Level of Use

This data was collected during a 2009 USGS survey of Landsat imagery users. Level of use was based on the percentage of respondents' work that used Landsat imagery in the year previous to the survey. We divided the respondents into three groups:

- Light users (used Landsat in 1-30% of their work) (n=871)
- Medium users (used Landsat in 31-70% of their work) (n=253)
- Heavy users (used Landsat in 71-100% of their work) (n=206)

The following figures compare these three groups on a number of variables. These analyses identify meaningful differences between these groups and contribute to a better understanding of the diverse uses of Landsat imagery and its users.

This is not a random sample of Landsat imagery users and the results presented here should not be generalized to the population of Landsat imagery users as a whole. These results also do not include respondents who did not know how much of their work had used Landsat in the past year (n=60) so percentages will not add up to 100%.

For more information about the survey, please refer to the full report (citation below).

Miller, H.M., Sexton, N.R., Koontz, L., Loomis, J., Koontz, S.R., and Hermans, C., 2011, The users, uses, and value of Landsat and other moderate-resolution satellite imagery in the United States—Executive report: U.S. Geological Survey Open-File Report 2011–1031, 42 p.

Statistics

Where data are compared, chi-square (χ^2) and t-test analyses are reported if they are significant ($p < 0.001$) and have at least a small effect size. Occasionally, significant differences of $p < 0.05$ are reported if there is at least a small effect size. Because statistically significant differences are more likely to occur with large sample sizes, effect sizes are necessary to understand if the differences are meaningful. For chi-square analyses, the effect sizes are phi (Φ) or Cramer's V and for t-tests, the effect size is Cohen's d. The following guidelines are used to determine the magnitude of the effect size (Cohen, 1988, p. 25 and 79):

Magnitude of effect size	Cramer's V/phi	Cohen's d
Small	0.1	0.2
Medium	0.3	0.5
Large	0.5	0.8

Statistics are reported for each figure in the following ways:

- If no meaningful differences were found, no statistics are reported for that figure.
- Statistics associated with a numbered footnote refer to dichotomous variables (variables with only two answer choices, such as yes and no) and only to certain data in a figure.
- Statistics that are not associated with a footnote refer to categorical variables (with more than two answer choices) and to all of the data in a figure.

Again, the results presented here are not generalizable to the population of Landsat users and are included to illustrate differences within this sample of users.

