

# Moss Landing Battery Fire

Update from EMBER to Monterey County Supervisors

17 March 2026



# EMBER

**E**stuary **M**onitoring of **B**attery **E**missions and  
**R**esidues resulting from the Moss Landing battery fire

<https://elkhornslough.org/moss-landing-battery-fire/>



# *Key theme of this talk*

**To detect ecological impacts of the battery fire, appropriate sampling is essential. This includes:**

- sampling soil surfaces immediately after the fire to detect ash layer
- sampling with high spatial coverage to detect patchy deposition
- sampling diverse organisms for a long time after the fire to track potential bioaccumulation

*EMBER has done this. Others have not.*

# *Sediment and geospatial team*



*Tracking spatial and temporal distribution of metals before and after the battery fire*

# *Sediment and geospatial team*



**Ivano Aiello**

**Professor & Dept Chair  
Geological Oceanography  
Moss Landing Marine Labs**



**Charlie Endris**

**Research Associate,  
Moss Landing Marine Labs**



**Seth Staten**

**Student Research Assistant,  
Moss Landing Marine Labs**

# First EMBER publication

## scientific reports



OPEN

### Coastal wetland deposition of cathode metals from the world's largest lithium-ion battery fire

Ivano W. Aiello<sup>1✉</sup>, Charlie Endris<sup>1</sup>, Steven Cunningham<sup>1</sup>, Monique Fountain<sup>2</sup>, Maxime M. Grand<sup>1</sup>, Wesley Heim<sup>1</sup>, Amanda S. Kahn<sup>1</sup> & Kerstin Wasson<sup>2</sup>

Fires at lithium-ion battery storage facilities pose emerging environmental risks that remain largely undocumented under real-world conditions. Following a major fire at the world's largest Battery Energy Storage System (BESS) in Moss Landing, California, we conducted rapid, high-resolution soil surveys to quantify metal fallout in adjacent estuarine wetlands. Field-portable X-ray fluorescence (FpXRF), validated by SEM/EDS, laboratory XRF, and ICP-MS, revealed a significant but transient surface enrichment of nickel (Ni), manganese (Mn), and cobalt (Co). This enrichment had Ni: Co mass ratios near 2:1 serving as a geochemical fingerprint of NMC-type cathode materials. The metals were confined to a shallow surface layer (<5 mm). Surface concentrations declined rapidly following precipitation and tidal inundation. The fallout's thin, transient and patchy distribution would have eluded standard coring methods but was detected through spatially intensive FpXRF sampling, highlighting the importance of rapid detection and the mobilization of metals into wetland ecosystems. These findings underscore the need for adaptive environmental monitoring following battery fires and raise critical considerations for ecosystem protection and infrastructure as energy storage systems expand.

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This article is in the 99<sup>th</sup> percentile (ranked 1,488<sup>th</sup>) of the 351,091 tracked articles of a similar age in all journals and the 99<sup>th</sup> percentile (ranked 25<sup>th</sup>) of the 4,041 tracked articles of a similar age in *Scientific Reports*

# *Robust pre- & post- fire comparison*

- Metal concentrations measured with field X-ray fluorescence analyzer
- Baseline concentrations established in 2023 at Hester Marsh permanent transects
- Same spots resampled after fire



# *Fire debris contamination*

Larger metal debris also detected 1-3 km from fire, consisting of almost pure battery metals; patchy and disappeared rapidly

