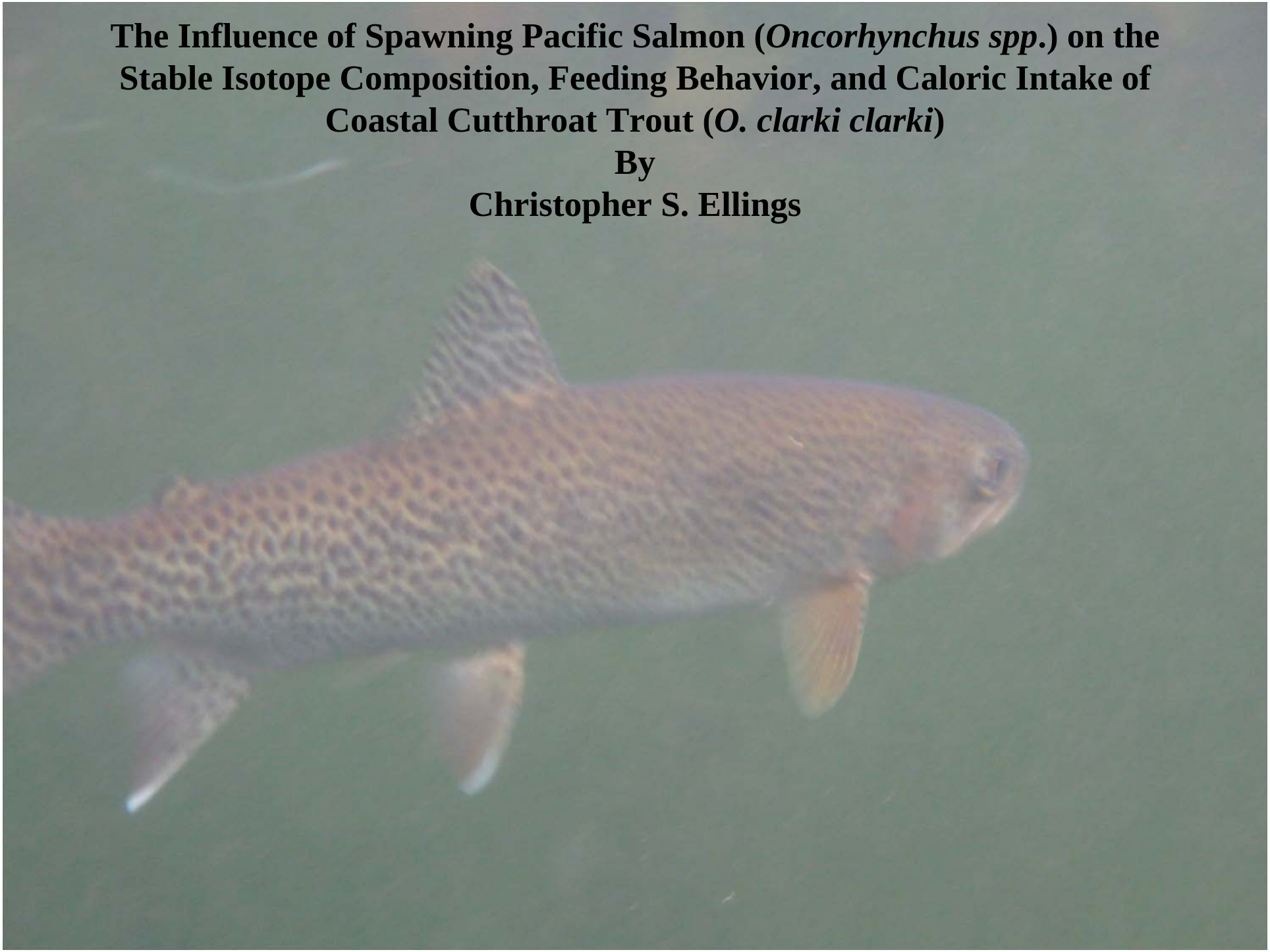
The Influence of Spawning Pacific Salmon (*Oncorhynchus spp*.) on the Stable Isotope Composition, Feeding Behavior, and Caloric Intake of Coastal Cutthroat Trout (*O. clarki clarki*)

By

Christopher S. Ellings



Transfer of Nutrients

Deposition of Nutrients

Utilization of Nutrients from Salmon by Terrestrial and Aquatic Biota

The specific objective of this study was to test the following four hypotheses:

- Juvenile cutthroat trout exposed to spawning salmon are enriched with marine-derived nutrients compared to cutthroat trout residing in the same stream but above an anadromous barrier.
- Cutthroat trout residing in the anadromous zone display a distinct increase in marine-derived nutrients following the peak of the salmon run.
- Cutthroat trout incorporate marine-derived nutrients into their tissues by directly consuming salmon carcass flesh, eggs, and alevins/fry.
- Cutthroat trout with access to salmon-derived prey items ingest more calories during winter and spring than cutthroat trout residing above an anadromous barrier.

