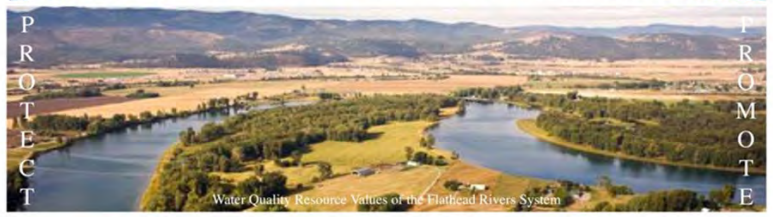
Impacts of Recreational Boating and Corresponding Wave Energy in a Lake-Influenced Large River System

Samantha Tappenbeck
Resource Conservationist

FLATHEAD
CONSERVATION DISTRICT
Locally-led Conservation Since 1945

Flathead River Commission



TETRA TECH

The Flathead River: It's Complicated

- Lake-level influence
- Currents and velocity
- Development and land use
- Wakes and waves

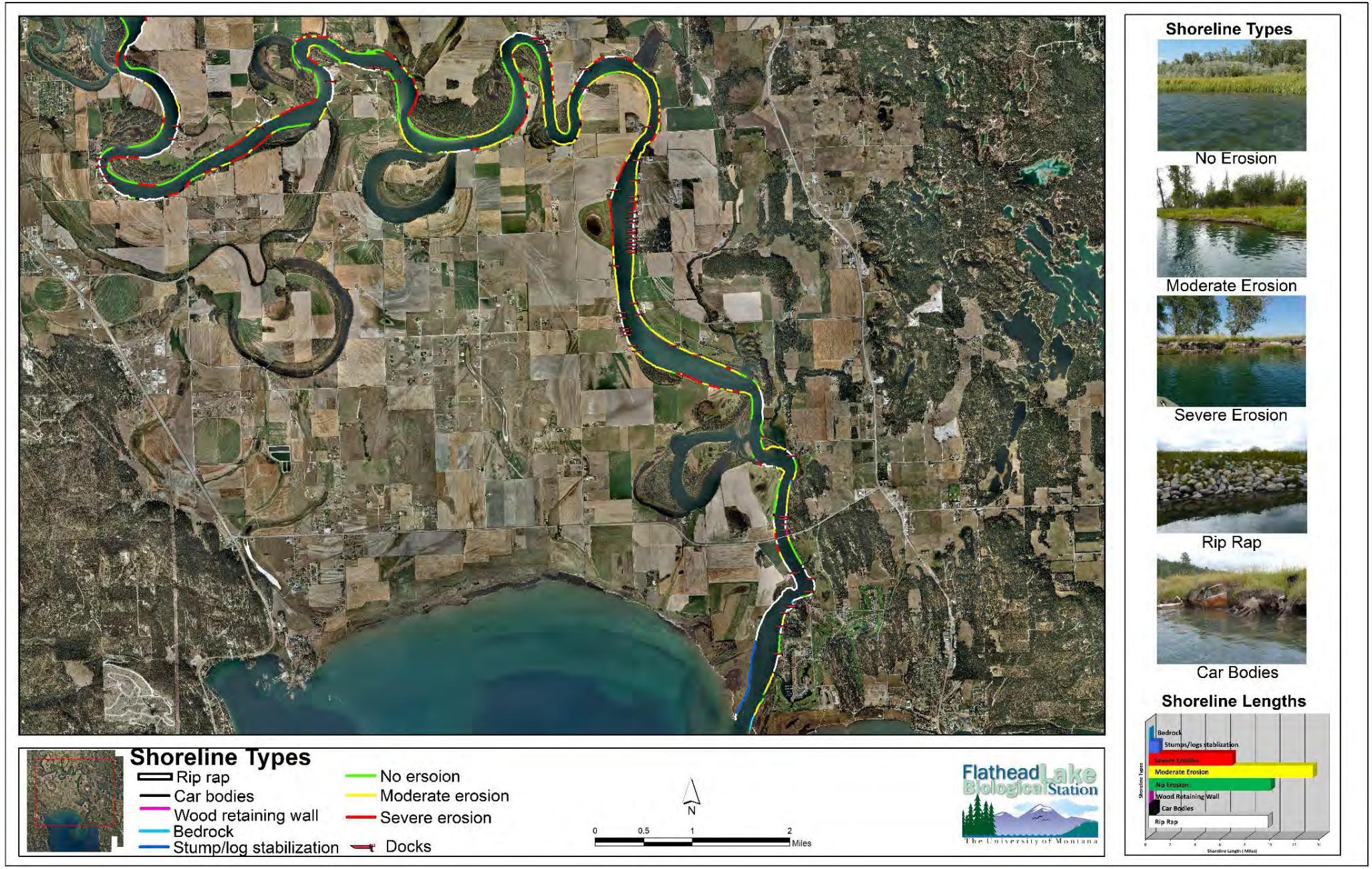
Water Quality Concerns

- Streambank erosion = 20-30% of suspended solids, 60% of nutrient loading in Flathead River
- Downstream transport to Flathead Lake
- TMDL identifies erosion as major contributor to pollutant loading in Flathead Lake
- Identified as priority in the Flathead-Stillwater Watershed Restoration Plan

Landowner Concerns

- Riverfront landowners are losing substantial acreage
- Threats to loss of structures and agricultural land
- Expense of stabilization measures
- Factors leading to accelerated erosion