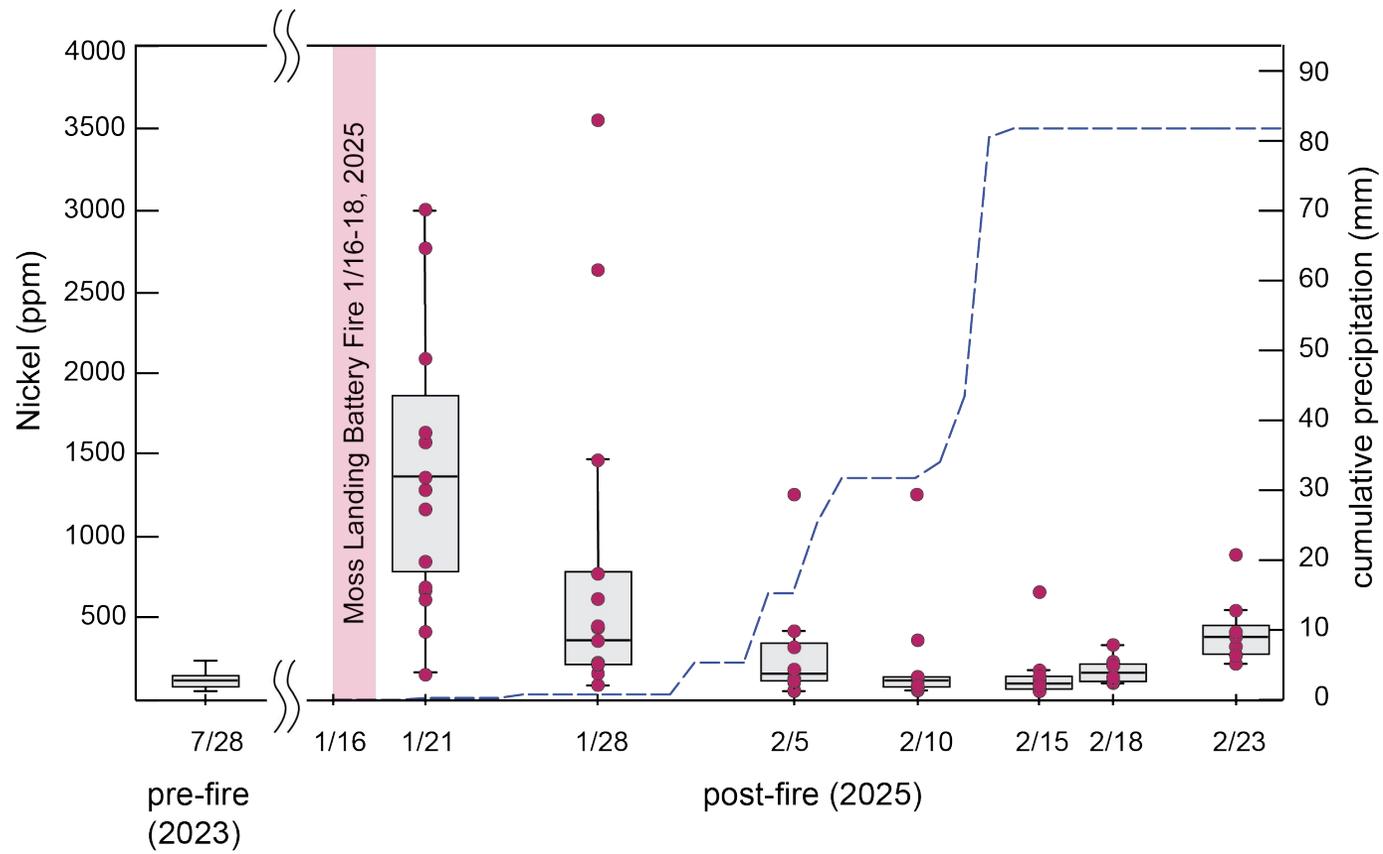


*Ash layer was very thin but concentrated:  
maximum Nickel concentrations 10x  
baseline initially, but decreased after rain*



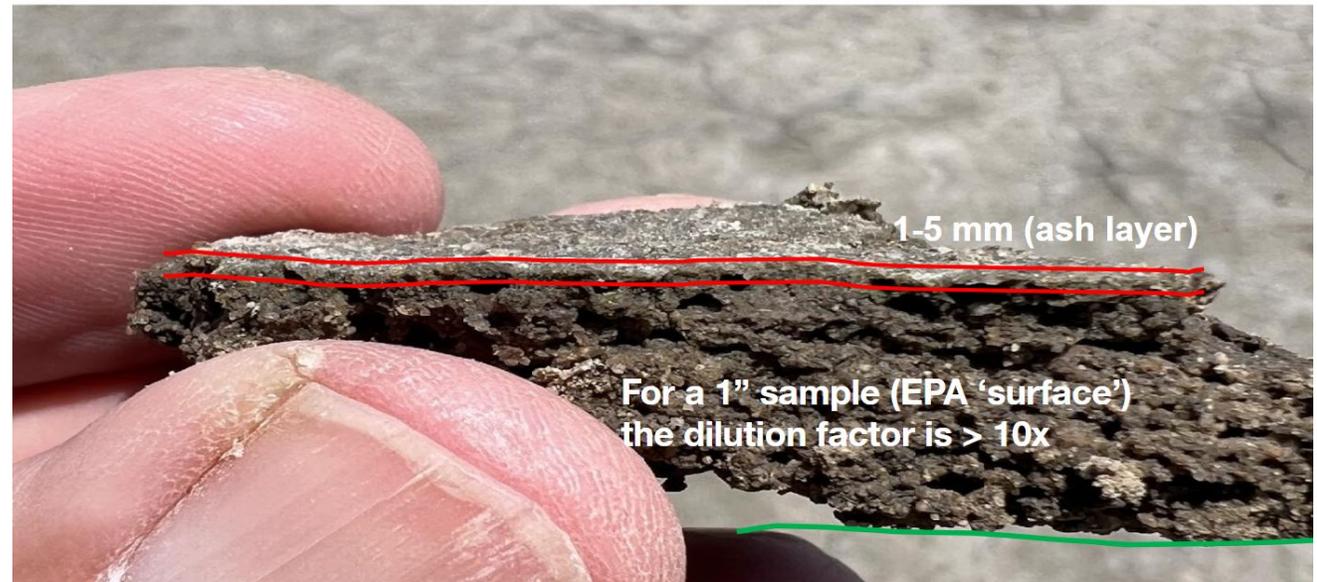
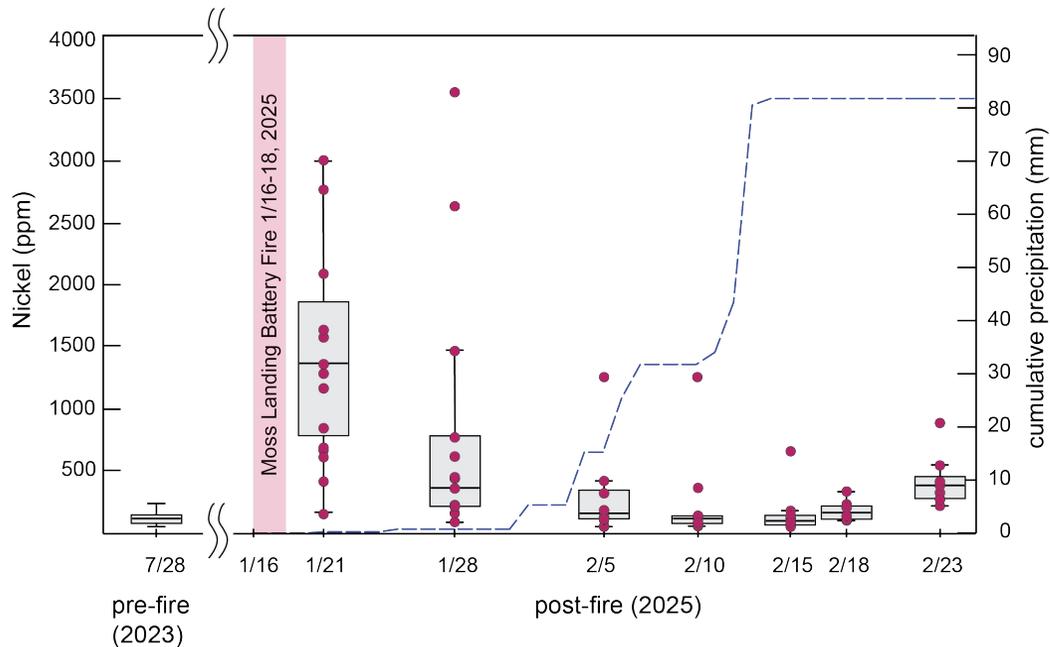
# *Patchy, short-lived phenomenon*

