RECLAMATION
Managing Water in the West

UV control of colonial hydroid biofouling

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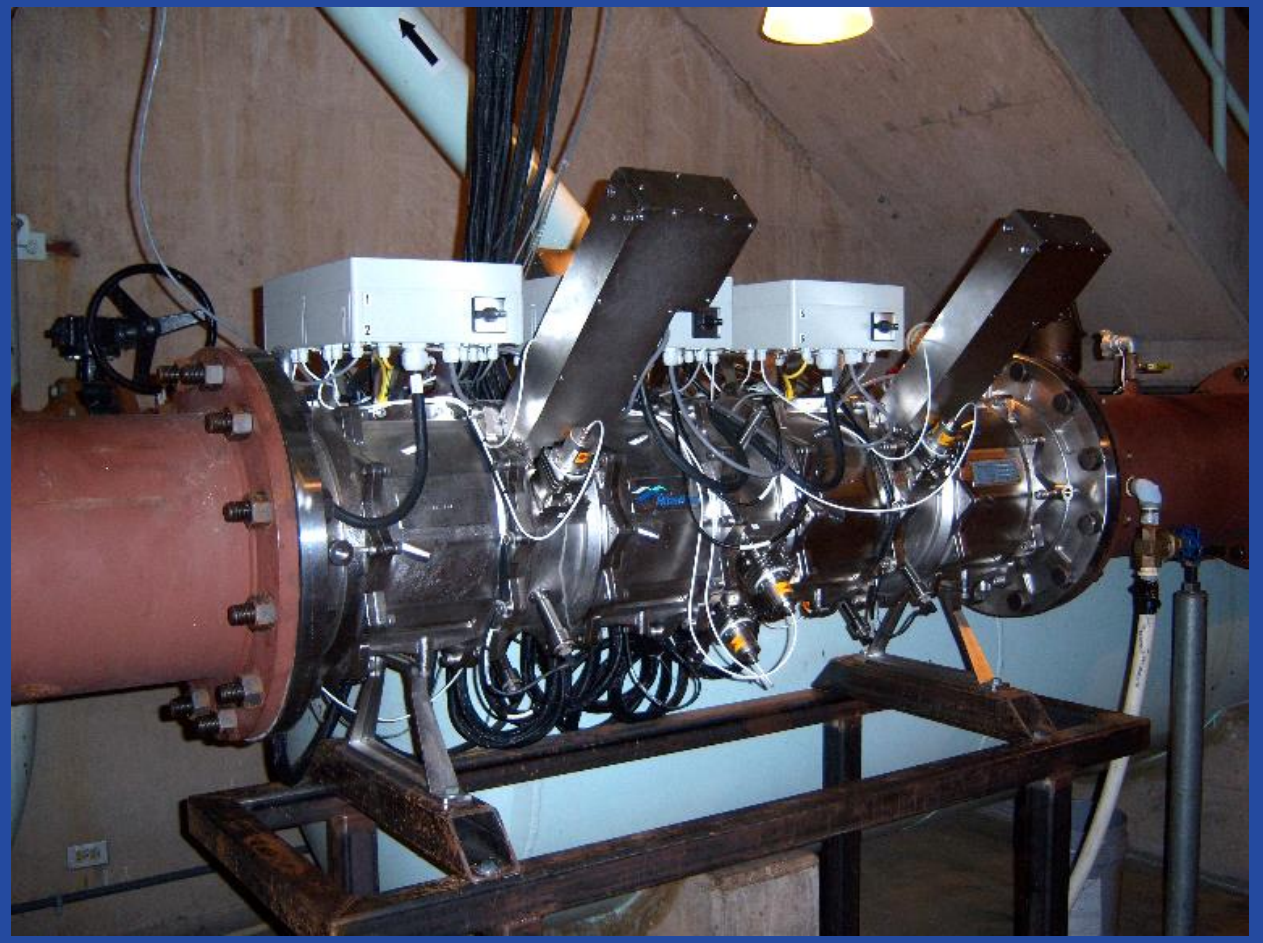
- **Previous UV research**
  - **Quagga mussel settlement prevention**
  - **Hydropower facilities along Colorado River**
- **UV treatment: passive and does not require discharge permitting**
- **UV dose**
  - **Lamp intensity, exposure time (flow), UVT (water clarity)**