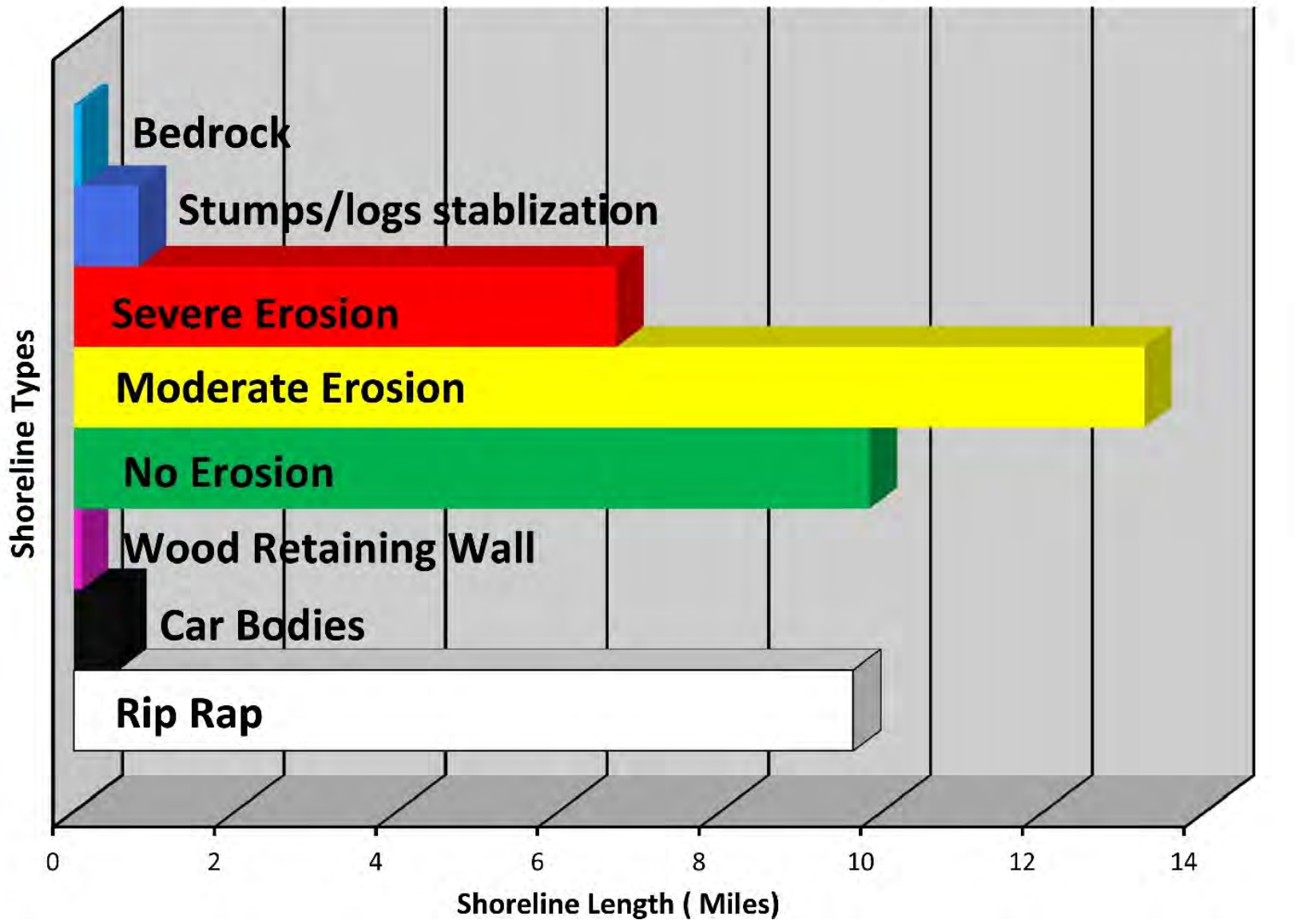
2010


Shoreline Types
Rip rap
Car bodies
Wood retaining wall
Bedrock
Stump/log stabilization
No ersoion
Moderate erosion
Severe erosion
Docks
N
0
0.5
1
2
Miles
Flathead Lake Biological Station
The University of Montana
Shoreline Types
No Erosion
Moderate Erosion
Severe Erosion
Rip Rap
Car Bodies
Shoreline Lengths
Bedrock
Stumps/logs stablization
Severe Erosion
Moderate Erosion
No Erosion
Wood Retaining Wall
Car Bodies
Rip Rap
Shoreline Types
Shoreline Length (Miles)

