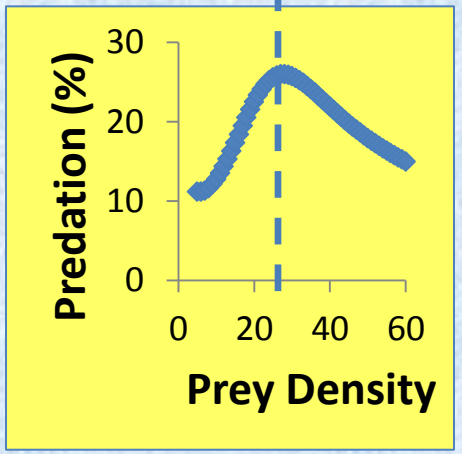
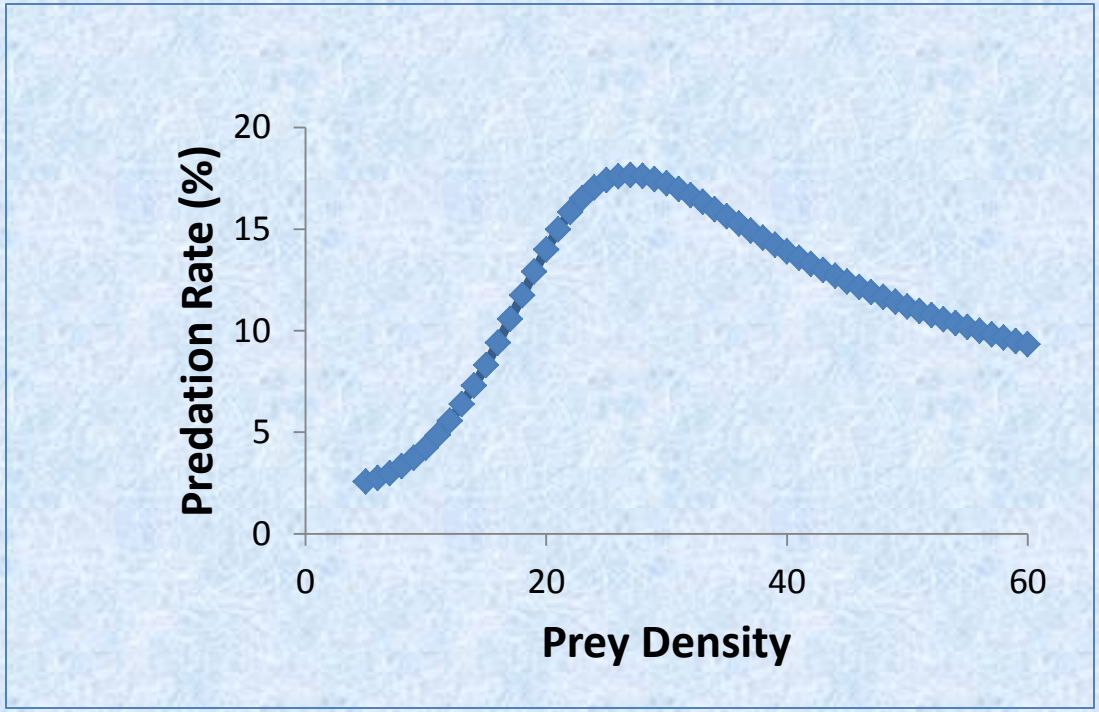
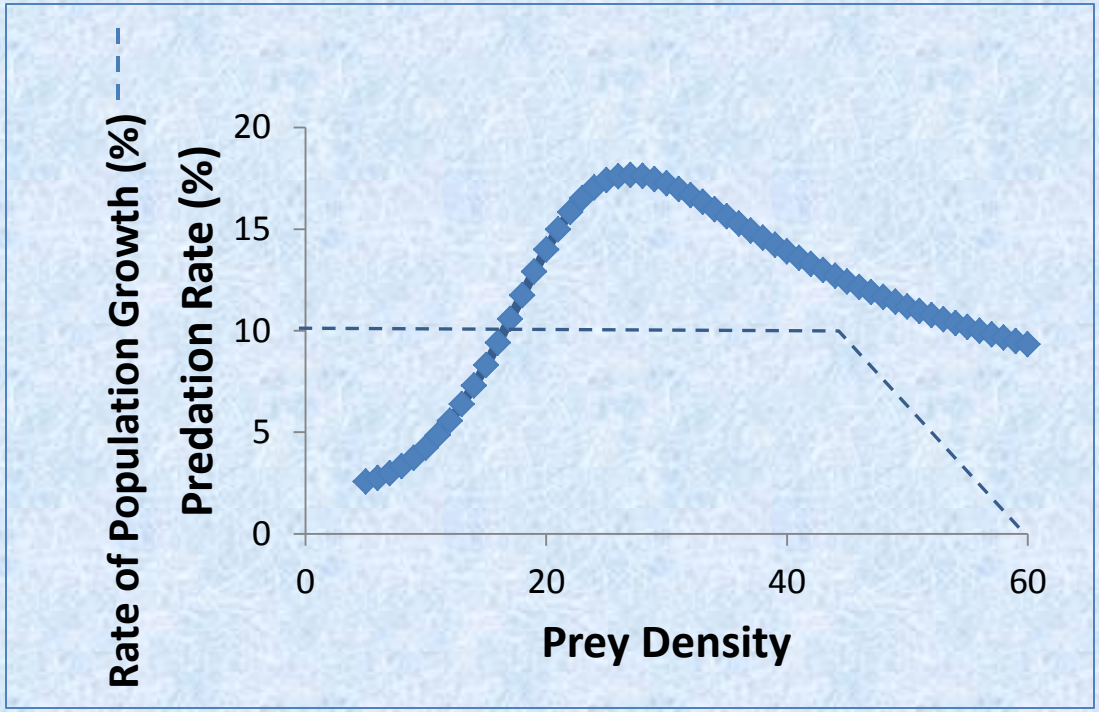


Model Applications



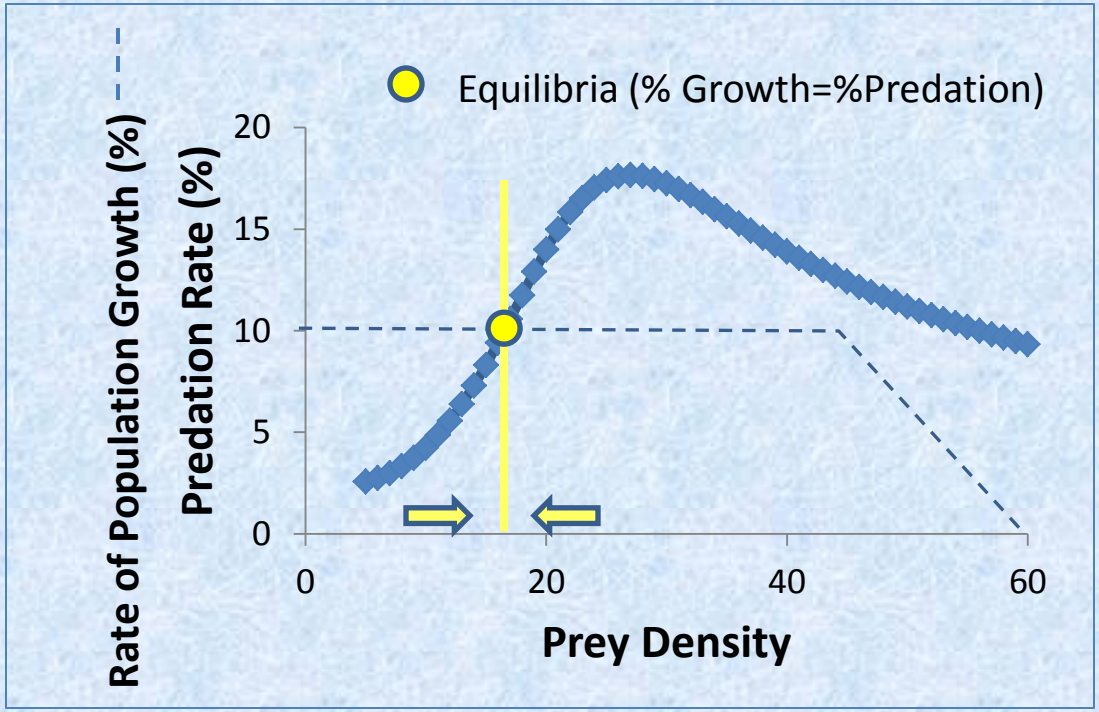
On theoretical grounds, a reasonable model for otter predation rate on seasonally available salmon during a single life-history stage