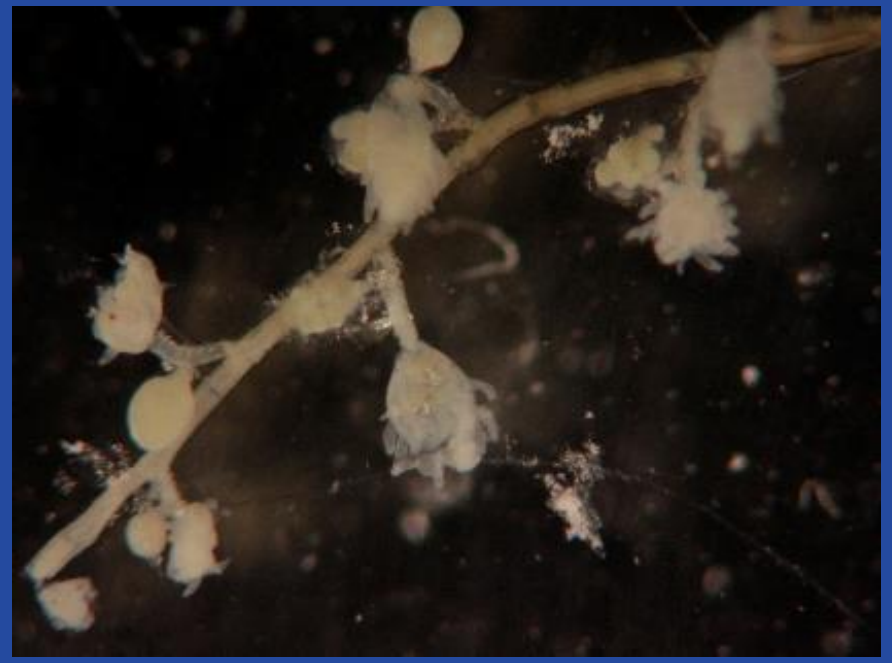
- **Quagga mussel UV study at Davis Dam, AZ**
- **Atlantium Technologies Ltd. medium pressure UV unit**
- **Tested doses between 20 and 100 mJ/cm²**
  - **Settlement reduction between 88-99%**



- **Atlantium UV units installed at Parker Dam**
- **Additional biofouling issues**
  - **Colonial hydroid (*Cordylophora caspia)***
  - **Freshwater sponge (*Ephydatia sp.*)**
  - **Bacterial growth**

Goal: Determine if UV treatment reduces all types of biofouling

- **Colonial hydroid**
  - **Invasive species**
  - **Significant biofouling potential at hydropower facilities**
  - **Carnivorous benthic predator- feeds on zooplankton**
  - **Colony growth and dispersal occurs by sexual reproduction (planula) and asexual budding (fragmentation)**



Methods

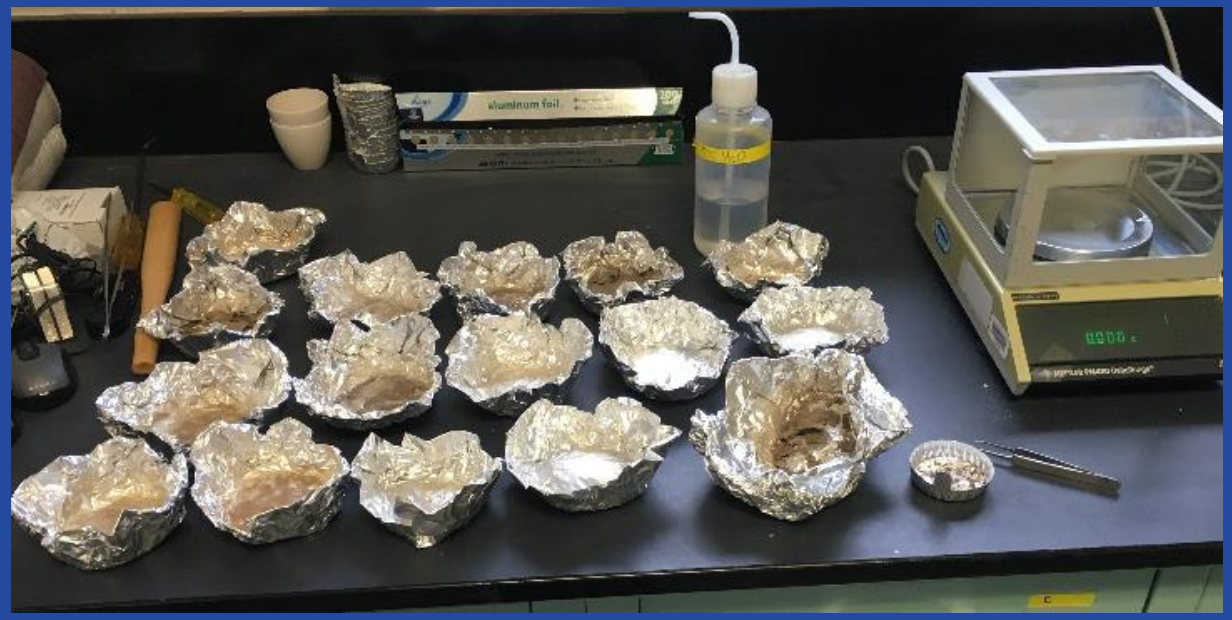
- Tests on multiple cooling lines
- Flow = 340 gpm
- Limited does control
  - No flow meter
- Bioboxes
  - Upstream and downstream
  - 2 gpm flow through
  - Settlement plates