Study Sites

Kennedy Creek

- Located in Mason and Thurston Counties, it flows directly into Totten Inlet.
- Size of watershed: 53km^2
- Length of anadromous reach: 4.4km
- Primary semelparous salmon run: Chum (*Oncorhynchus keta*)

Donkey Creek

- Located in Grays Harbor County, it is a tributary to the West Fork of the Humptulips River.
- Size of watershed: 17.3km^2
- Length of anadromous reach: 2.6km
- Primary semelparous salmon runs: Chum (*Oncorhynchus keta*), Coho (*O. kisutch*), and Chinook (*O. tshawytscha*)

Stable Isotope Analysis

$$\delta^{15}N \text{ or } \delta^{13}C \text{ ‰} =$$

$$[(R_{sample} - R_{standard})/R_{standard})] \text{ X } 1000$$

Caloric Index Value (CIV)

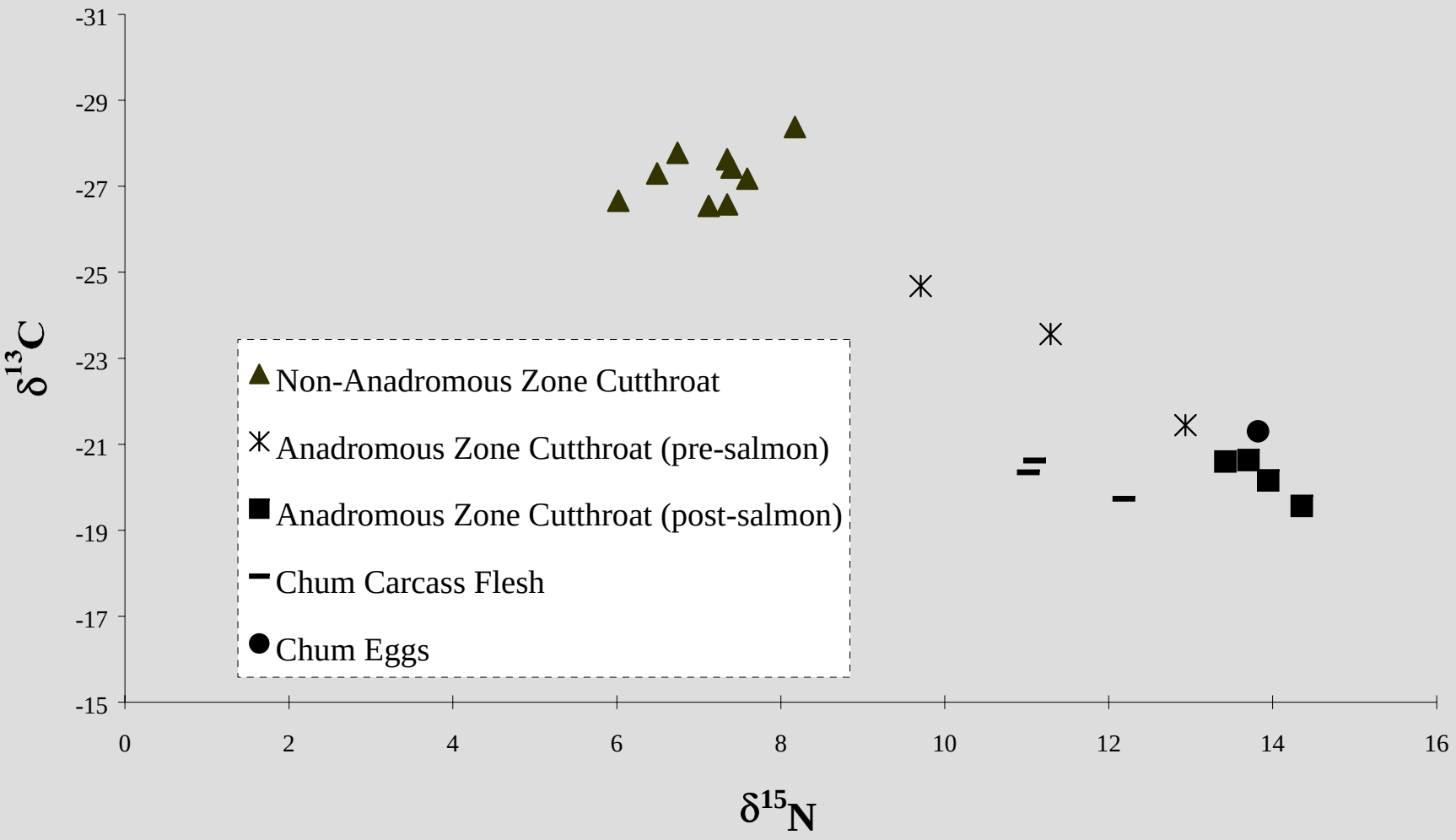
$$\text{CIV} = \frac{\text{Caloric content of food item (cal)}}{\text{Cutthroat body weight (g)}}$$