Model Applications



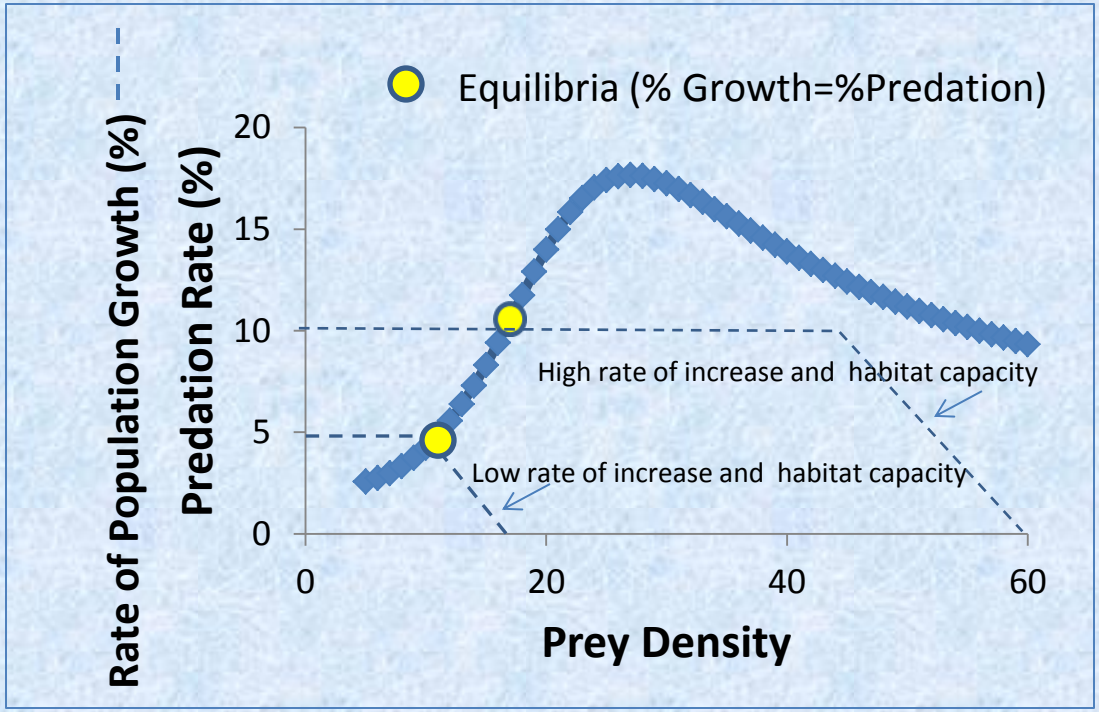
Now introducing the relationship between rate of prey population growth and density in the absence of single-stage predation rate.
Assuming density-dependent regulation at high prey densities.

Model Applications



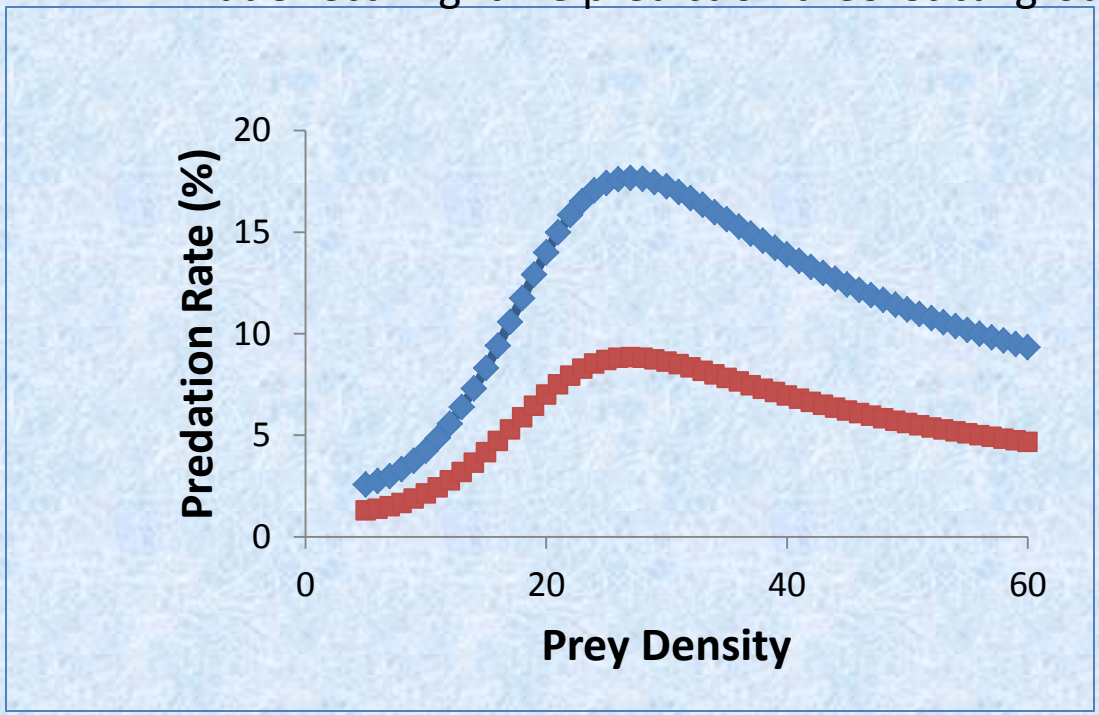
A stable equilibrium exists when rate of population growth equals predation rate.

The Importance of Habitat



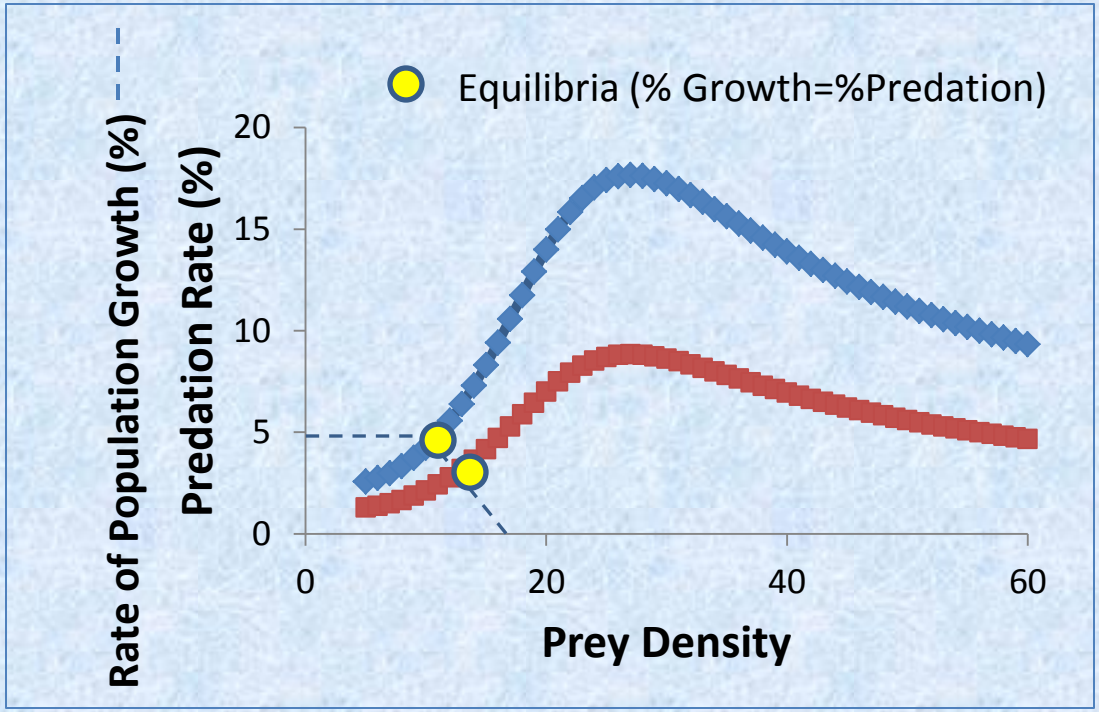
The Importance of Habitat

- Supposing we reduced predation rate by 50%
- What effect might we predict on theoretical grounds?



