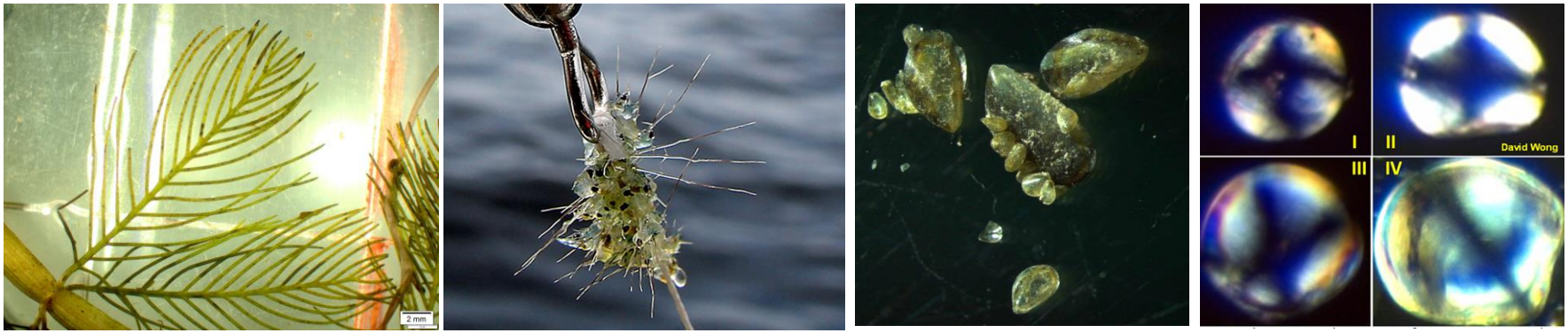
Using Pressurized Water Spray to Remove Dreissenid Mussels

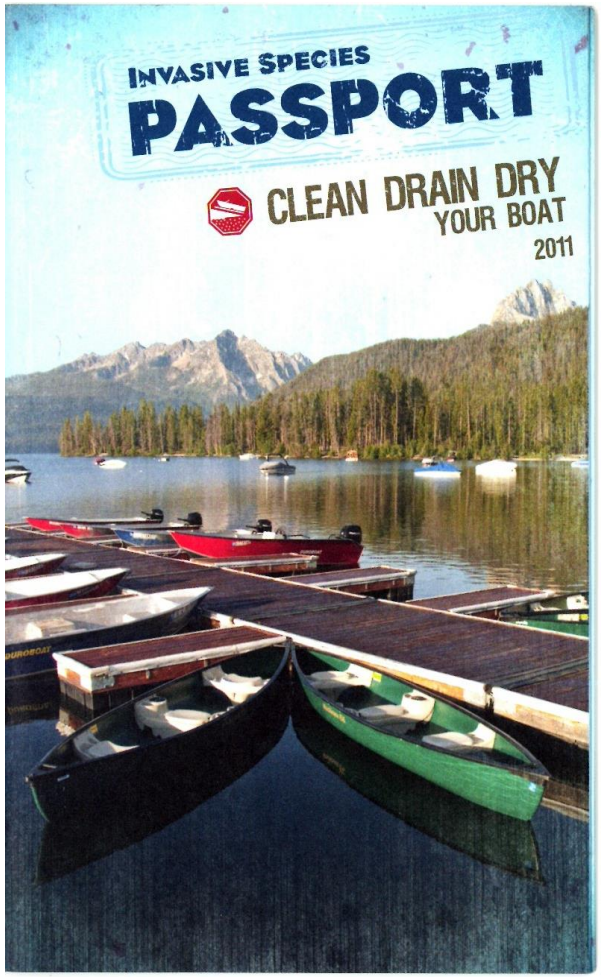
AIS Spread to Inland Waters

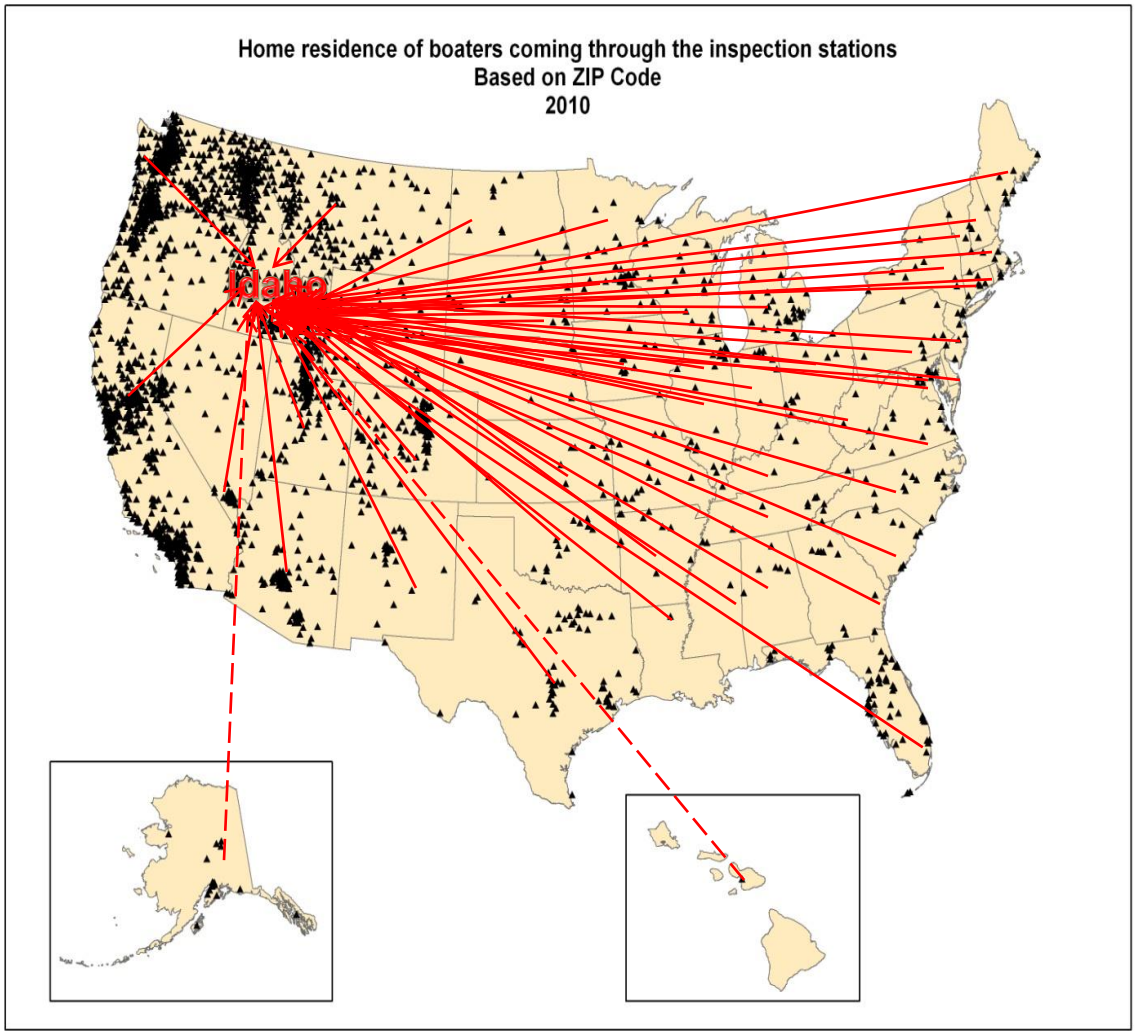
- The spread of AIS to the inland water bodies of North America is most likely be attributed to the **unintentional overland transport of trailered boats** contaminated with the invasive organisms into an uninfested body of water (Bossenbroek et al. 2001; Johnson et al. 2001; Leung et al. 2006).



