1. Populations of the limpet Lottia digitalis inhabit Doran and Spud Point.  
2. When Lottia digitalis are transplanted to Spud Point, limpets die. In two separate trials, 2/5 and 3/5 limpets died within 4 days of being transplanted.

3.1 Spud Point limpets developed adaptations to higher stress (Temperature and Contaminants)?
3.2 Multixenobiotic resistance (MXR) and Heat Shock Proteins (HSPs) are biomarkers for stress and indicate adaptation.

Research Questions
1. How do MXR and HSP activity differ between Spud Point and Doran?  
2. Do MXR and HSP70 activities change following transplantation?  
3. How does temperature affect MXR and HSP activity?

Characterizing MXR adaptation

Characterizing Heat Shock Protein adaptation

Initial Doran vs. Spud Point and 48 Hour Doran Transplants

Linking Stress and Adaptation

Doran

Spud Point

Survival

Heat Shock Proteins

MXR Proteins

Temperature Stress

Contaminant Stress

Organisms transplanted from Doran to Spud Point experience multiple sources of stress.
• These sources either cause an organism to adapt or perish.
• For organisms to survive, first lines of defense must be mobilized.
• HSPs and MXR proteins are adaptive and protect organisms against multiple sources of stress.
• In those organisms which survive, these proteins become more prevalent and this allows for adaptation to stressful environments.

Discussion

How do MXR and HSP activity differ between Spud Point and Doran?
• MXR activity at Spud Point is significantly greater than at Doran.
• This correlates with higher concentrations of polycyclic aromatic hydrocarbons (PAH) and temperatures at Spud Point.
• Limpet survival and greater expression of MXR and HSP at Spud Point suggest that limpets are better adapted to live in higher stressed locations.

Do MXR and HSP70 activities change following transplantation?
• Several limpets transplanted from Doran to Spud Point acutely died.
• MXR activity prior to transplant was minimal and organisms have been unable to increase MXR activity.
• PAH sources surrounding Spud Point may have influenced limpet mortality in conjunction with temperature.

The roles of anthropogenic and temperature stress on MXR and HSP activity
• Several limpets transplanted from Doran to Spud Point acutely died.
• MXR activity prior to transplant was minimal and increased after transplantation.
• Those limpets which died may have been unable to increase MXR activity.
• PAH sources surrounding Spud Point may have influenced limpet mortality in conjunction with temperature.

A special thanks to Nature McGrain, Fred Griffin and Carol Vines for giving insight and aid during my project.

Acknowledgments
This research was graciously supported by grant 108104-53251 to S.L. Williams from the NSF.

Figure 1: Environmental Temperature Profile

Spud Point vs. Doran 7/3/2006-7/10/2006

Fluorescence Ratio of Initial vs. one week Temperature Treatments

Fluorescence Ratio of Initial vs. one week Temperature Treatments

Figure 2: Initial MXR Activity Difference

Fluorescence ratio of Spud Point vs. Doran

Figure 3: Lab Temperature Exposures

Fluorescence Ratio of Spud Point vs. Doran

Spud Point Average Temp: 13.91°C
Doran Average Temp: 12.85°C
Spud Point Upper Average: 14.53°C
Doran Lower Average: 11.72°C