Methods

- Monthly hydroid planula sampling
  - 20-µm plankton tow net
  - Microscopically analyzed and suspects genetically analyzed (PCR)
- No planula observed during 2 year study
  - Planula settle quickly after release
- Colonization of bioboxes likely a result of fragmentation

Methods

- Dry weight of biomass accumulation
  - 6 plates per biobox
    - 3 monthly
    - 3 six months
- Hydroid colony counts
  - Plate counts not representative
    - Hydroid settles on walls and bottom of the biobox

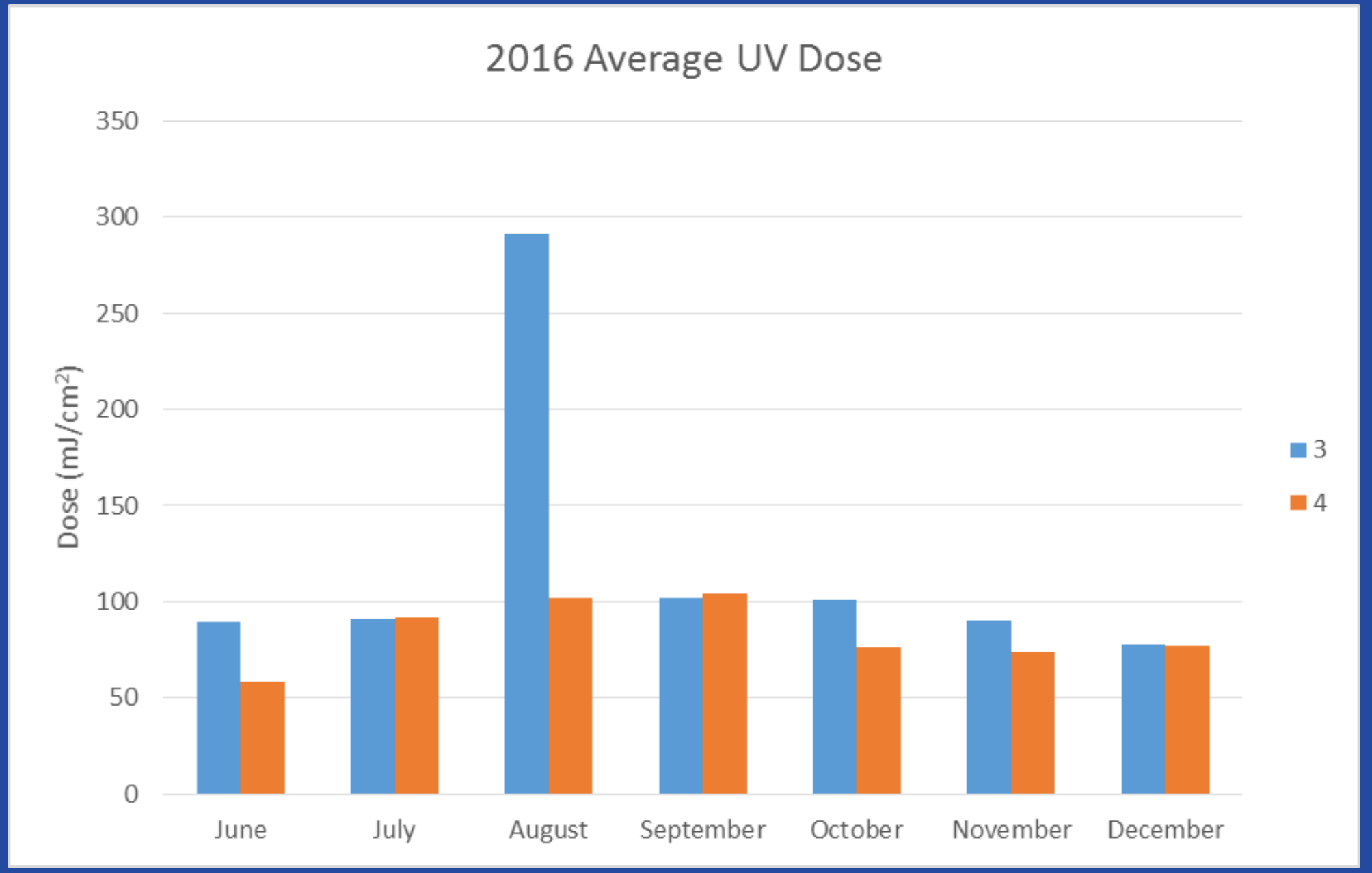


Methods

- Microbial monitoring
  - Installed small bioboxes with 100 µm cartridge filters
  - Adenosine triphosphate (ATP)
    - Luminultra® test kit
  - Biological activity reaction tests (BART)

