

**RESIDUAL EFFECTS OF LEAD AND ZINC MINING
ON FRESHWATER MUSSELS IN THE
TRI-STATE MINING DISTRICT**

presented by:

Robert T. Angelo

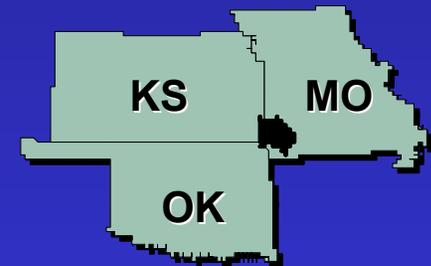
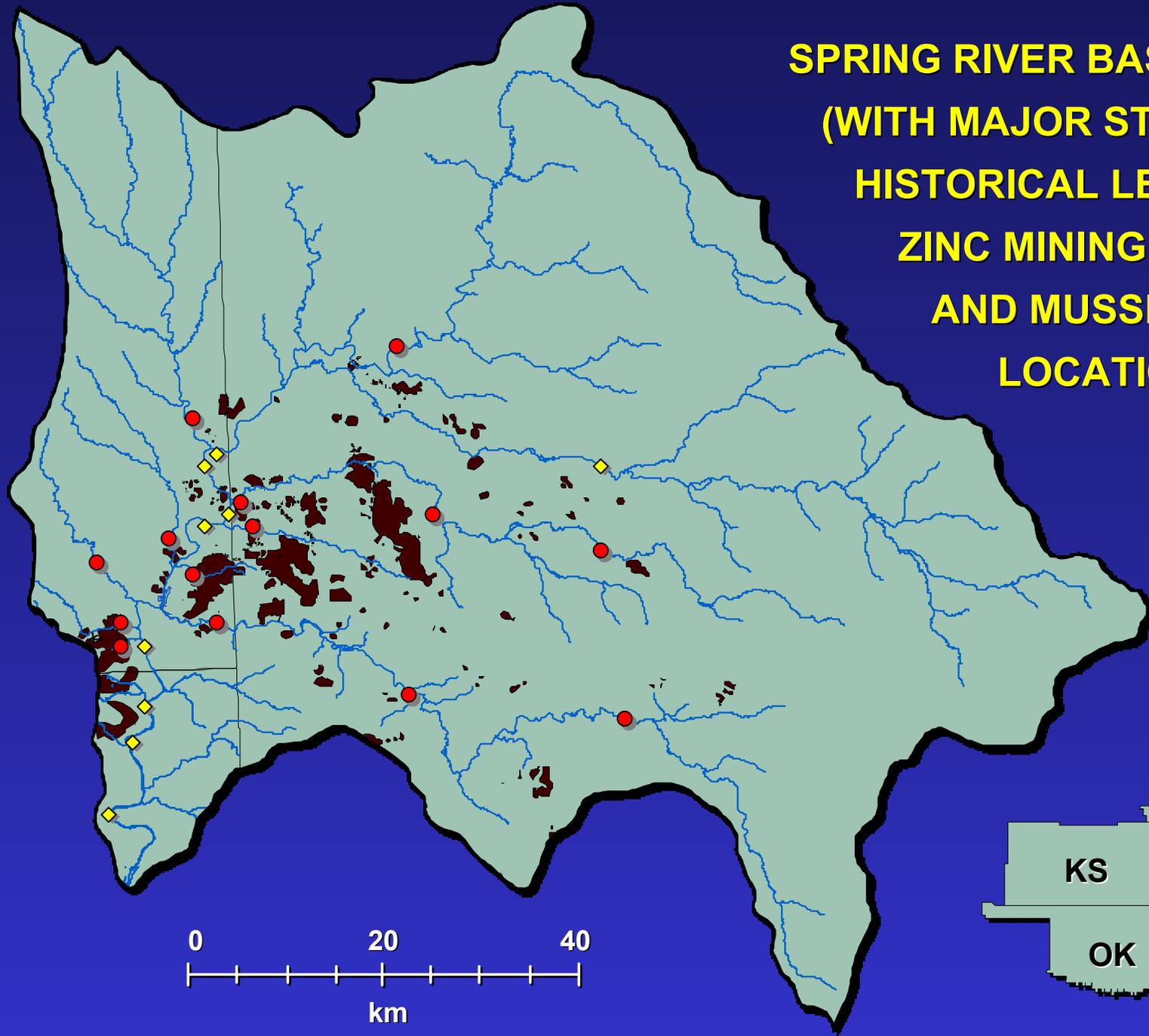
**Kansas Department of Health and Environment
Bureau of Environmental Field Services
Technical Services Section**



STUDY OBJECTIVES

- **Examine occurrence and distribution of native freshwater mussels in Spring River Basin.**
- **Evaluate current mussel densities, dominant taxa, and principal age-classes in selected stream reaches.**
- **Ascertain metal contaminant levels in mussel soft tissues and shell materials, focusing primarily on cadmium, lead, and zinc.**
- **Explore relationships between mussel community parameters, shell/soft tissue contaminant levels, and environmental (sediment/water-column) contaminant concentrations.**

**SPRING RIVER BASIN
(WITH MAJOR STREAMS,
HISTORICAL LEAD AND
ZINC MINING AREAS,
AND MUSSEL SURVEY
LOCATIONS)**





Spring River, sta. 1



Spring River, sta. 2



Spring River, sta. 4

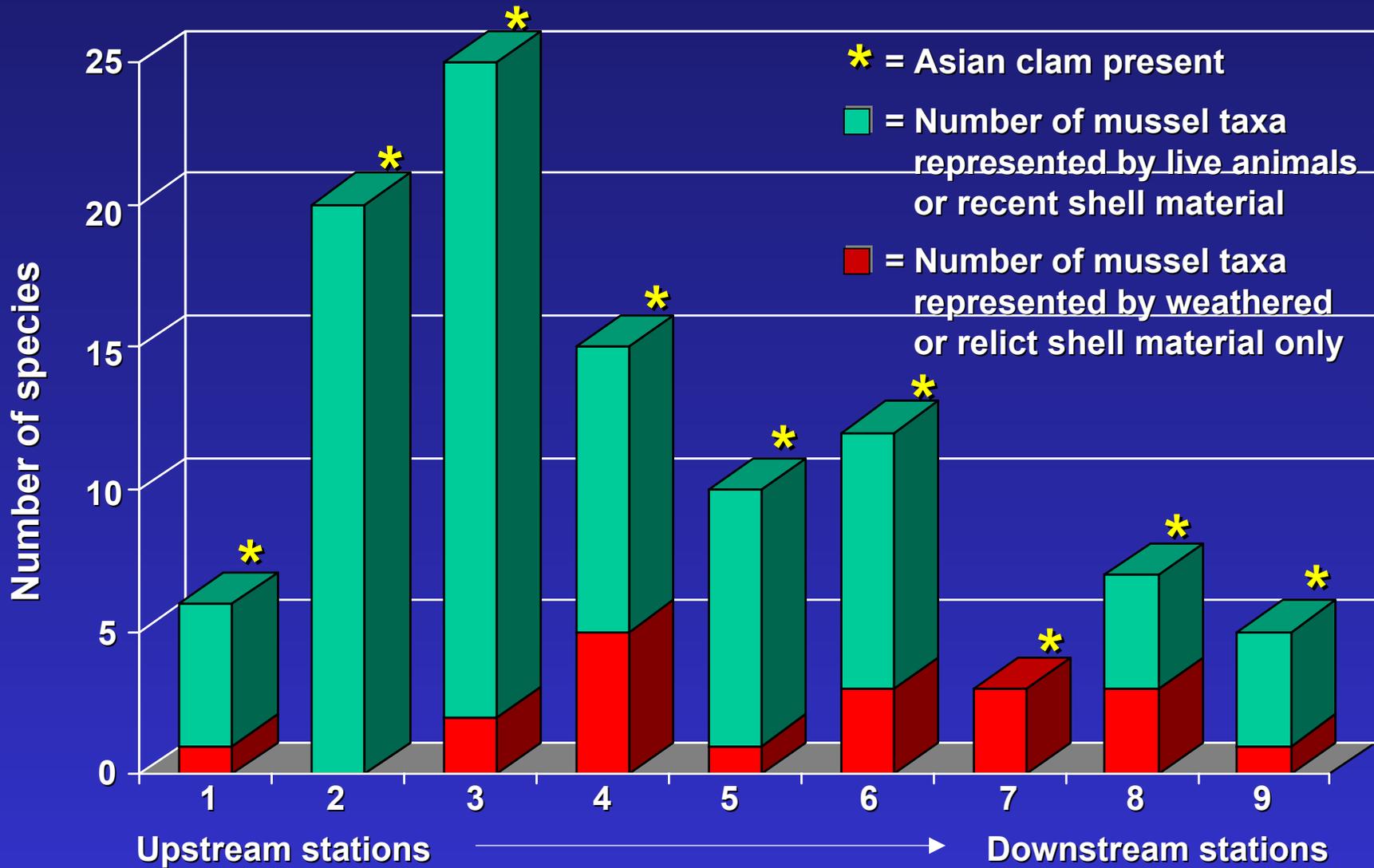


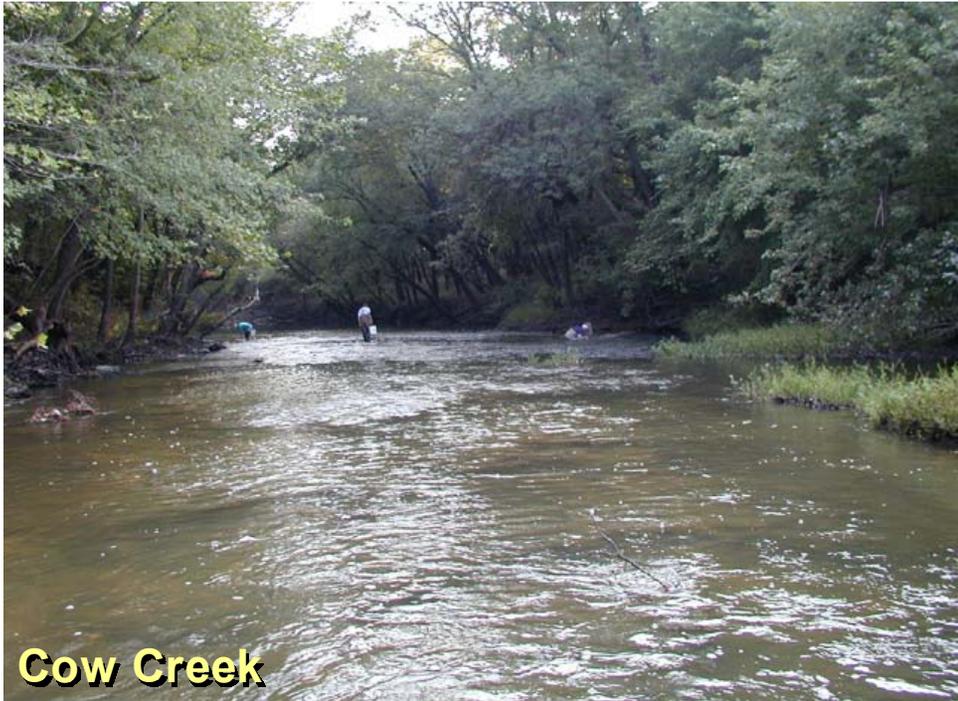
Spring River, sta. 6

MUSSEL SPECIES OBSERVED IN SPRING RIVER

1. *Alasmidonta marginata*
 2. *Amblema plicata*
 3. *Cyprogenia aberti*
 4. *Elliptio dilatata*
 5. *Fusconaia flava*
 6. *Fusconaia ozarkensis*
 7. *Lampsilis cardium*
 8. *Lampsilis rafinesqueana*
 9. *Lampsilis siliquoidea*
 10. *Lampsilis teres*
 11. *Lasmigona complanata*
 12. *Lasmigona costata*
 13. *Leptodea fragilis*
 14. *Ligumia recta*
 15. *Ligumia subrostrata*
 16. *Obliquaria reflexa*
 17. *Pleurobema sintoxia*
 18. *Potamilus ohiensis*
 19. *Potamilus purpuratus*
 20. *Ptychobranthus occidentalis*
 21. *Pyganodon grandis*
 22. *Quadrula cylindrica*
 23. *Quadrula metanevra*
 24. *Quadrula pustulosa*
 25. *Quadrula quadrula*
 26. *Strophitus undulatus*
 27. *Tritogonia verrucosa*
 28. *Truncilla donaciformis*
 29. *Venustaconcha ellipsiformis*
-
- Species listed as endangered, threatened, or in need of conservation by KDWP
 - Species represented only by weathered shell material

MUSSEL SPECIES RICHNESS DOCUMENTED AT NINE SURVEY SITES ALONG SPRING RIVER





Cow Creek



North Fork Spring River



Brush Creek

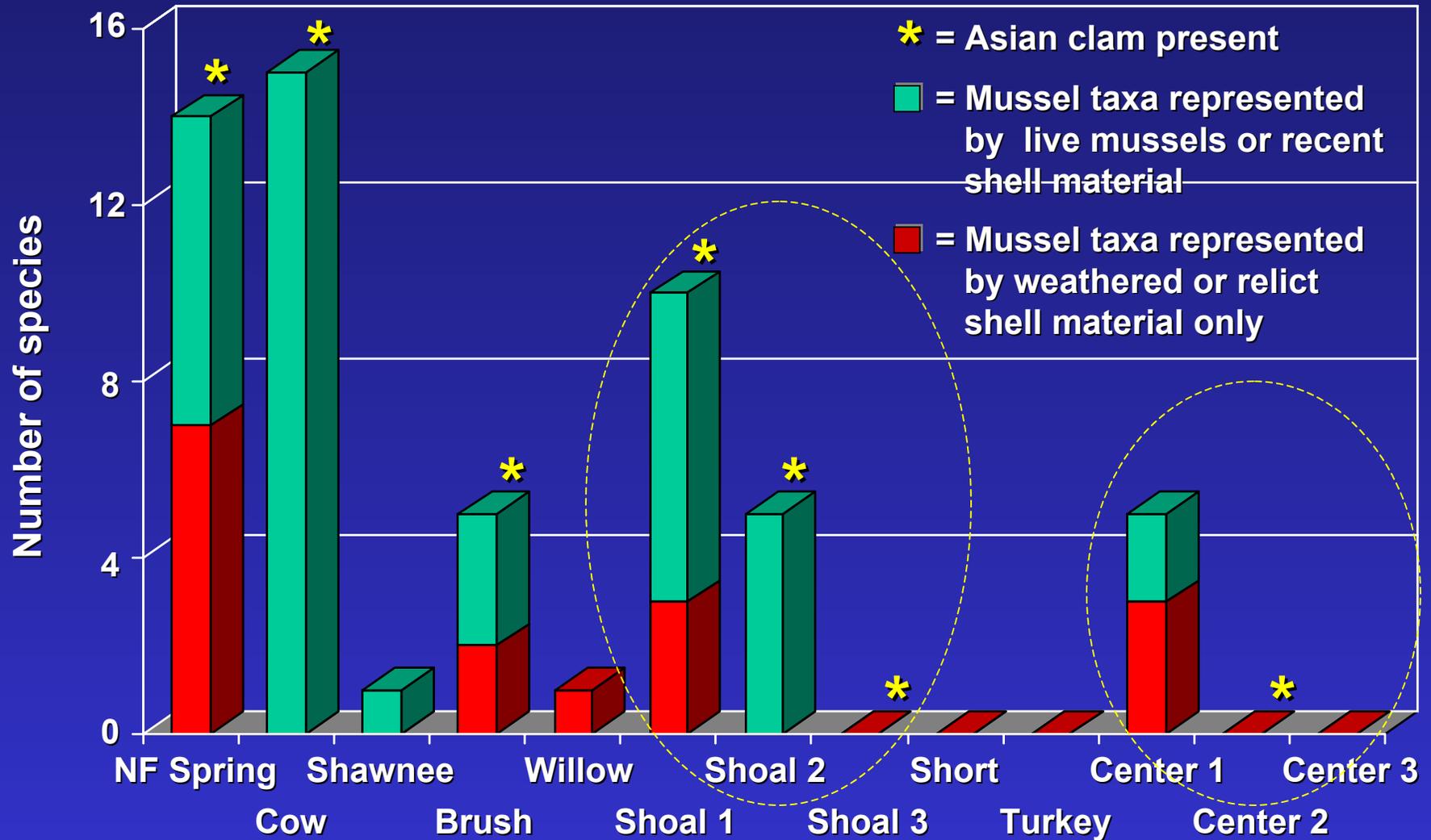


Shoal Creek, sta. 3

MUSSEL SPECIES OBSERVED IN MAJOR TRIBUTARIES OF SPRING RIVER

1. *Amblema plicata*
 2. *Elliptio dilatata*
 3. *Fusconaia flava*
 4. *Fusconaia ozarkensis*
 5. *Lampsilis cardium*
 6. *Lampsilis rafinesqueana*
 7. *Lampsilis siliquoidea*
 8. *Lampsilis teres*
 9. *Lasmigona complanata*
 10. *Lasmigona costata*
 11. *Leptodea fragilis*
 12. *Ligumia subrostrata*
 13. *Pleurobema sintoxia*
 14. *Potamilus ohiensis*
 15. *Potamilus purpuratus*
 16. *Pyganodon grandis*
 17. *Quadrula pustulosa*
 18. *Quadrula quadrula*
 19. *Strophitus undulatus*
 20. *Toxolasma lividis*
 21. *Toxolasma parvus*
 22. *Tritogonia verrucosa*
 23. *Venustaconcha ellipsiformis*
-
- Species listed as endangered, threatened, or in need of conservation by KDWP
 - Species not found in Spring River