2010

2010

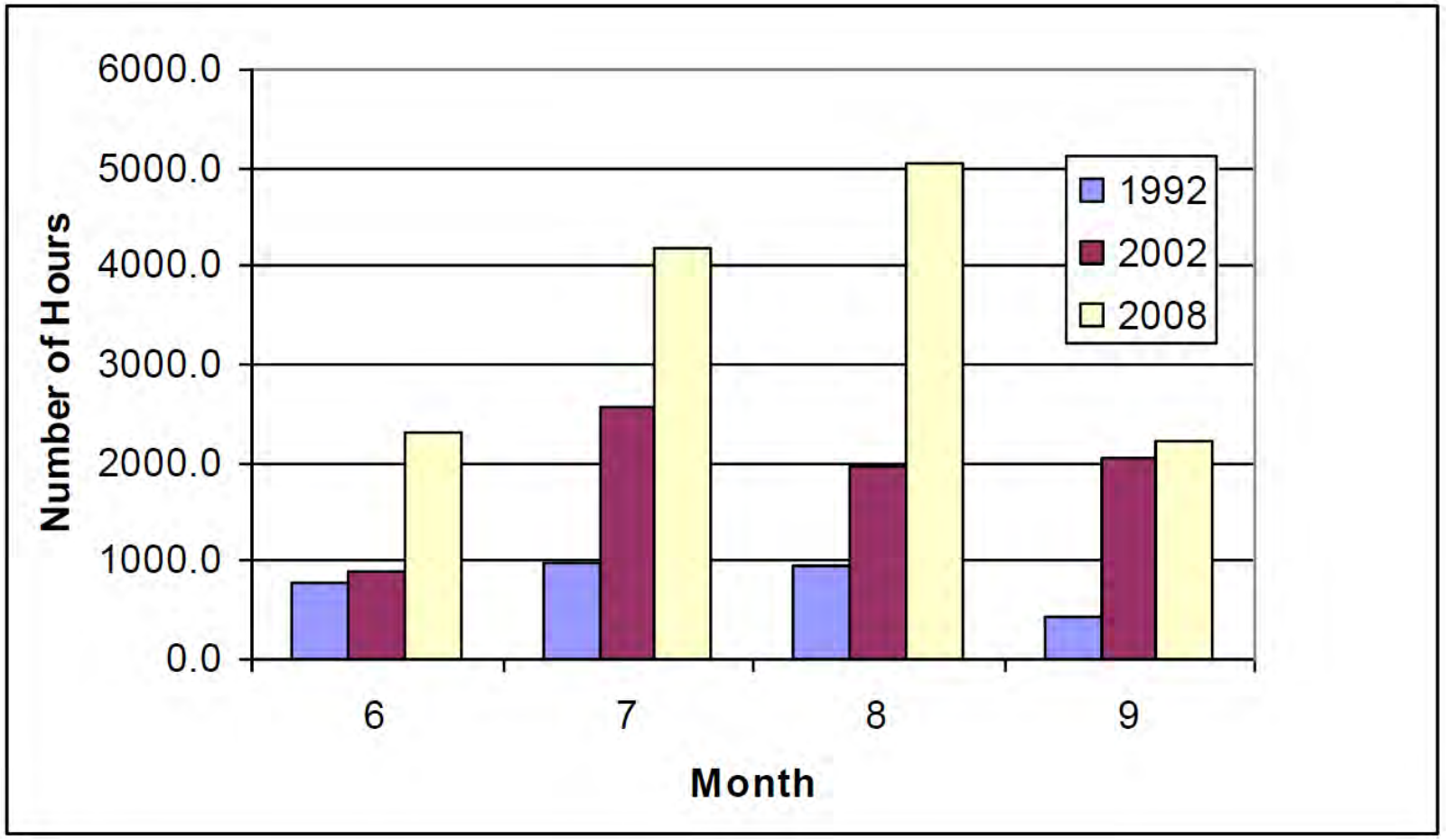
Shoreline Lengths



What are the impacts of recreational boating?

- Complex system
- Easy to measure sediment loads, difficult to measure erosion from specific drivers
- Anecdotal evidence that increased boat use is driving accelerated rates of erosion