- Time series shows dramatic increase in Nickel in some spots along permanent transects at Hester, but high variance
- Decreased following rains



# Patchy, short-lived phenomenon

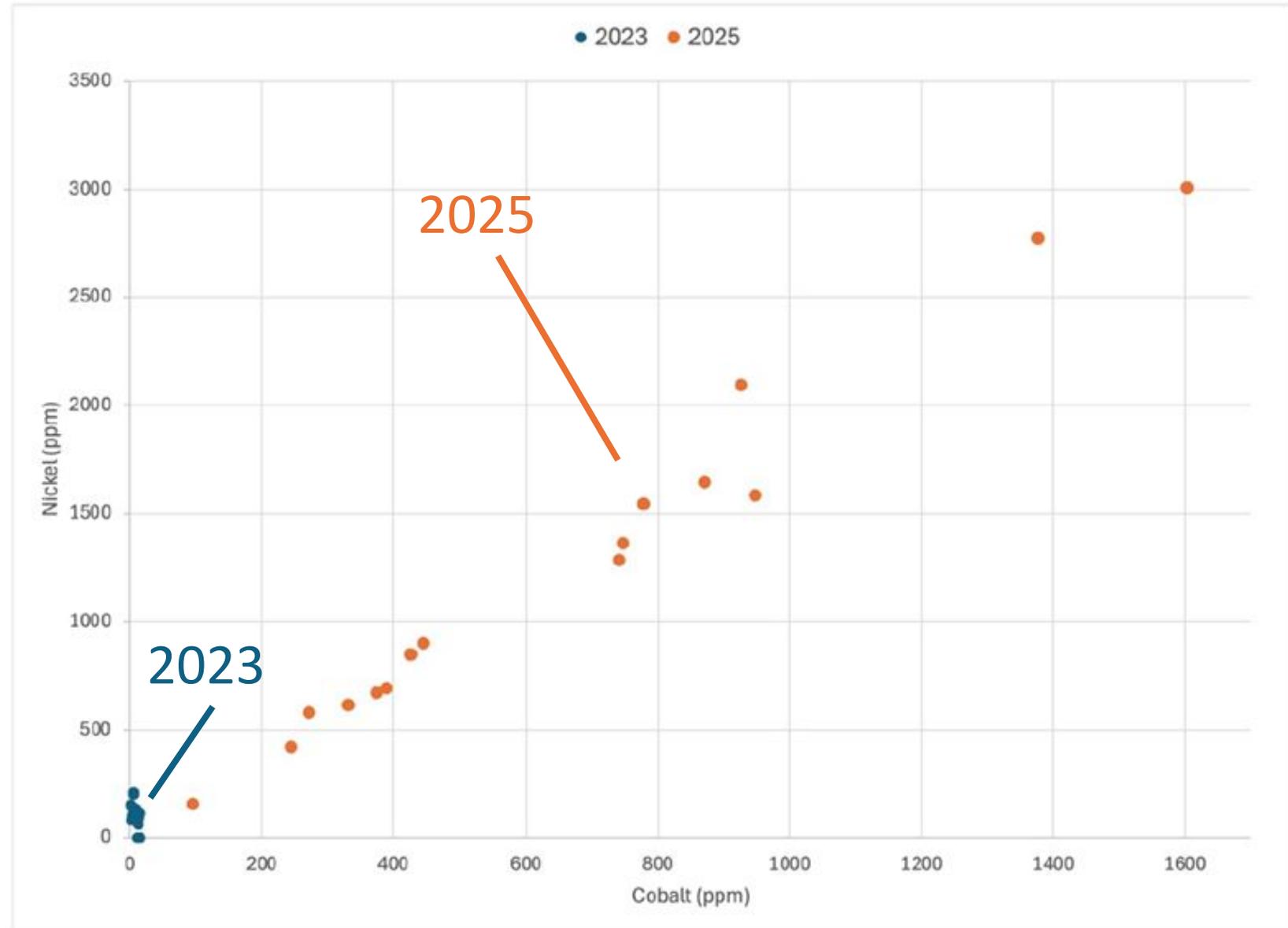
- Few, deep cores such as those taken by agencies initially were not suited to detecting thin, patchy layer of battery metals on soil surface
- Cores collected 8 months later by Terraphase were taken too late (see letter submitted by EMBER to Nicki Fowler)