MUSSEL SPECIES RICHNESS DOCUMENTED AT 13 SITES ON MAJOR TRIBUTARIES OF SPRING RIVER

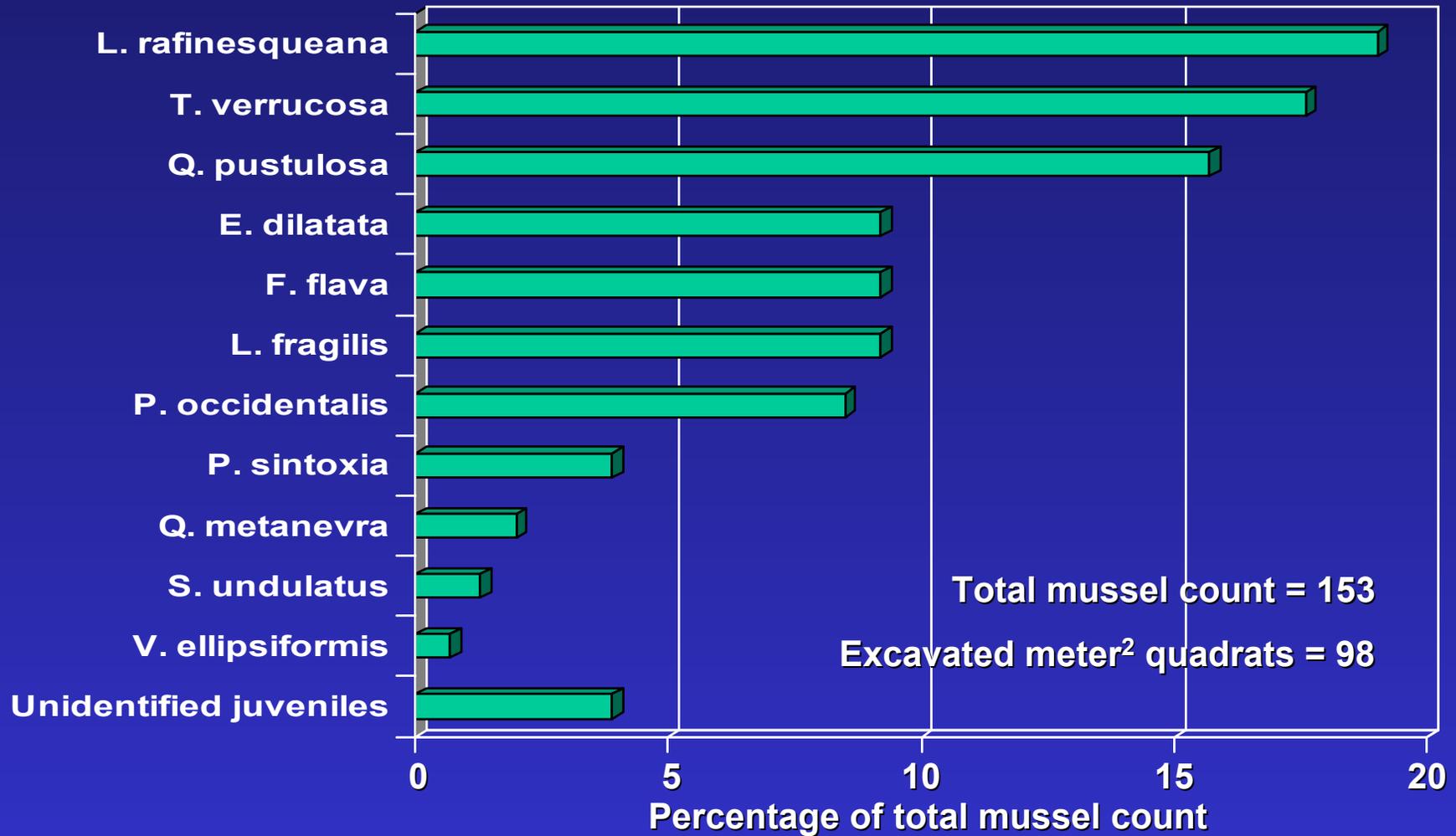




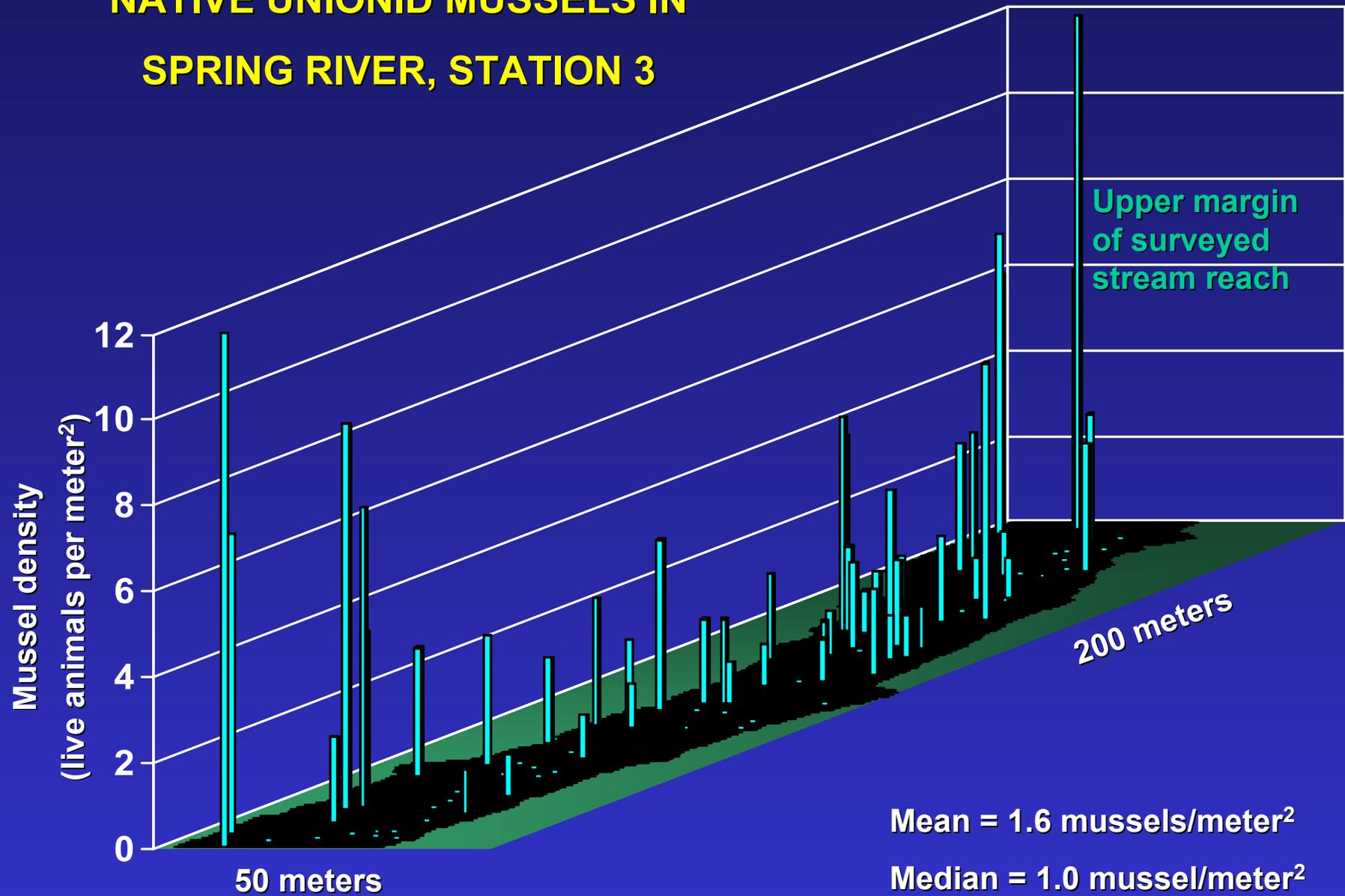
Spring River, sta. 3



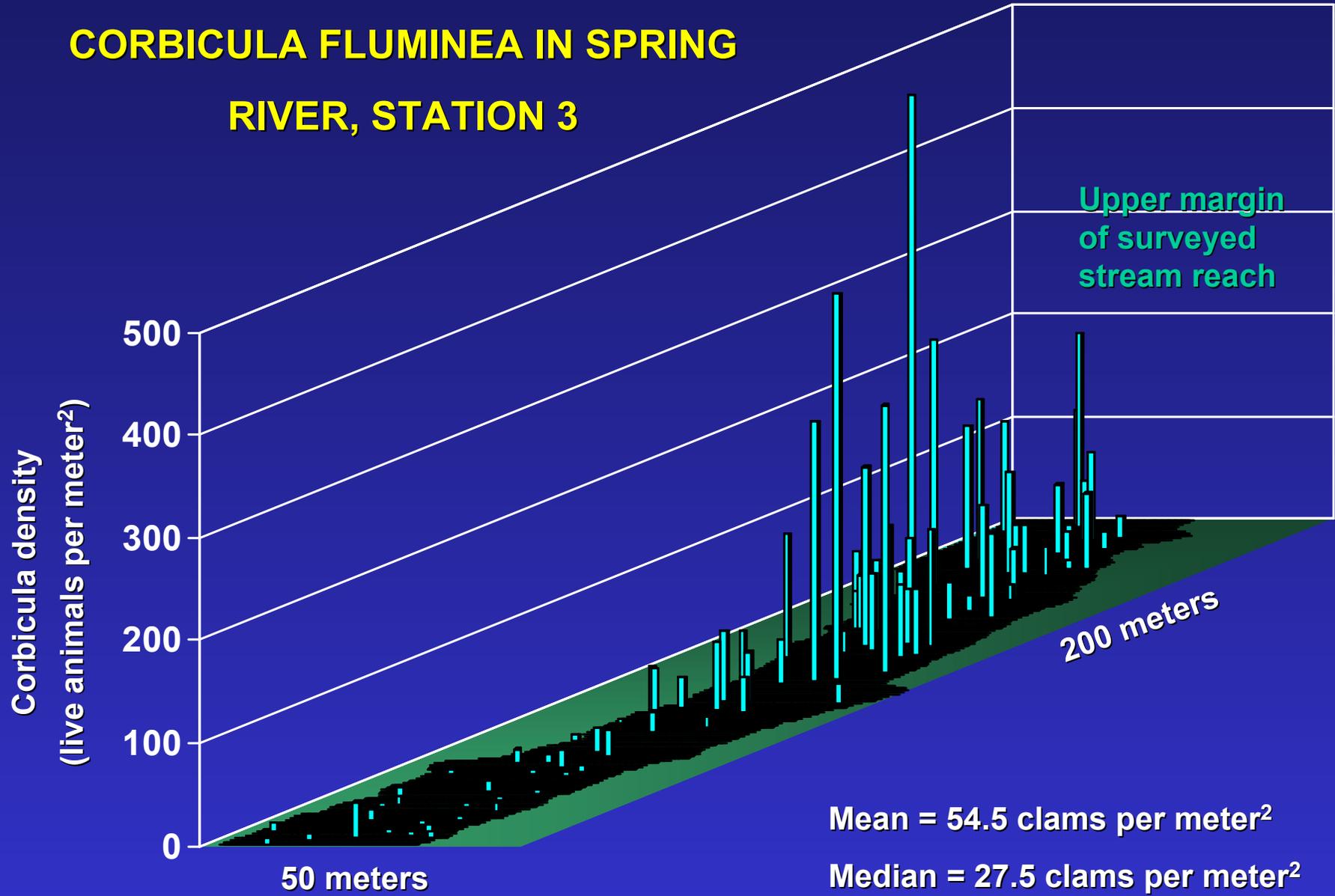
RELATIVE ABUNDANCE OF MUSSEL TAXA ENCOUNTERED DURING QUANTITATIVE SURVEY OF SPRING RIVER, STATION 3