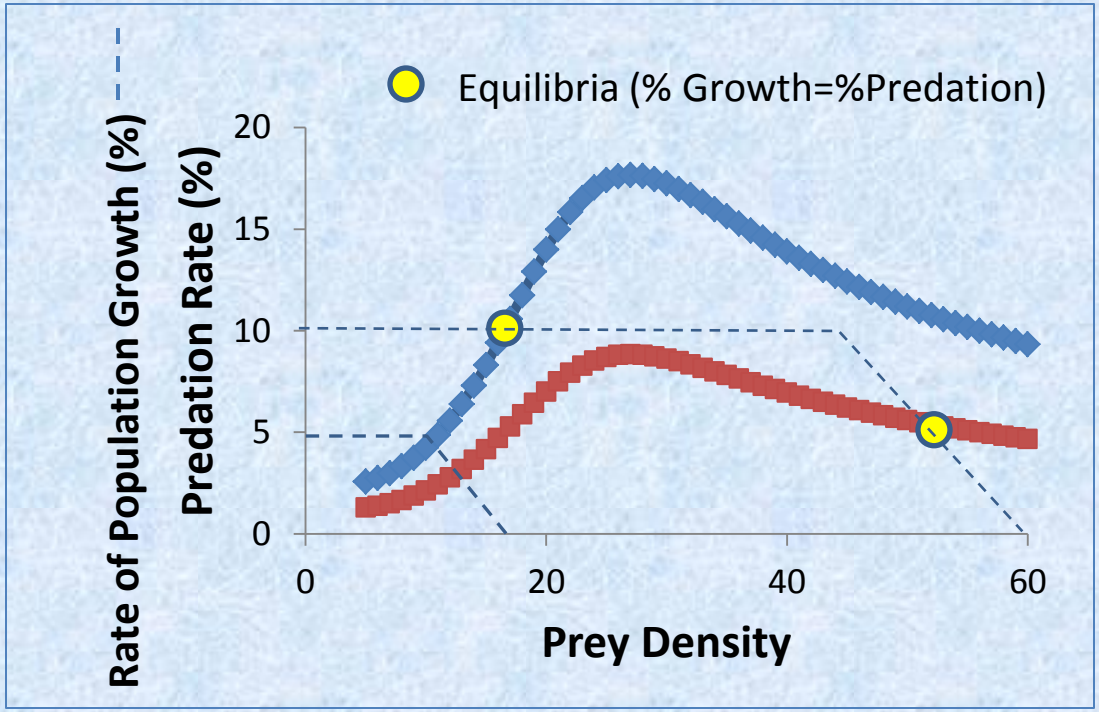
Predation Management
(Habitat Limited)

- It depends on population rate of increase and habitat capacity.
- Low rate of increase and habitat capacity=little effect



Predation Management
(Habitat Expanded and Enhanced)

- It depends on population rate of increase and habitat capacity.
- High rate of increase and habitat capacity=large effect



Take-Home re: 

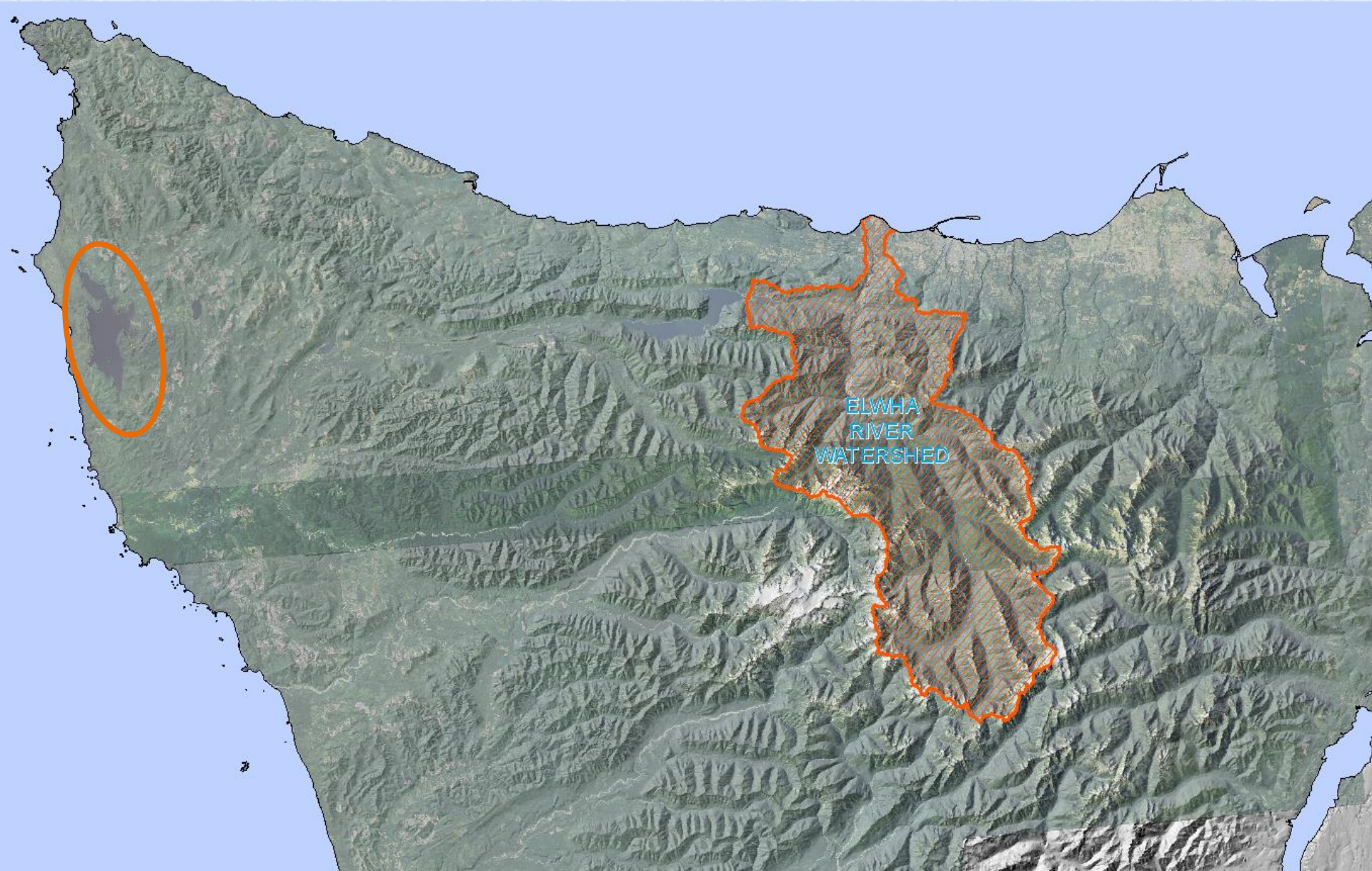
- Habitat management is good predation management
  - Habitat capacity is prerequisite for effective predation management
  - A high abundance of prey (requiring habitat capacity) reduces 
  - Reduced predator efficiency at low numbers of prey improves system stability at low density equilibrium
    - » Eg., effect of cool water and high flows on early returns of sockeye into the Ozette River