Caloric values used to generate the caloric index value (CIV):

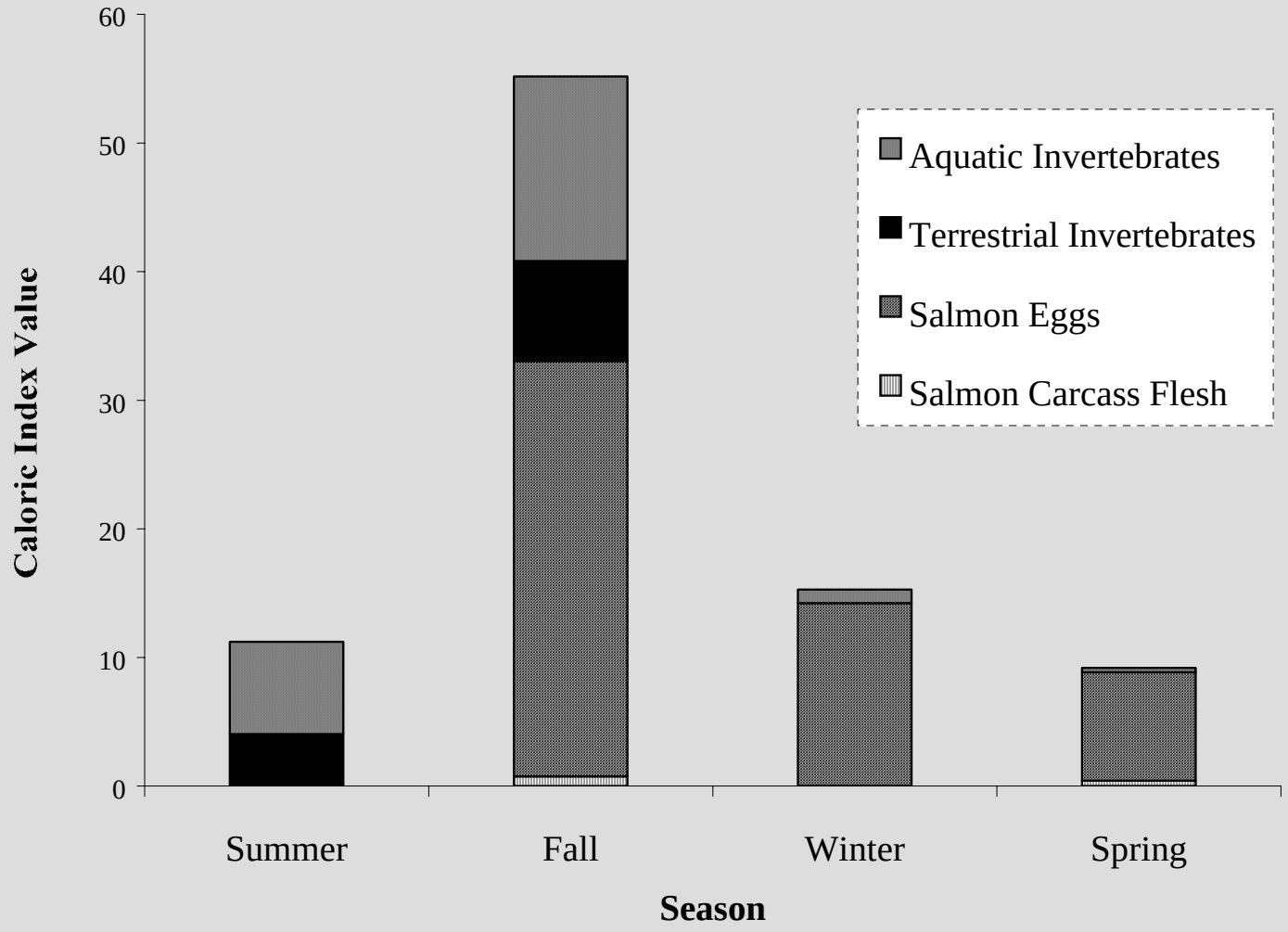
Prey Item	Caloric Value (cal/g wet weight)
Invertebrates (Aquatic and Terrestrial)	3782.5
Eggs (Salmon and Whitefish)	4450.0
Flesh (Salmon Flesh and Unknown Fish Flesh)	645.0

values are from Eastman (1996)

Dual-Isotope Ratio Plot for Coastal Cutthroat Trout, Chum Salmon Carcass Flesh, and Chum Salmon Eggs Collected from Kennedy Creek, WA.