ABUNDANCE AND DISTRIBUTION OF NATIVE UNIONID MUSSELS IN SPRING RIVER, STATION 3



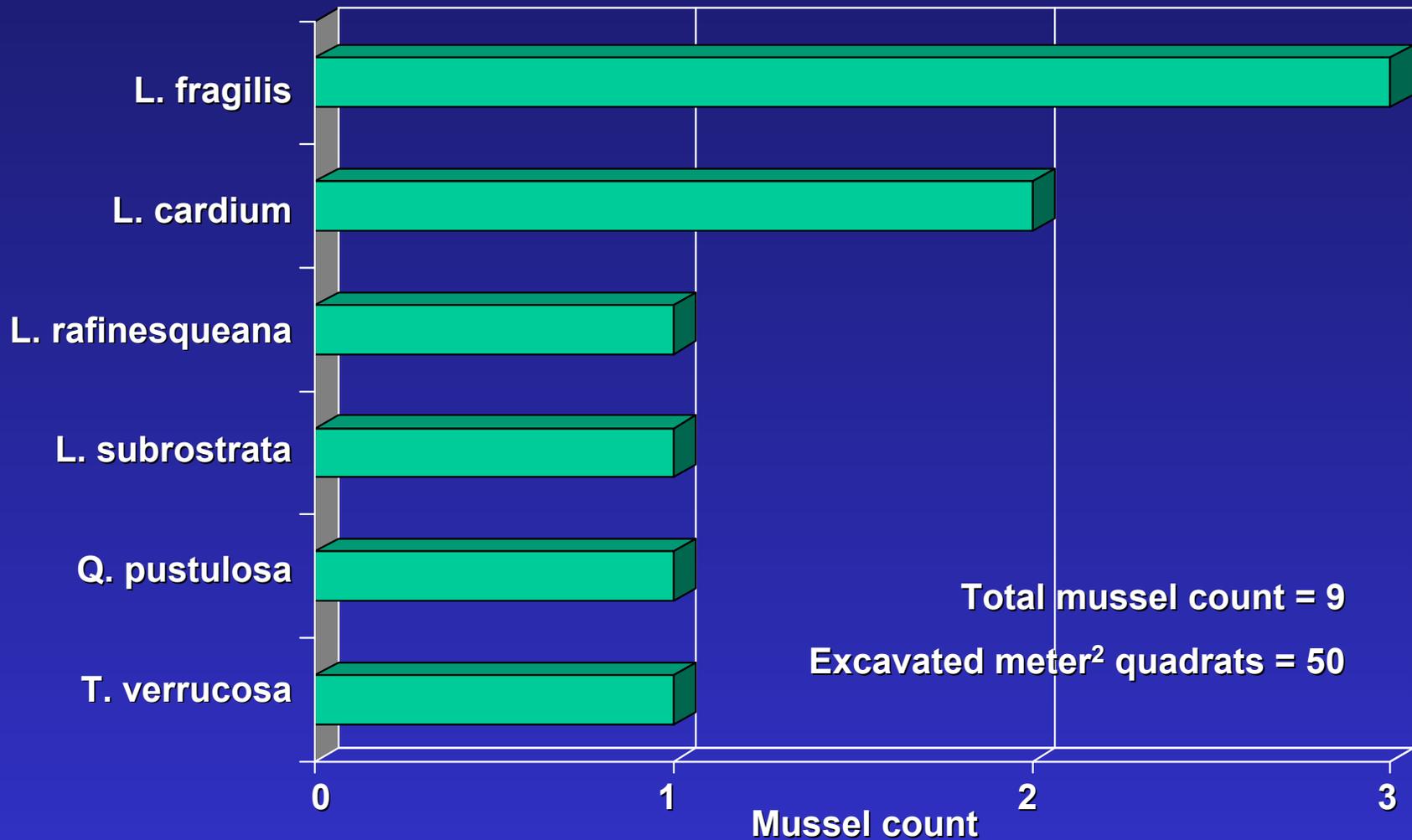
ABUNDANCE AND DISTRIBUTION OF CORBICULA FLUMINEA IN SPRING RIVER, STATION 3



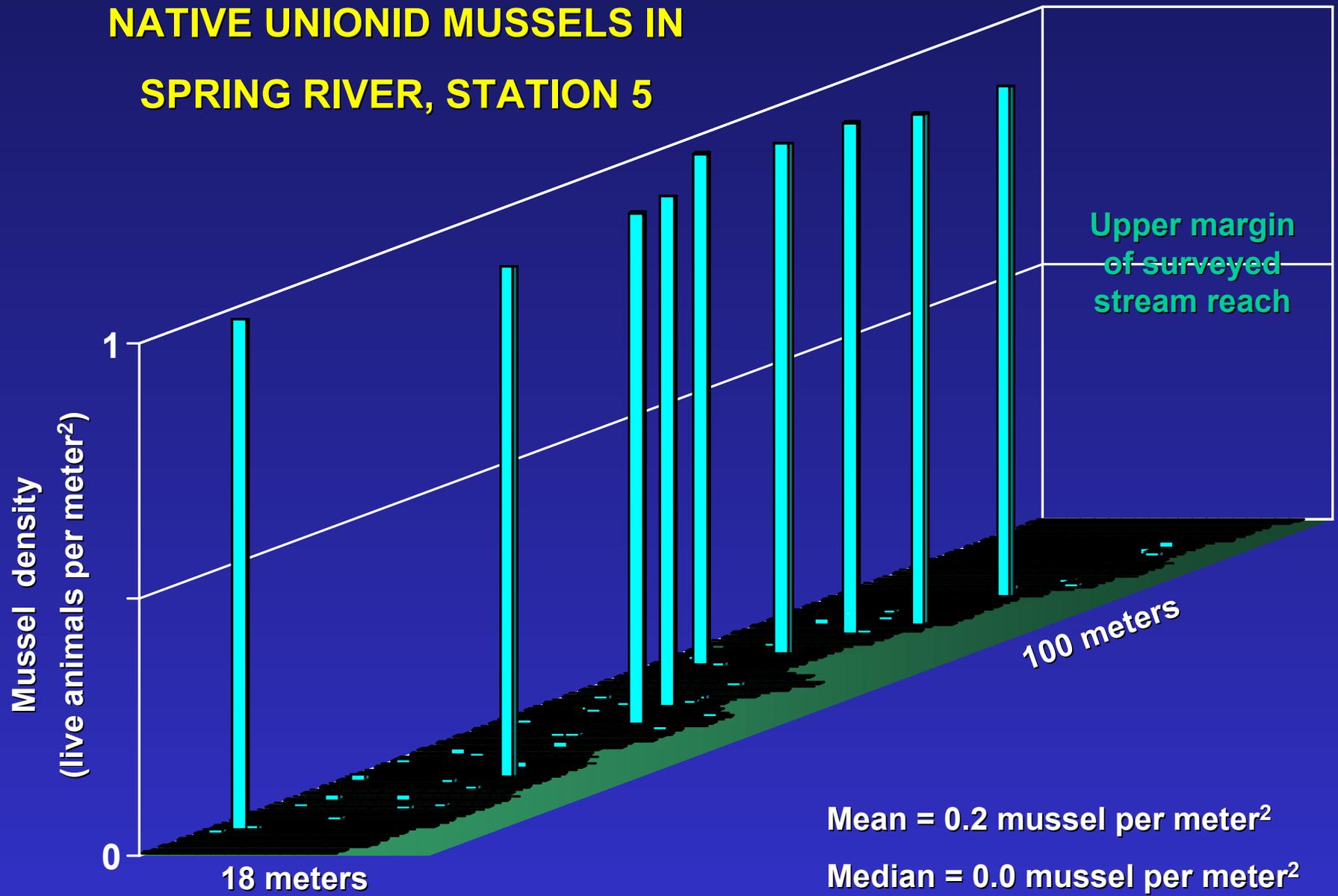


Spring River, sta. 5

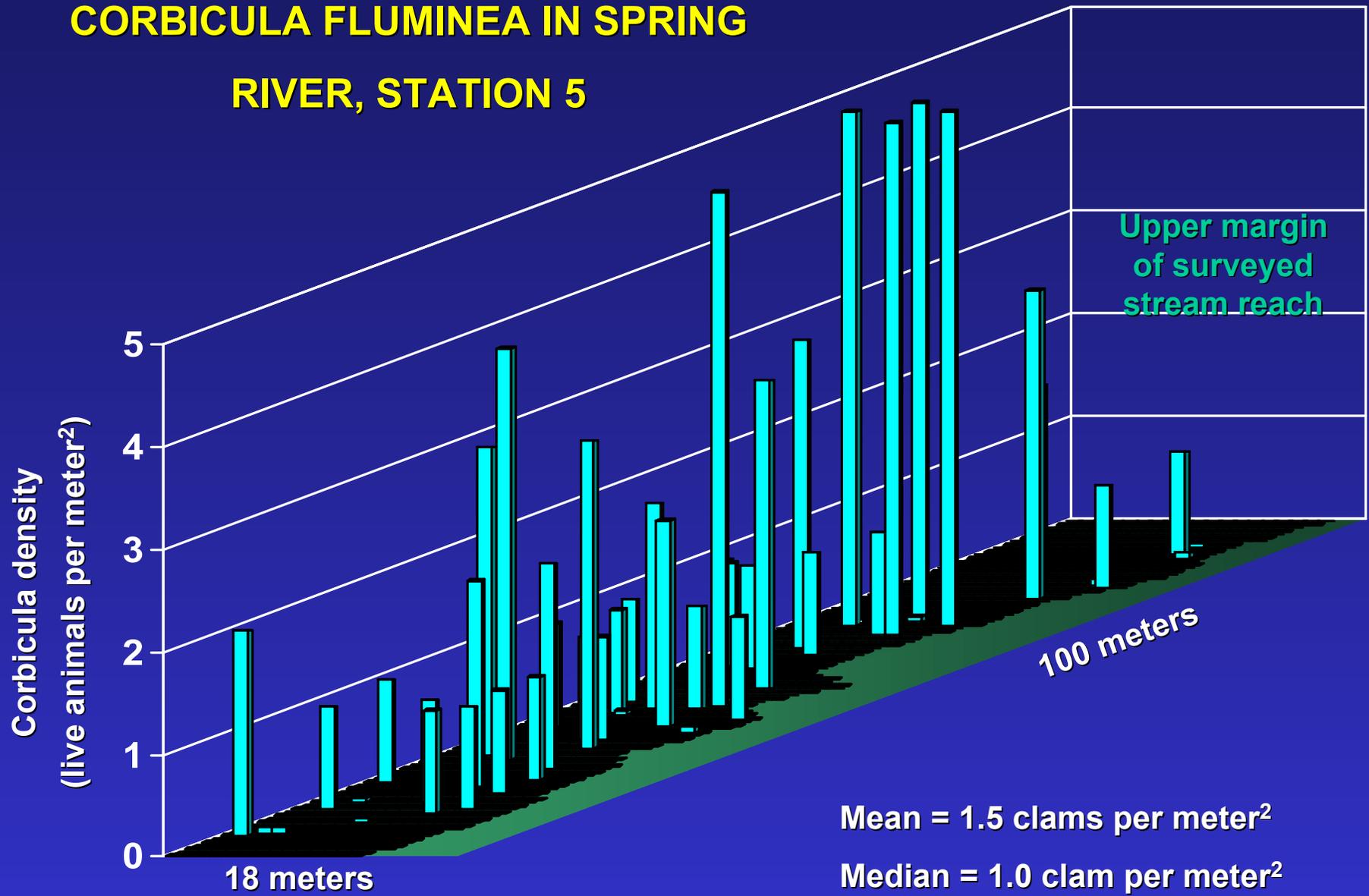
MUSSEL TAXA AND NUMBERS ENCOUNTERED DURING QUANTITATIVE SURVEY OF SPRING RIVER, STATION 5