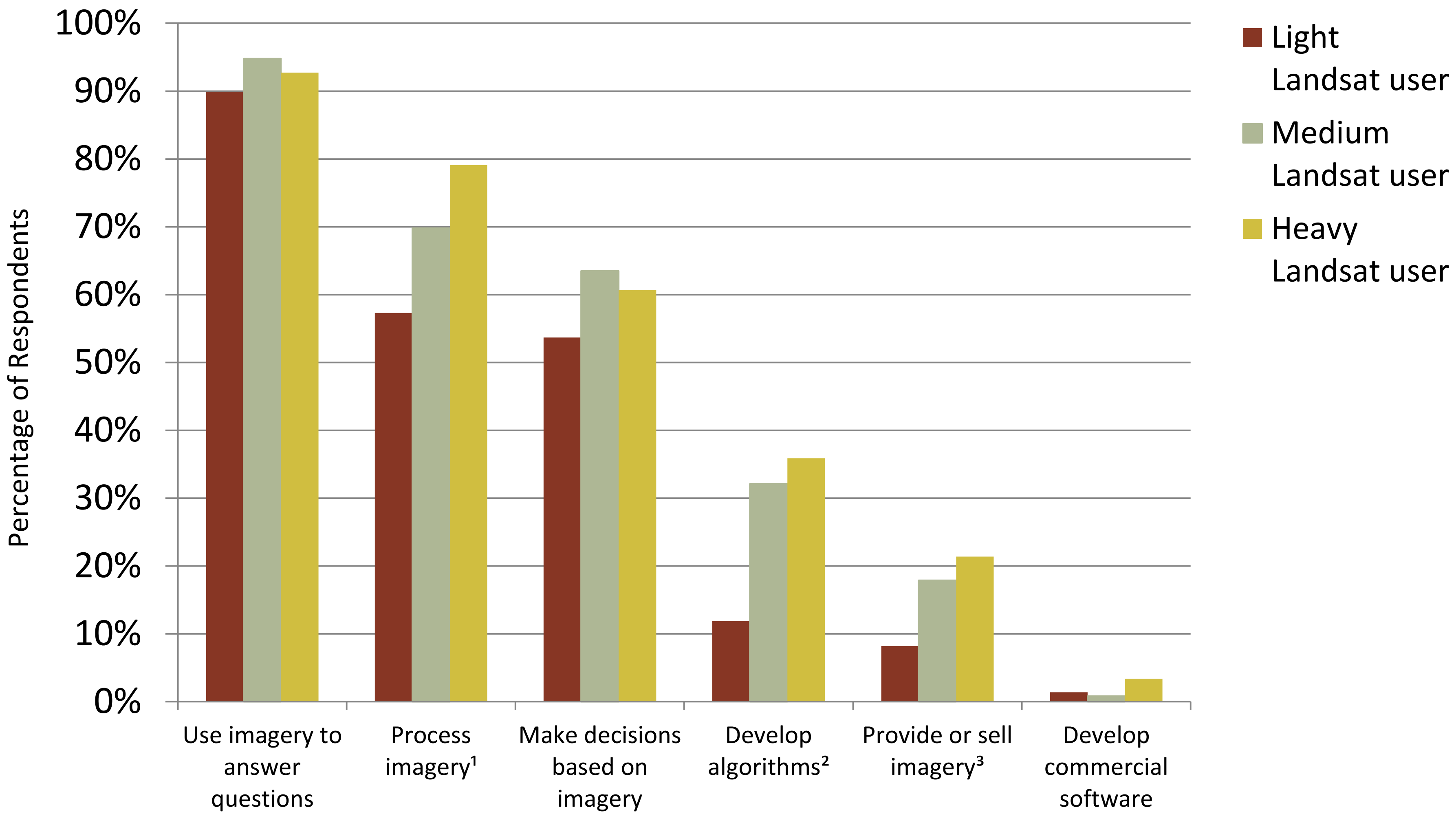
Use of Landsat Imagery

The way in which Landsat users in the sample use the imagery is important for a baseline understanding of uses, including:

- generally how the imagery is used,
- types of imagery used,
- the level of use in their work,
- the scales and locations of projects, and
- changes in use of the imagery over time.

Survey questions asked respondents to consider their use of Landsat in their work over the year previous to the survey.

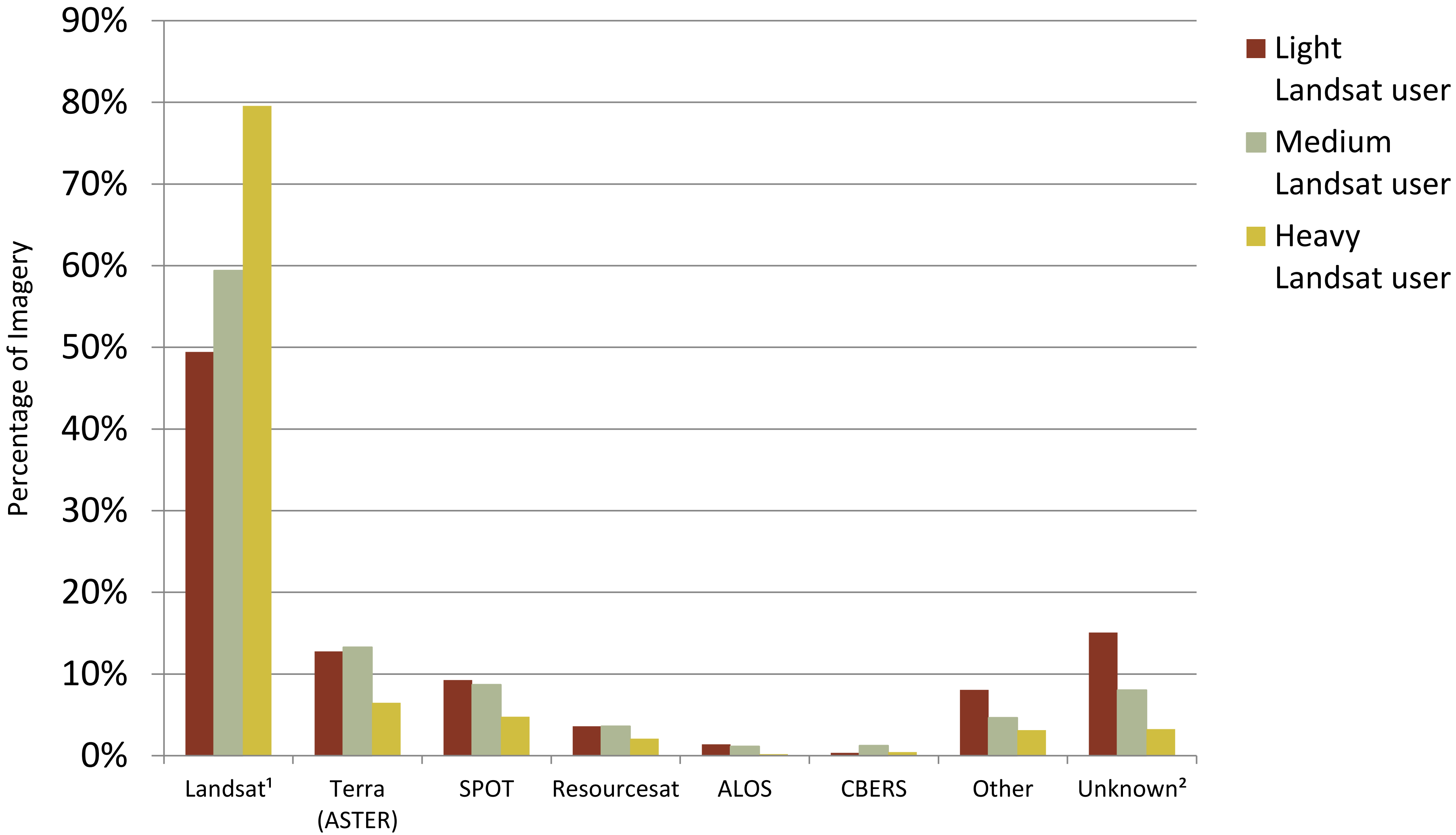
General Uses of Moderate-Resolution Imagery