# Battery metal signature

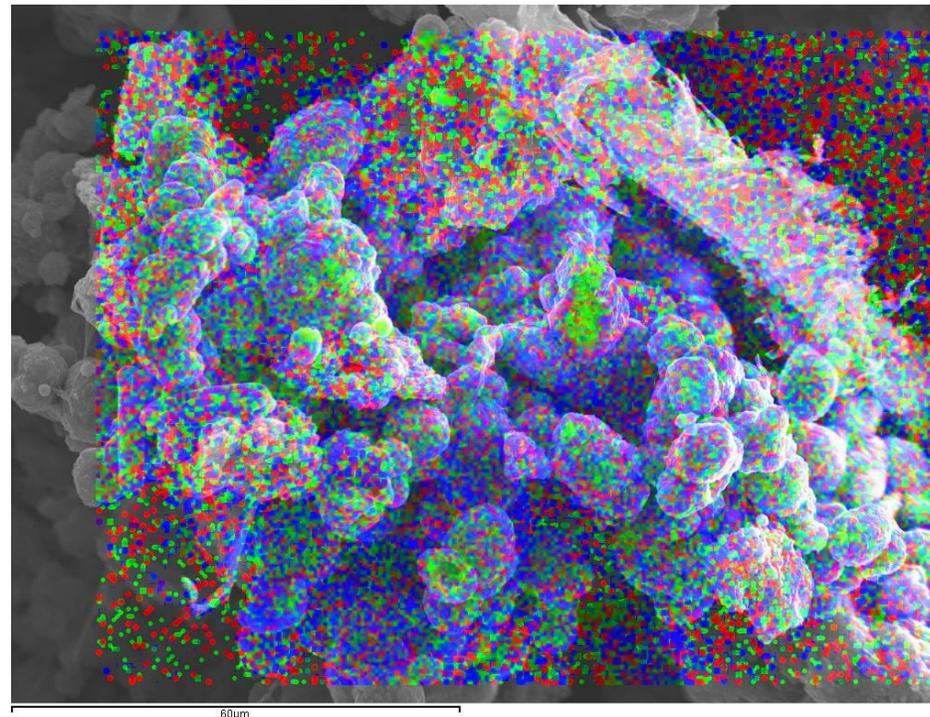
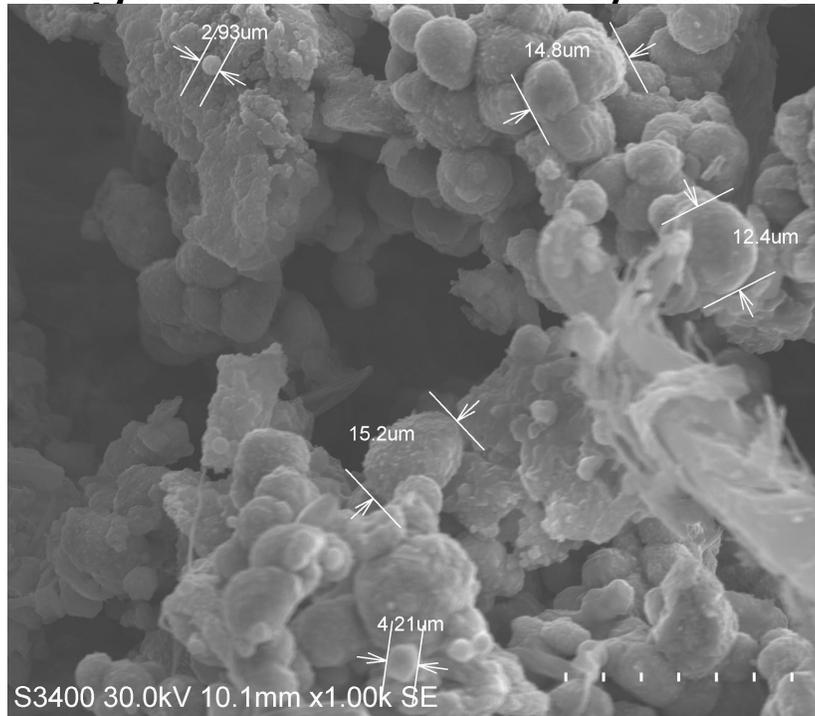
- Ni:Co correlated only **after fire**, same ratio as batteries
- Peak concentrations dramatically higher in **2025** than **2023**

Jan 21, 2025, first sampling



# *Structure of metals in marsh resembled battery material*

**Scanning Electron Microscope Energy Dispersive X-ray Spectroscopy:**  
Samples from Hester Marsh reveal Mn, Ni, Co metal microparticles clustered together and closely resembling material used in battery cathodes



**Red:**  
manganese  
**Green:**  
cobalt  
**Blue:**  
nickel

# Structure of metals in marsh resembled battery material

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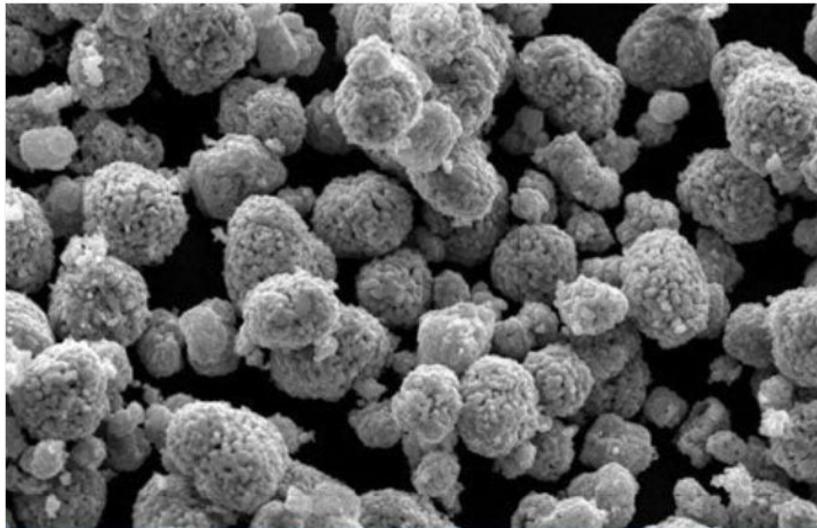
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# *Geospatial summary*

**Highly concentrated metals on Elkhorn marshes:** thin, patchy fallout layer of Nickel, Cobalt and Manganese deposited on wetlands

**Battery source:** Proportions of metals and particle morphology match batteries

**Rapid redistribution:** Rain and tides quickly reduced surface concentrations; the metals from the fallout layer were redistributed in estuarine ecosystem



Mike Takaki

# *Biota team*

*Tracking uptake or accumulation of metals related to the battery fire into plants, invertebrates, and fish in Elkhorn Slough*