ABUNDANCE AND DISTRIBUTION OF NATIVE UNIONID MUSSELS IN SPRING RIVER, STATION 5

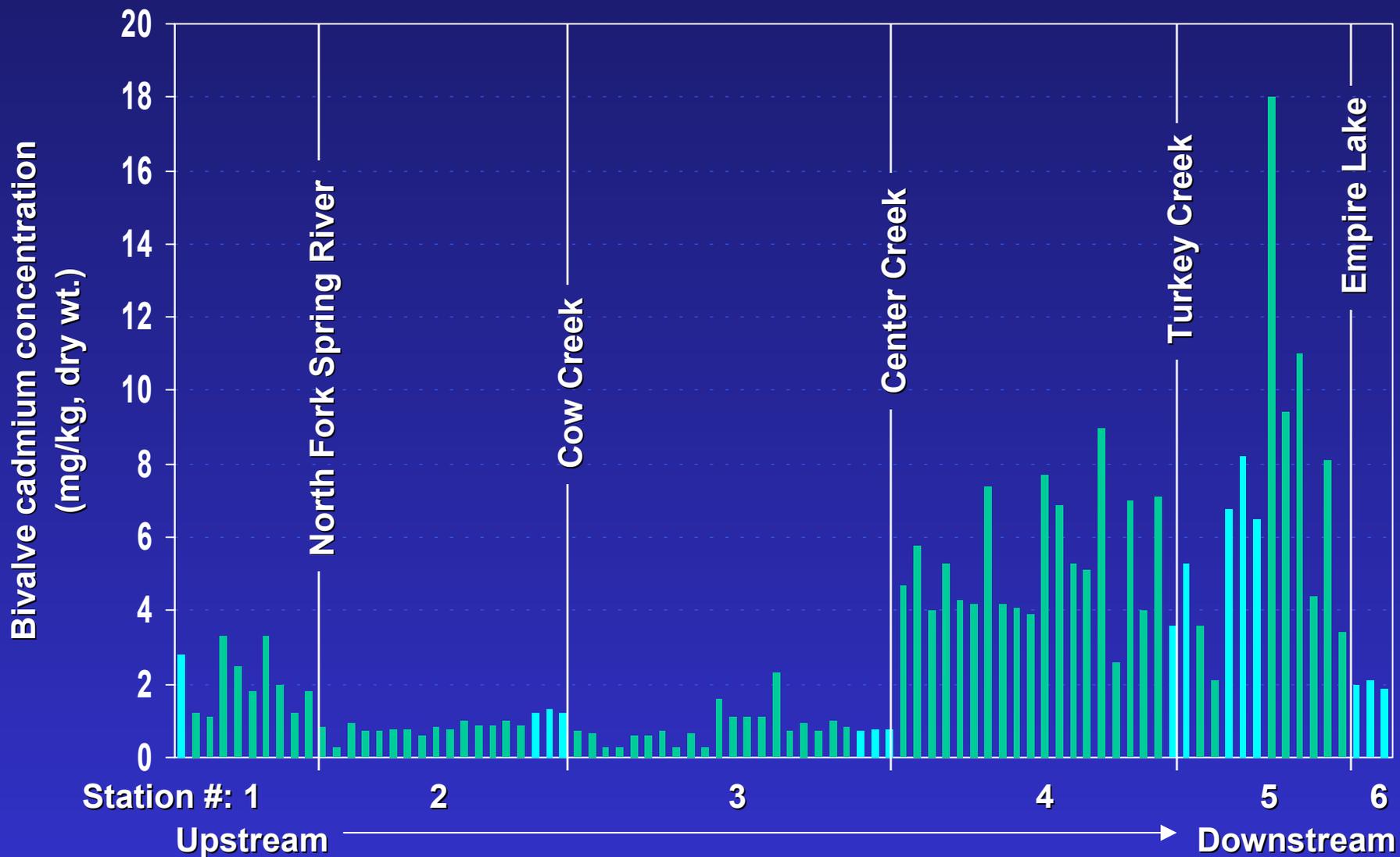


ABUNDANCE AND DISTRIBUTION OF CORBICULA FLUMINEA IN SPRING RIVER, STATION 5

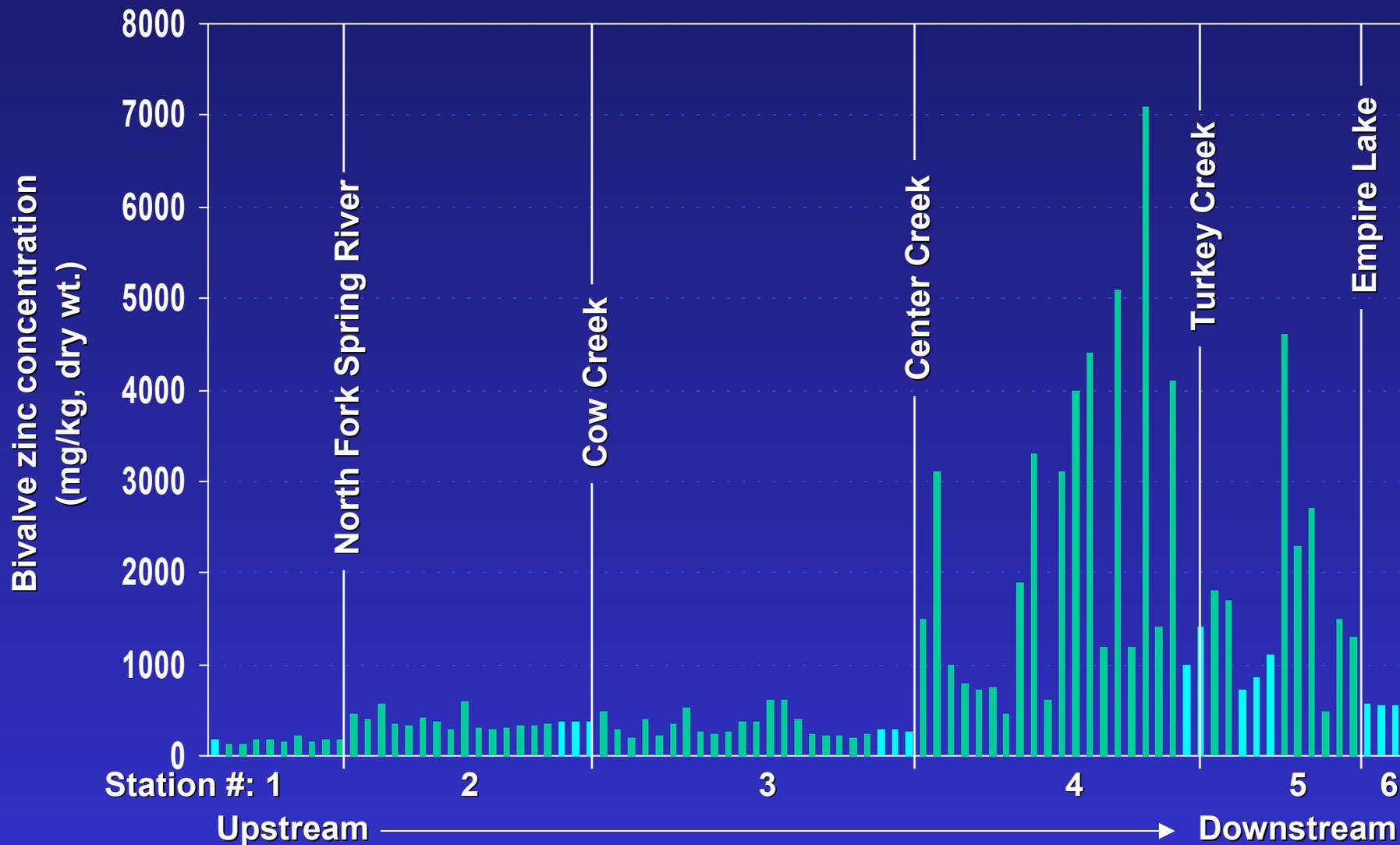




CADMIUM CONCENTRATIONS IN SOFT TISSUES OF ALL BIVALVES COLLECTED FROM SPRING RIVER



ZINC CONCENTRATIONS IN SOFT TISSUES OF ALL BIVALVES COLLECTED FROM SPRING RIVER



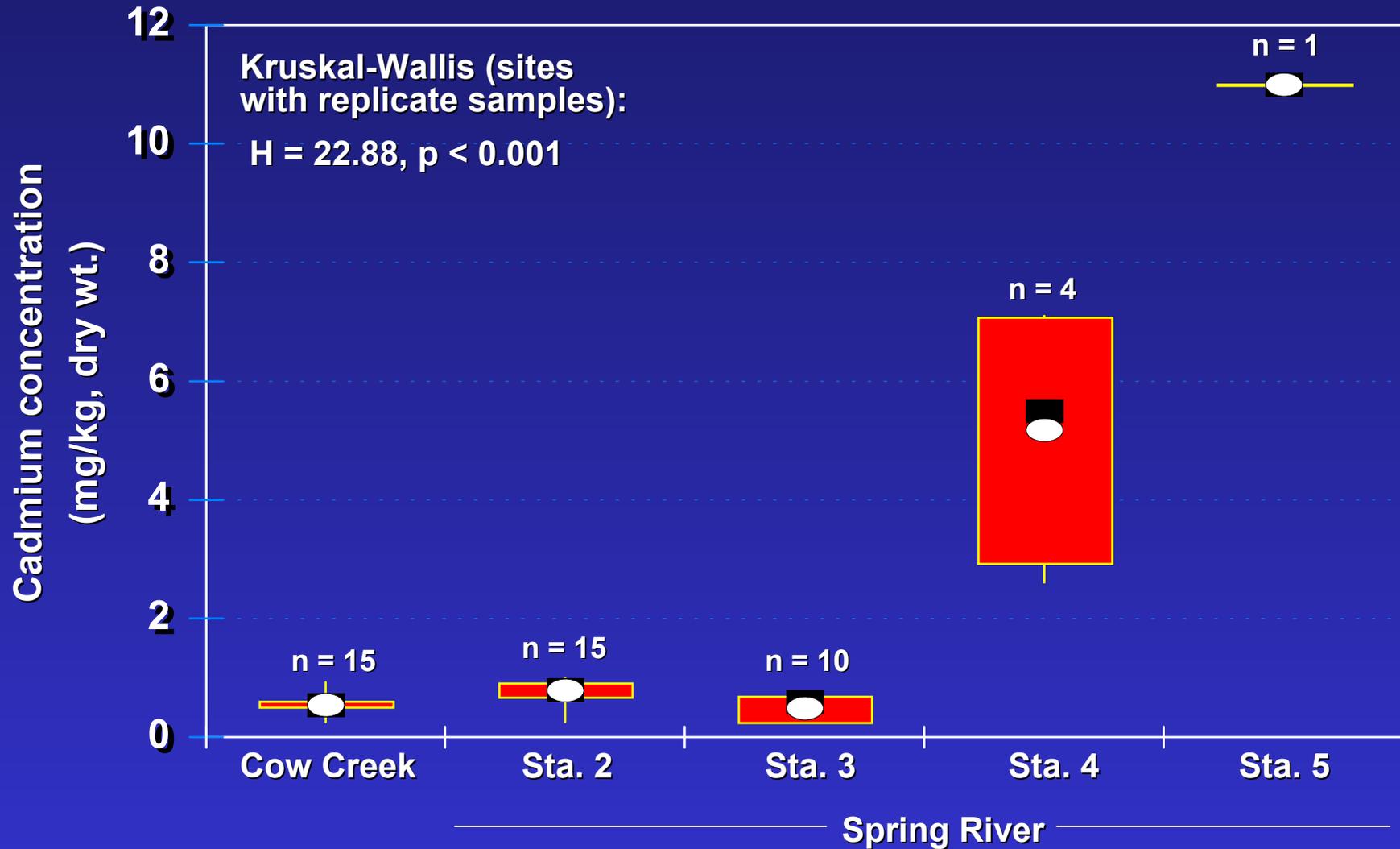


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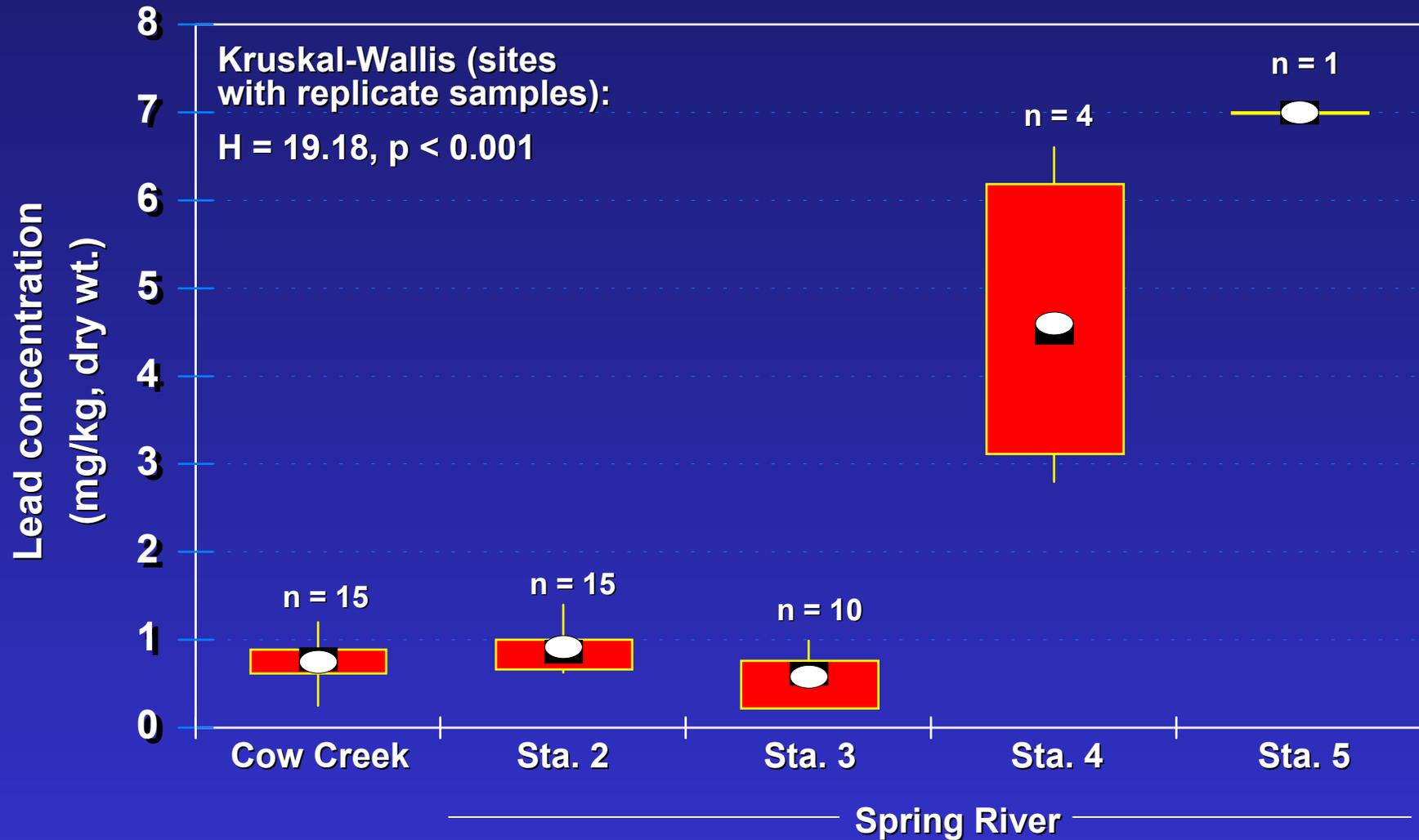
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Pistolgrip mussel,
Tritogonia verrucosa

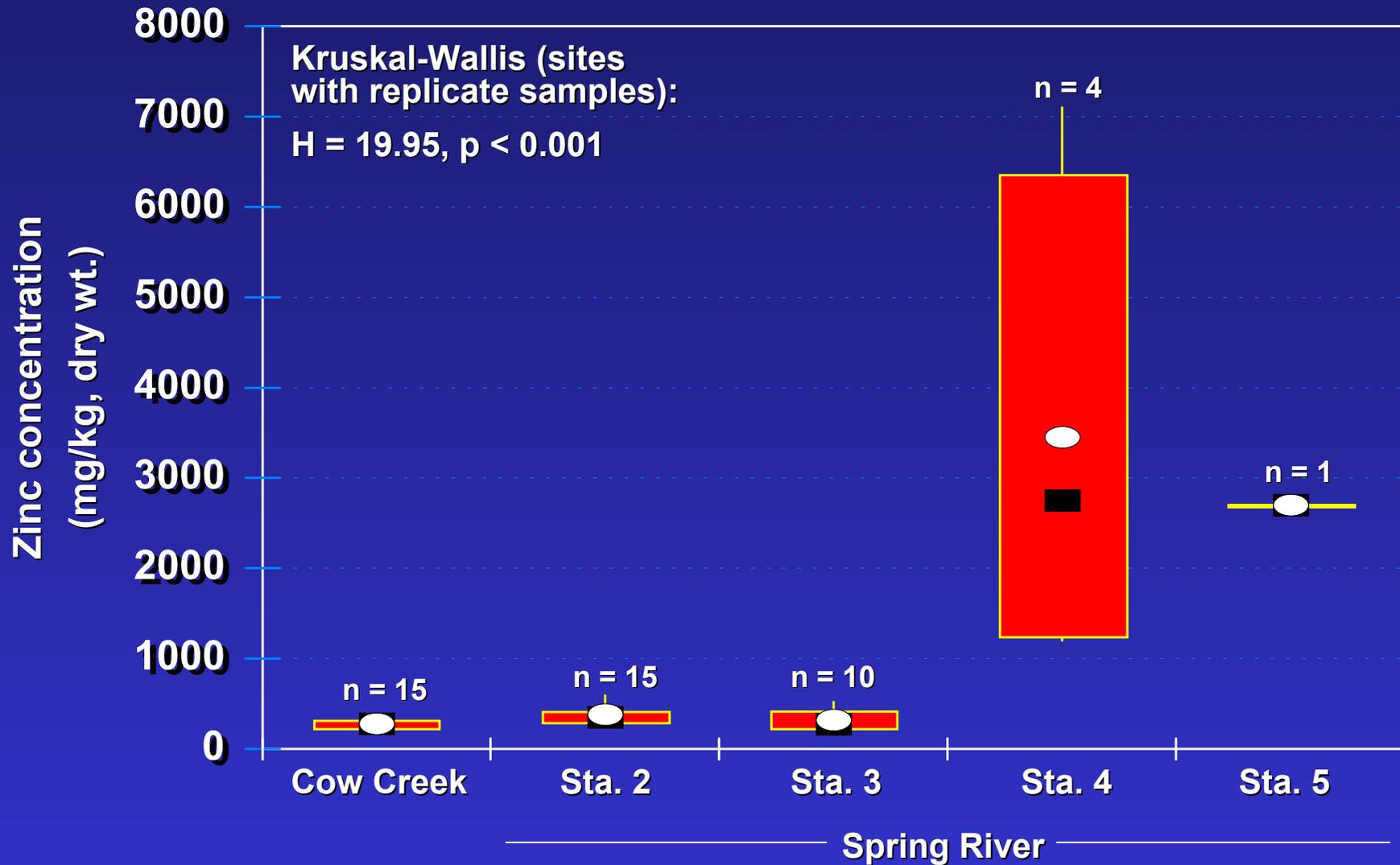
CADMIUM CONCENTRATIONS IN SOFT TISSUES OF PISTOLGRIP MUSSEL, TRITOGONIA VERRUCOSA



LEAD CONCENTRATIONS IN SOFT TISSUES OF PISTOLGRIP MUSSEL, TRITOGONIA VERRUCOSA



ZINC CONCENTRATIONS IN SOFT TISSUES OF PISTOLGRIP MUSSEL, TRITOGONIA VERRUCOSA



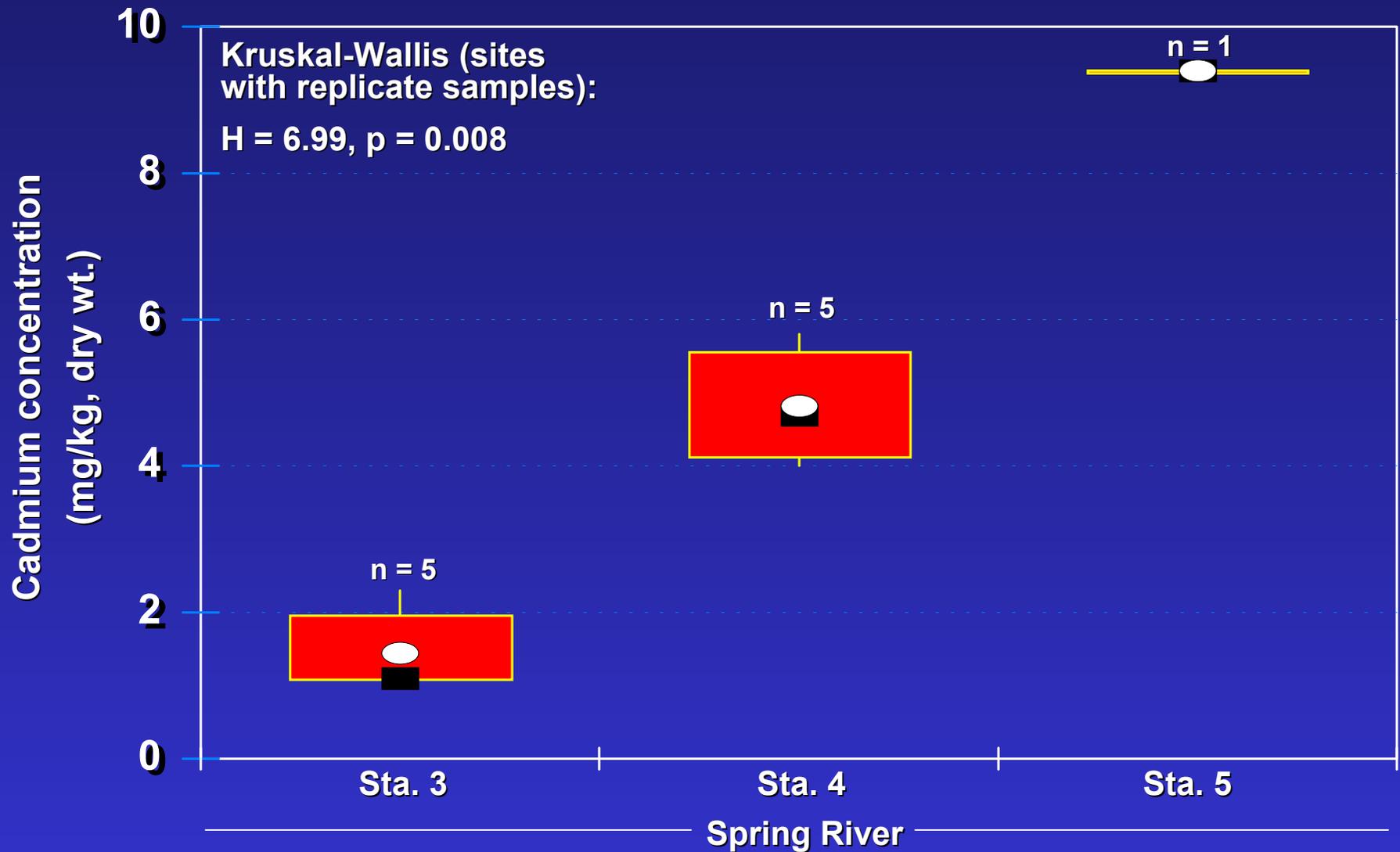
The image shows two Neosho mucket shells, *Lampsilis rafinesqueana*, resting on a bed of small, light-colored, rounded river stones. The shells are dark brown with prominent, lighter-colored concentric growth lines. The top shell is positioned in the upper left, and the bottom shell is in the lower right. A yellow ampersand (&) is located to the left of the top shell, and a yellow percent sign (%) is located to the left of the bottom shell. The text 'Neosho mucket, *Lampsilis rafinesqueana*' is written in yellow in the upper right quadrant of the image.