Photos by David Wong and MNDNR

Boat Inspection and Decontamination





Idaho' boat inspection and decontamination program (Ferriter and Anderson 2015)

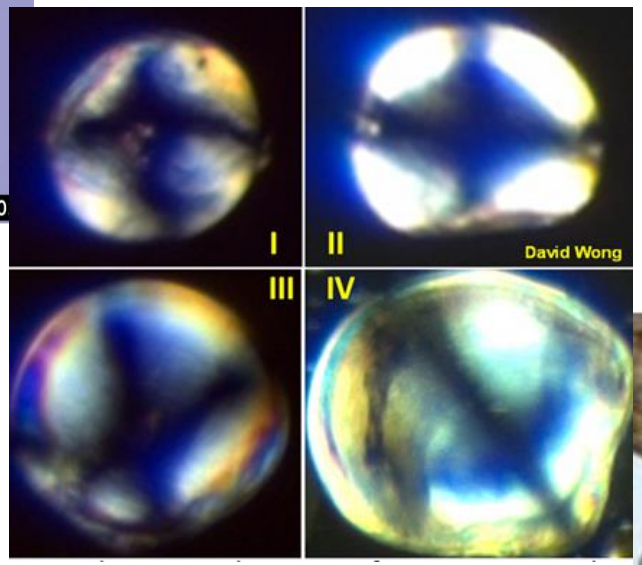
Prevention: Clean Drain Dry

Why CLEAN?

- Make sure no spread to an AIS-free waterbody: Alive/Dead Organisms or Residuals
- Early Detection: EDNA can still recognize even it is dead or just piece of the organism; It will provide confusing results