Boat use estimates for the Flathead River

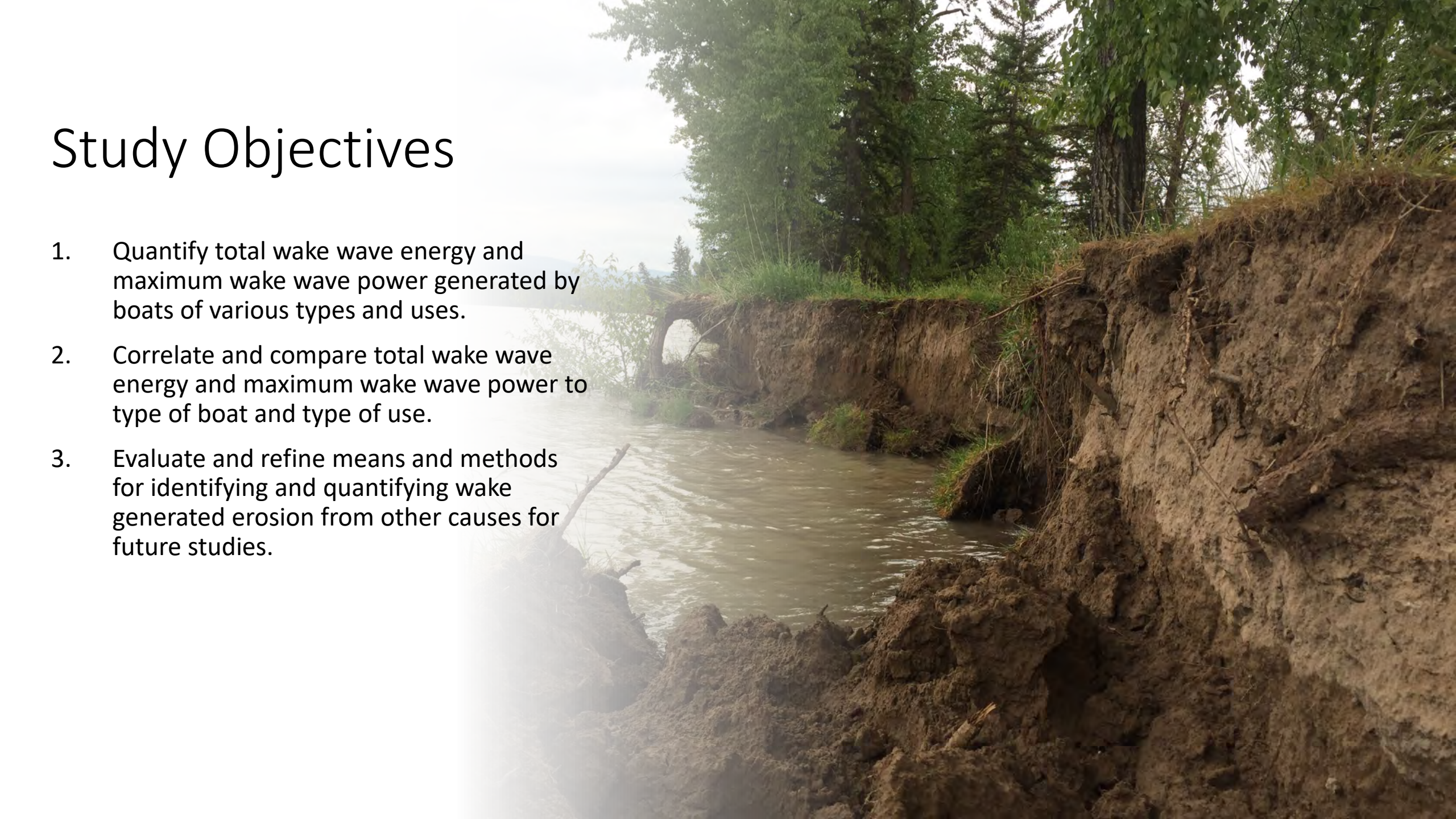


- Nearly doubled between 2002 and 2008
- More than quadrupled since 1992
- Study concluded there is likely an increased rate of bank erosion

Data from Montana Fish, Wildlife & Parks Boating Survey on the Flathead River and Sloughs Upstream of Flathead Lake, 2008

Study Objectives

1. Quantify total wake wave energy and maximum wake wave power generated by boats of various types and uses.
2. Correlate and compare total wake wave energy and maximum wake wave power to type of boat and type of use.
3. Evaluate and refine means and methods for identifying and quantifying wake generated erosion from other causes for future studies.