Neosho mucket,
Lampsilis rafinesqueana

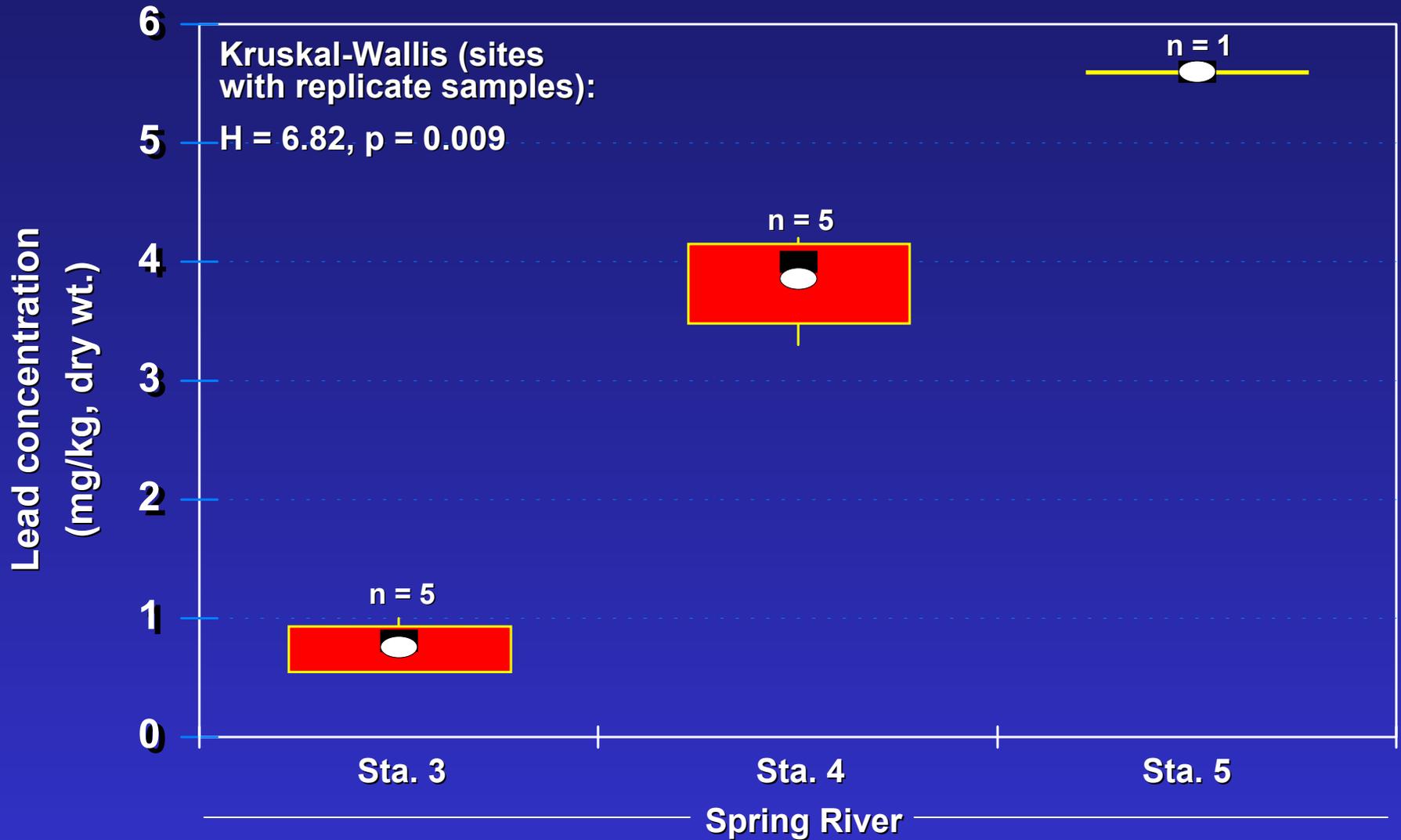
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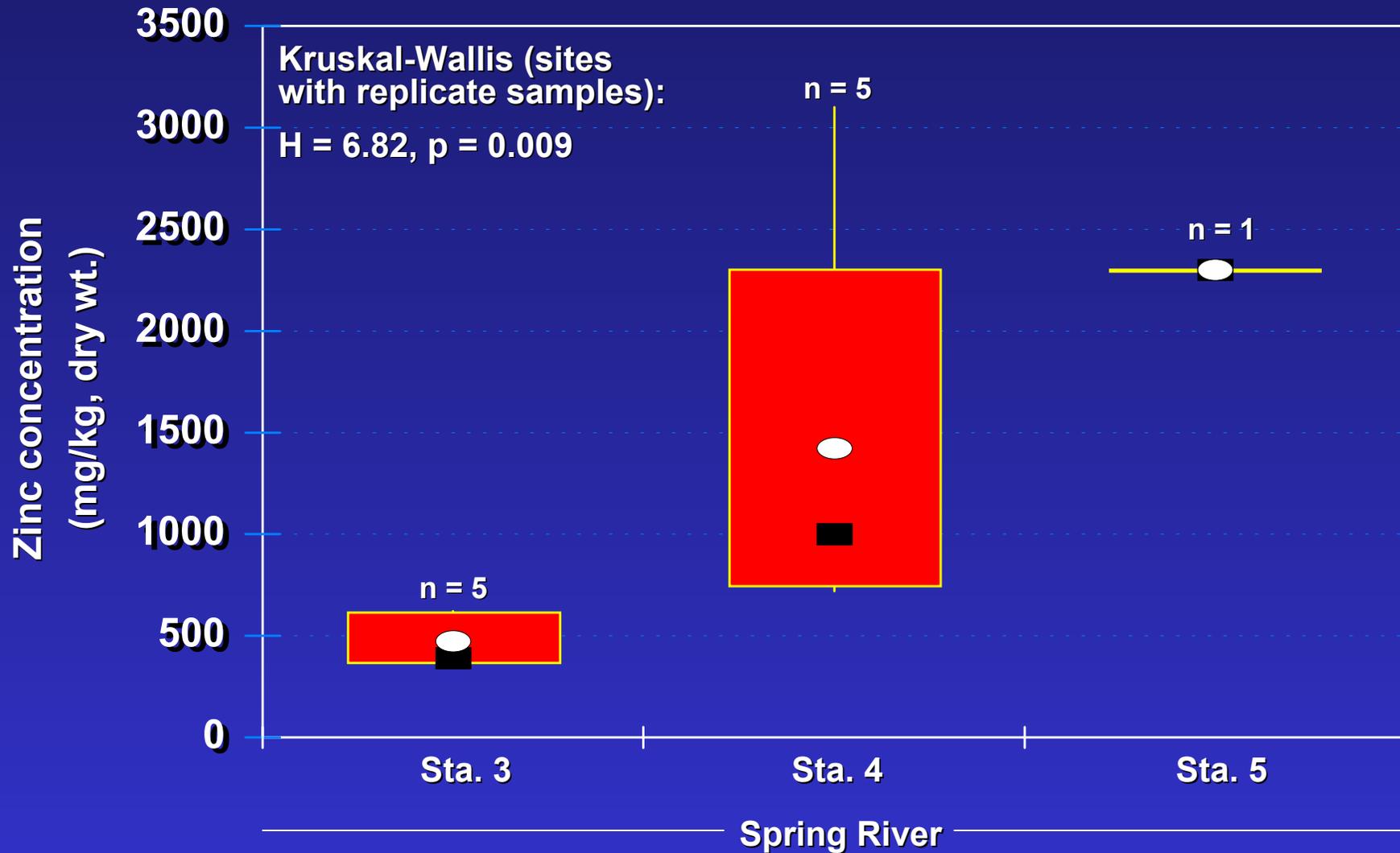
CADMIUM CONCENTRATIONS IN SOFT TISSUES OF NEOSHO MUCKET, *LAMPSILIS RAFINESQUEANA*



LEAD CONCENTRATIONS IN SOFT TISSUES OF NEOSHO MUCKET, *LAMPSILIS RAFINESQUEANA*



ZINC CONCENTRATIONS IN SOFT TISSUES OF NEOSHO MUCKET, *LAMPSILIS RAFINESQUEANA*

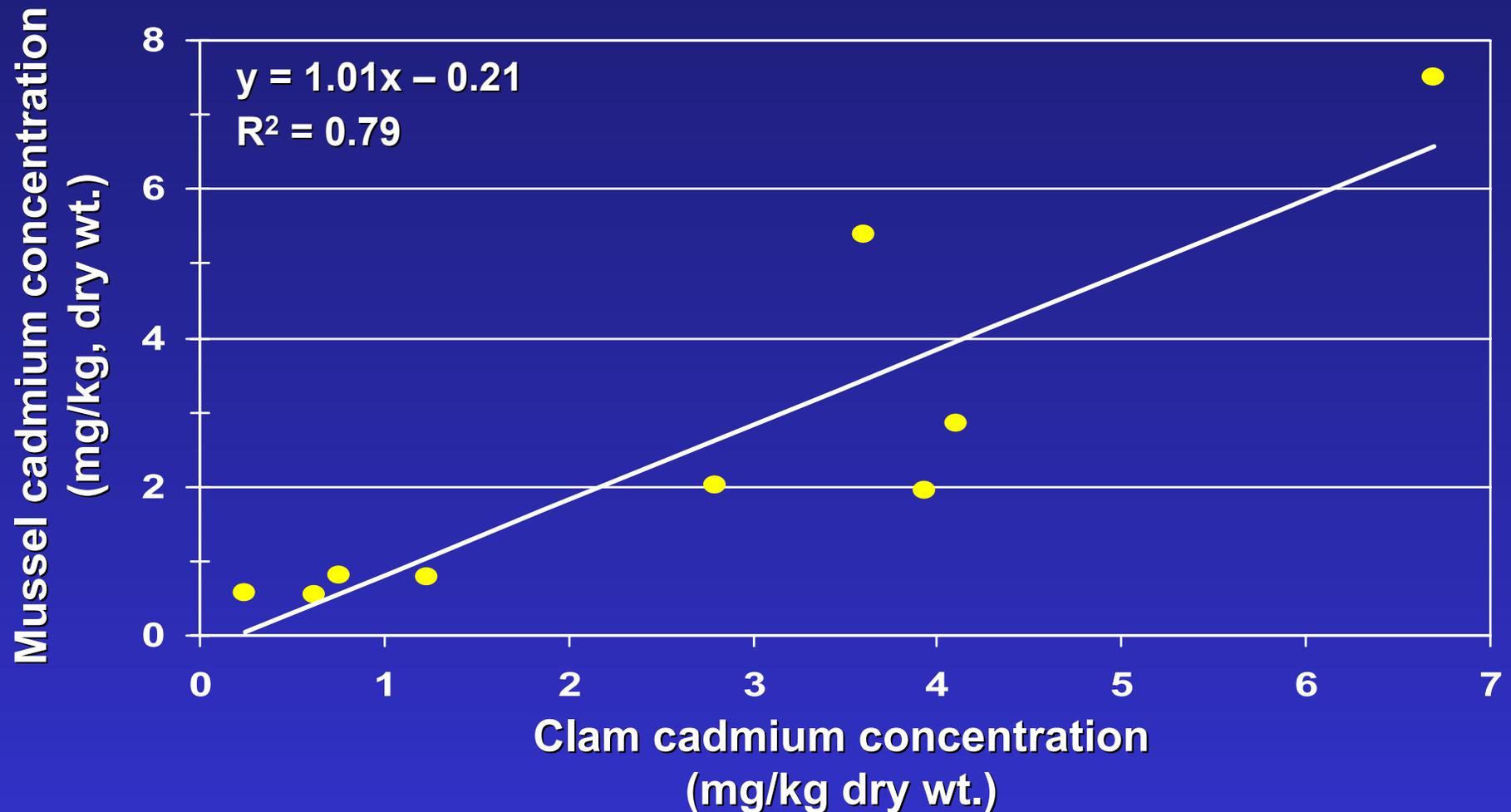




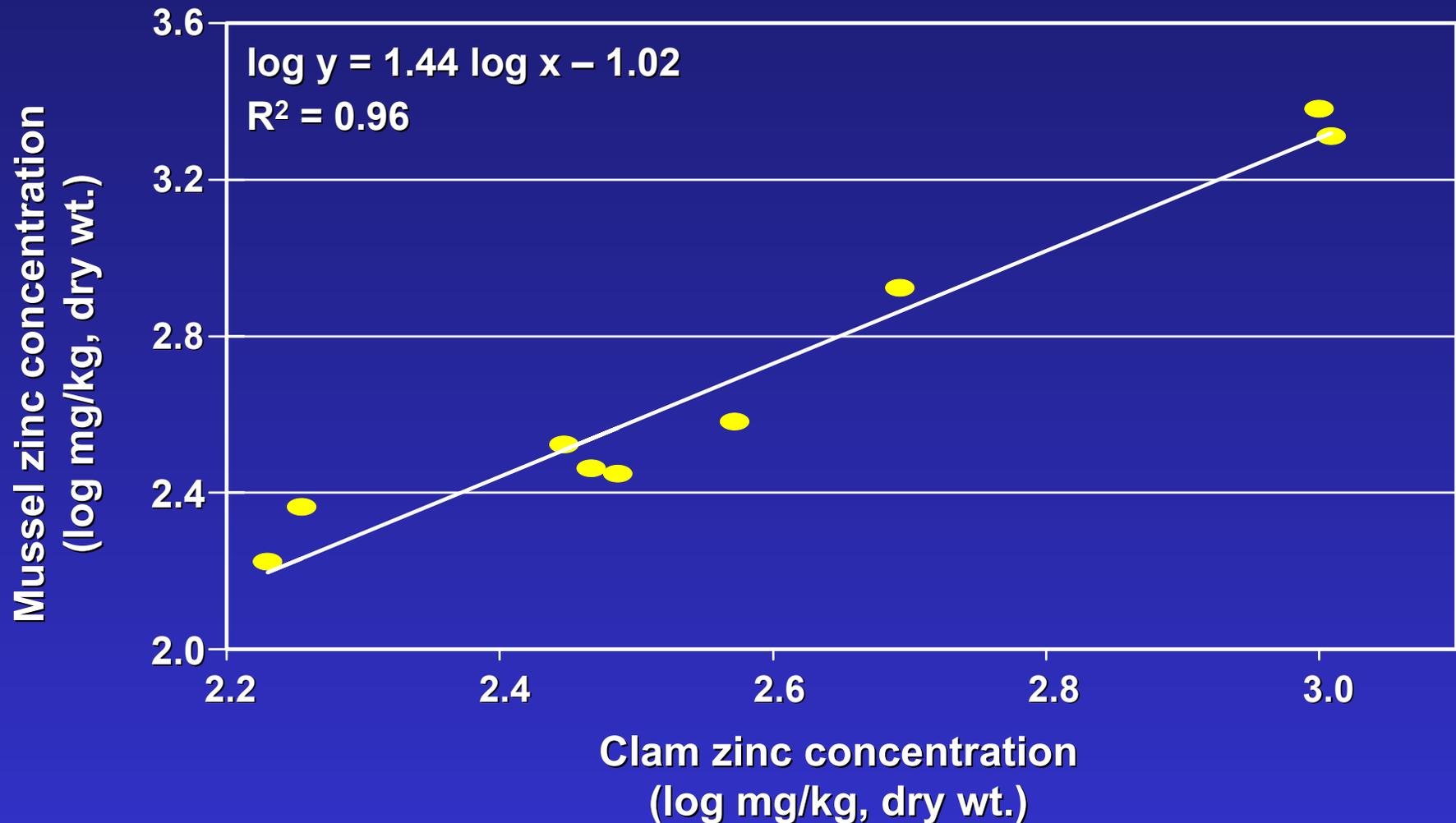
Asian clam,
Corbicula fluminea

COMPARISON OF CADMIUM CONCENTRATIONS IN SOFT TISSUES OF FRESHWATER MUSSELS VERSUS ASIAN CLAM

(MEAN CONCENTRATIONS, NINE SITES)