Prevention: Clean Drain Dry

Aquatic Plant Seeds and Microorganisms

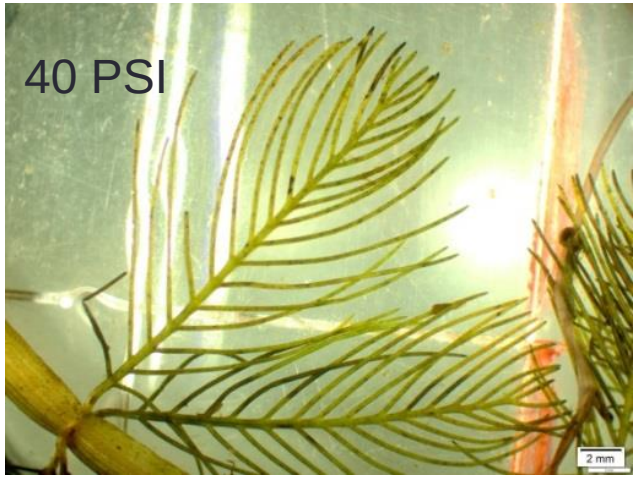


Clean: Pressure Wash



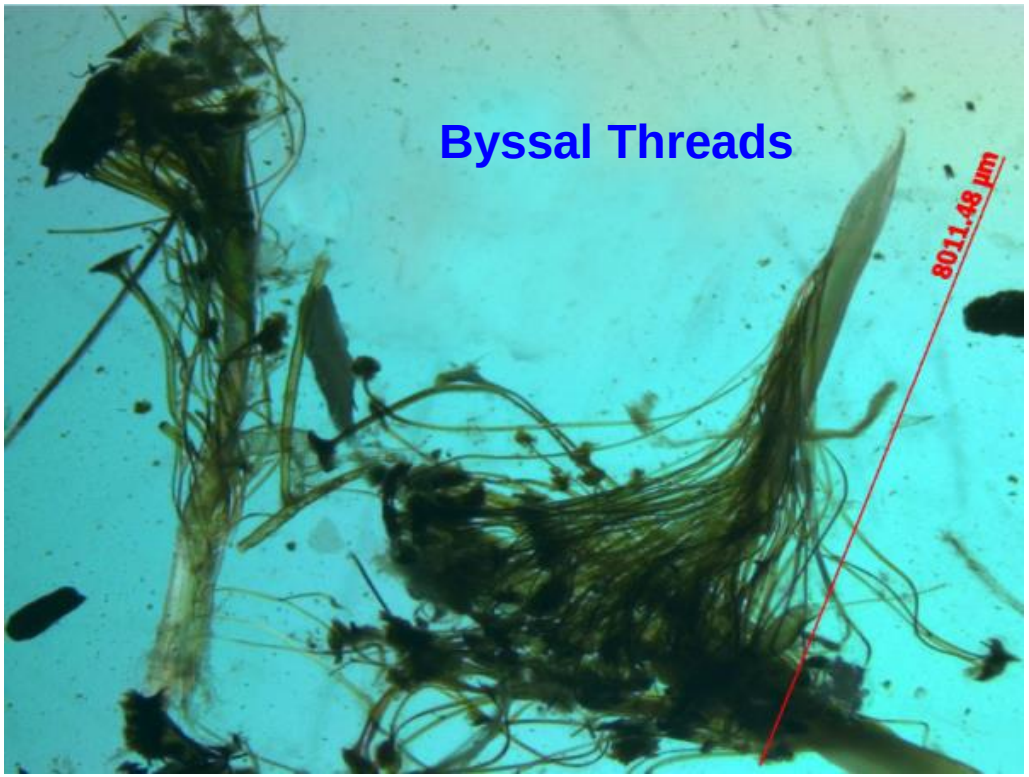


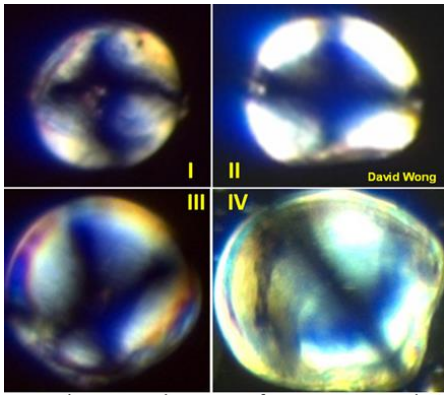

Clean: Pressure Wash

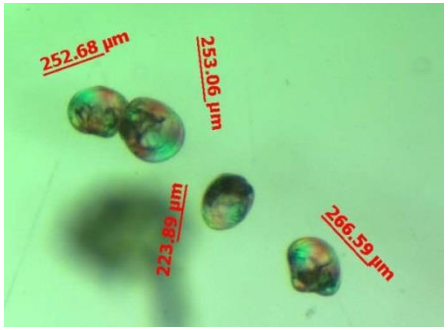


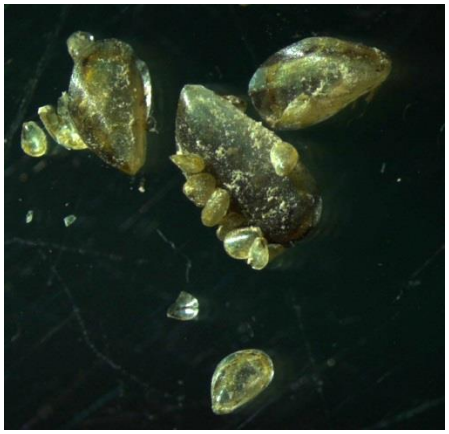
200 PSI

Dreissenid Life Cycle





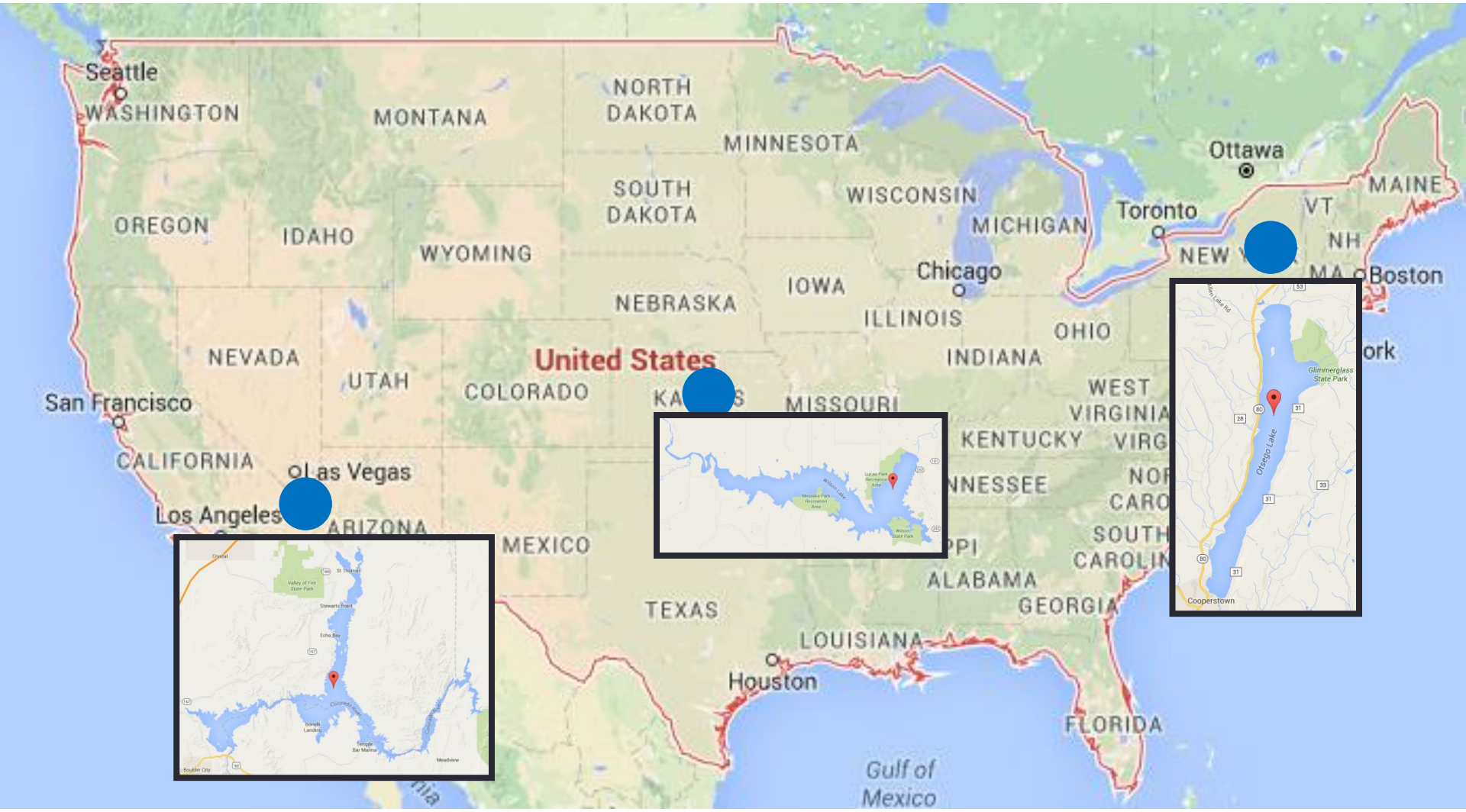




Objectives

1. How high pressure is needed in order to effectively remove 100% of dreissenids from a watercraft?
2. What is the minimum amount of time required to remove 100% of dreissenids using pressurized water spray from an encrusted watercraft in winter and summer seasons?