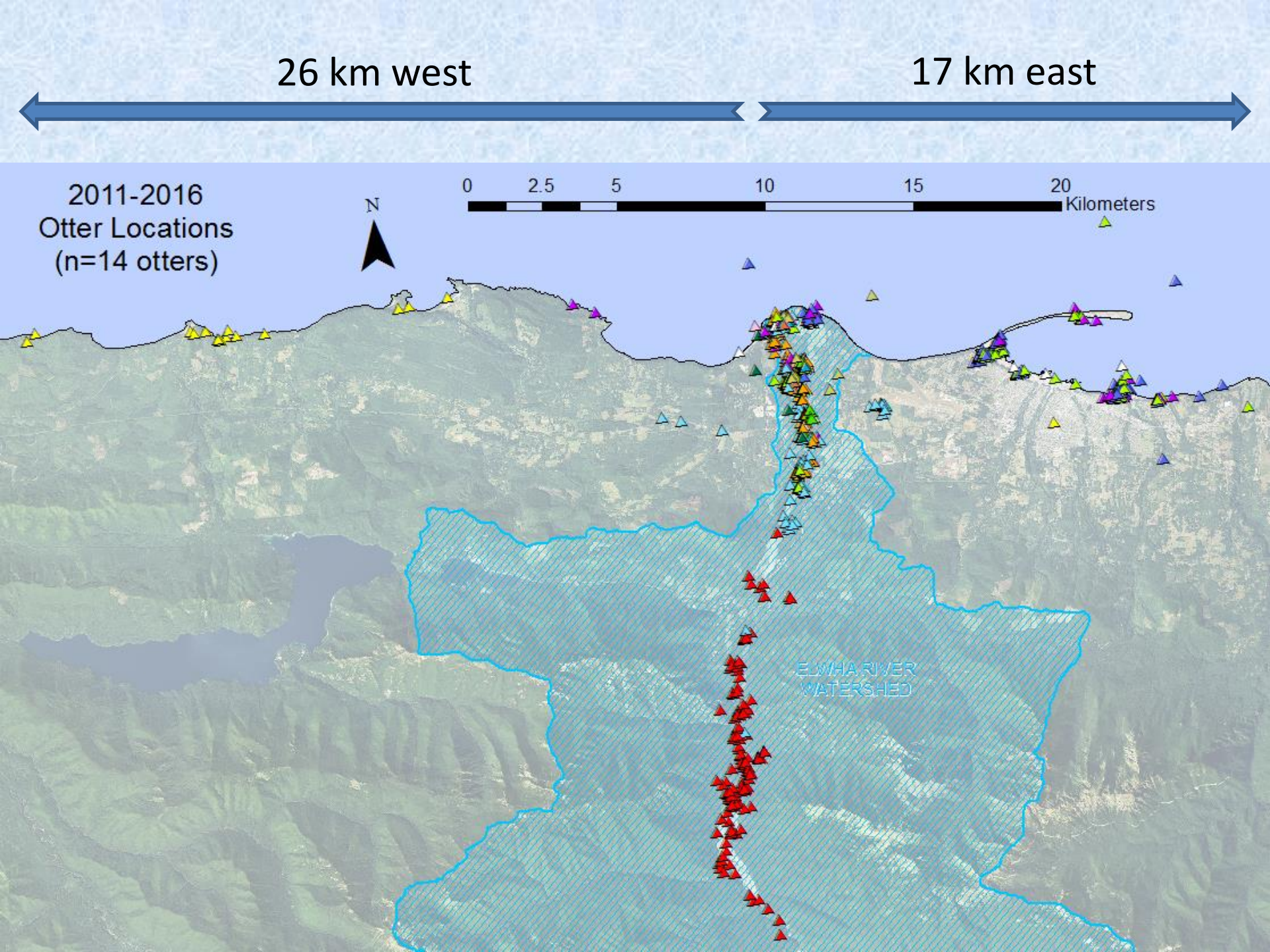
Goals and Objectives

Highlight key predator/prey concepts for subsequent discussions of managing predation effects on sockeye salmon in the Lake Ozette ecosystem.

- Key factors influencing mammalian predation effects on prey
- Are there lessons from local studies of otter movements in the Elwha ecosystem?

Olympic Peninsula




26 km west
17 km east
2011-2016
Otter Locations
(n=14 otters)
N
0
2.5
5
10
15
20
Kilometers
ELWHA RIVER
WATERSHED

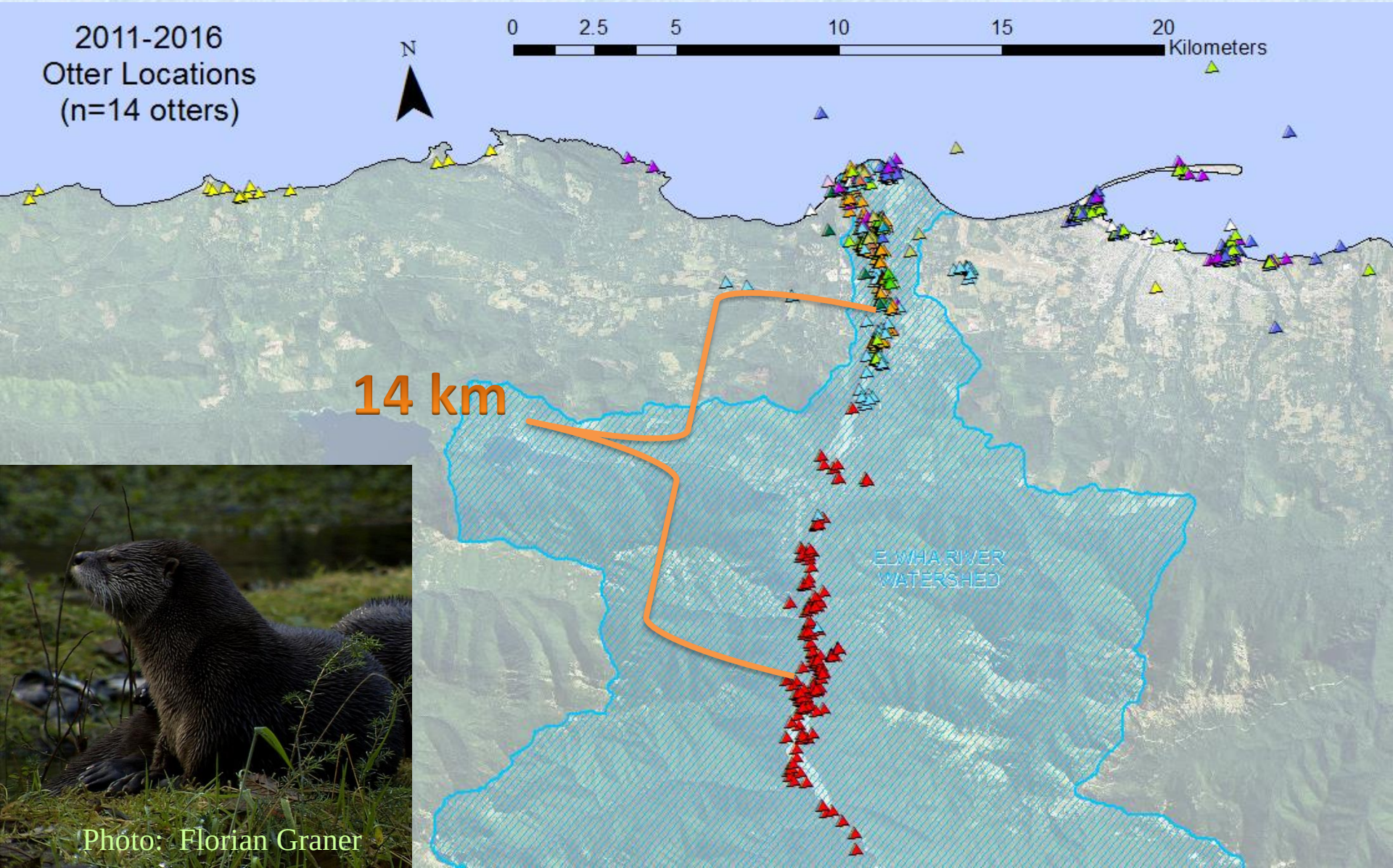
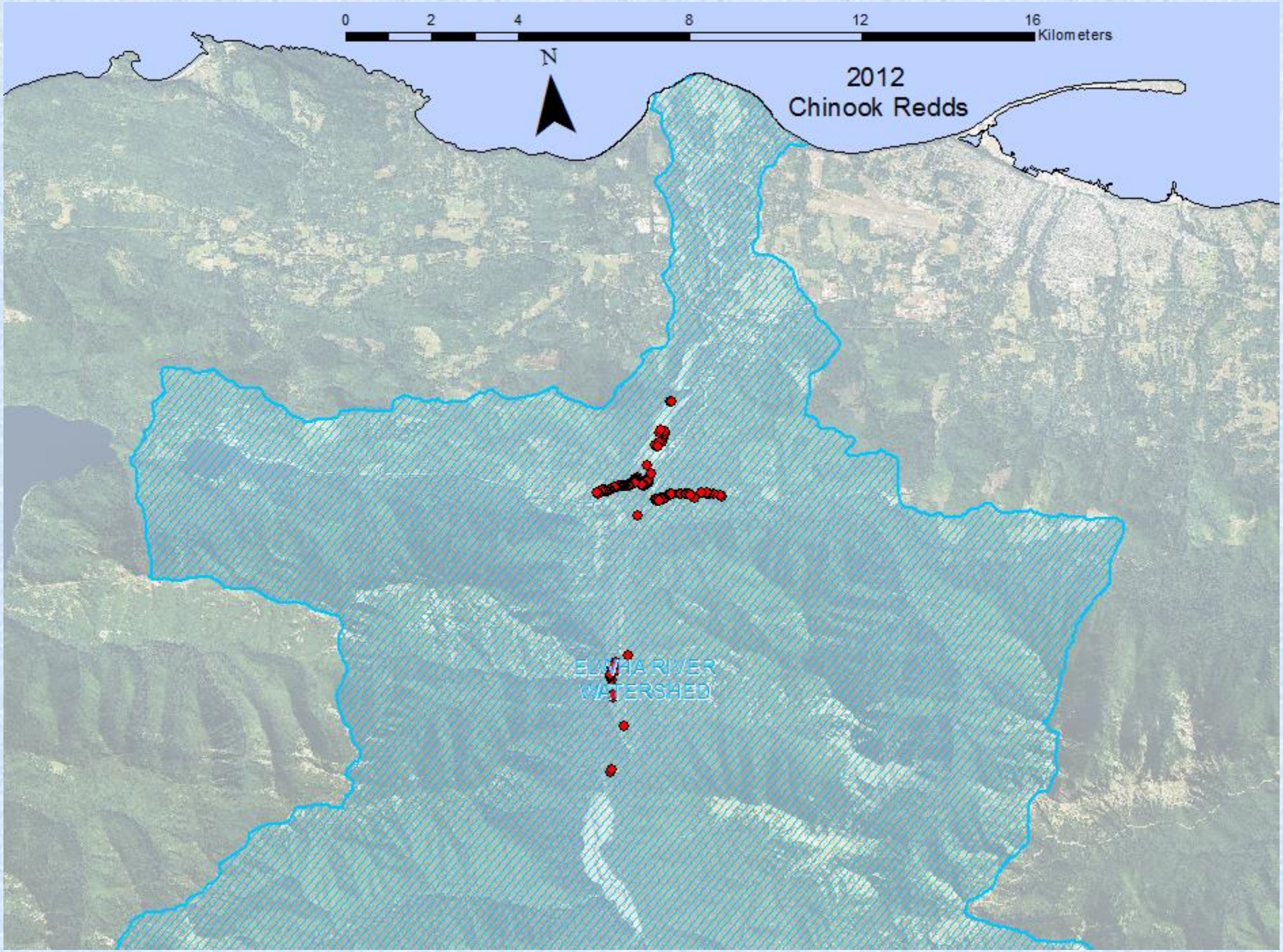