[1] χ^2 = 50.95; Cramer's V = 0.192
[2] χ^2 = 102.47; Cramer's V = 0.272
[3] χ^2 = 39.38; Cramer's V = 0.168

Miller, H.M., Sexton, N.R., Koontz, L., Loomis, J., Koontz, S.R., and Hermans, C., 2011, The users, uses, and value of Landsat and other moderate-resolution satellite imagery in the United States—Executive report: U.S. Geological Survey Open-File Report 2011–1031, 42 p.

Moderate-Resolution Imagery Used in Work

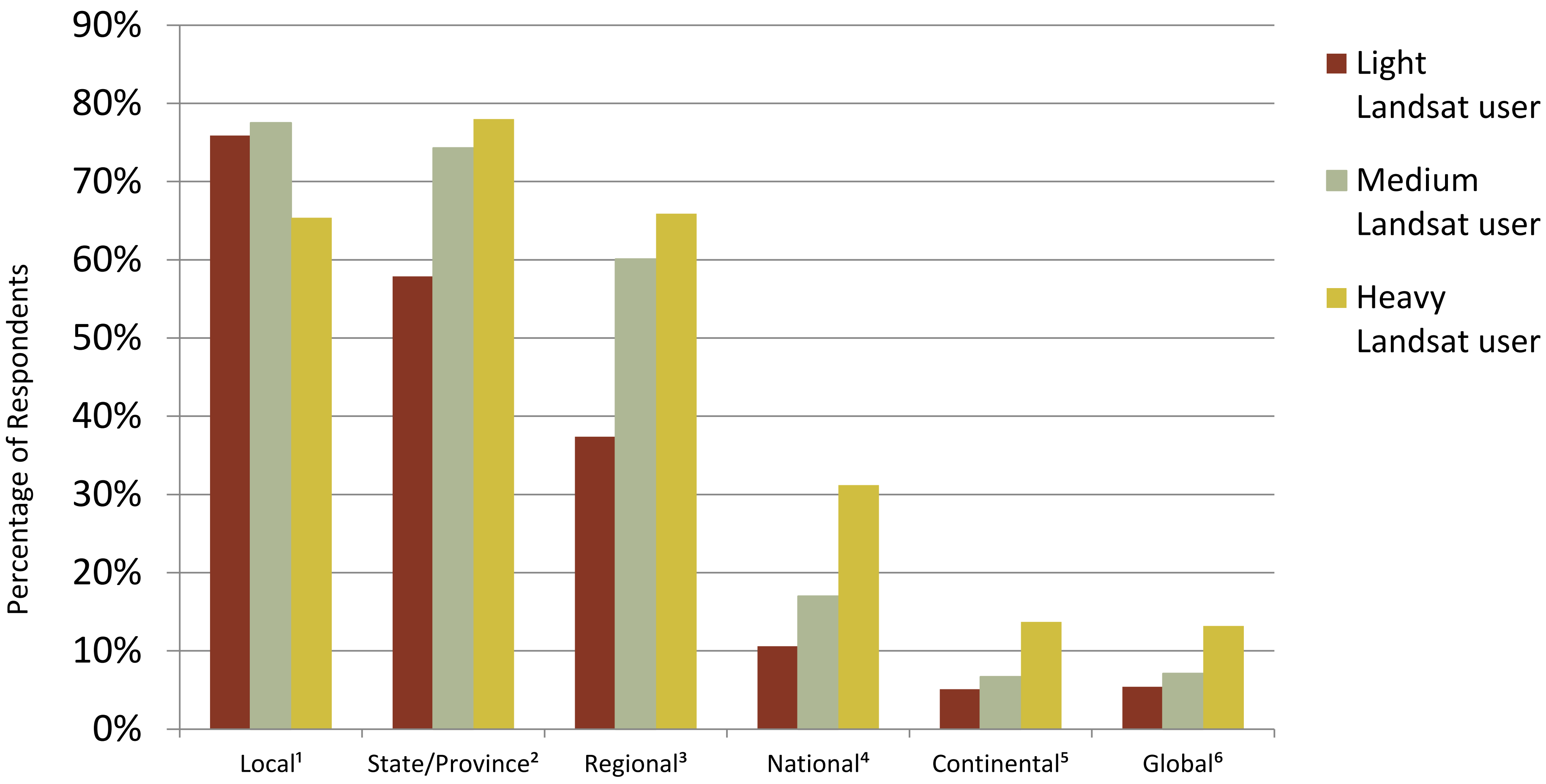


[1]F = 91.41; $\eta^2 = 0.249$

[2]F = 107.40; $\eta^2 = 0.280$

Miller, H.M., Sexton, N.R., Koontz, L., Loomis, J., Koontz, S.R., and Hermans, C., 2011, The users, uses, and value of Landsat and other moderate-resolution