Experimental Locations



Methods

- 3000 PSI
- 1500 PSI
- 1100 PSI

LANDA
Pressure Washer

Methods

Bayliner/sunken boat lift/ Canoe pieces encrusted with mussels

Results

Species	Season	Pressure	Week out of Water	Density	Second	N
Zebra	summer	1100	0	27,020	197	30
Zebra	summer	1500	0	3,665	256	12
Zebra	summer	3000	0	4,668	42	12
Quagga	summer	1500	0	6,578	233	12
Quagga	summer	3000	0	7,686	45	12
Quagga	winter	1500	0	8,956	319	12
Quagga	winter	3000	0	8,341	274	12

Results

Species	Season	Pressure	Week out of Water	Density	Second	N
Zebra	summer	1500	1	4,976	14	12
Zebra	summer	3000	1	4,466	5	12
Quagga	summer	1500	1	6,998	12	12
Quagga	summer	3000	1	8,811	6	12
Quagga	winter	1500	2	10,785	21	12
Quagga	winter	3000	2	10,485	4	12
Quagga	winter	1500	4	6,982	10	12
Quagga	winter	3000	4	7,039	1	12

Findings of the Study I: Pressure

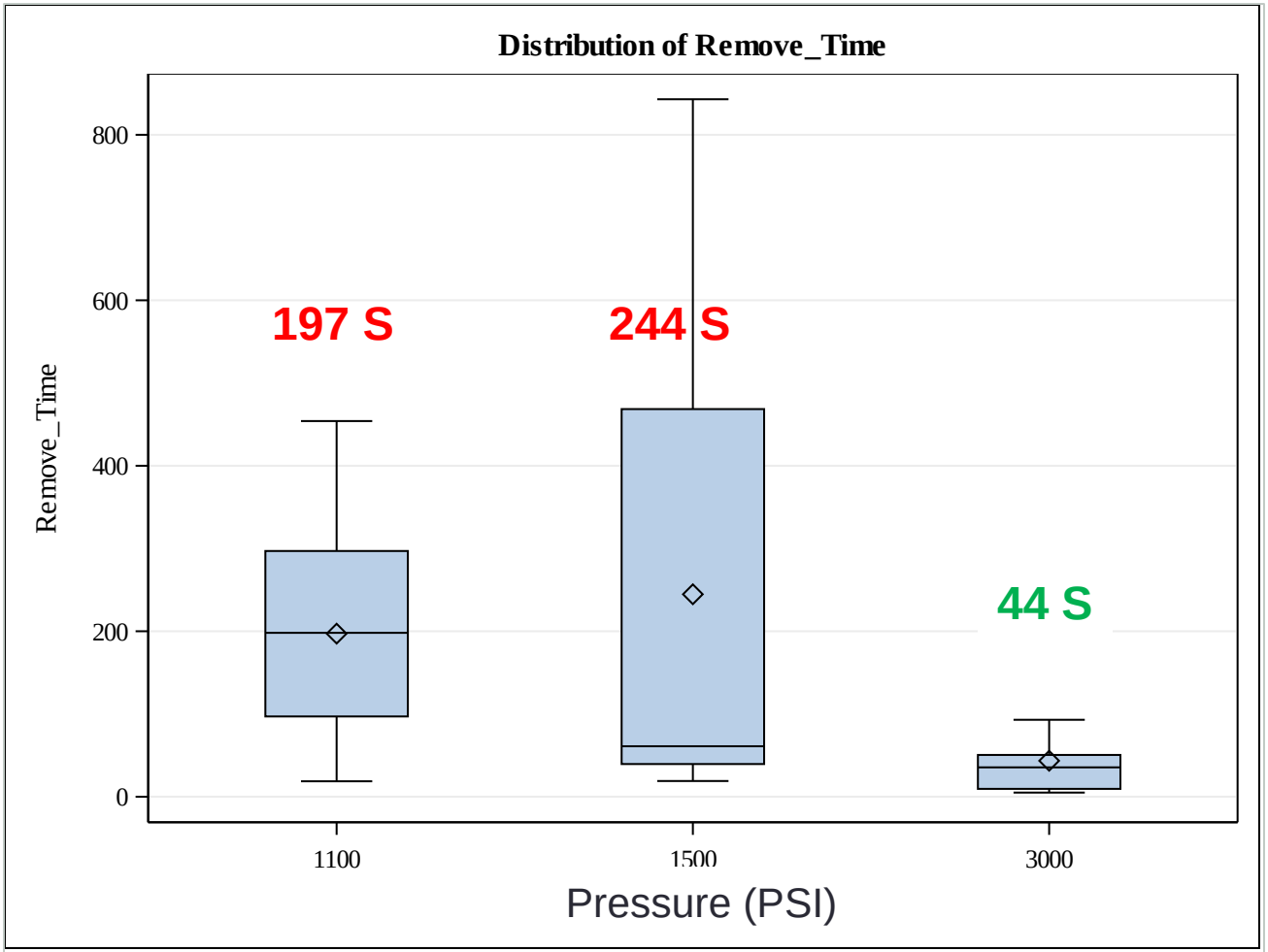
- Analysis of Covariance (Summer Tests):

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	717535.367	239178.456	8.50	<.0001
Error	74	2081731.855	28131.512		
Corrected Total	77	2799267.222			

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Species	1	21842.5778	21842.5778	0.78	0.3811
Density	1	440114.7923	440114.7923	15.64	0.0002
Pressure	1	255577.9964	255577.9964	9.09	0.0035