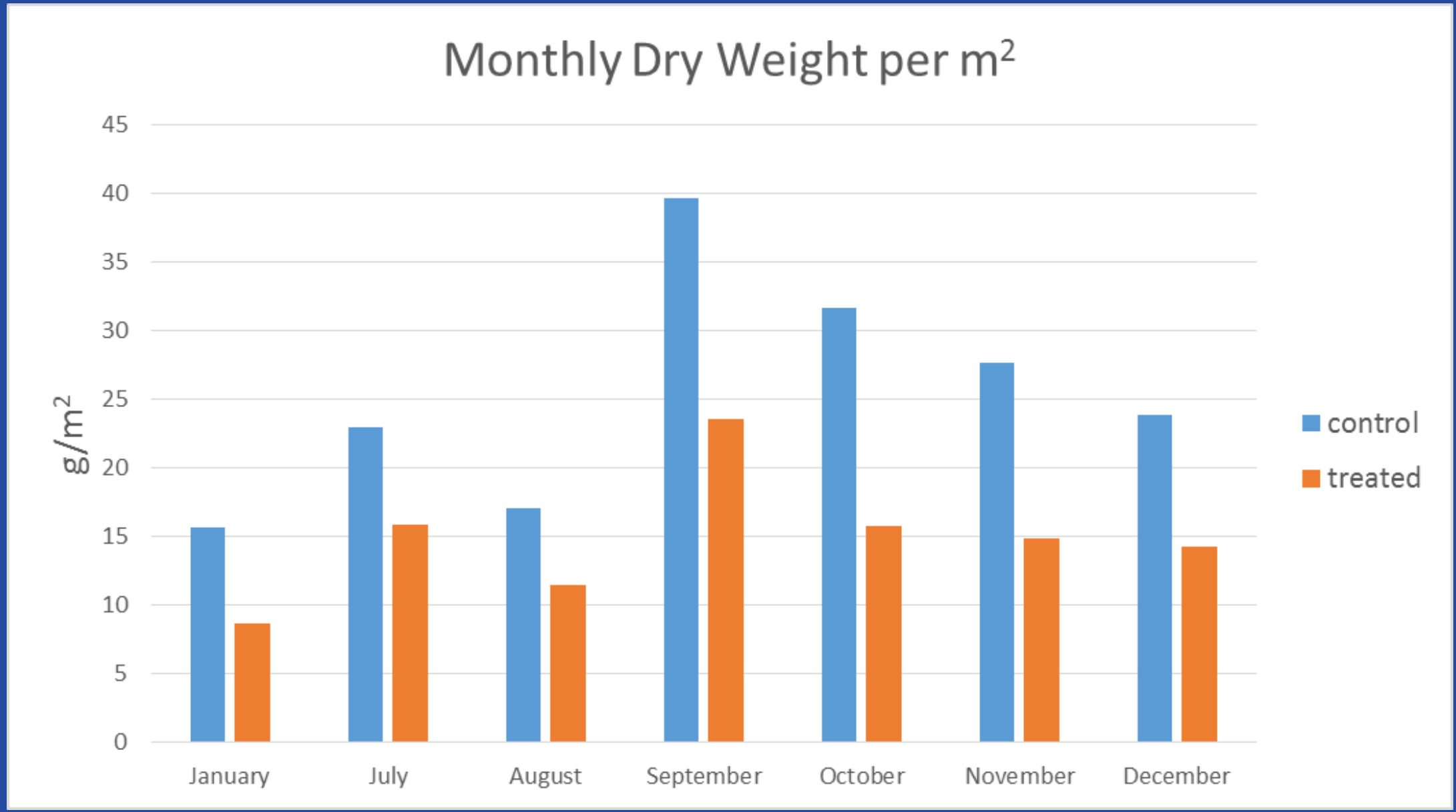
Issues

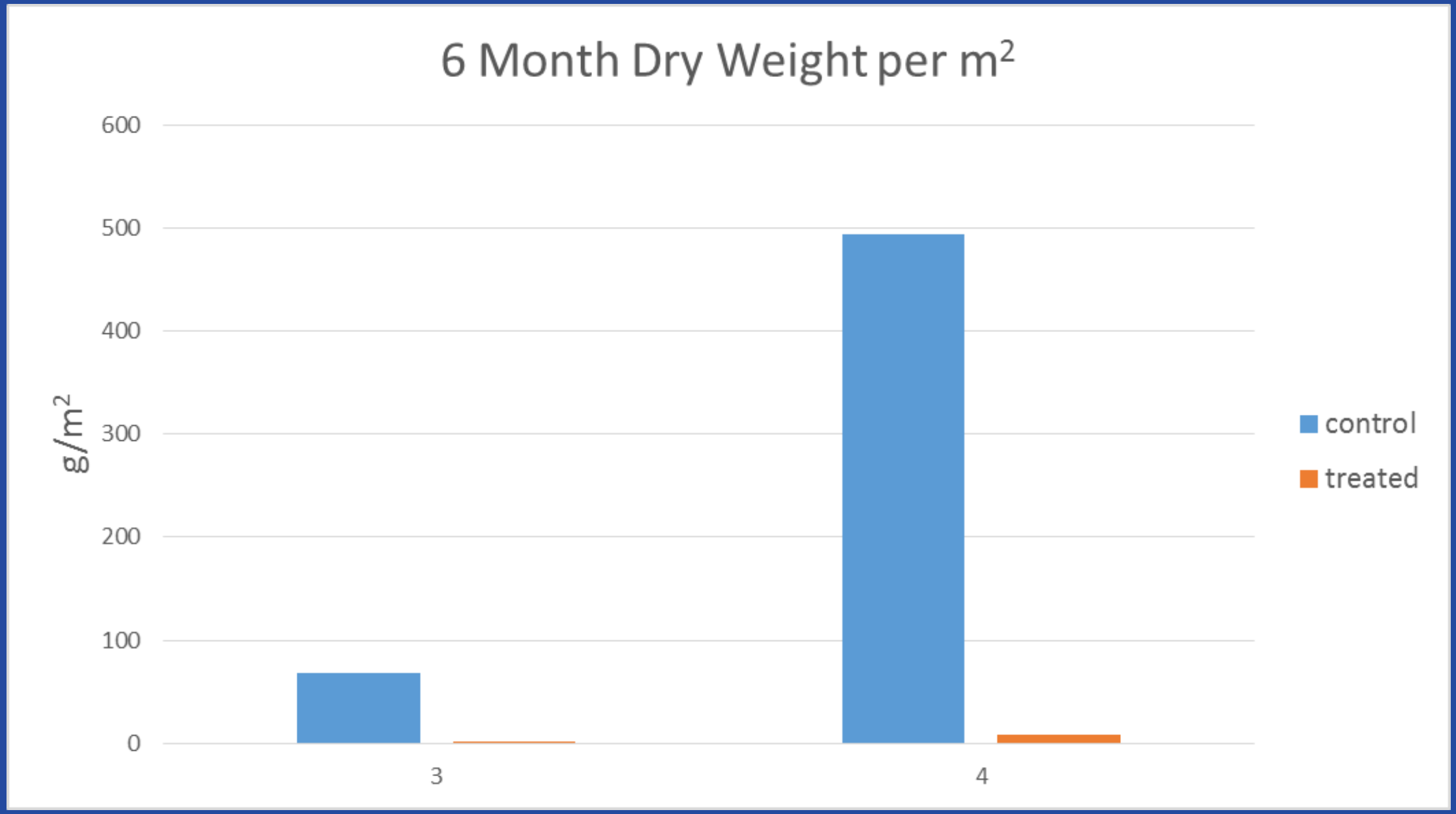
- Periods of untreated water entering downstream bioboxes
  - Head pressure resulted in backflow of untreated water
  - When cooling water flow stopped and UV turned off automatically
    - Unit 4: 192 hours
    - Unit 3: 5 hours
  - Installed system to stop backflow into bioboxes in 2017
- Dose was variable during tests
  - Periods of time when dose=0
    - Unit 4: 7 hours
    - Unit 3: 9 hours
- Operational conditions in hydropower facilities may limit control