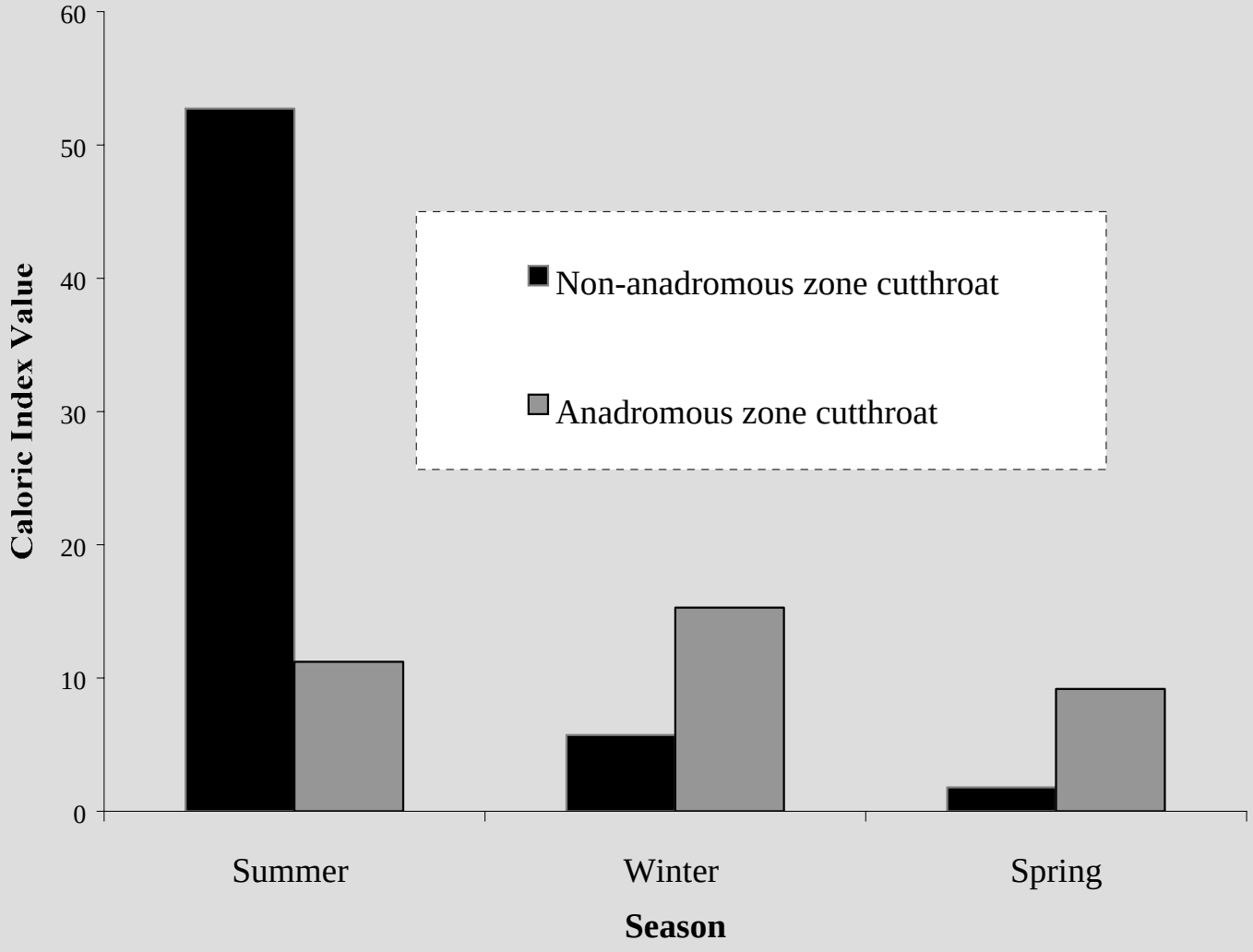


The Caloric Index Value (CIV) of the Primary Prey Items Consumed by Coastal Cutthroat Trout in the Anadromous Zone of Kennedy Creek, WA.