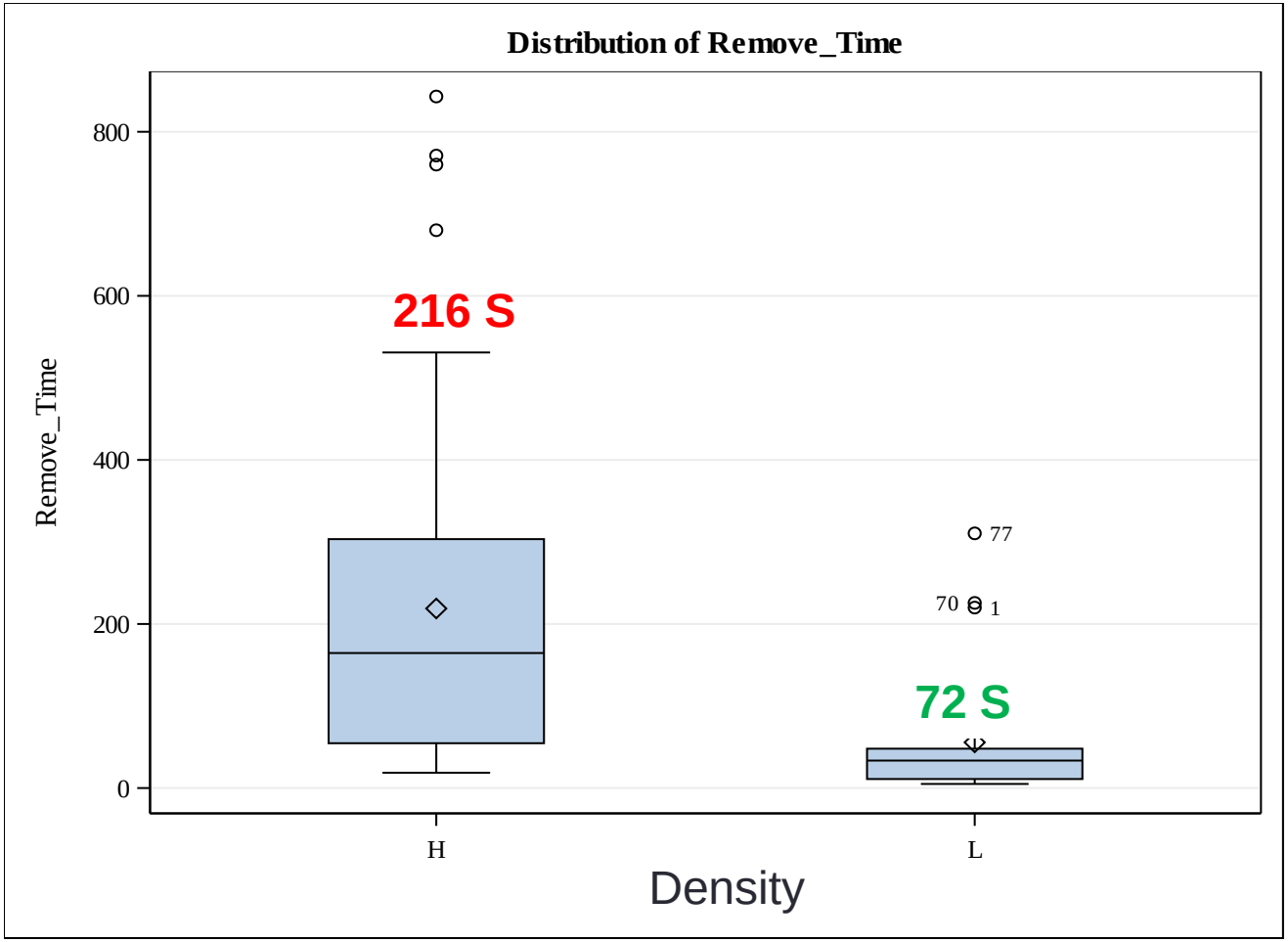
Findings of the Study I: Pressure

- Analysis of Variance (Summer Tests):