2016 Average UV Dose
350
300
250
200
150
100
50
0
Dose (mJ/cm²)
June
July
August
September
October
November
December
3
4

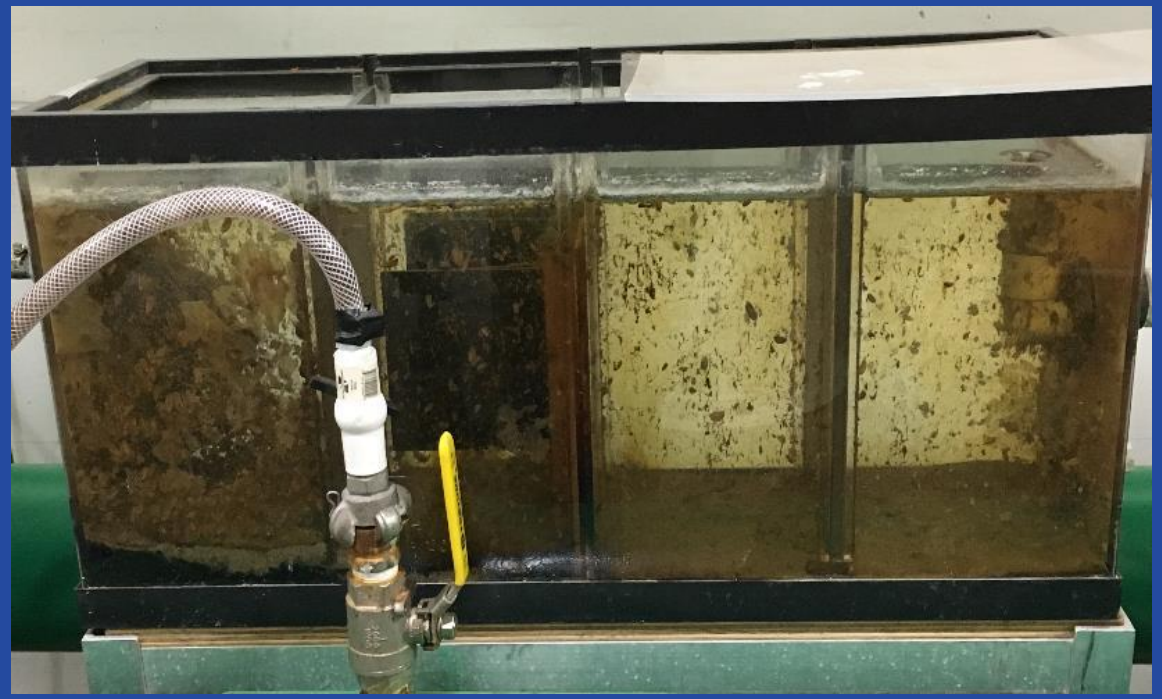
Results

- Despite test contamination with untreated water visual observations indicate UV reduced biofouling
  - Mussel settlement consistently reduced
  - Thick layer of bacterial growth observed in untreated biobox
  - Not as consistently effective for hydroid and sponge
- Hydroid and sponge
  - Asexual reproduction
    - Possibly requires higher dose
    - Settlement during outages
- Reduced sponge numbers in 3 month test
  - Control= 112
  - UV Treated= 3