**COMPARISON OF ZINC CONCENTRATIONS IN SOFT TISSUES
OF FRESHWATER MUSSELS VERSUS ASIAN CLAM
(LOG MEAN CONCENTRATIONS, NINE SITES)**

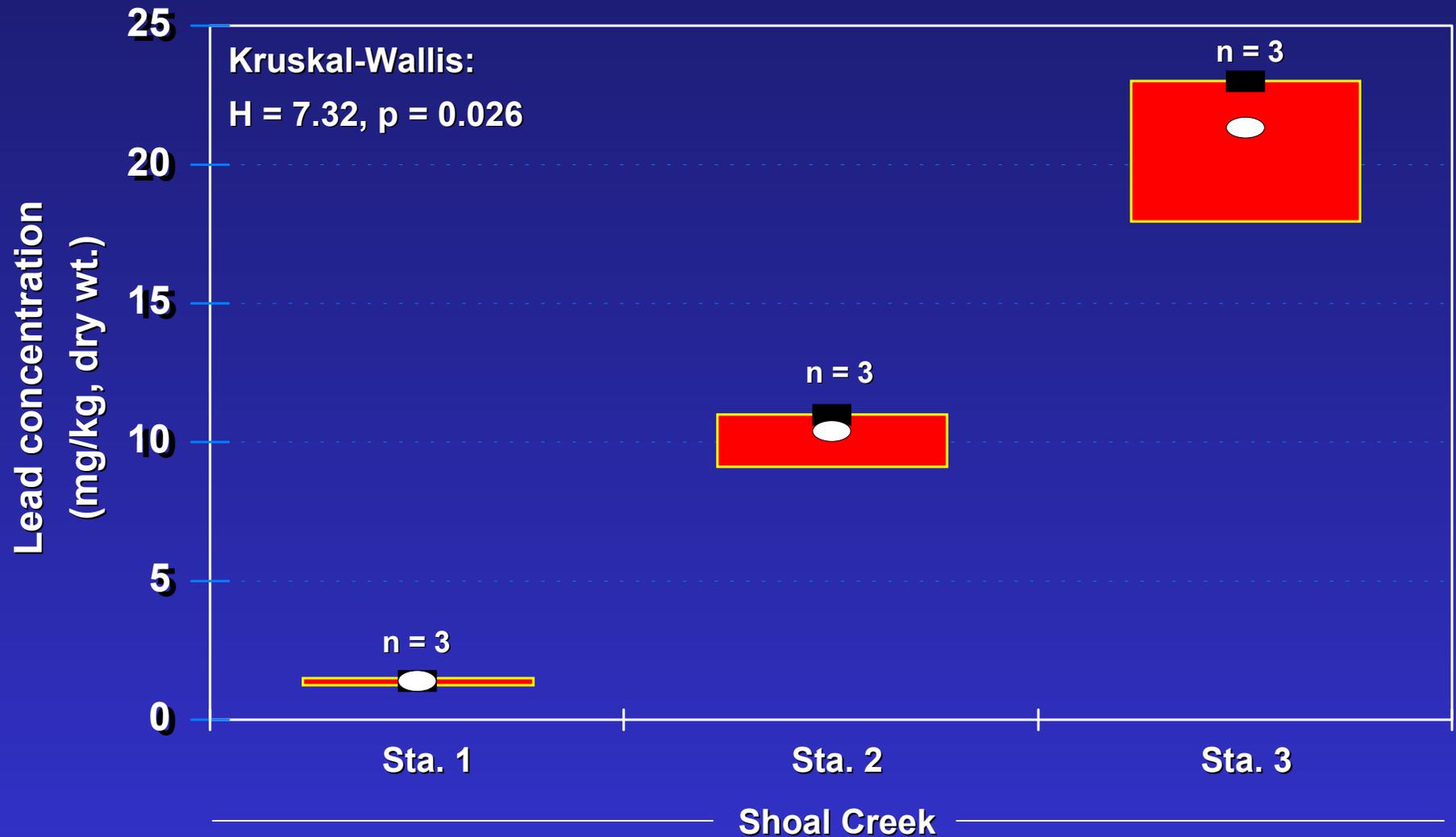


CADMIUM CONCENTRATIONS IN SOFT TISSUES OF ASIAN CLAM, CORBICULA FLUMINEA

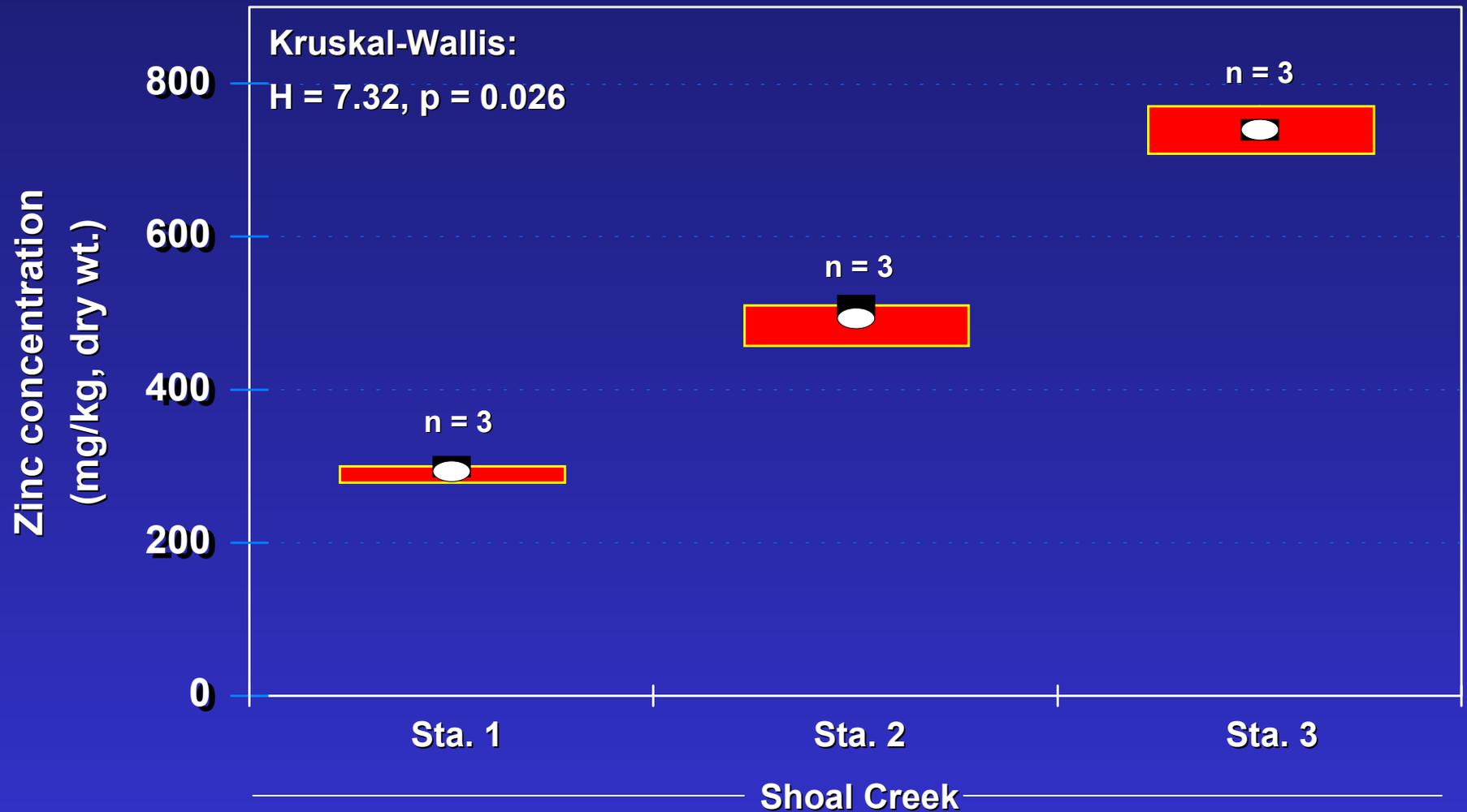
(COMPOSITE CLAM SAMPLES)



LEAD CONCENTRATIONS IN SOFT TISSUES OF ASIAN CLAM, CORBICULA FLUMINEA (COMPOSITE CLAM SAMPLES)

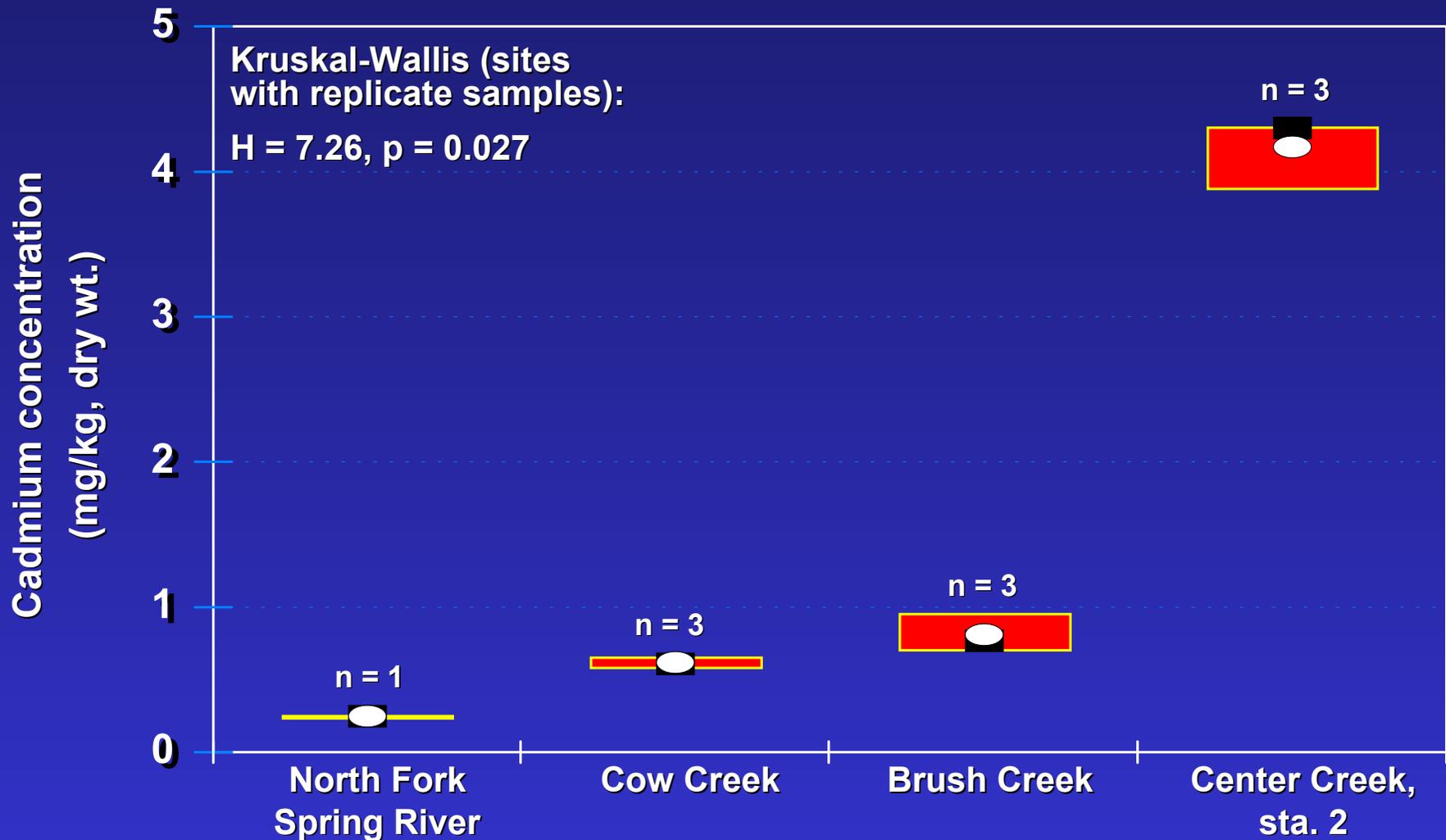


ZINC CONCENTRATIONS IN SOFT TISSUES OF ASIAN CLAM, CORBICULA FLUMINEA (COMPOSITE CLAM SAMPLES)