26 km west
17 km east
2011-2016
Otter Locations
(n=14 otters)
N
0 2.5 5 10 15 20
Kilometers
14 km
ELWHA RIVER
WATERSHED
Photo: Florian Graner


Photo: Florian Graner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Kilometers
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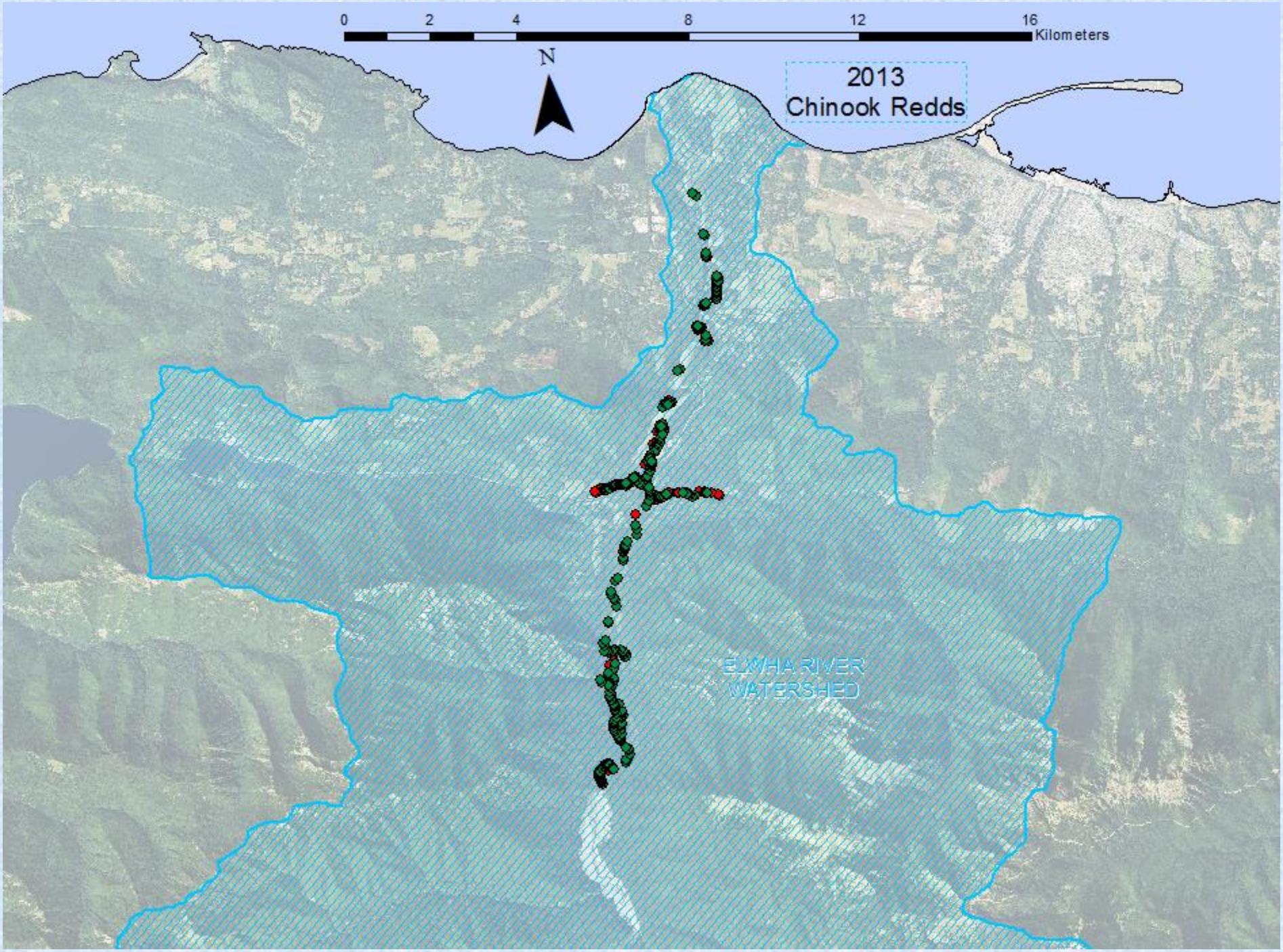
2012
Chinook Redds
ELWHA RIVER
WATERSHED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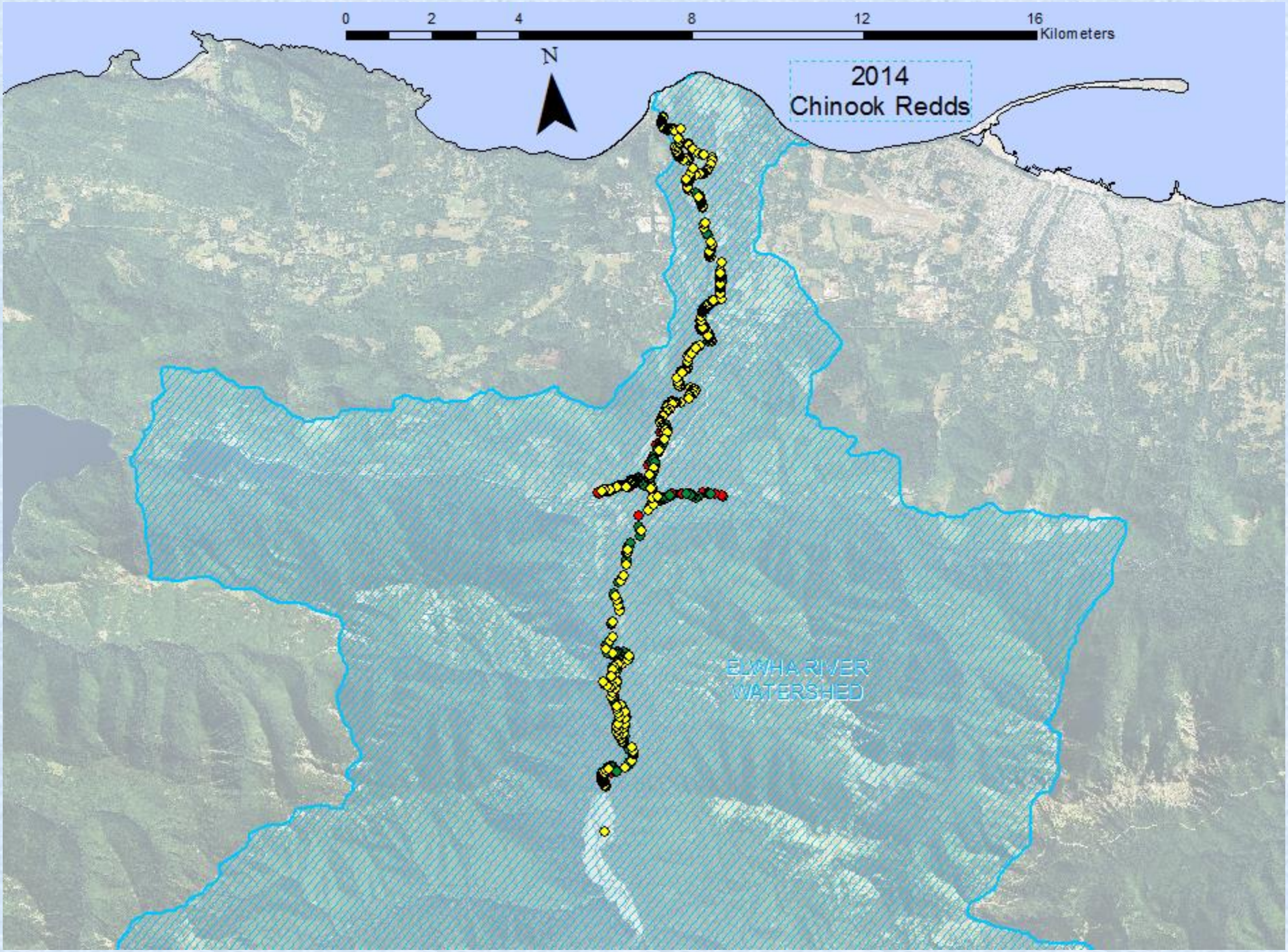