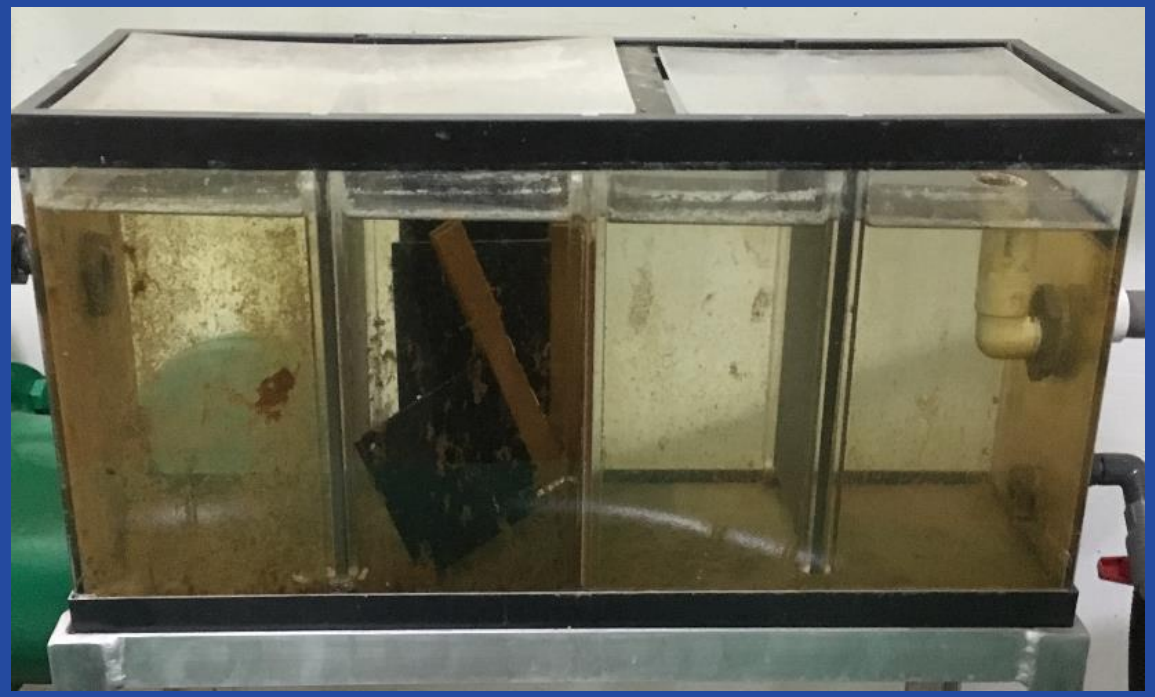

Monthly Dry Weight per m2
45
40
35
30
25
20
15
10
5
0
g/m2
January
July
August
September
October
November
December
control
treated


6 Month Dry Weight per m2
600
500
400
300
200
100
0
g/m2
3
4
control
treated

- **Control – Unit 4**



- **UV Treated – Unit 4**



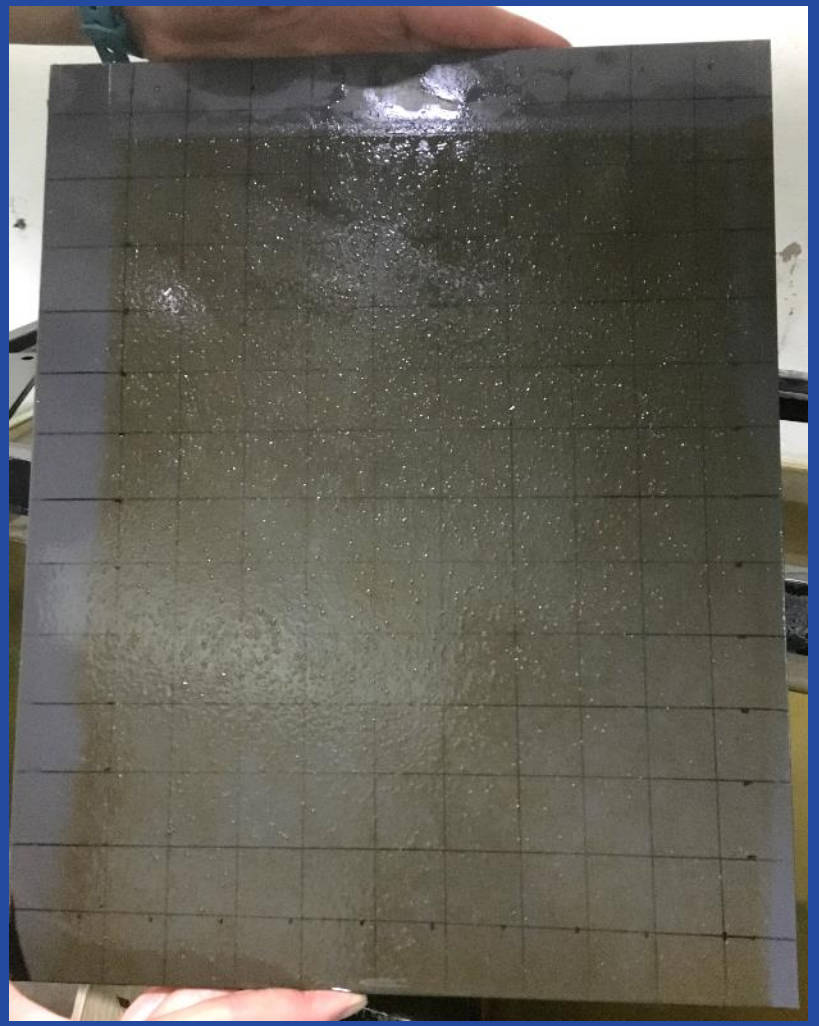
96% organic (LOI test)