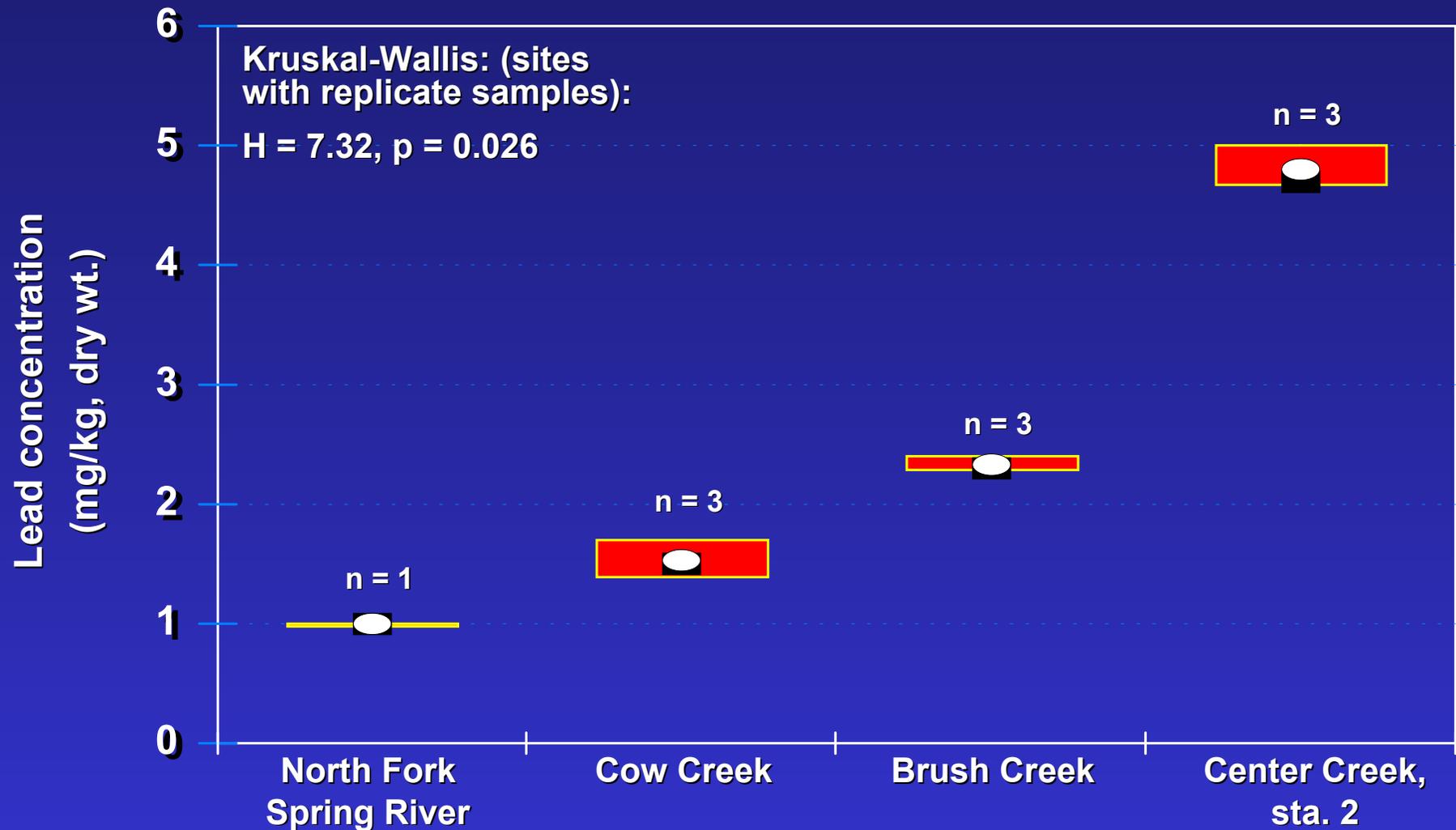


CADMIUM CONCENTRATIONS IN SOFT TISSUES OF ASIAN CLAM, CORBICULA FLUMINEA

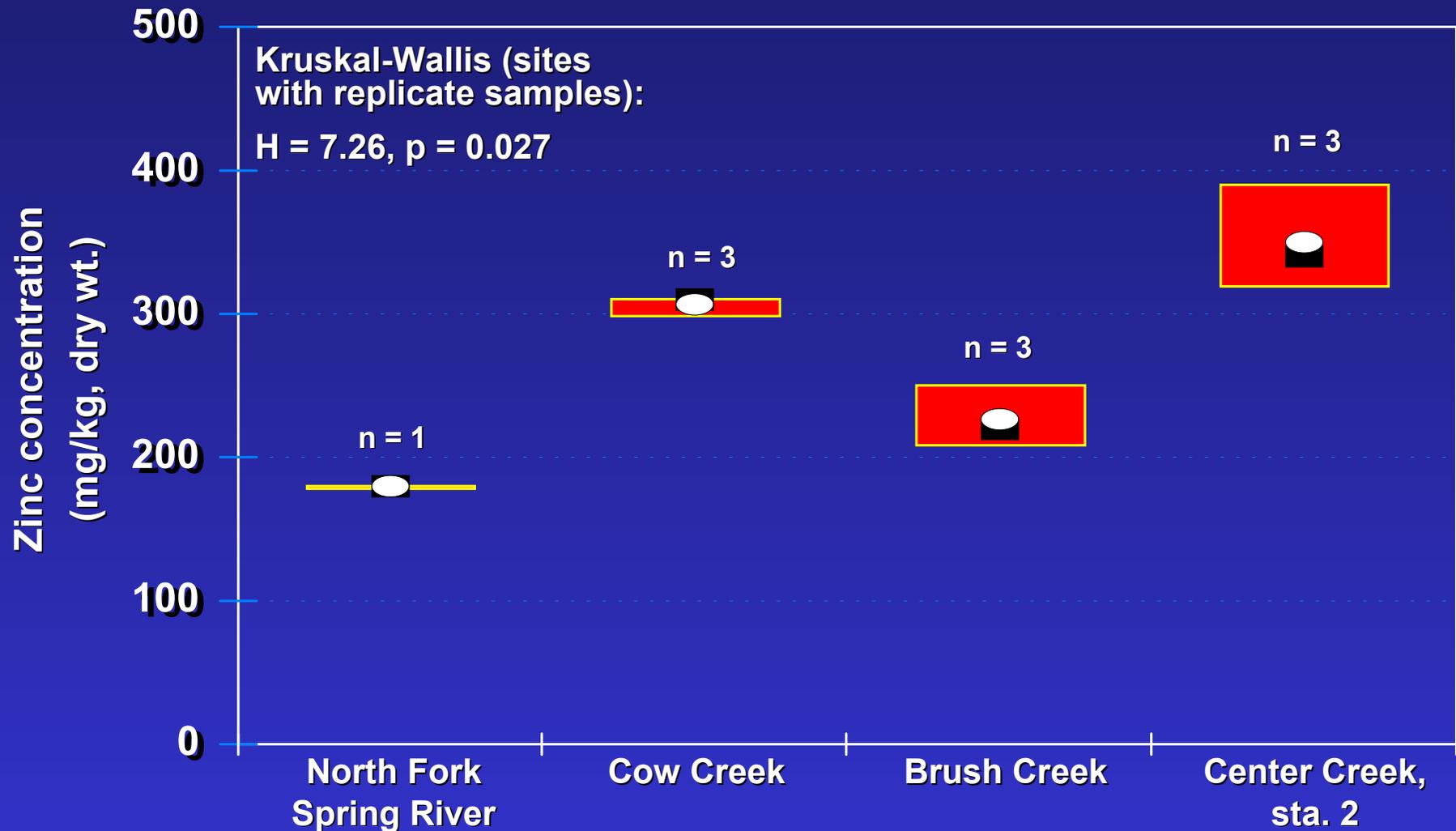
(COMPOSITE CLAM SAMPLES)



LEAD CONCENTRATIONS IN SOFT TISSUES OF ASIAN CLAM, CORBICULA FLUMINEA (COMPOSITE CLAM SAMPLES)

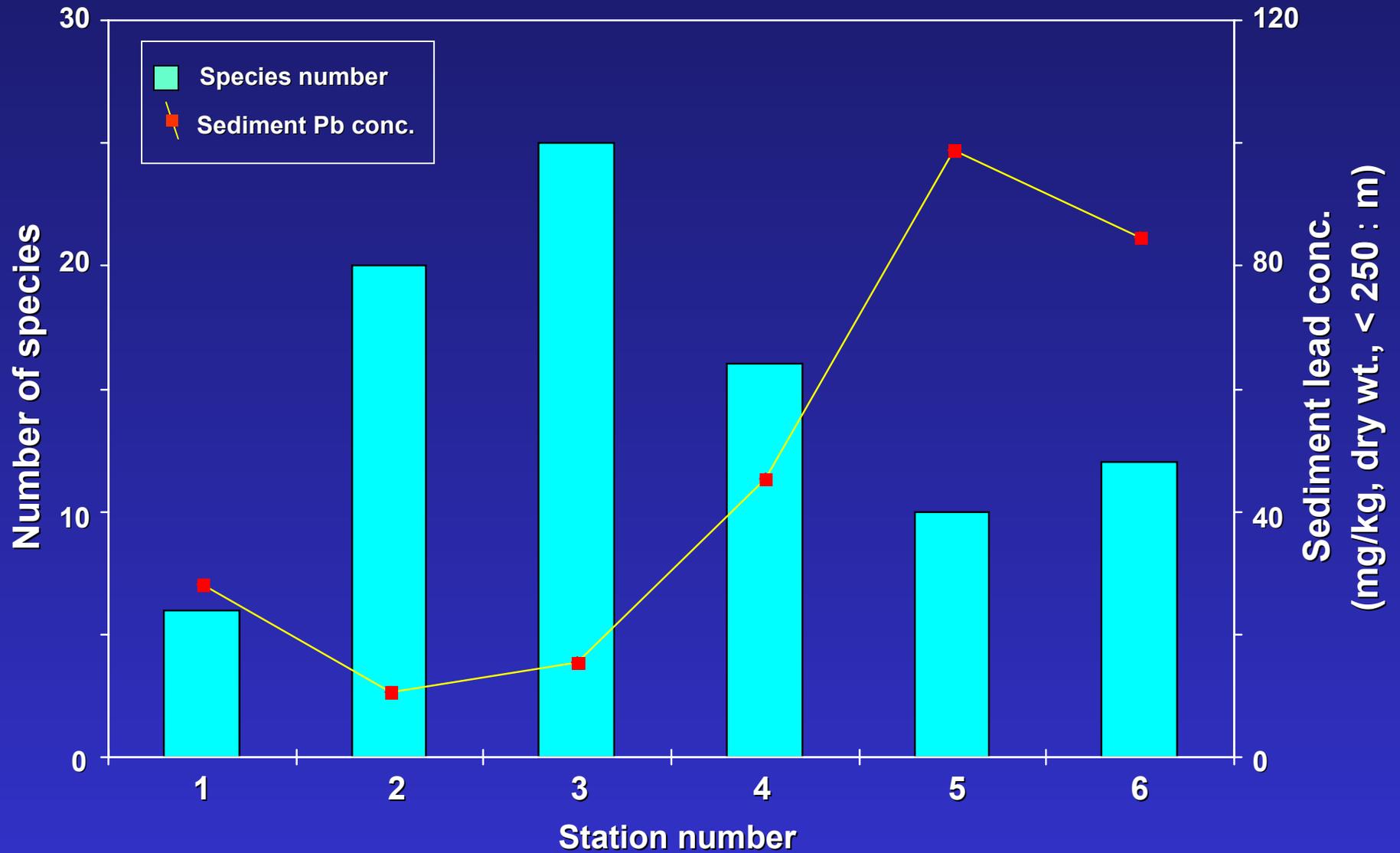


ZINC CONCENTRATIONS IN SOFT TISSUES OF ASIAN CLAM, CORBICULA FLUMINEA (COMPOSITE CLAM SAMPLES)

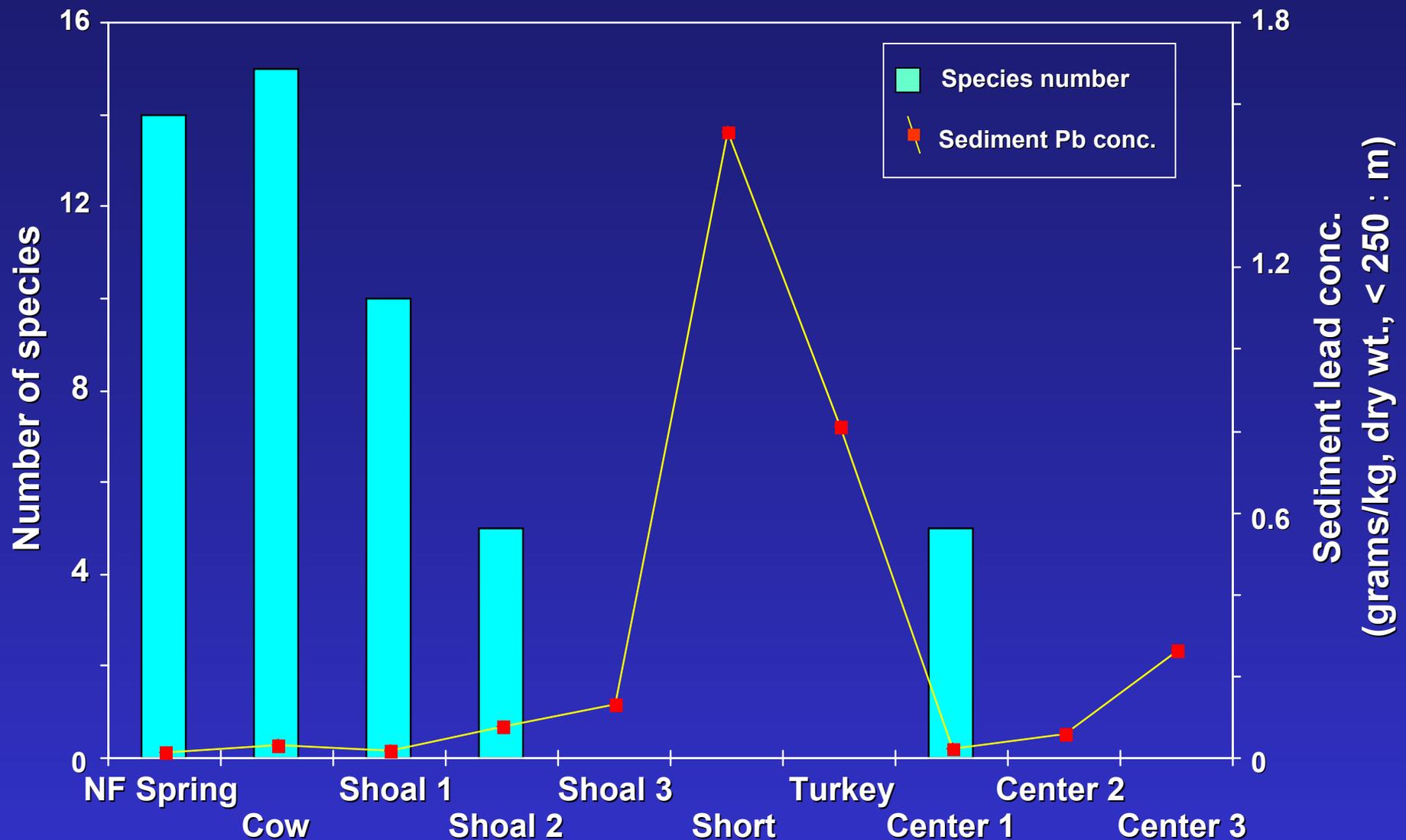




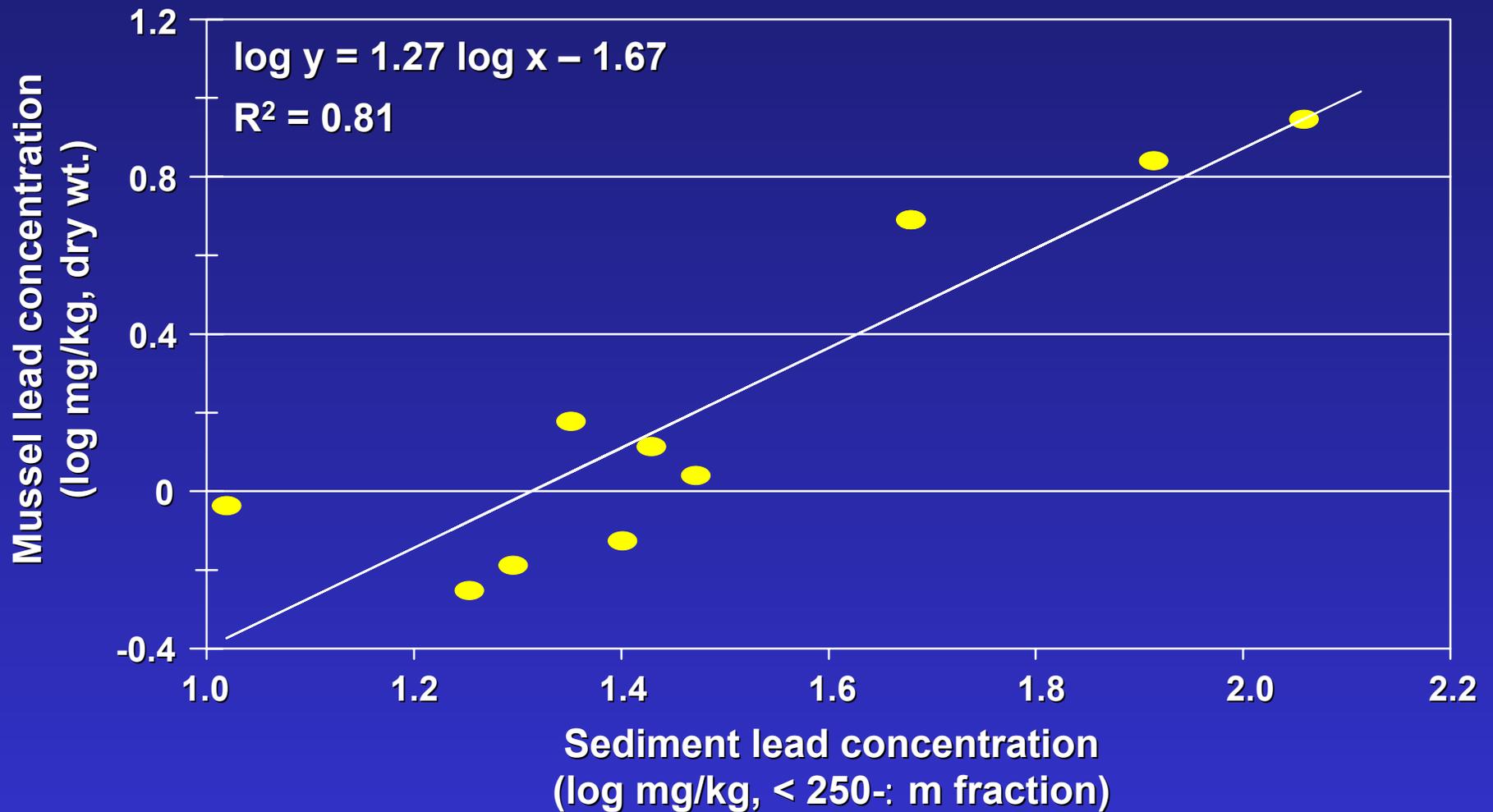
MUSSEL SPECIES RICHNESS VERSUS SEDIMENT LEAD LEVEL AT SIX SPRING RIVER SAMPLING LOCATIONS