ELWHA RIVER
WATERSHED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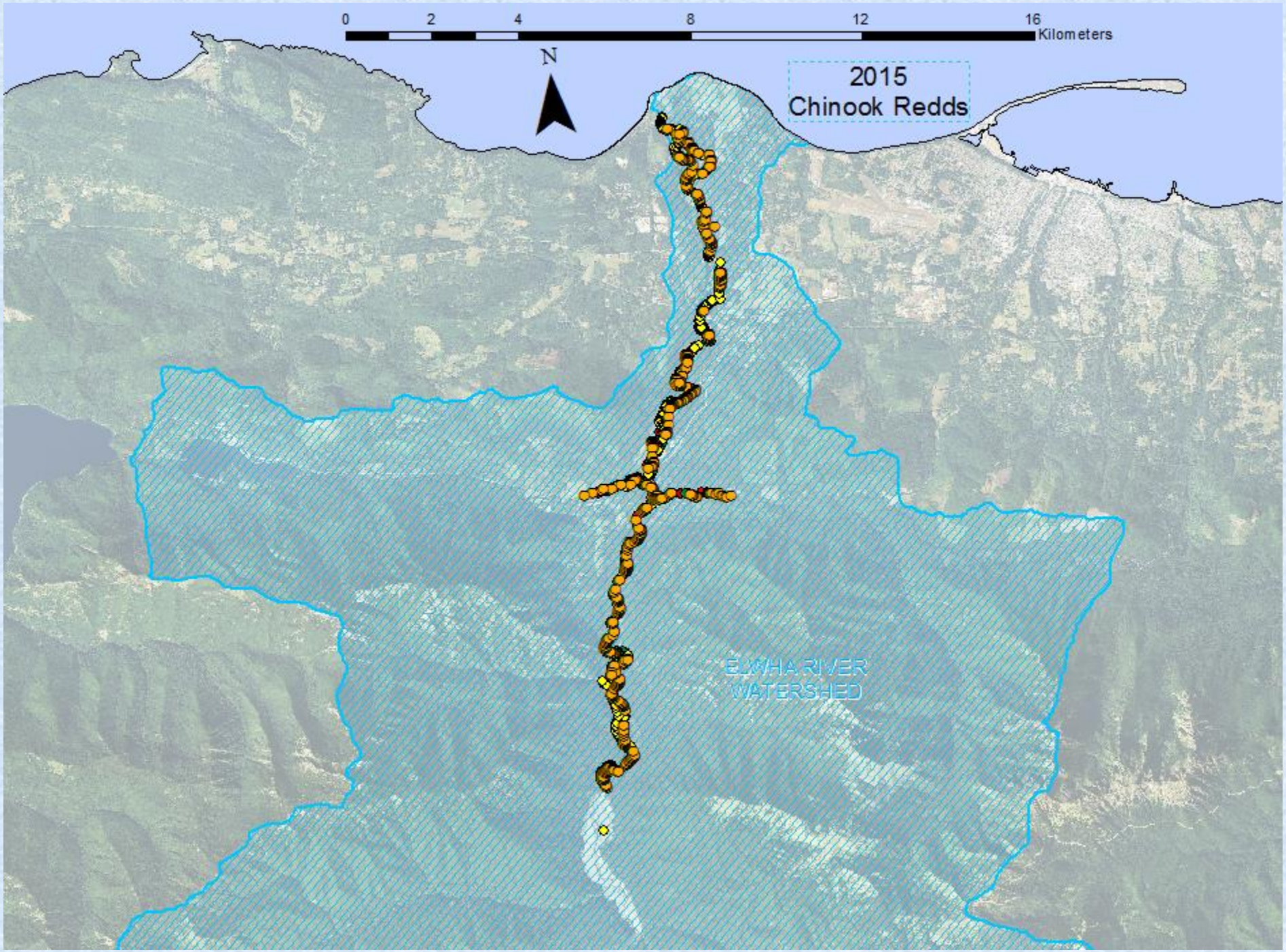
Chinook Redds
ELWHA RIVER
WATERSHED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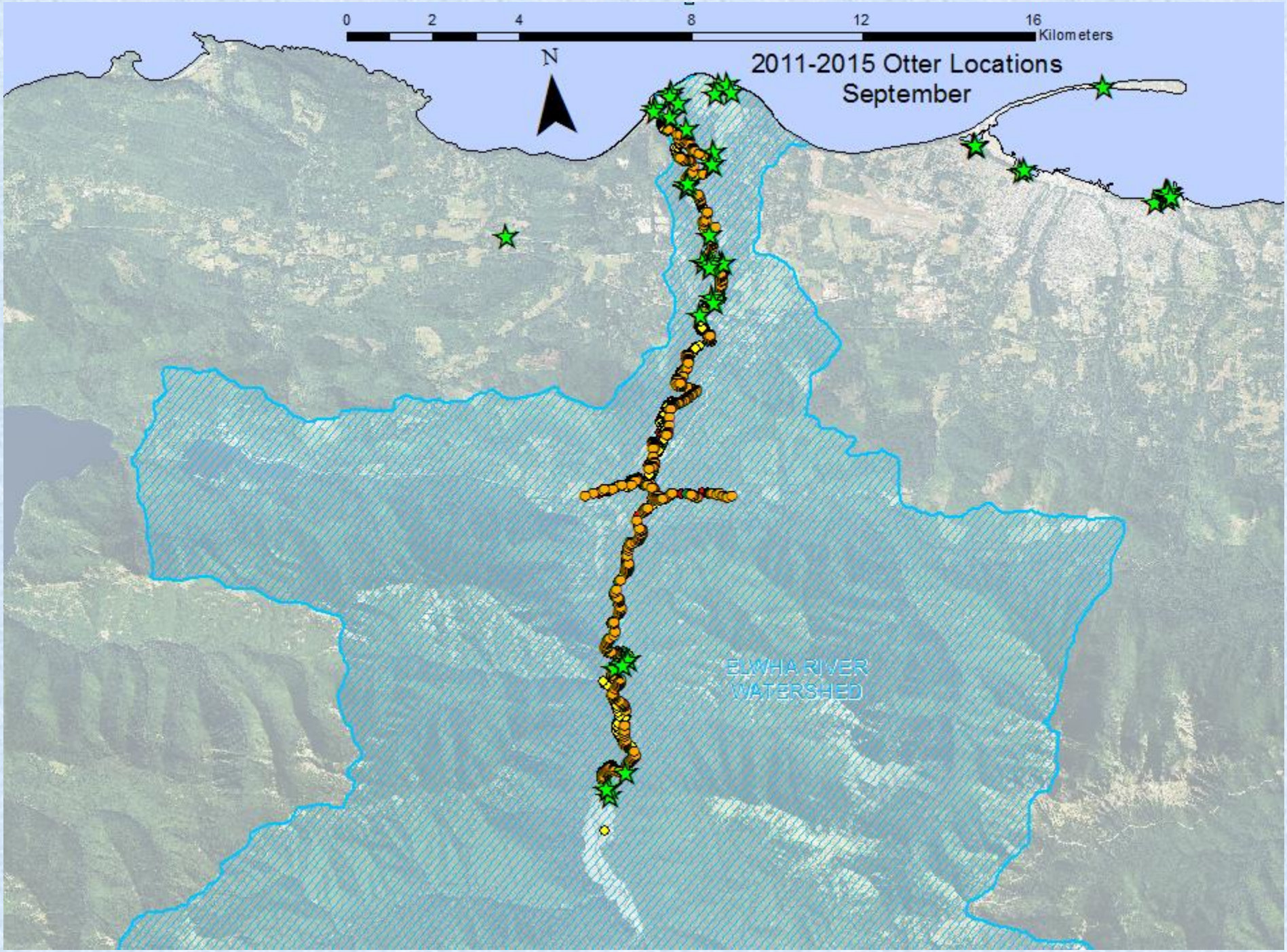
ELWHA RIVER
WATERSHED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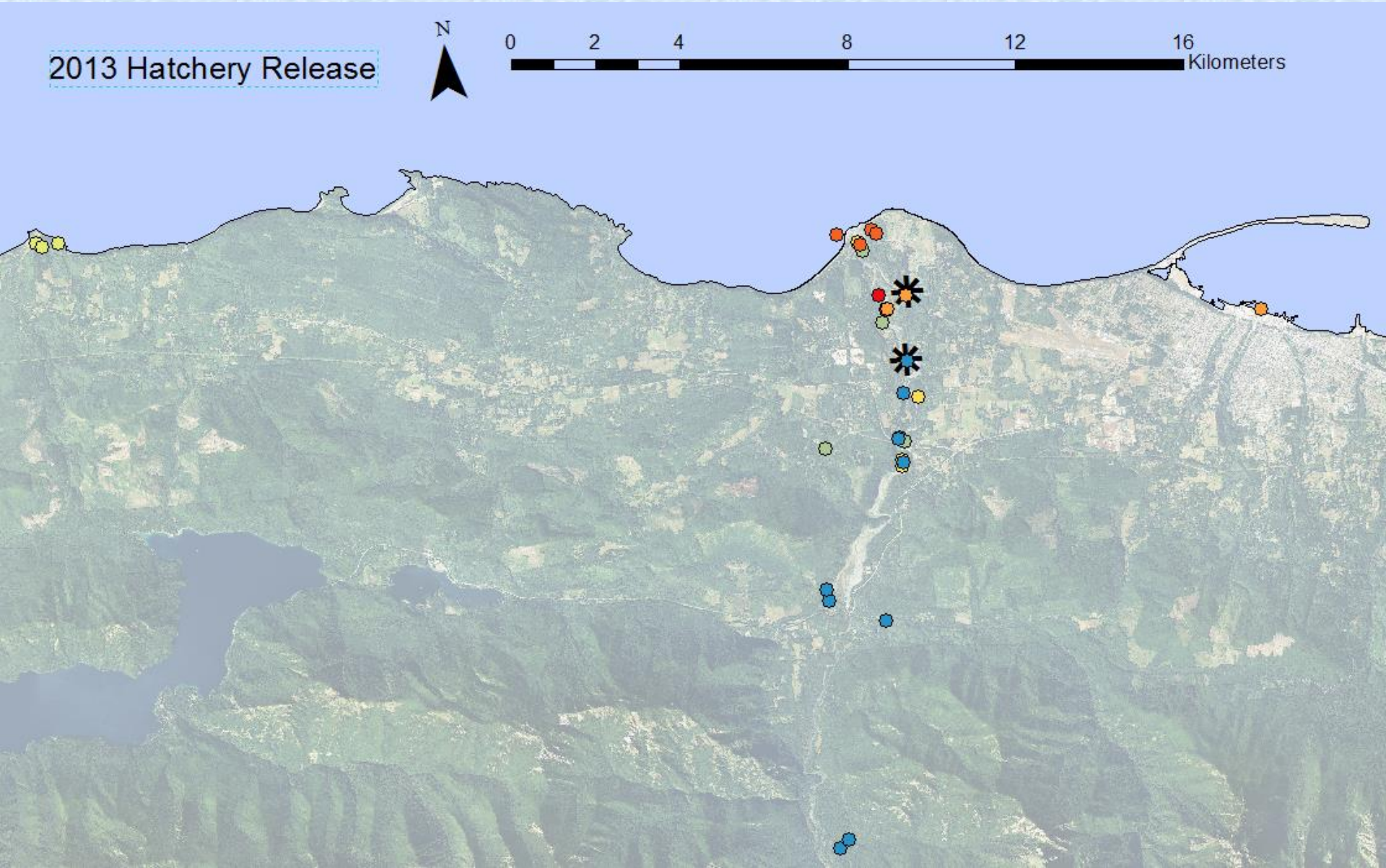
Kilometers
N
2011-2015 Otter Locations
September
ELWHA RIVER
WATERSHED