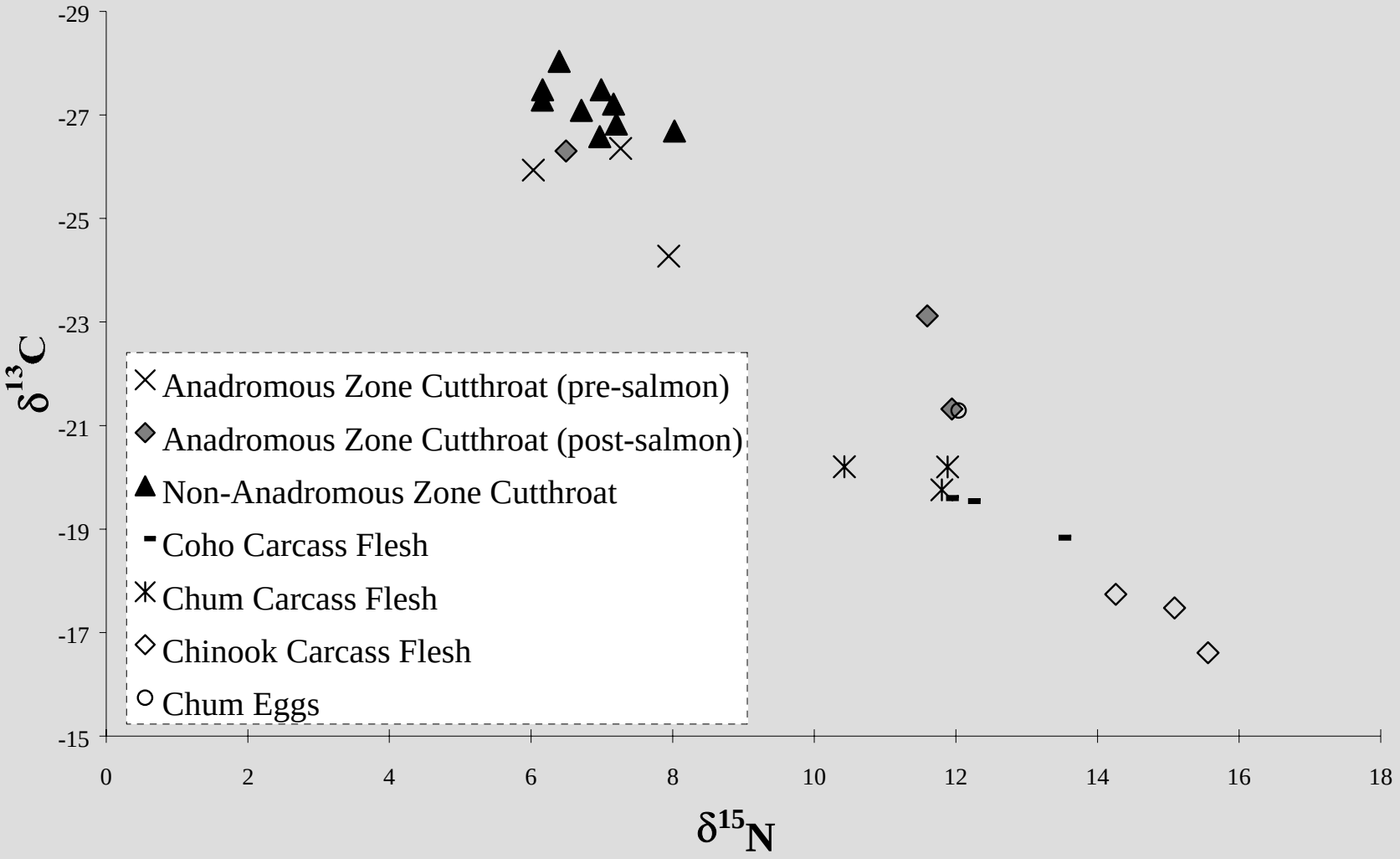


All samples were averaged by prey category and season collected.