satellite imagery in the United States—Executive report: U.S. Geological Survey Open-File Report 2011–1031, 42 p.

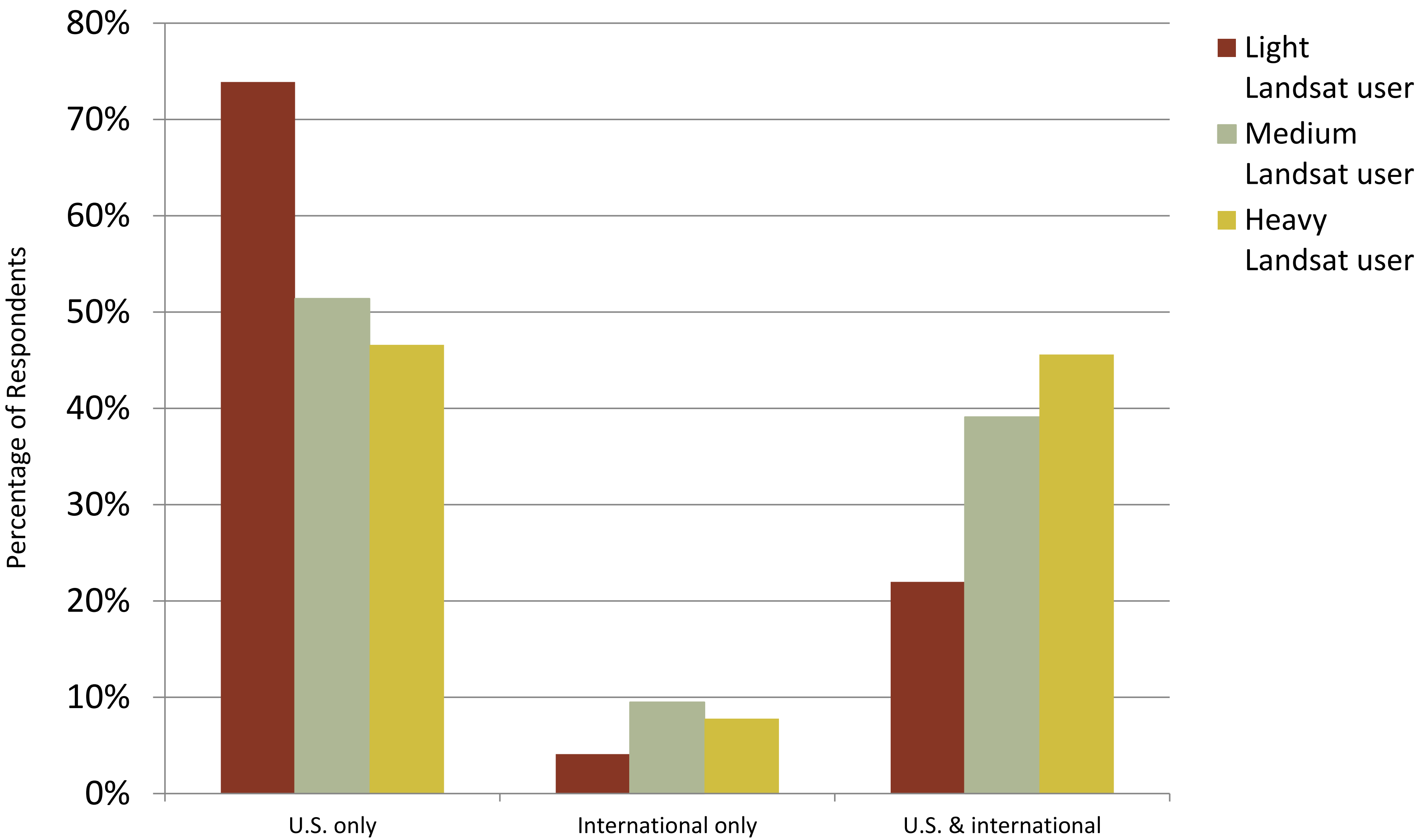
Scales of Projects Using Landsat Imagery



[1]χ^2 = 14.55; Cramer's V = 0.102
[2]χ^2 = 49.32; Cramer's V = 0.188
[3]χ^2 = 82.38; Cramer's V = 0.244
[4]χ^2 = 56.97; Cramer's V = 0.203
[5]χ^2 = 19.73; Cramer's V = 0.119
[6]χ^2 = 17.12; Cramer's V = 0.111

Miller, H.M., Sexton, N.R., Koontz, L., Loomis, J., Koontz, S.R., and Hermans, C., 2011, The users, uses, and value of Landsat and other moderate-resolution satellite imagery in the United States—Executive report: U.S. Geological Survey Open-File Report 2011–1031, 42 p.