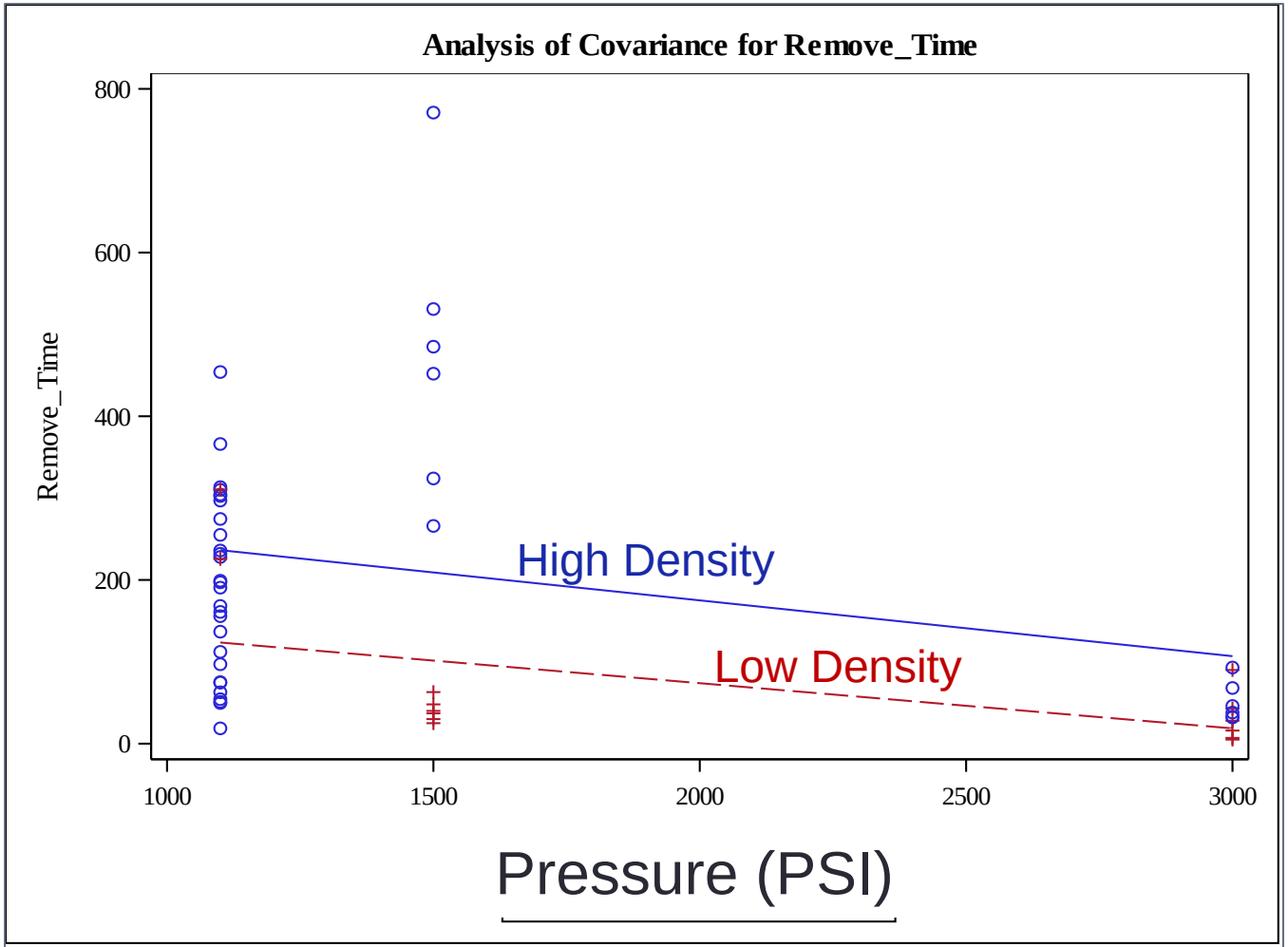
Findings of the Study I: Density

- Analysis of Variance (Summer Tests):



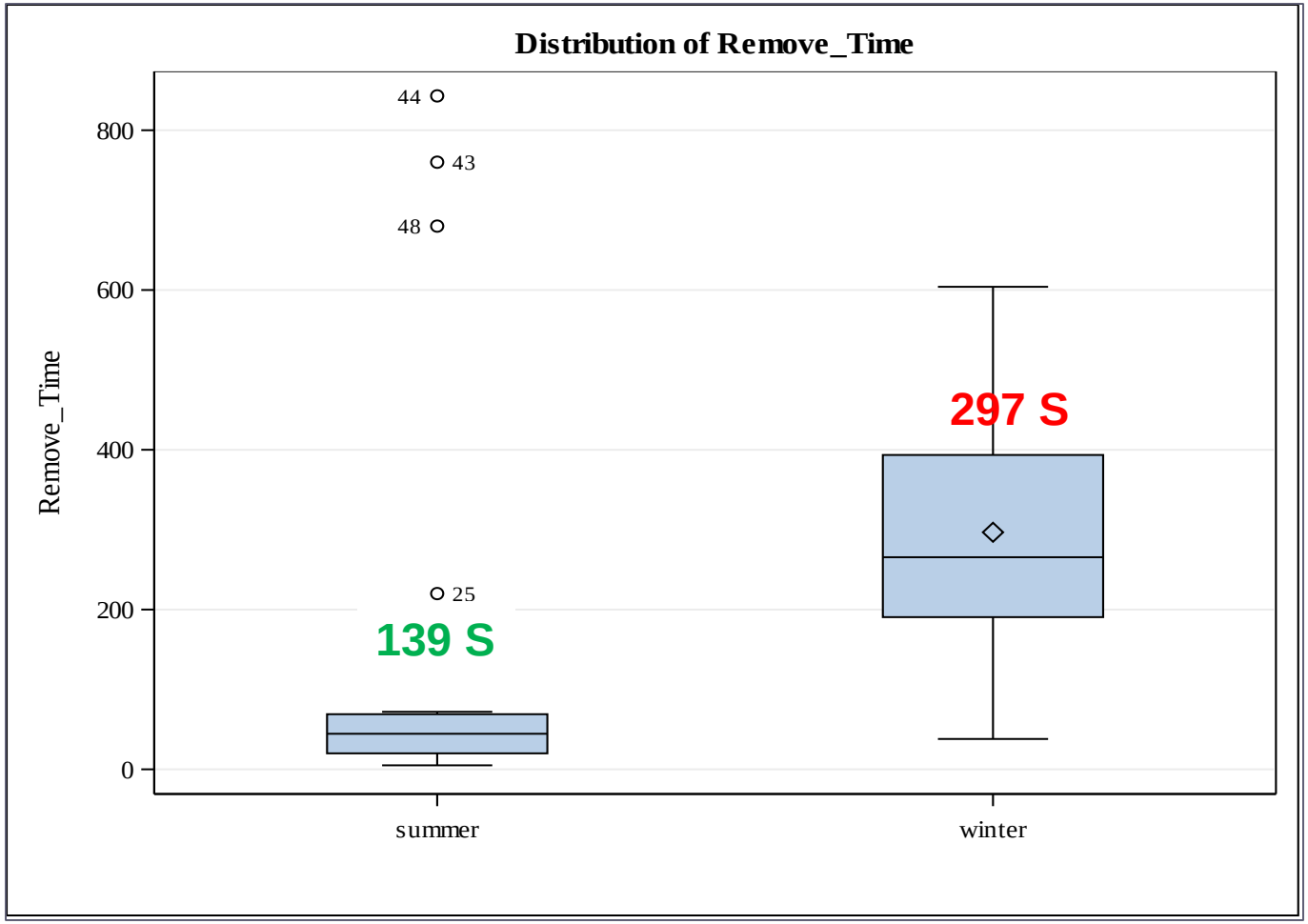
Findings of the Study I: Pressure & Density

- **Analysis of Covariance (Summer Tests on Zebra Mussels Only):**



Findings of the Study II: Season

- Analysis of covariance on Quagga Mussels (Summer vs. Winter)