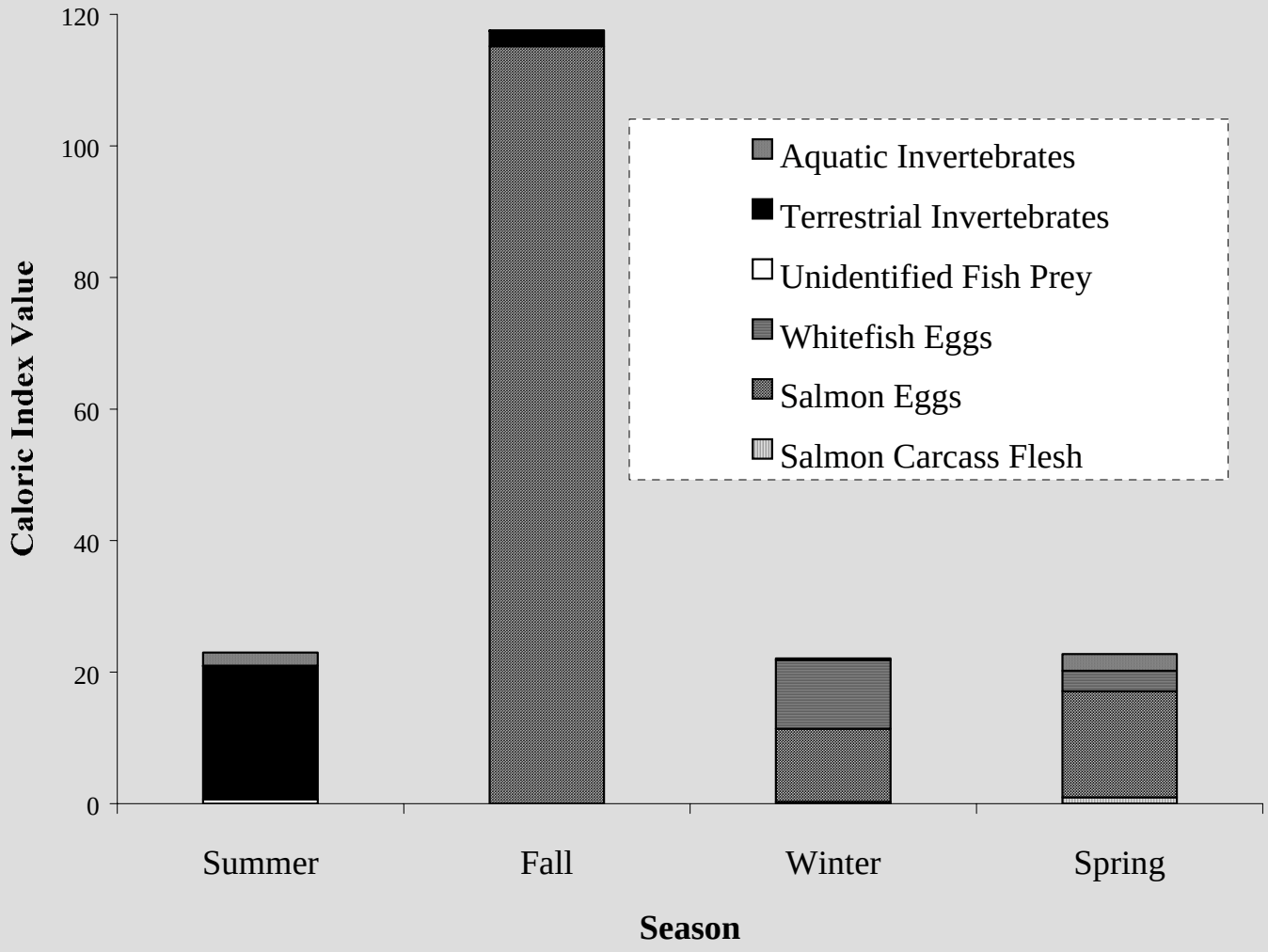
The Average Total Caloric Index Value for the Primary Prey Items Consumed by Anadromous Zone and Non-Anadromous Zone Coastal Cutthroat Trout in Kennedy Creek, WA.



Dual-Isotope Ratio Plot for Coastal Cutthroat Trout, Coho Carcass Flesh, Chum Carcass Flesh, Chinook Carcass Flesh, and Chum Salmon Eggs Collected from Donkey Creek, WA.