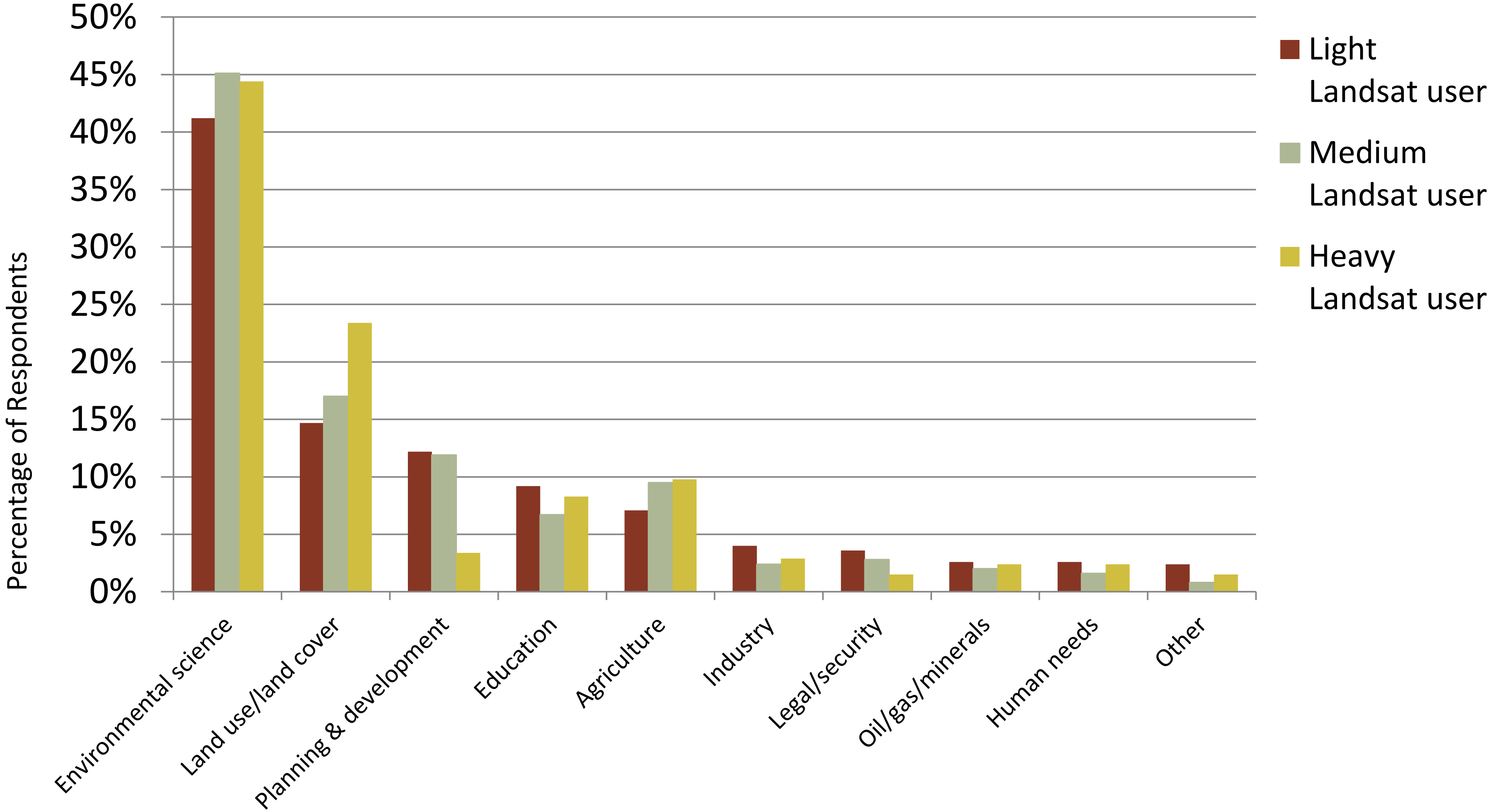
Locations of Projects Using Landsat Imagery



$\chi^2 = 88.57$; Cramer's V = 0.179

Miller, H.M., Sexton, N.R., Koontz, L., Loomis, J., Koontz, S.R., and Hermans, C., 2011, The users, uses, and value of Landsat and other moderate-resolution satellite imagery in the United States—Executive report: U.S. Geological Survey Open-File Report 2011–1031, 42 p.