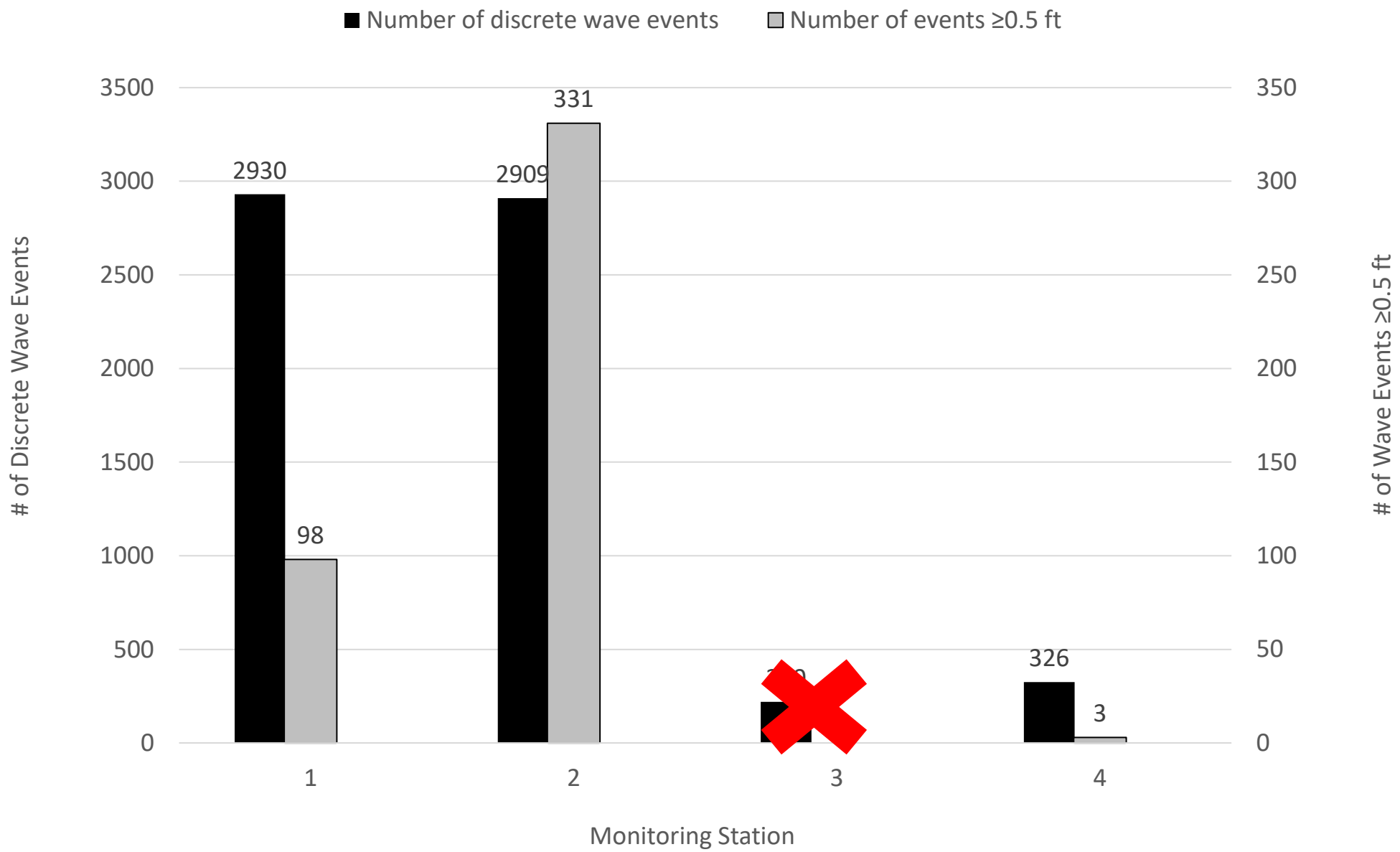

Monitoring Station 4
Monitoring Station 3
Monitoring Station 2
Monitoring Station 1
Flathead River
Flathead Lake
Kalispell
Map Area

Data Analysis

- Maximum wave height
- Wave amplitudes
- Maximum wave power
- Total wave energy

- Boat type and/or types that generated the wave event
- Boat use during the wave generated event
- Qualitatively evaluate turbidity generated during the wave event





Number of discrete wave events