# Biota team



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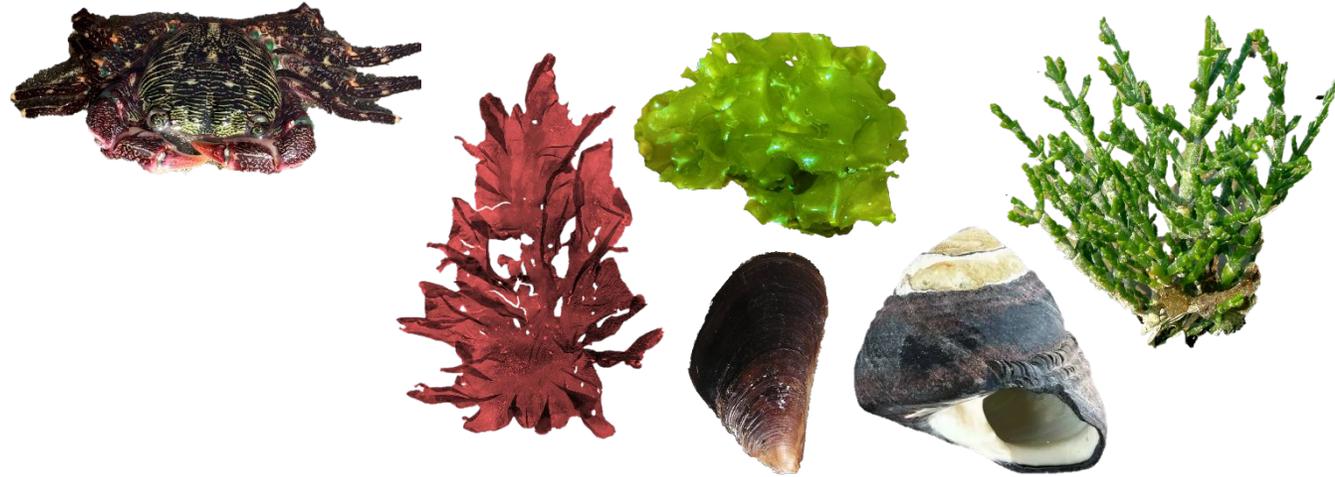


Jacob Harris

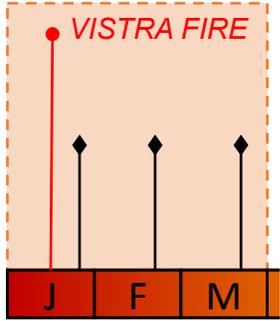
Coastal & Ocean Stewardship  
Program Manager,  
Amah Mutsun Land Trust

# *Target species*

- **Plants/algae**
- **Molluscs**
- **Crustaceans**
- **Fish**

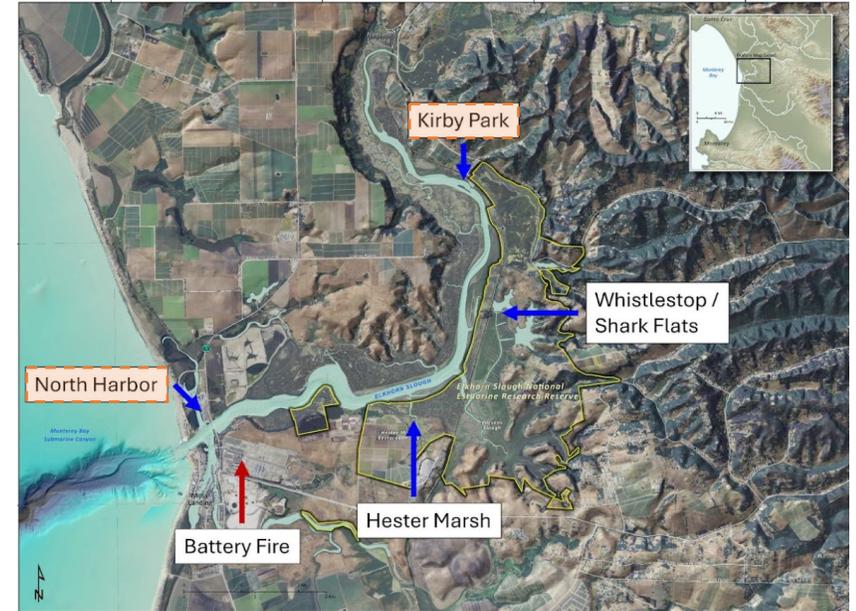
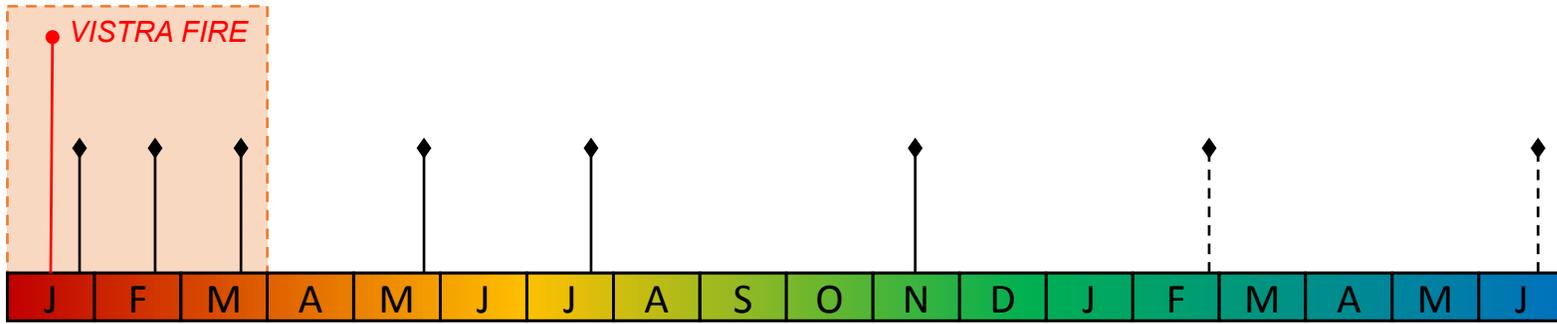


# Rapid mobilization after fire



Sampling within week - previously scheduled Tribal-Reserve monitoring pivoted, Moss Landing Marine Laboratories engaged