Primary Application of Landsat Imagery*

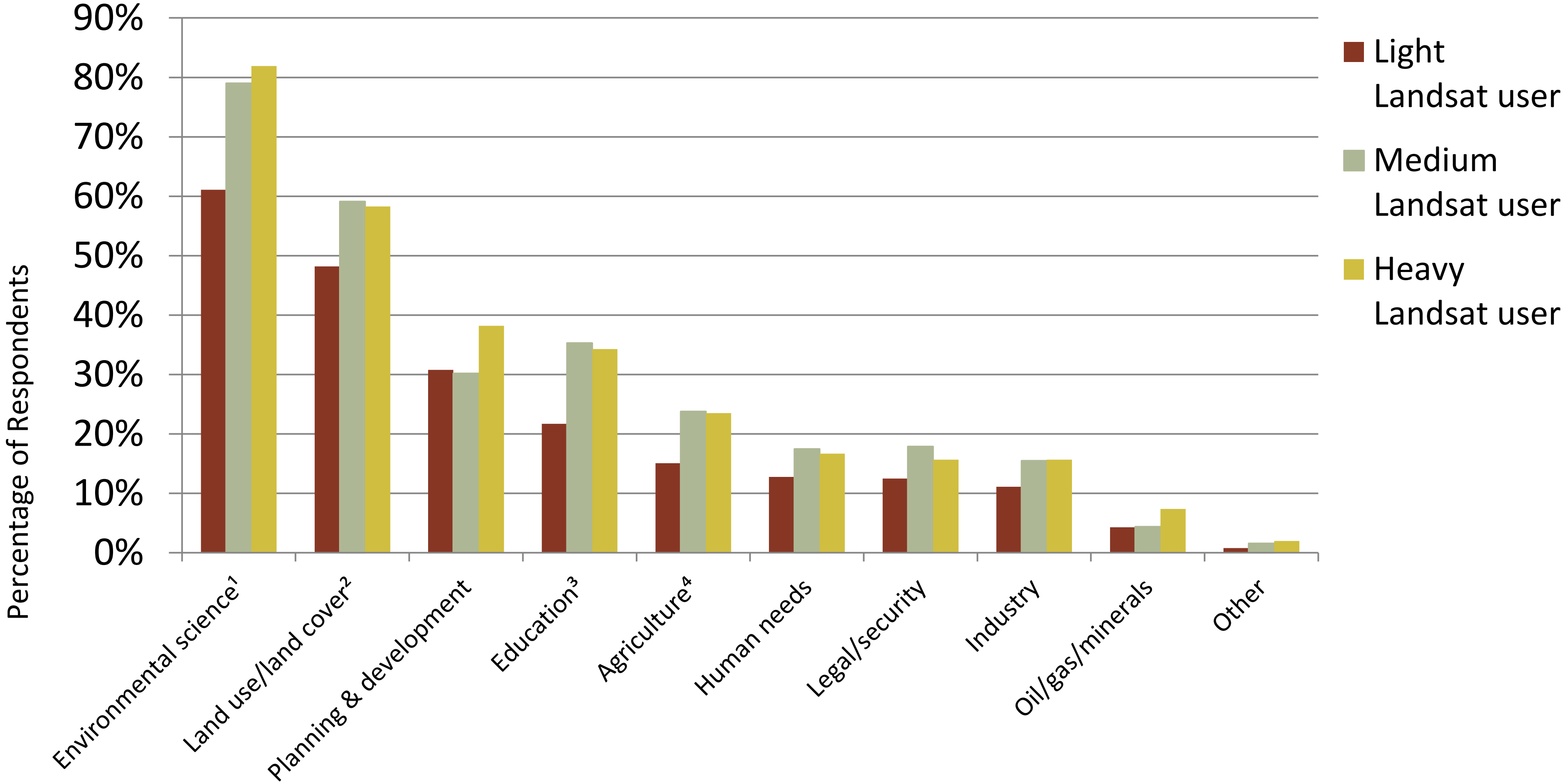


χ^2 = 153.48; Cramer's V = 0.192

*Respondents could select only one application from a list of 36 applications. The 36 applications were then collapsed into the 10 categories seen here for analysis purposes.

Miller, H.M., Sexton, N.R., Koontz, L., Loomis, J., Koontz, S.R., and Hermans, C., 2011, The users, uses, and value of Landsat and other moderate-resolution satellite imagery in the United States—Executive report: U.S. Geological Survey Open-File Report 2011–1031, 42 p.

