Introduction
Melanoma is the deadliest form of skin cancer, and the rate of cutaneous melanoma in Vermont is among the highest in the nation. An average of 111 men and 94 women are diagnosed with melanoma annually. Melanoma is the fifth most common cancer diagnosed among Vermonters and accounts for roughly six percent of all cancers diagnosed among Vermont men and five percent diagnosed among Vermont women. An average of 16 men and 8 women die from melanoma annually in Vermont, and it accounts for roughly 2% of all cancer deaths in males, and 1% of all cancer deaths in women. Known risk factors include: a history of sunburn, excessive ultraviolet (UV) light exposure, fair skin, and a family history of melanoma. In this study, we conduct an in-depth assessment of Vermont Cancer Registry data in order to determine what types of trends exist by age, sex, and geography among melanoma cases in Vermont.

Methods
Analysis was conducted using a limited dataset that included all cutaneous melanoma cases from 2001 to 2010 in the Vermont Cancer Registry.

DESCRIPTIVE STATISTICS: We calculated descriptive statistics on the frequency of melanoma cases by age and sex, the frequency of tumor locations by age and sex, and the stage at diagnosis of melanoma cases by age category.

LOGISTIC REGRESSION ANALYSIS: We used logistic regression analyses to determine whether males had a higher odds than females of developing tumors at certain body locations, and vice-versa. We then plotted histograms for different tumor locations based on age group.

T-TESTS: We used t-tests to determine if there was a significant difference in mean age of diagnosis by sex and mean age of diagnosis among in-situ versus invasive tumors.

STANDARDIZED INCIDENCE RATIOS (SIR): We calculated age-and-sex-adjusted SIRs at the county and sub-county level, comparing incidence in these geographies to the state rate. We used Byar’s Z values to determine statistical significance of these SIRs.

LEAST-SQUARES AND GEOGRAPHICALLY-WEIGHTED REGRESSION: We used linear regression to assess the relationship between the per-capita income of a town (taken from 1999 Census data) and the incidence rate of melanoma in that town. Because the income of towns is not spatially independent, we then conducted a geographically-weighted regression, which adjusts for this spatial dependence by creating a separate regression model for each town that accounts for the per-capita incomes of nearby towns.

Results
- Females had a younger mean age at diagnosis (56.3 years old) than males (53.6 years old) (p<0.001). (Figure 1)
- The mean of age at diagnosis for invasive tumors (59.1 years old) was slightly lower than that of in-situ tumors (62.2 years old). Figure 2 provides a fuller presentation of the relationship between age and stage at diagnosis.
- There was no significant difference in stage at diagnosis by sex (Chi-square=3.52, p=0.74). (Figure 3)
- Sex was strongly associated with the location of tumors: Males were more likely than females to have tumors on their face (OR=1.49), trunk (OR=1.96), and scalp or neck (OR=4.15). Females were more likely than males to have tumors on the upper (OR=1.43) or lower limbs (OR=5.52). All associations of tumor location and sex were strongly statistically significant (p<0.001). (Figure 4)
- From 2001 to 2010, Vermont had a statewide incidence rate of 29.0 per 100,000 person-years (95% CI: 27.7, 30.4). Bennington County had the highest incidence rate of all counties in VT, and was significantly higher than the statewide rate (SIR=1.40, p<0.001). This rate held when stratifying by sex (Females: SIR=1.38, p=0.003; Males: SIR=1.43, p=0.003). Incidence in Lamoille county was also significantly higher than that of the statewide rate (SIR=1.31, p=0.014). Franklin and Orleans Counties had incidence rates significantly lower than the state rate (Franklin: SIR=0.73, p=0.001; Orleans: SIR=0.73, p=0.012). Map 1 shows the distribution of county-level SIRs.
- In addition to this county-level heterogeneity in melanoma incidence, mapping of sub-county SIRs indicates that there is also spatial heterogeneity in melanoma incidence within counties (Map 2).
- At the town-level, increasing per-capita income was significantly associated with an increased incidence of melanoma (p<0.001), however, our geographically-weighted regression analysis shows that this is not consistent throughout the state, and this trend appears to not be the case in the central portion of the state (Map 3).

Implications and Further Study
Our results demonstrate that there is spatial heterogeneity in the melanoma rates in Vermont, which persists when examining incidence at both the county and sub-county levels. Furthermore, there are strong trends in tumor location and age at diagnosis by sex. Additionally, in northern and southern portions of the state, there is a strong correlation between per-capita income and melanoma incidence within towns. These findings can be used in guiding the targeting of intervention efforts into populations where they will be most effective.

Future study will include analysis of occupation and industry data and analysis of melanoma mortality for cases diagnosed between 2001 and 2010.

References
1 Vermont Cancer Registry. 2006-2011.