What about hatchery releases? Do otters focus there?

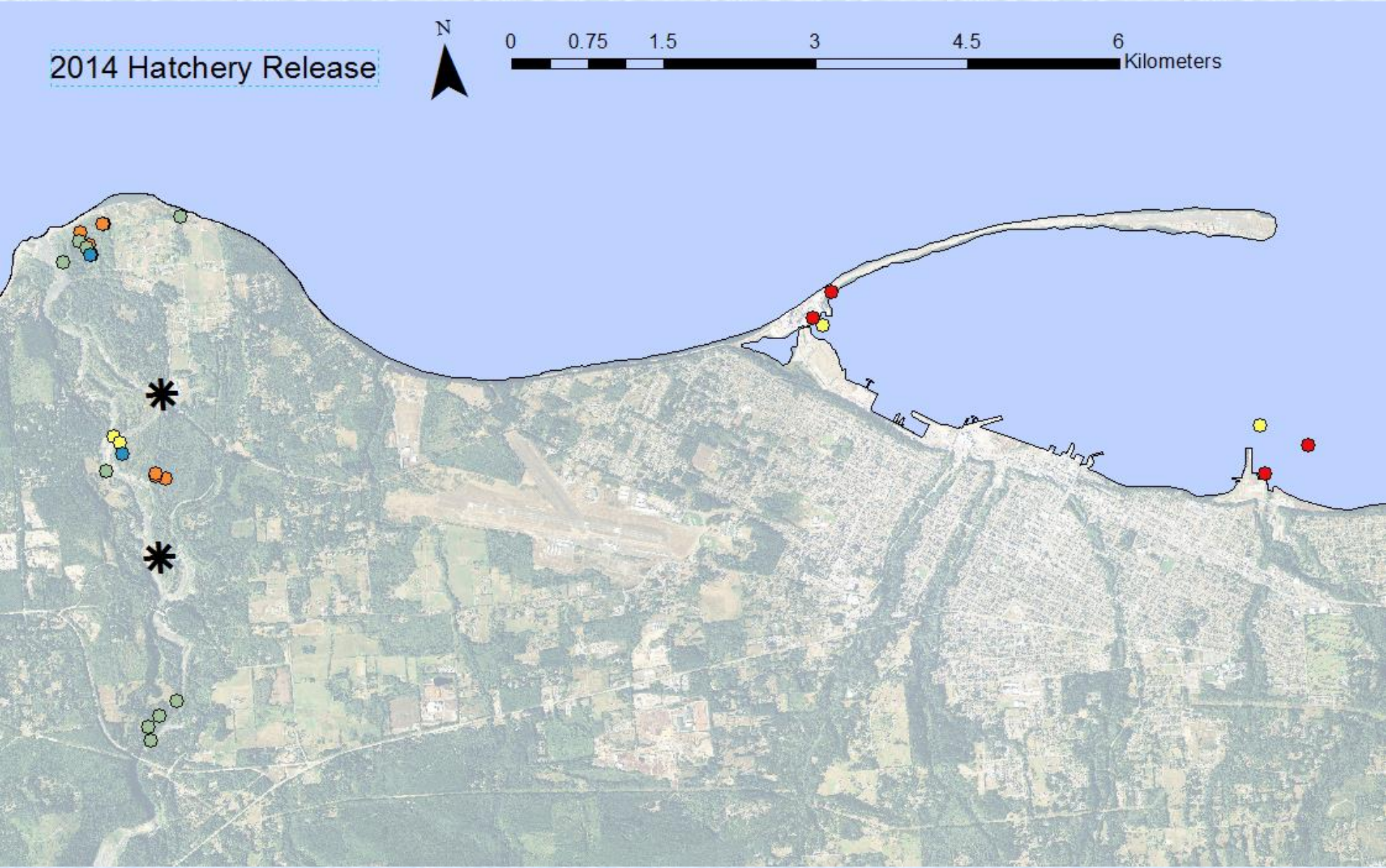
3/15/2013 to 4/12/2013

Hatchery releases of steelhead, coho, chum, and chinook (n= 8 otters)