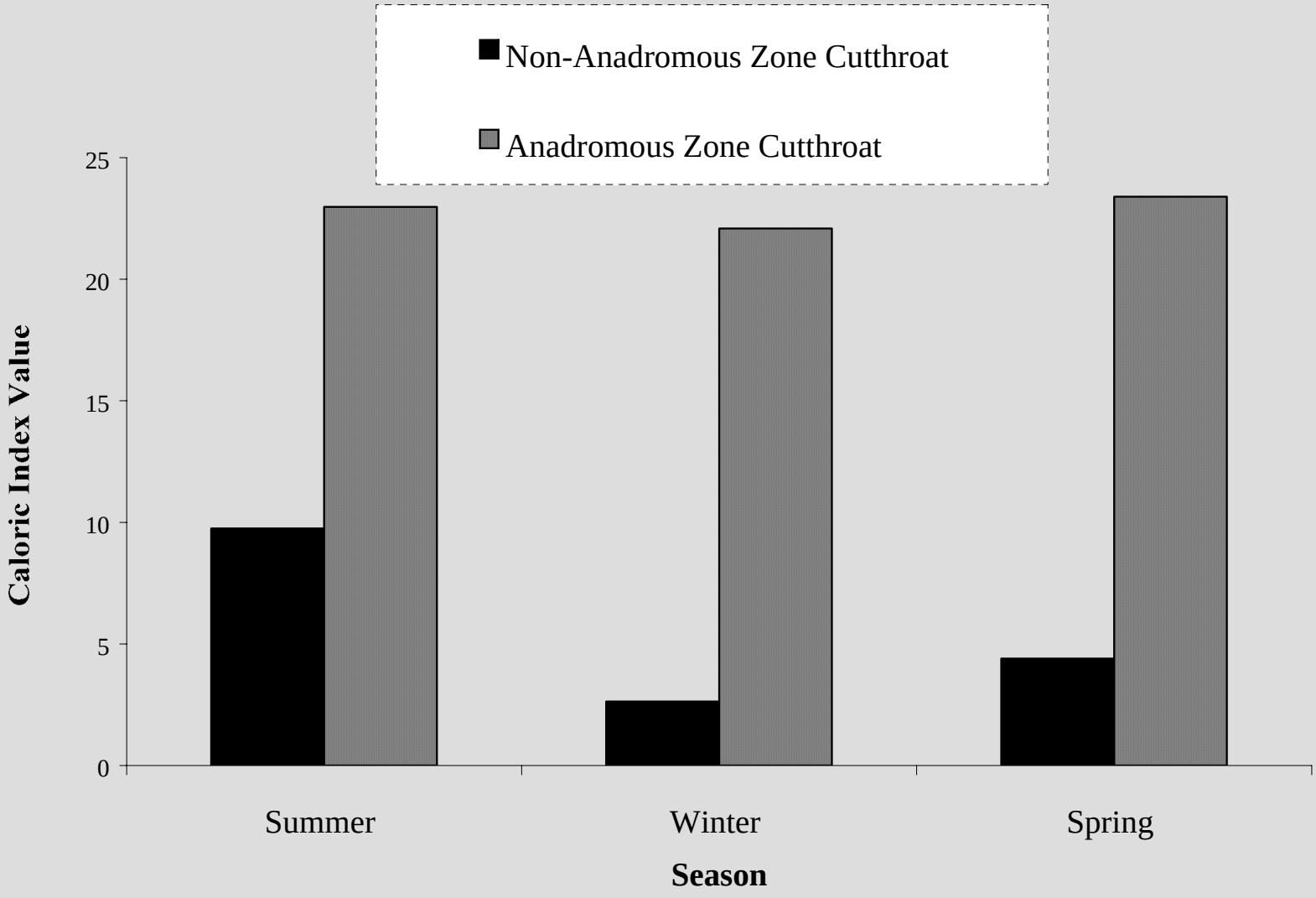


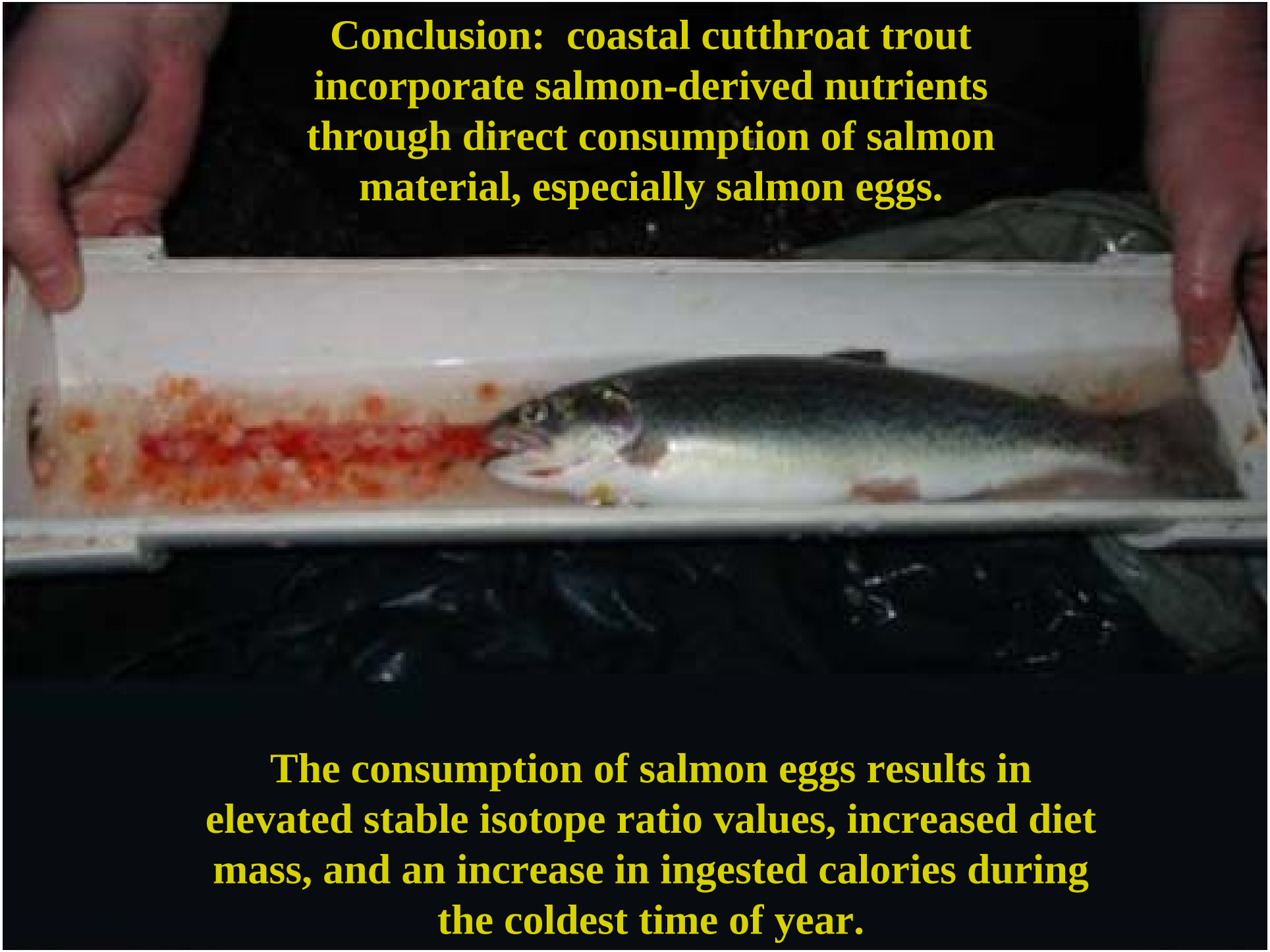
The Caloric Index Value (CIV) of the Primary Prey Items Consumed by Coastal Cutthroat Trout in the Anadromous Zone of Donkey Creek, WA.



All samples were averaged by prey category and season collected.

The Average Total Caloric Index Value for the Primary Prey Items Consumed by Anadromous Zone and Non-Anadromous Zone Coastal Cutthroat Trout in Donkey Creek, WA.




Conclusion: coastal cutthroat trout incorporate salmon-derived nutrients through direct consumption of salmon material, especially salmon eggs.
The consumption of salmon eggs results in elevated stable isotope ratio values, increased diet mass, and an increase in ingested calories during the coldest time of year.

Inferring Benefit Through Bioenergetic Theory

$$I = M + G + E$$ (Moyle and Cech 1996)

I = ingested food energy (measured in calories)
M = metabolism
G = growth (both in somatic and reproductive tissue)
E = energy excreted