Number of events ≥0.5 ft
# of Discrete Wave Events
# of Wave Events ≥0.5 ft
3500
3000
2500
2000
1500
1000
500
0
350
300
250
200
150
100
50
0
2930
98
2909
331
326
3
1
2
3
4
Monitoring Station

Weekend Snapshot – Monitoring Station 2

Sat. 16 July 2022

78 Wave Events Recorded

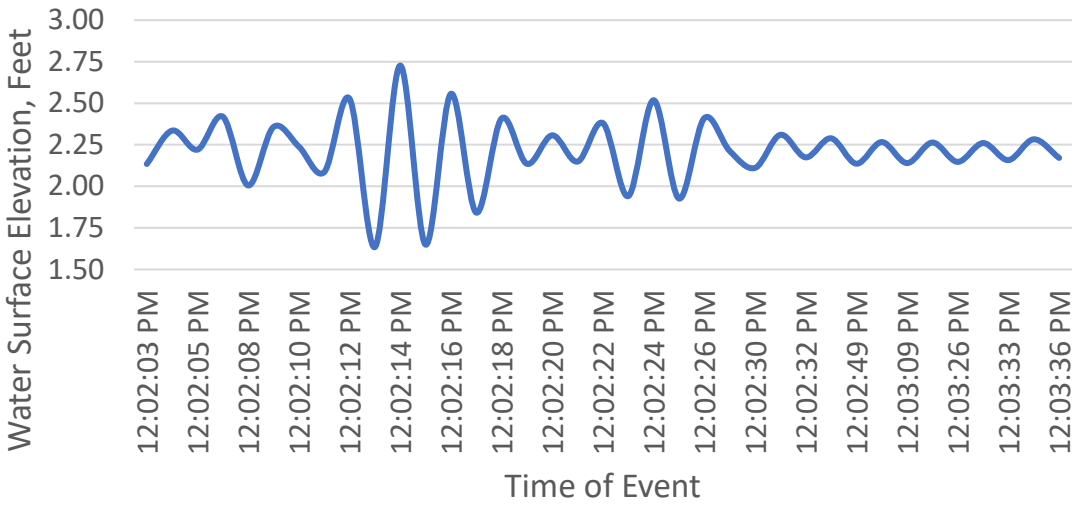
- 50 attributable to boats or series of boats
- 17 occurred before or after video recording timeframe
- 11 attributable to wind