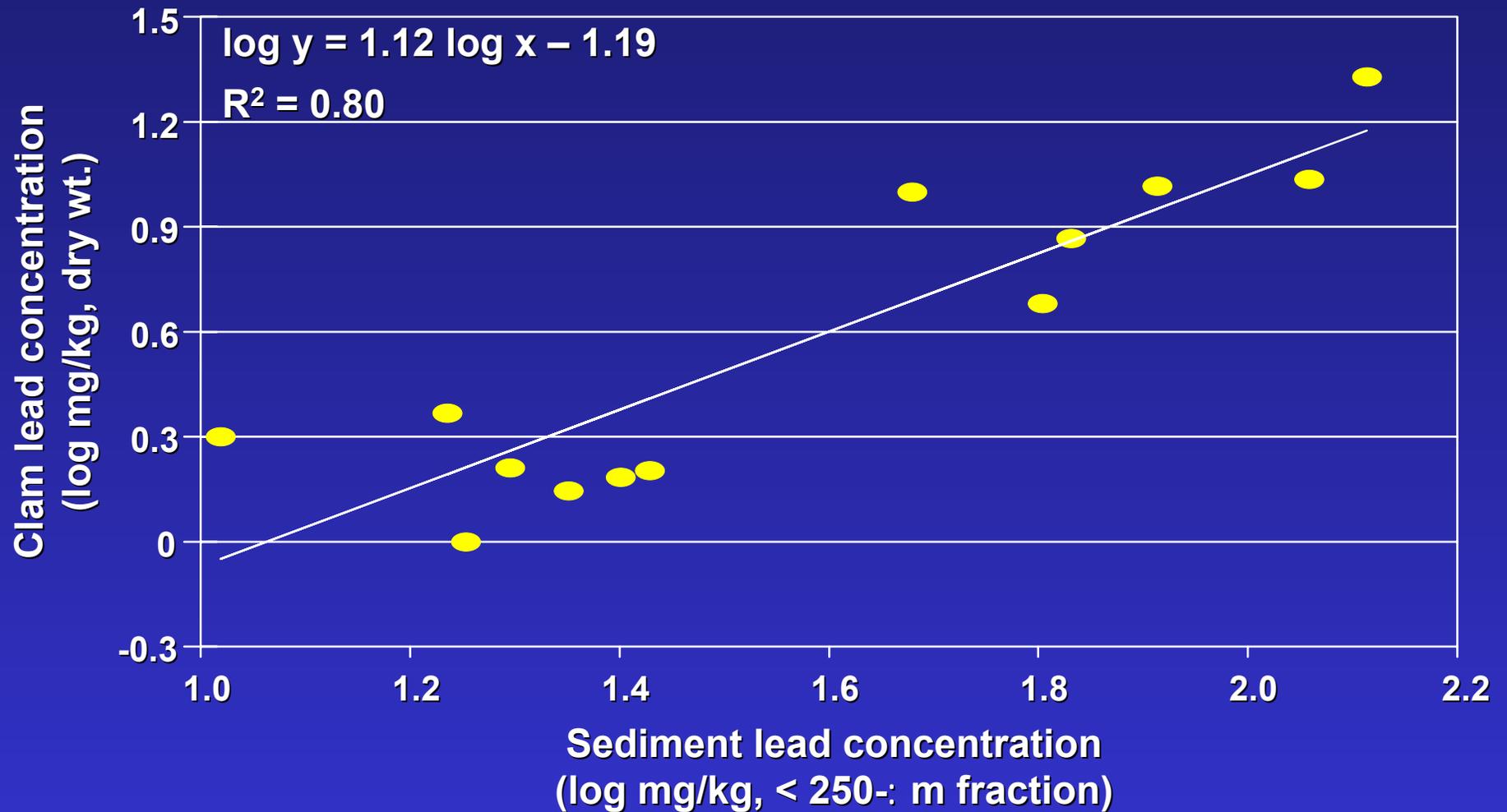
MUSSEL SPECIES RICHNESS VERSUS SEDIMENT LEAD LEVEL AT TEN PERENNIAL TRIBUTARY LOCATIONS



**COMPARISON OF LEAD CONCENTRATIONS IN SOFT TISSUES
OF NATIVE MUSSELS VERSUS FLUVIAL SEDIMENT
(LOG MEAN CONCENTRATIONS, TEN SITES)**

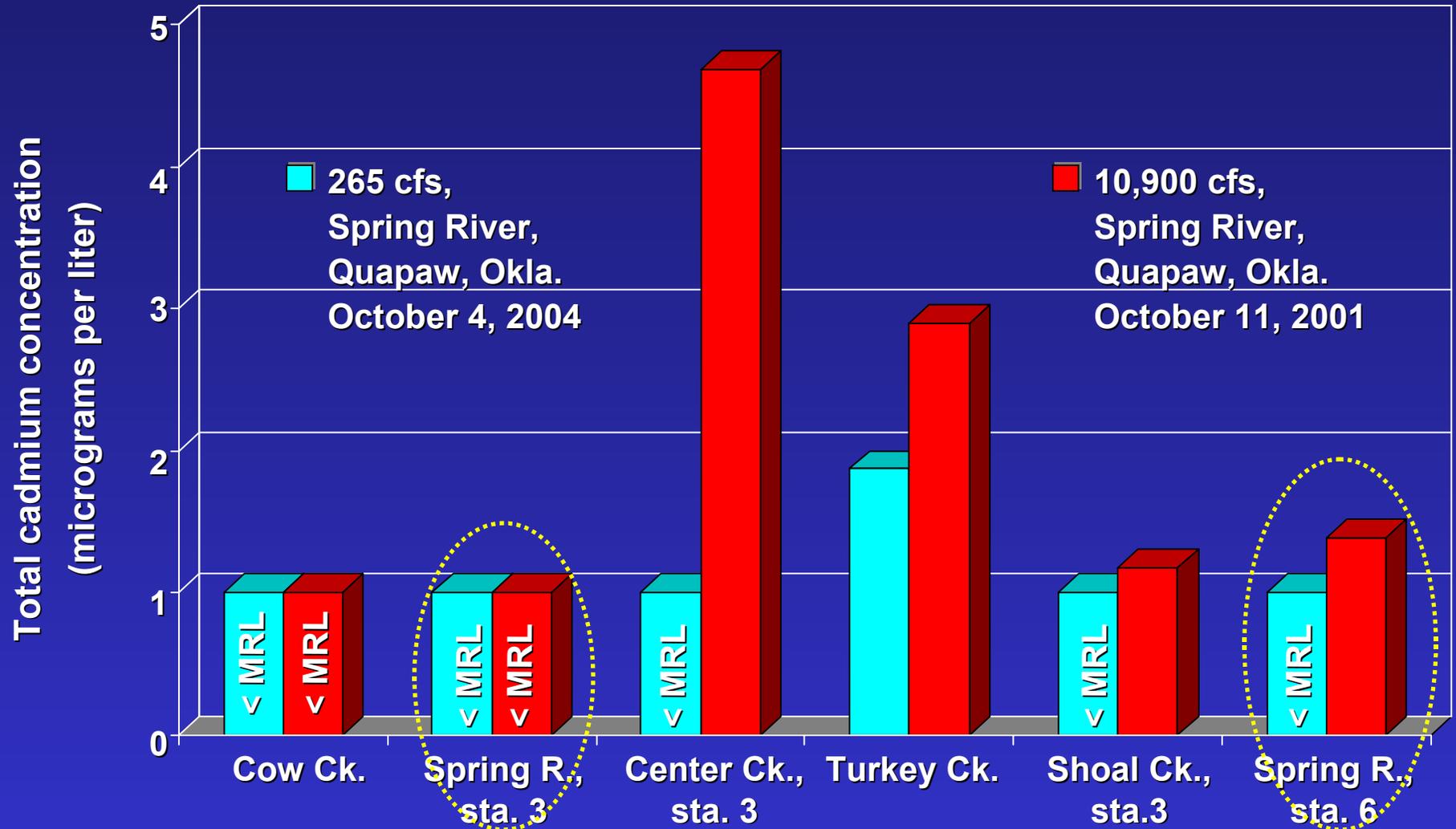


**COMPARISON OF LEAD CONCENTRATIONS IN SOFT TISSUES
OF ASIAN CLAM VERSUS FLUVIAL SEDIMENT
(LOG MEAN CONCENTRATIONS, 13 SITES)**

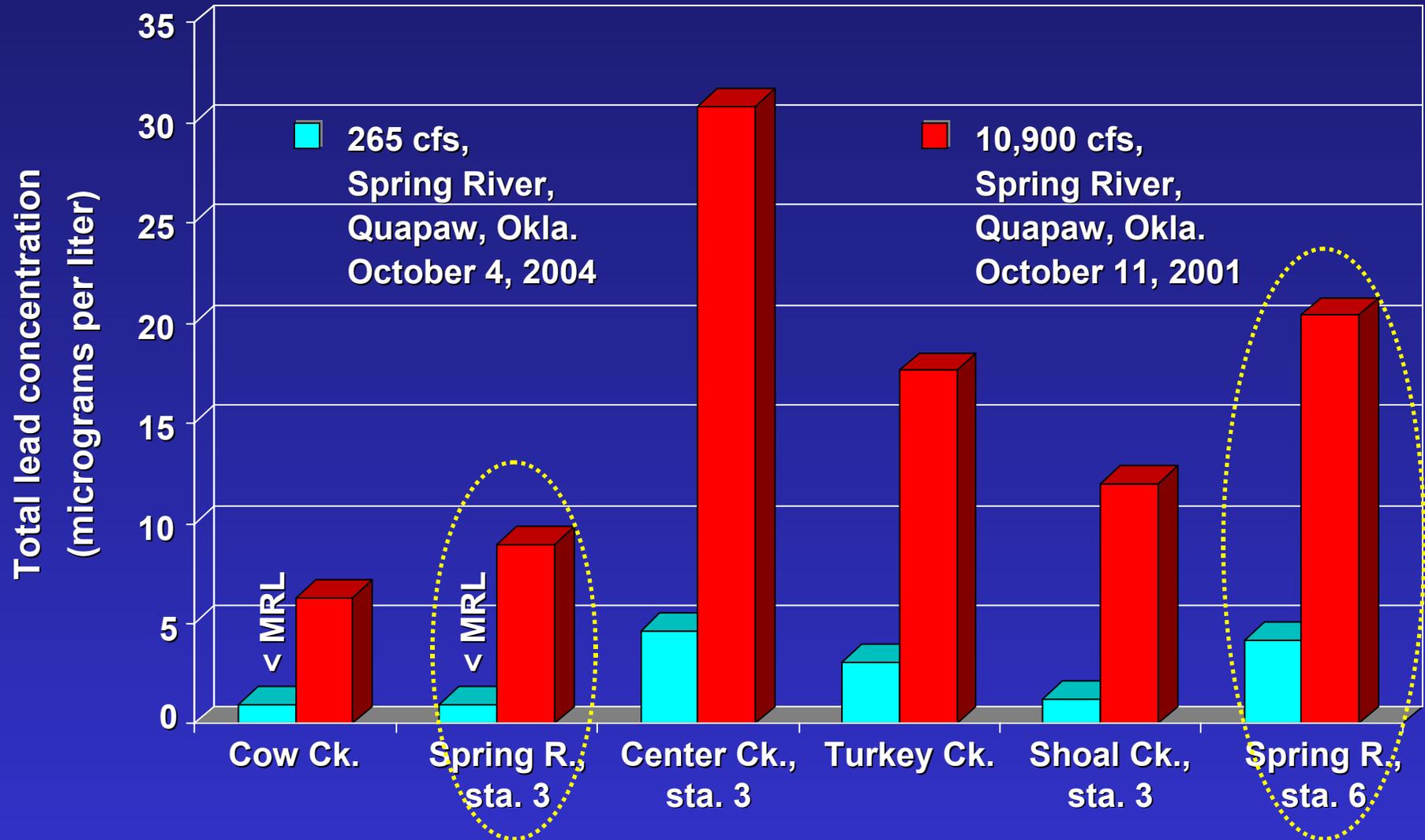




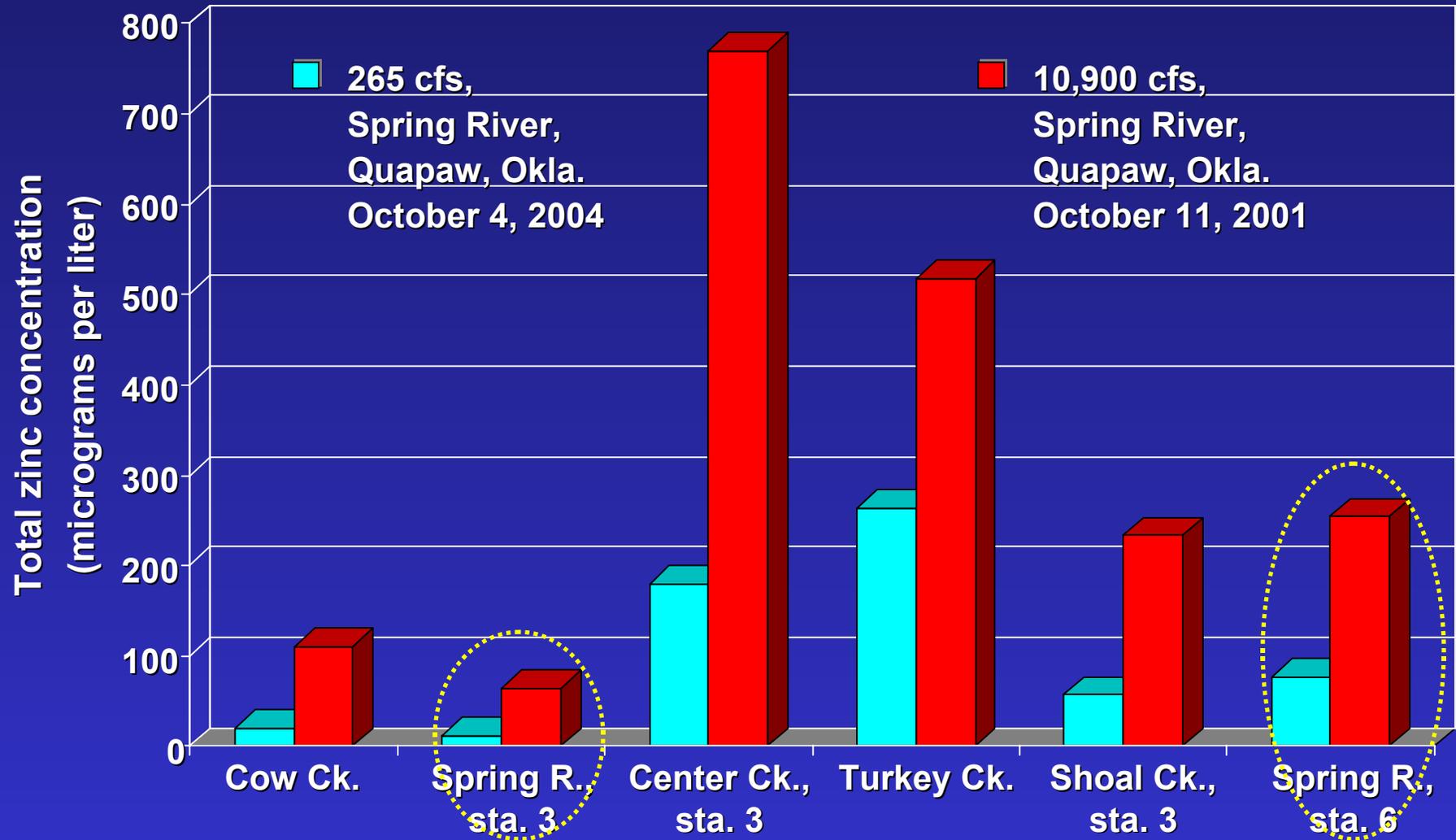
WATER-COLUMN CADMIUM CONCENTRATIONS MEASURED DURING LOW FLOW AND HIGH FLOW SYNOPTIC SURVEYS



WATER-COLUMN LEAD CONCENTRATIONS MEASURED DURING LOW FLOW AND HIGH FLOW SYNOPTIC SURVEYS



WATER-COLUMN ZINC CONCENTRATIONS MEASURED DURING LOW FLOW AND HIGH FLOW SYNOPTIC SURVEYS



CONCLUSIONS

- **The Spring River Basin supports a diverse freshwater mussel assemblage, but stream reaches draining former lead and zinc mining areas contain depauperate faunas compared to upstream reference reaches.**
- **Mussel densities in the Spring River drop precipitously below the confluences of Center and Turkey creeks. Mussels are seemingly absent in the lower reaches of these and several other mining-impacted tributaries.**
- **Mussels and other bivalves still occurring downstream of former mining areas exhibit significantly elevated levels of cadmium, lead, and zinc in soft body tissues.**
- **Bivalve tissue contaminant levels throughout the basin parallel local environmental (water-column/sediment) contaminant concentrations.**

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