Mean stable isotope values for cutthroat and rainbow trout at various levels of adult salmon abundance. The numbers of fish sampled are in parentheses.

Reference	Stream and Year	Species	Adult Salmon Abundance Estimate (Adults/1000m)	$\delta^{15}N$	$\delta^{13}C$
Kline et al. 1990	Sashin Creek, AK. 1985	Rainbow Trout	25,000 Pink Salmon	12.8 (10)	-22.3 (10)
Bilby et al. 1996	Grizzly Creek, WA. 1992	Age-1 and -2 Cutthroat Trout	475 Coho Salmon	10.8 (6)	-24.0 (5)
This Study	Kennedy Creek, WA. 2002	Age-1 and -2 Cutthroat Trout	11,484 Chum Salmon	13.9 (4)	-20.2 (4)
This Study	Donkey Creek, WA. 2002	Age-1 and -2 Cutthroat Trout	484 Chum, Coho, and Chinook Salmon	10.0 (3)	-23.4 (3)

Acknowledgements

Advisors/Coauthors:

Mr. Jeff Cederholm & Dr. Gerardo Chin-Leo

Research Assistants:

Matt Barnhart, Andy Olson, Claudine Reynolds, Josh Pearce, and Aspen Madrone

Funding Assistance: South Sound Fly-fishers

Coastal Cutthroat Trout Symposium Travel Assistance Grant

For more information or a digital copy of the paper please e-mail me: searunchris@yahoo.com