# Field collections continued

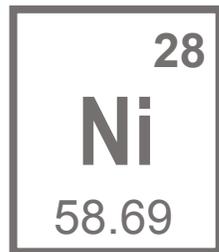
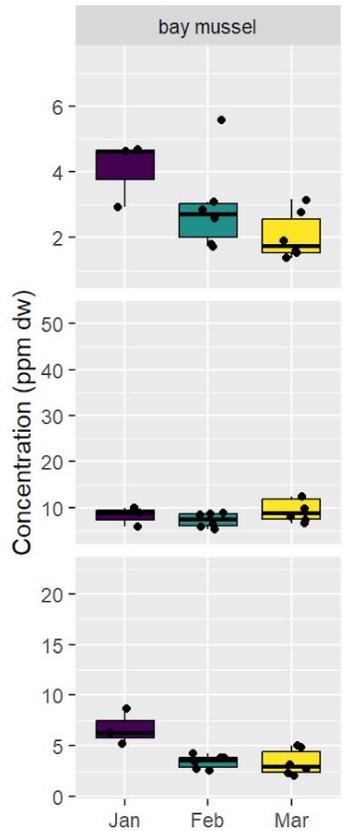


Preliminary results from:

- 2 sites
- 3 months
- 2 taxonomic groups

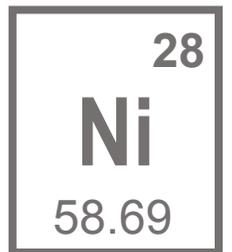
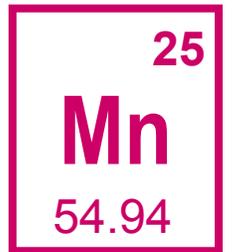
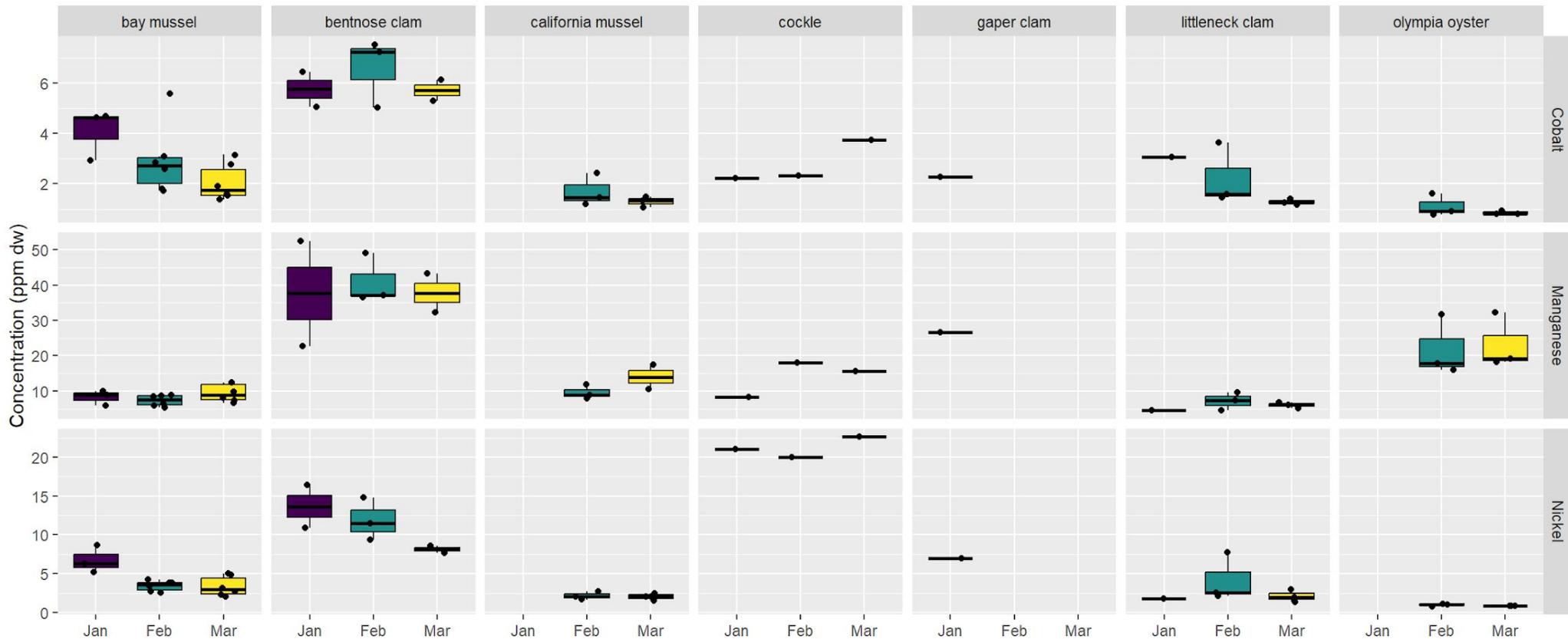
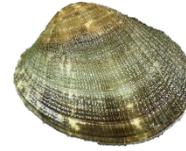
# Results from first months