Findings of the Study III: Time out of water

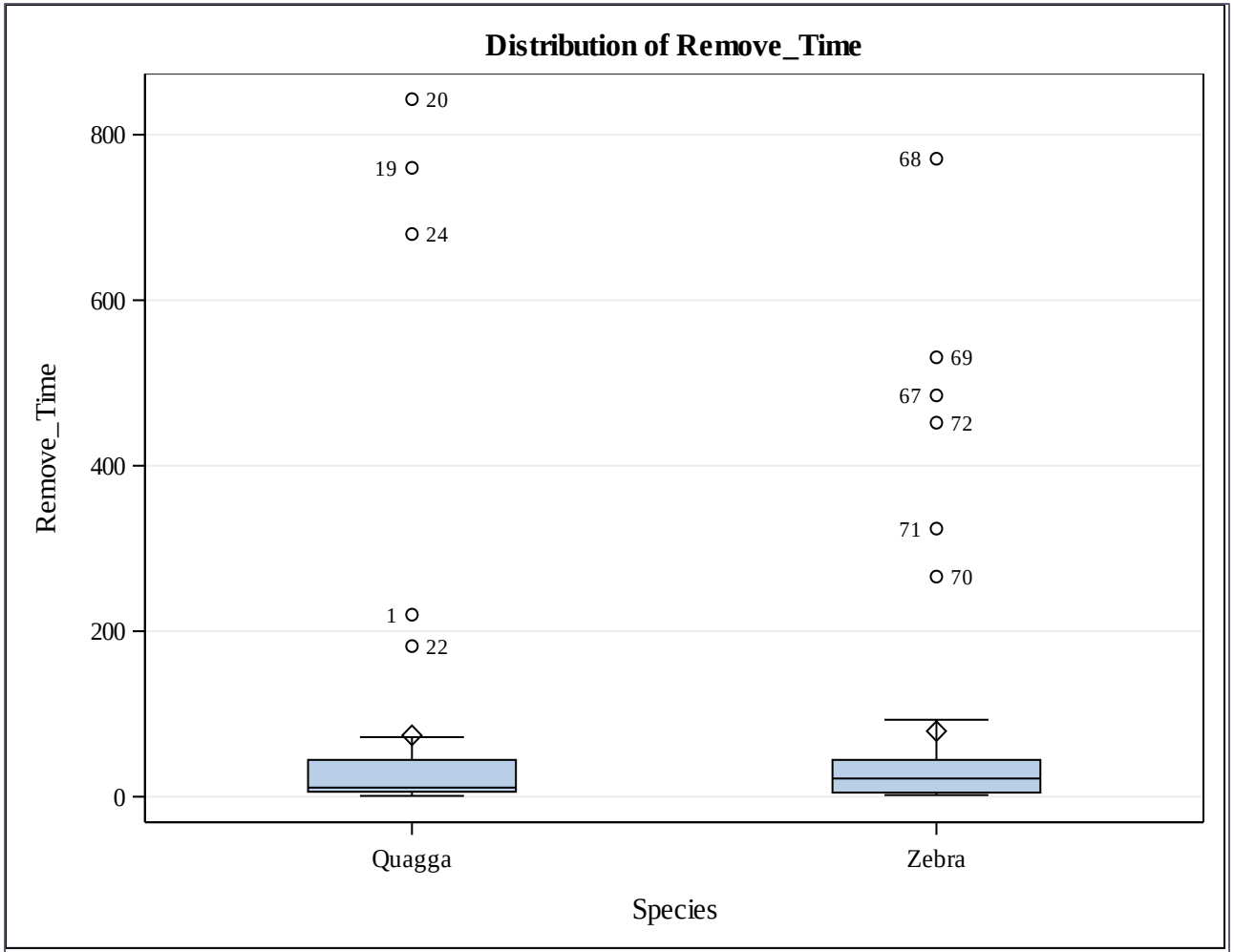
- Analysis of covariance (Summer: 0 and 1 week):

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	966549.125	241637.281	11.74	<.0001
Error	91	1872204.281	20573.673		
Corrected Total	95	2838753.406			

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Species	1	615.0938	615.0938	0.03	0.8631
Density	1	269558.0104	269558.0104	13.10	0.0005
Time out of water	1	435646.7604	435646.7604	21.17	<.0001
Pressure	1	260729.2604	260729.2604	12.67	0.0006

Findings of the Study III: Time out of water

- Analysis of covariance (Summer: 0 and 1 week):



Findings of the Study III: Time out of water

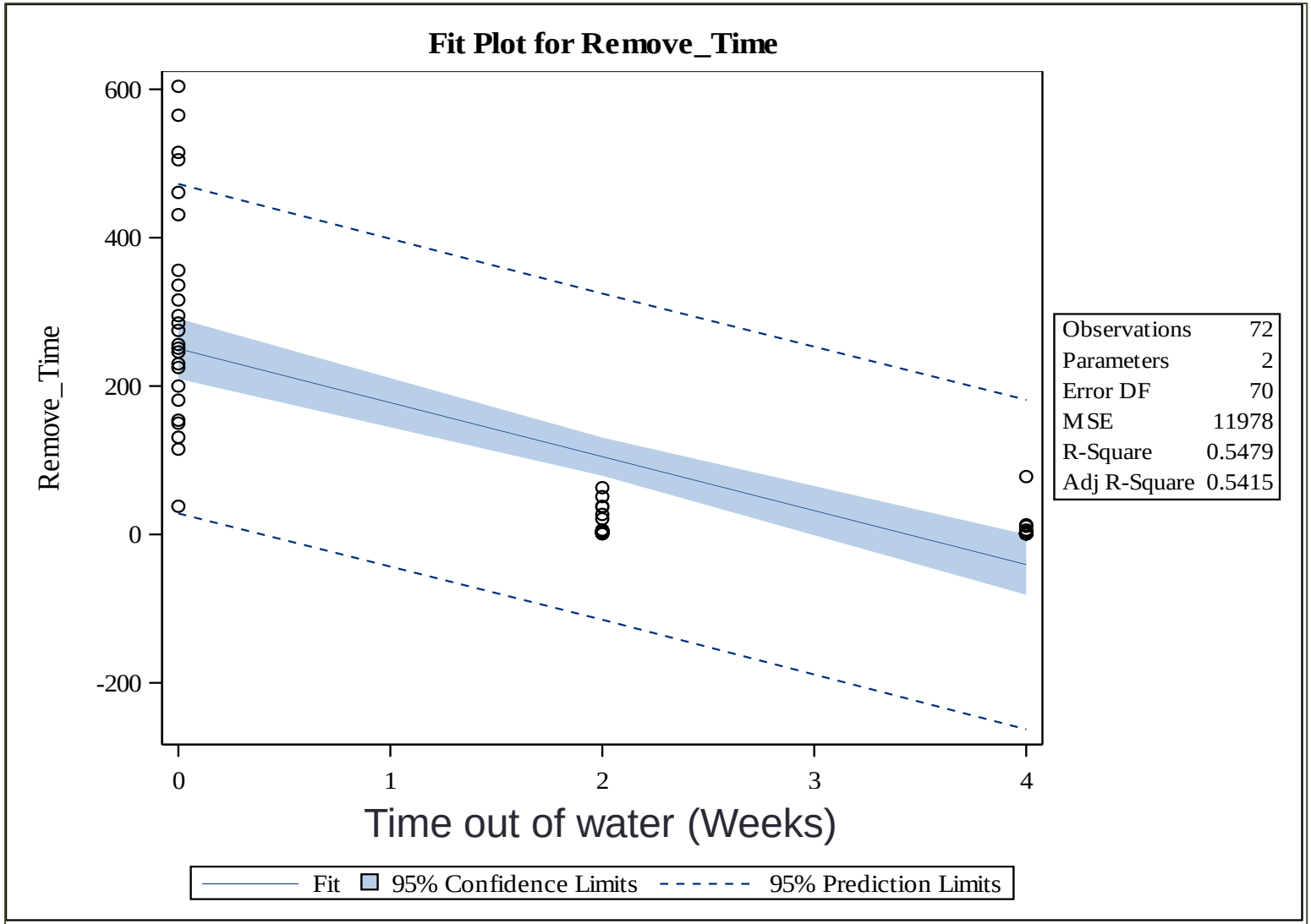
- Analysis of covariance (Winter: 0, 2 and 4 weeks):