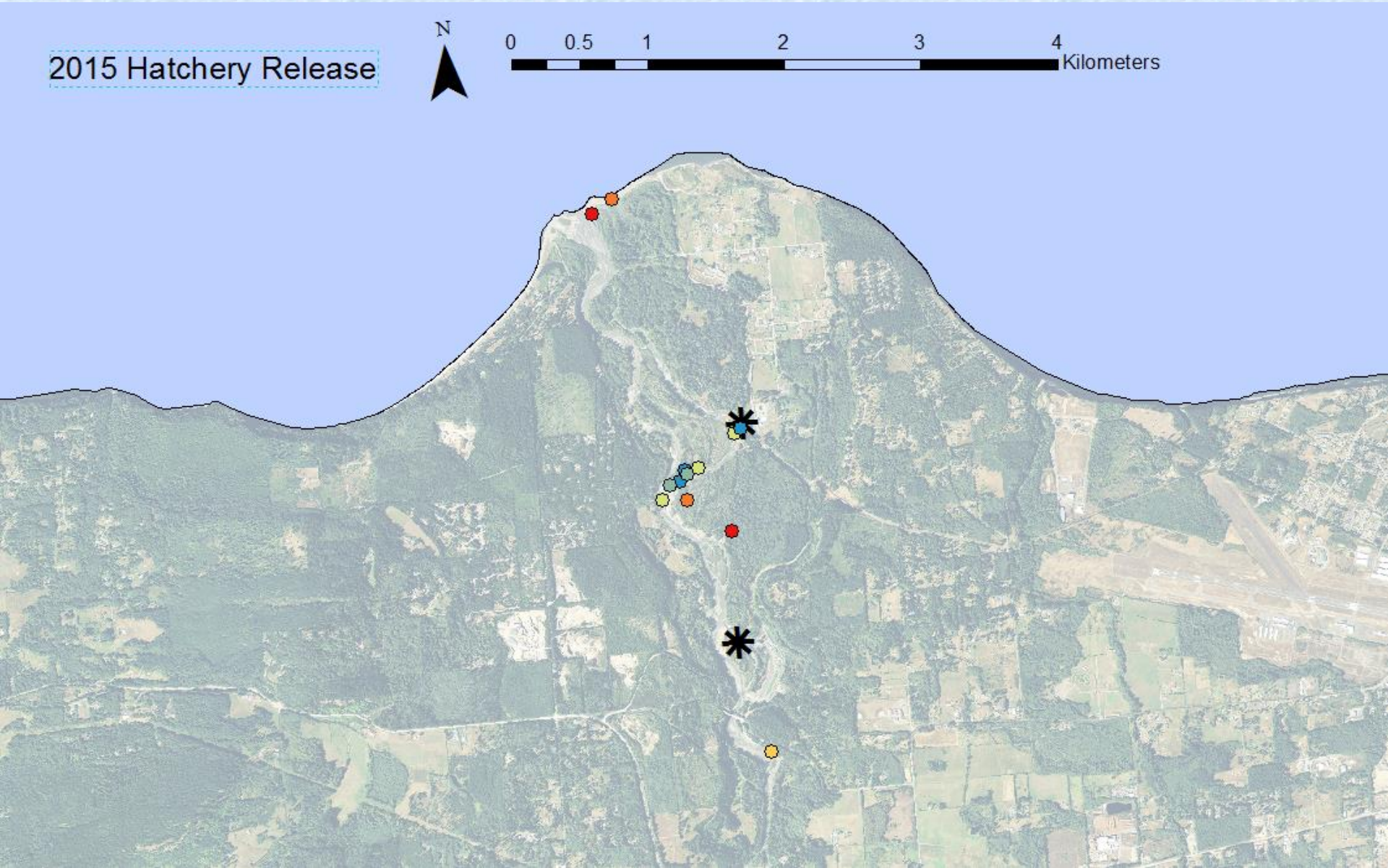
3/24/2014 to 4/21/2014

Hatchery releases of steelhead, coho, pink, chum, and chinook (n= 5 otters)



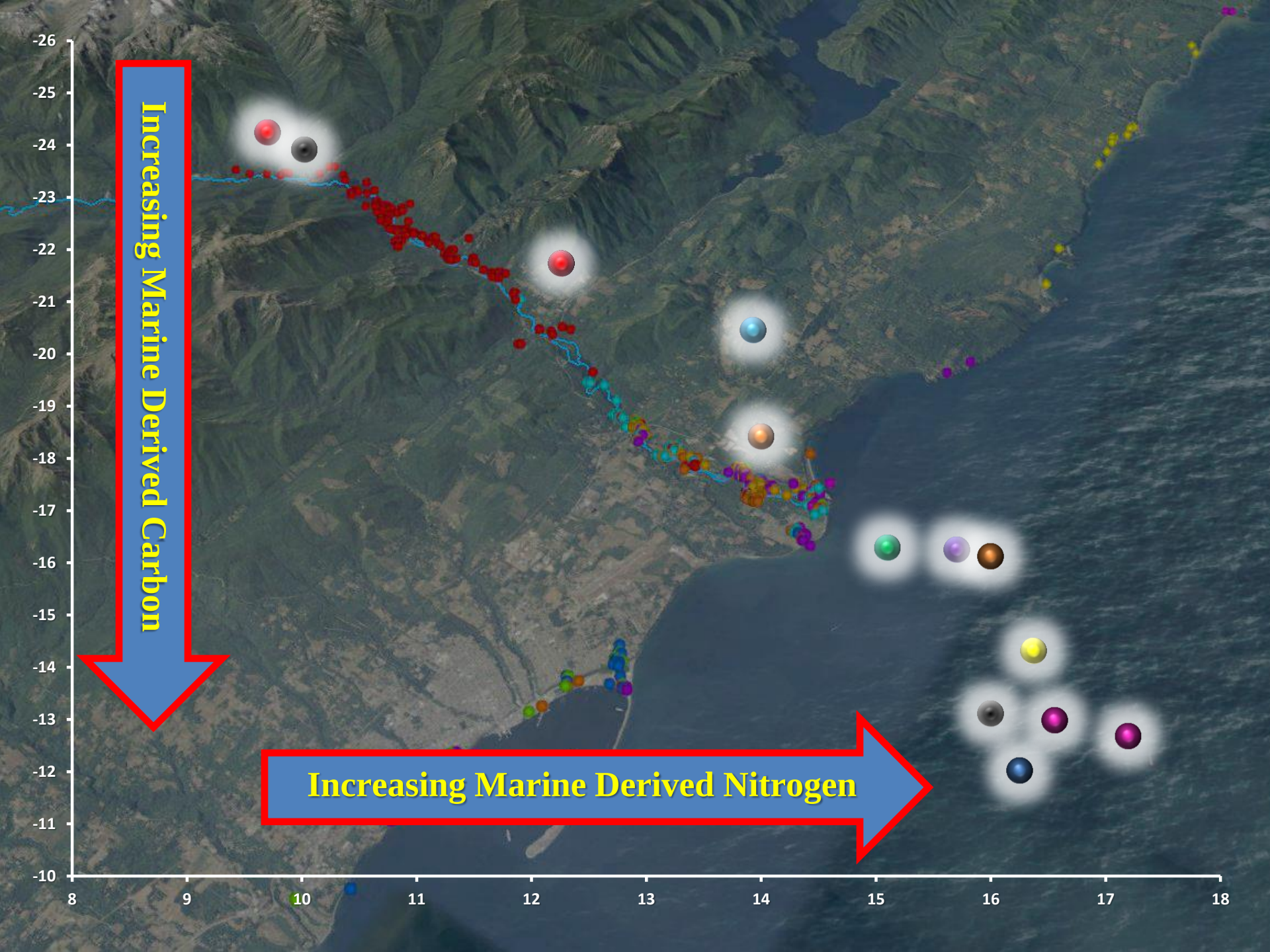
3/16/2015 to 4/6/2015

Hatchery releases of steelhead, coho, chum, and chinook (n= 6 otters)



Prey remains found in Elwha otter scat, below dams, pre dam removal

River Segment	Prey Remains Present in Scat	Frequency in Otter Scat
Below dams		
	COASTRANGE SCULPIN	12
	STEELHEAD / RAINBOW TROUT	9
	UNKNOWN SALMON SPECIES*	6
	PRICKLY SCULPIN	3
	STARRY FLOUNDER	3
	KOKANEE SALMON	2
	NORTHERN CLINGFISH	2
	OLYMPIC SALAMANDER	2
	ROSYLIP SCULPIN	2
	SOCKEYE SALMON	2
	3 SPINED STICKLEBACK	1
	UNKNOWN FISH SPECIES	1
	UNKNOWN SCULPIN	1
	CUTTHROAT TROUT	1
	GUNNEL	1
	SNAILFISH SPECIES	1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Increasing Marine Derived Carbon
Increasing Marine Derived Nitrogen

Take-Home Messages

- Otters move widely and frequently throughout a watershed
- Otters exhibit prey-switching behavior- not apparently focused on just one resource, even when that resource is locally or seasonally abundant
- Management of otter predation would take an ecosystem-wide approach

2013-2015
February only otter locations