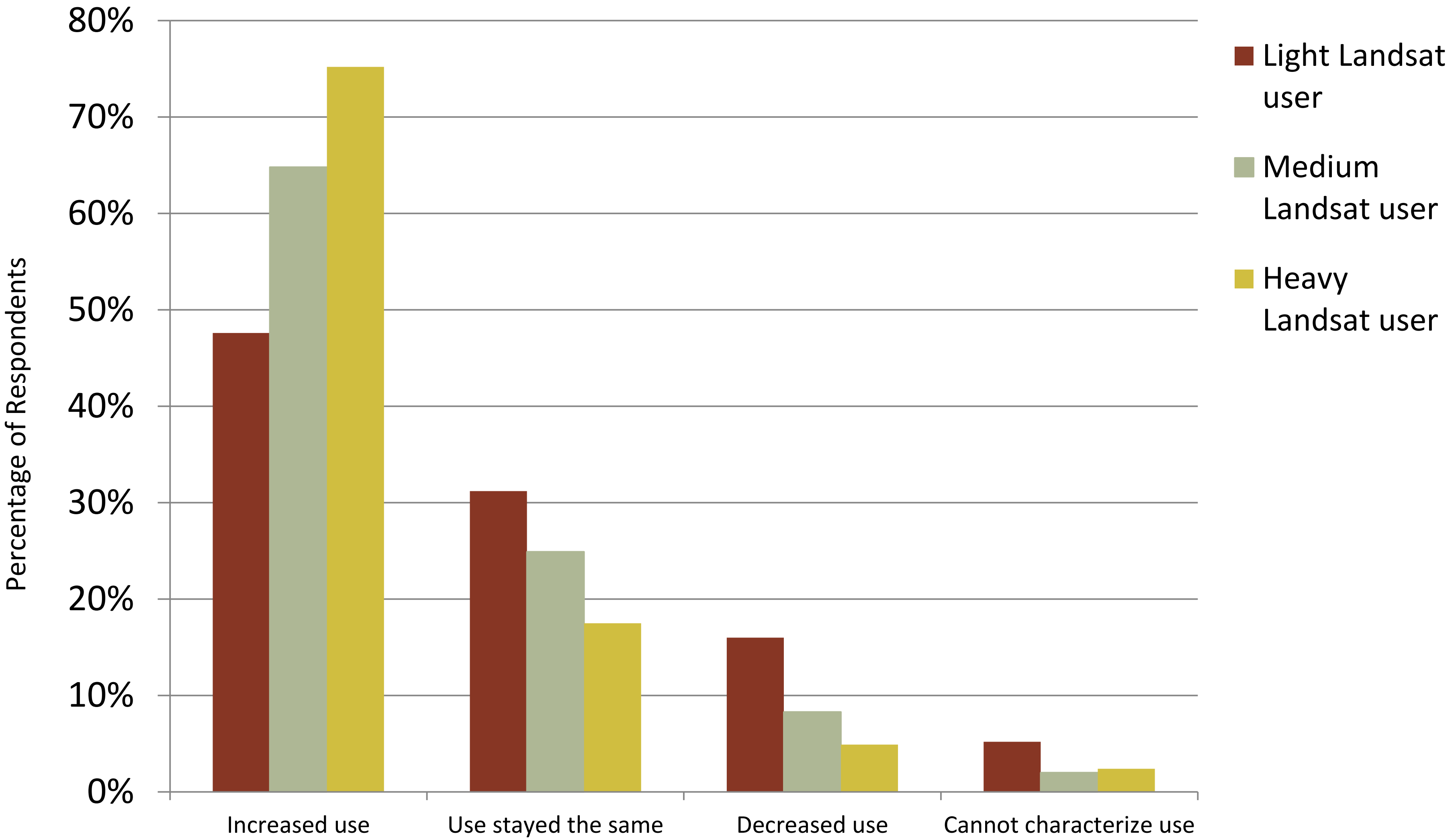
Secondary Applications of Landsat Imagery*



[1] $\chi^2 = 58.49$; Cramer's V = 0.206
[2] $\chi^2 = 19.35$; Cramer's V = 0.119
[3] $\chi^2 = 27.33$; Cramer's V = 0.141
[4] $\chi^2 = 20.27$; Cramer's V = 0.122

*Respondents could select multiple applications from a list of 36 applications. The 36 applications were then collapsed into the 10 categories seen here for analysis purposes.