## Bivalves



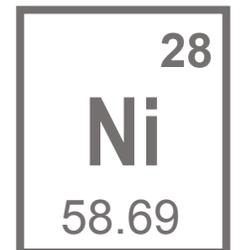
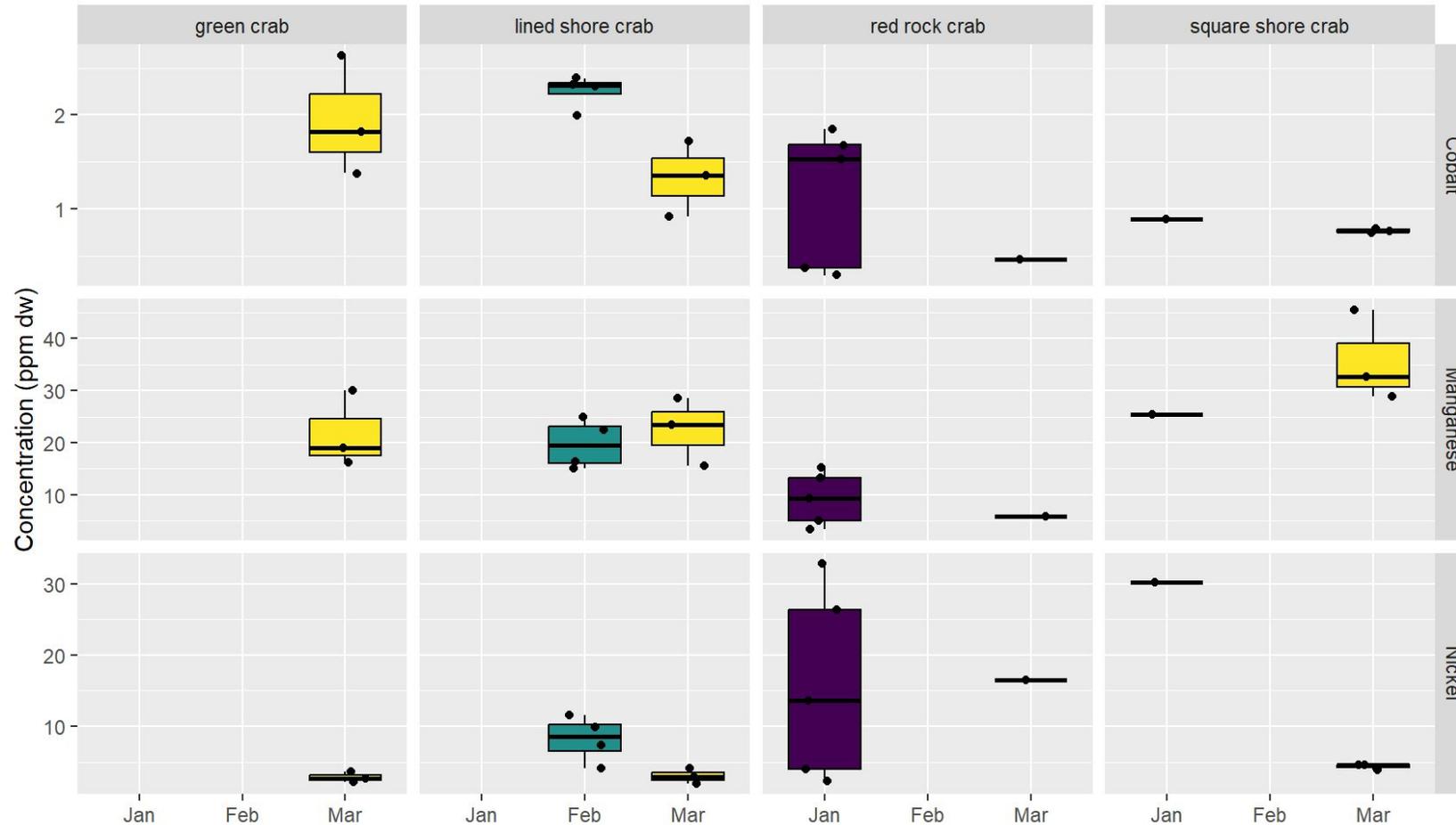
# Diversity of animals sampled