71 Wave Events Recorded

- 50 attributable to boats or series of boats
- 13 occurred before or after video recording timeframe
- 8 attributable to wind

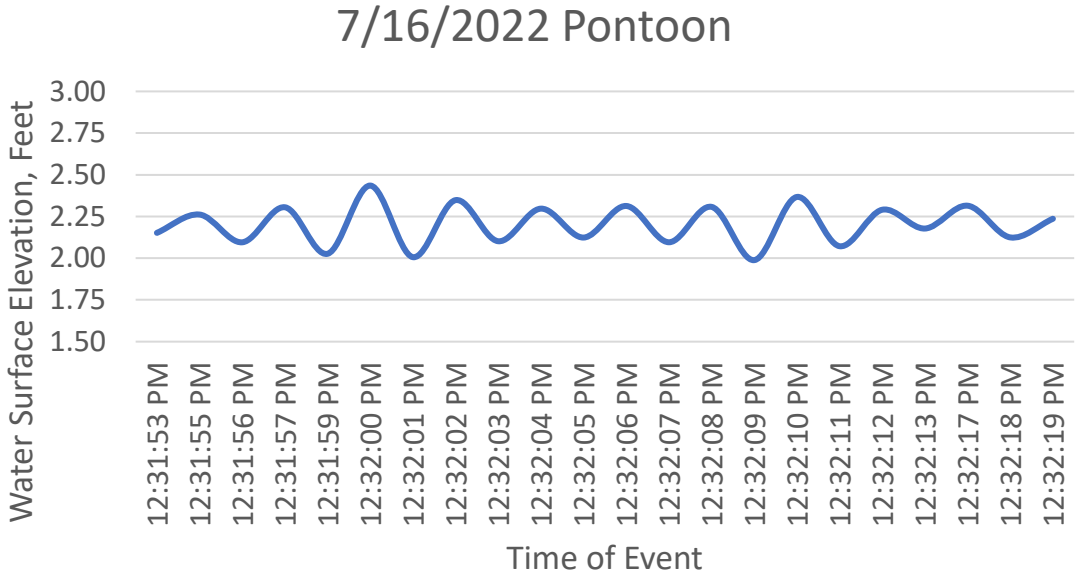
Sun. 17 July 2022

July 7-22: total wave energy = 15 kJ m^{-2}


7/16/2022 Wakeboat with Surfer
Water Surface Elevation, Feet
3.00
2.75
2.50
2.25
2.00
1.75
1.50
12:02:03 PM
12:02:05 PM
12:02:08 PM
12:02:10 PM
12:02:12 PM
12:02:14 PM
12:02:16 PM
12:02:18 PM
12:02:20 PM
12:02:22 PM
12:02:24 PM
12:02:26 PM
12:02:30 PM
12:02:32 PM
12:02:49 PM
12:03:09 PM
12:03:26 PM
12:03:33 PM
12:03:36 PM
Time of Event


SM8816588664 2022/07/16 12:01:26.4 GMT−06:00


SM8816588664 2022/07/16 12:31:38.2 GMT−06:00


7/16/2022 Pontoon
Water Surface Elevation, Feet
3.00
2.75
2.50
2.25
2.00
1.75
1.50
12:31:53 PM
12:31:55 PM
12:31:56 PM
12:31:57 PM
12:31:59 PM
12:32:00 PM
12:32:01 PM
12:32:02 PM
12:32:03 PM
12:32:04 PM
12:32:05 PM
12:32:06 PM
12:32:07 PM
12:32:08 PM
12:32:09 PM
12:32:10 PM
12:32:11 PM
12:32:12 PM
12:32:13 PM
12:32:17 PM
12:32:18 PM
12:32:19 PM
Time of Event

Preliminary Findings

- Duration of Boat Wake Wave Events Varies
  - Shortest = ~10 seconds
  - Longest = ~8 minutes
- Wake Wave Heights
  - Vary by type of watercraft, speed, plane, and distance
  - The largest wave heights recorded were attributable to wake and ski boats
- Wave Height is single biggest factor in power and energy
- Wave height is more influential on total wave energy than number of waves
  - It takes 3 to 4 waves of ~0.5 ft to equal the wave energy of a single 1-foot wave
  - It takes 7 to 10 waves of ~0.25 ft to equal the wave energy of a single 1-foot wave.