- **Control – Unit 3**

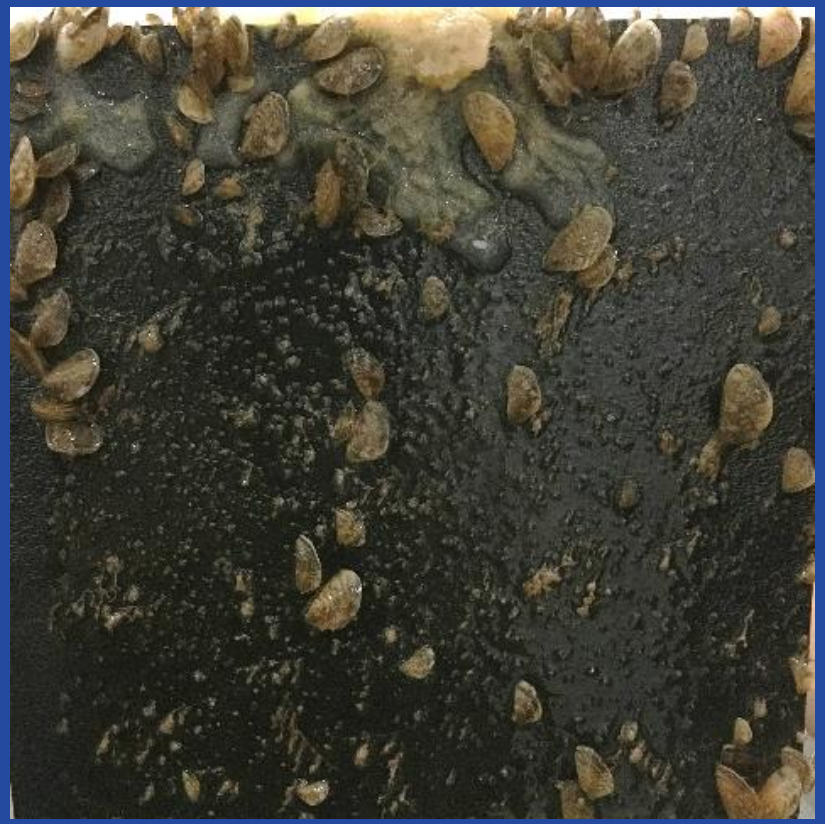
- **UV Treated – Unit 3**

- Control

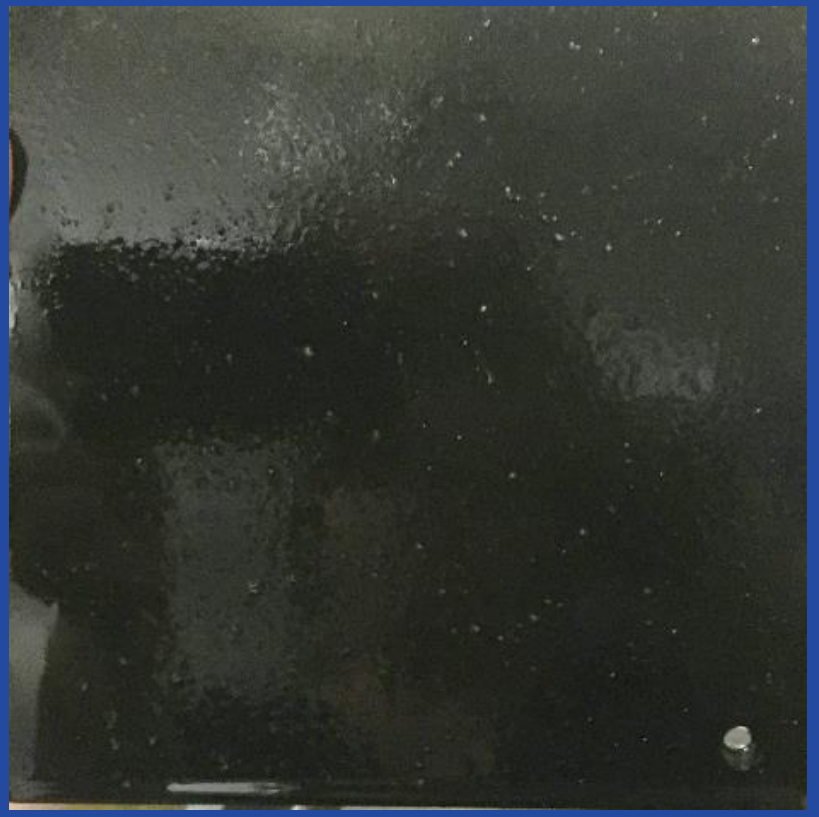
- UV Treated



Control Settlement Plates



UV Treated Settlement Plates



Observations

- O&M reduced at Parker Dam since UV installed
- Before UV
  - 16 coolers replaced per year
  - 640 staff hours + materials
- After UV
  - 4 coolers replaced per year
  - No units re-packed
  - Less scale on heat-exchangers
  - 160 staff hours + materials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