## Bivalves



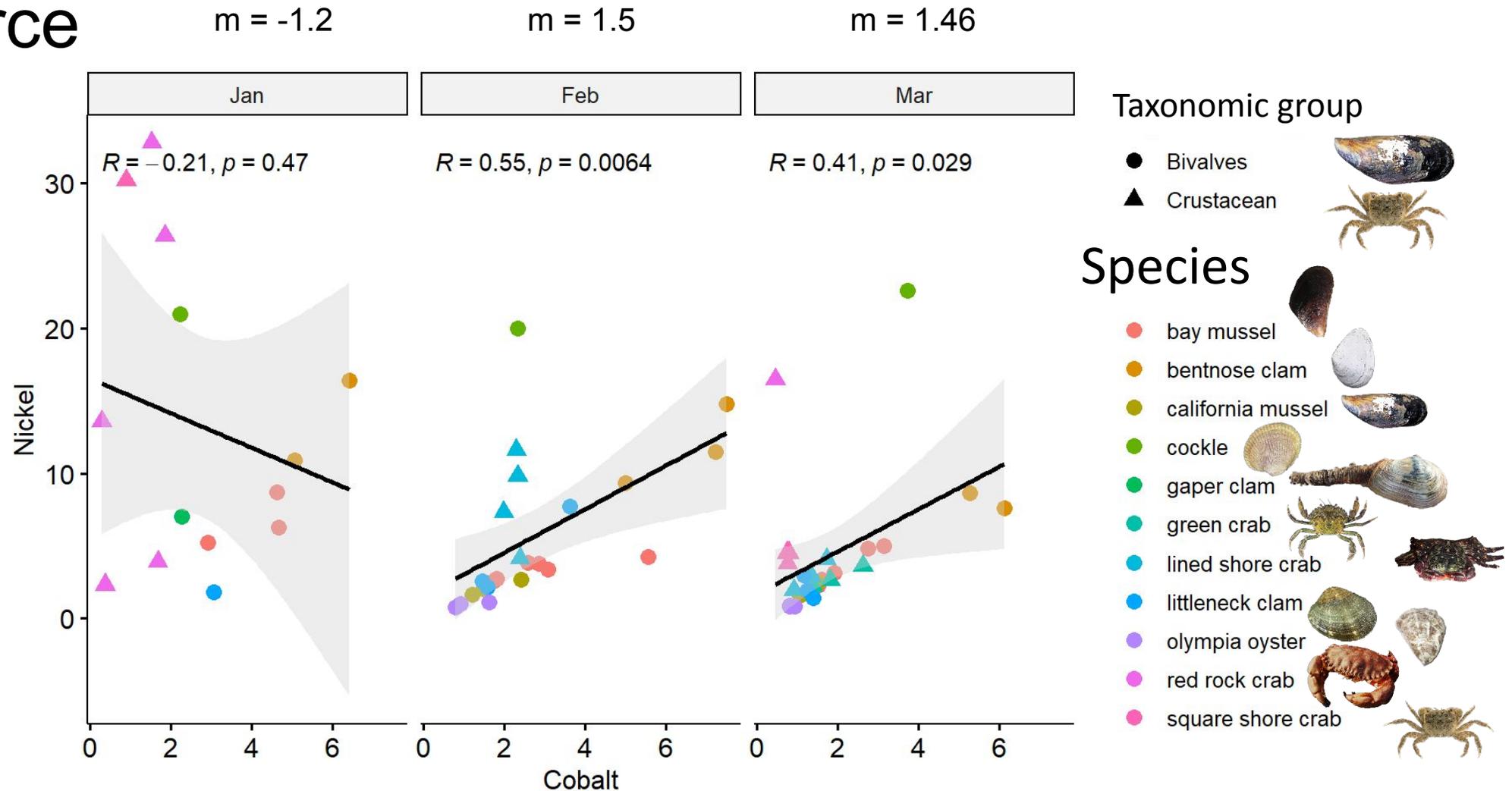
# Diversity of animals sampled

## Crustaceans



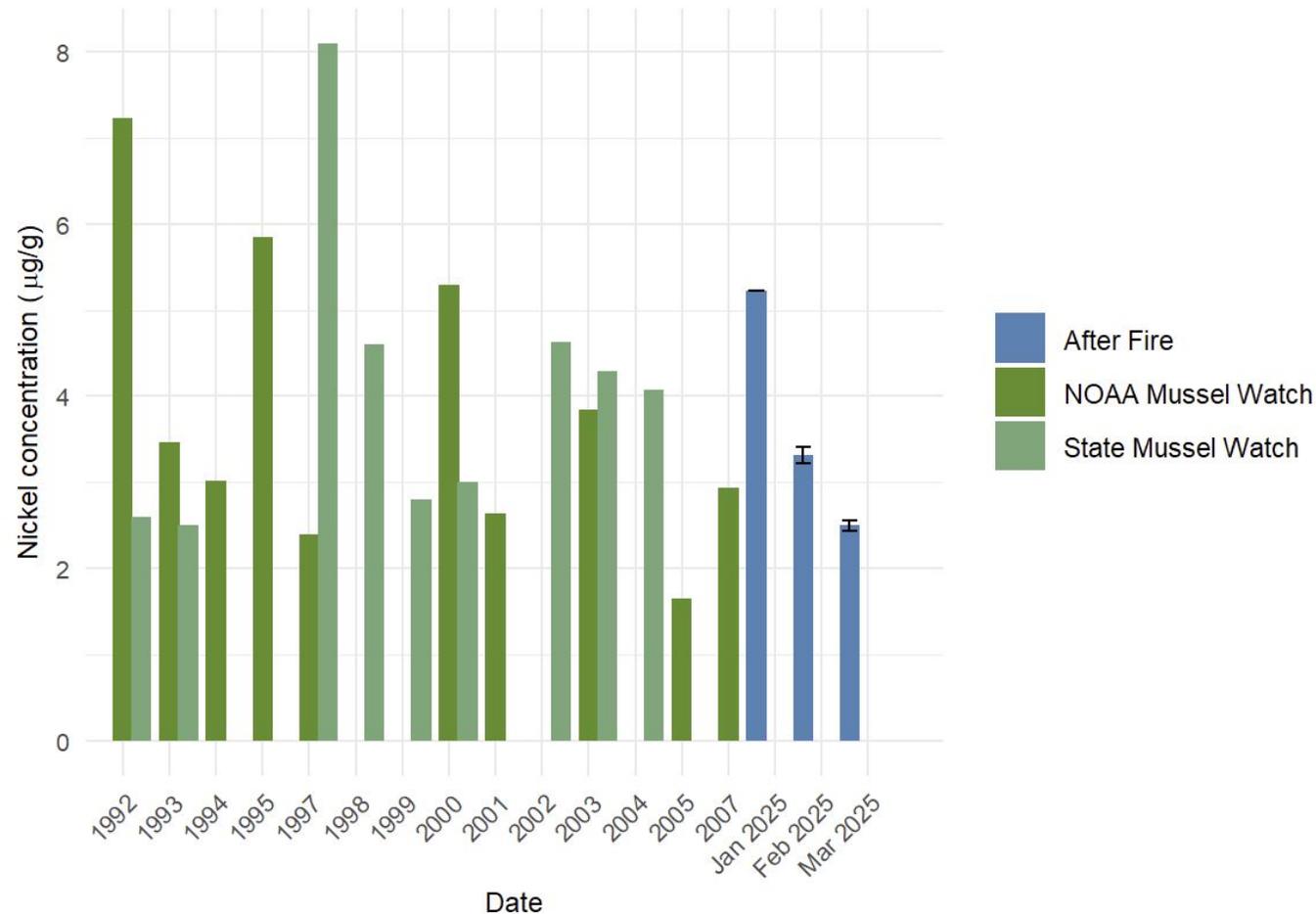
# Nickel-Cobalt relationship

Highly correlated in Feb-Mar, consistent with a common, shared source



# Temporal context

Metal concentrations in mussels **after fire** are within range of what has been measured from Elkhorn Slough **in the past**



# *Biota summary*

Results from the first 3 months after the fire show correlated nickel and cobalt concentrations in Elkhorn Slough animals, which may suggest a battery metal source.

Metal concentrations in mussels are within range with what has been measured from Elkhorn Slough in the past.

**No conclusions about ecological impacts of the battery fire should be drawn yet from these initial data.** Bioaccumulation can be a slow process and we must analyze data from many species, sites and dates to understand potential impacts.



# Key takeaways overall

Battery metals were deposited in adjacent wetlands as a **thin, pachy, concentrated layer**, that dispersed within weeks. Thus sampling with deep cores, and/or little spatial coverage, and/or in later months, cannot detect the contamination that occurred.

**Bioaccumulation can occur slowly and unevenly across sites and species**, so until many dates, sites and species have been analyzed for metals, conclusions cannot be drawn. So claims of absence of ecological impacts (e.g. Terraphase 12/2025) are premature at best and misleading at worst.



Mike Takaki

# EMBER

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