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	1084021.028	361340.343	31.89	<.0001
Error	68	770616.847	11332.601		
Corrected Total	71	1854637.875			

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Density	1	57743.347	57743.347	5.10	0.0272
Time out of water	1	1016172.000	1016172.000	89.67	<.0001
Pressure	1	10105.681	10105.681	0.89	0.3484

Findings of the Study III: Time out of water

- Analysis of covariance (Winter: 0, 2 and 4 weeks):



Findings of the Study: Summary

- Time (0, 1, 2, or 4 weeks) the watercraft out of the water is the most significant factor affecting removal time
  - High Water pressure (1100, 1500, and 3000 PSI) is significant on time to remove mussels from a watercraft
    - No significant difference between quagga and zebra mussels was found in the summer season (No data for removal times of zebra mussels in the winter season)

Study Limitations

- Using pressurized water spray to remove zebra mussels from watercraft in winter has never been completed
- 1100 PSI on quagga mussels are not done whether in summer or winter time
- The current study is only for hull/surface area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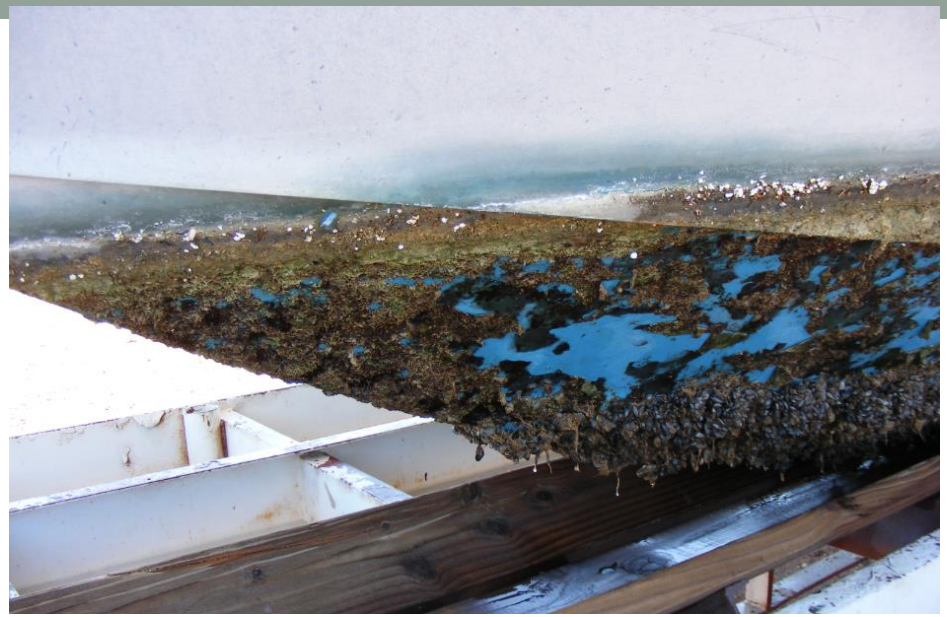
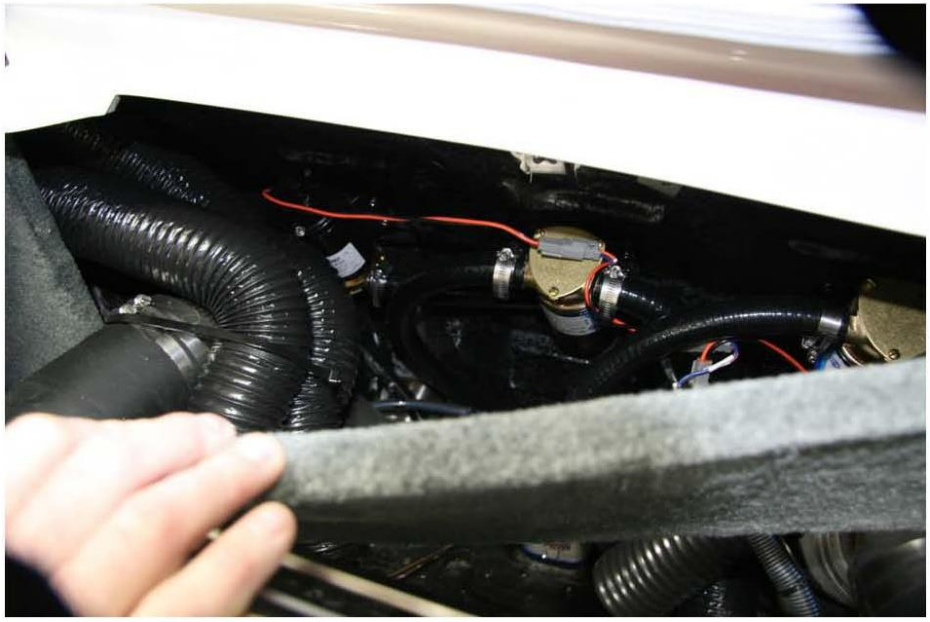


Hull: Easy to access

Gimbal area: Hard to access



Ballast system:
Cannot be Accessed

Acknowledgements

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