Questions?

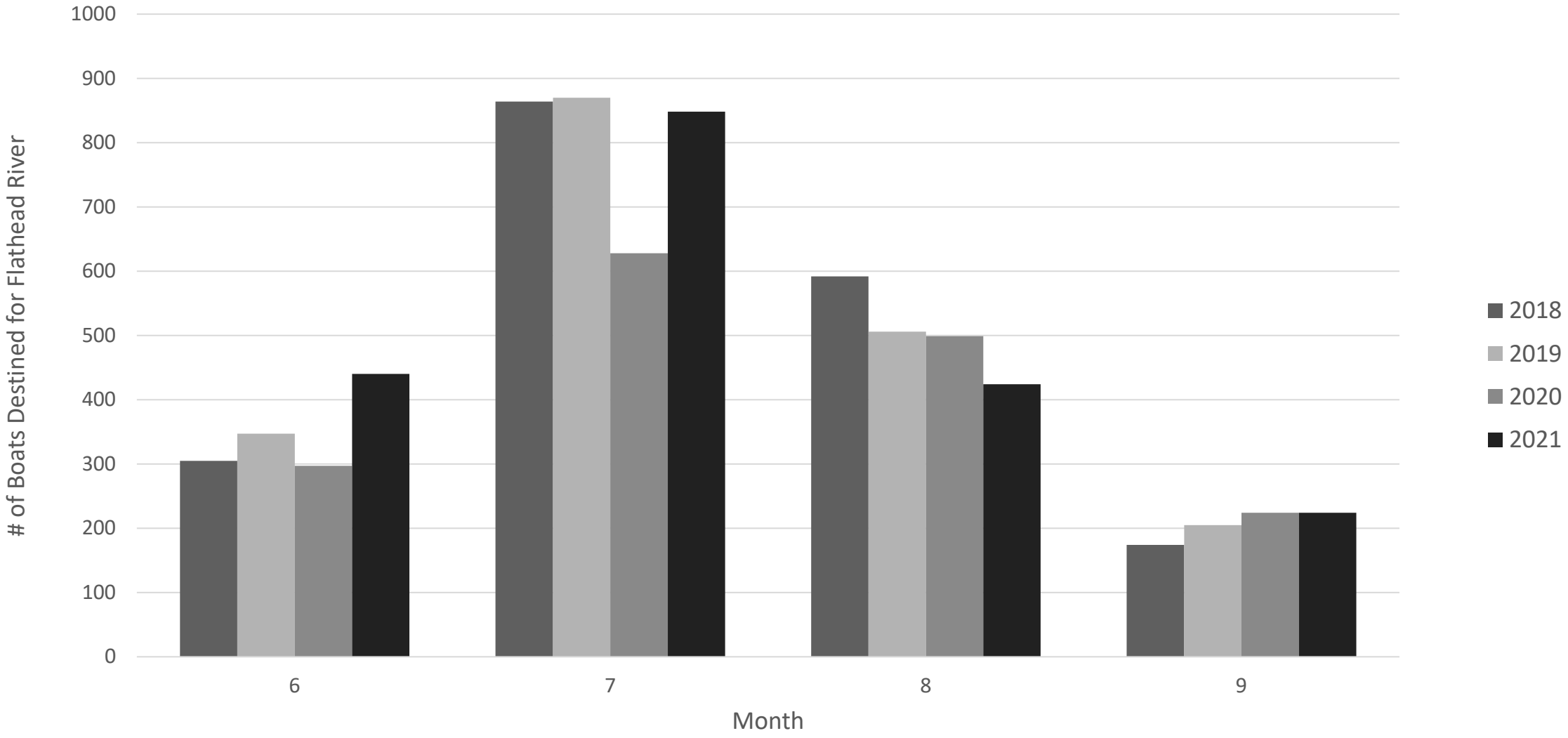
FLATHEAD
CONSERVATION DISTRICT

Contact info:
Samantha Tappenbeck
Email: samantha@flatheadcd.org
Phone: 406-752-4220

2010

1938
(pre-dam)

Boat use estimates for the Flathead River



Data from Montana Fish, Wildlife & Parks AIS check stations, destination: Flathead River (headwaters to confluence with Clark Fork Rv)