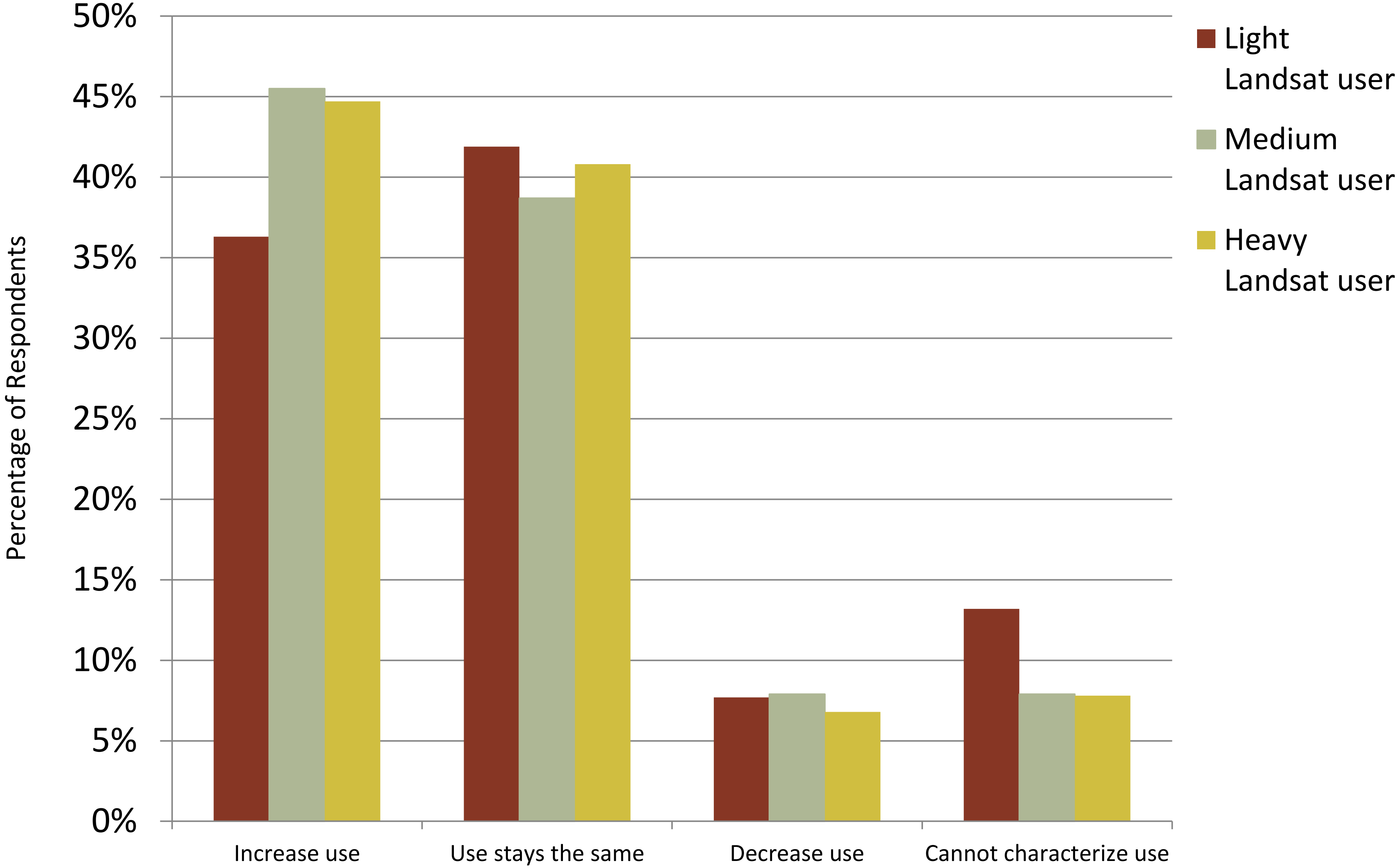
Change in Use of Landsat Imagery over the Past 10 Years



$\chi^2 = 147.88$; Cramer's V = 0.188

Miller, H.M., Sexton, N.R., Koontz, L., Loomis, J., Koontz, S.R., and Hermans, C., 2011, The users, uses, and value of Landsat and other moderate-resolution satellite imagery in the United States—Executive report: U.S. Geological Survey Open-File Report 2011–1031, 42 p.

Change in Use of Landsat Imagery over the Next 5 Years



Miller, H.M., Sexton, N.R., Koontz, L., Loomis, J., Koontz, S.R., and Hermans, C., 2011, The users, uses, and value of Landsat and other moderate-resolution satellite imagery in the United States—Executive report: U.S. Geological Survey Open-File Report 2011–1031, 42 p.

Impacts of No Cost Data Policy

The entire archive of Landsat imagery became available at no cost at the beginning of 2009. To determine the impacts of this policy change, we asked respondents about their imagery acquisitions before and after the policy change (calendar year 2008 and calendar year 2009, respectively).

Changes in Landsat Imagery Acquisitions from 2008 to 2009

Variable	Level of Use	2008 Means	2009 Means	t	p*	Cohen's d*
Number of scenes acquired	Light	66	74	-1.61	NS	NA
	Medium	119	205	-2.11	NS	NA
	Heavy	177	296	-3.17	0.002	0.246
Dollars spent on imagery	Light	$1,513	$613	2.37	NS	NA
	Medium	$6,017	$390	3.38	0.001	0.394
	Heavy	$30,604	$7,584	2.42	0.017	0.378

*NS = Not significant; NA = Not applicable

Value of Landsat Imagery

In economic terms, the value of information is equal to what individuals would pay for that information. However, measuring that value contains many challenges:

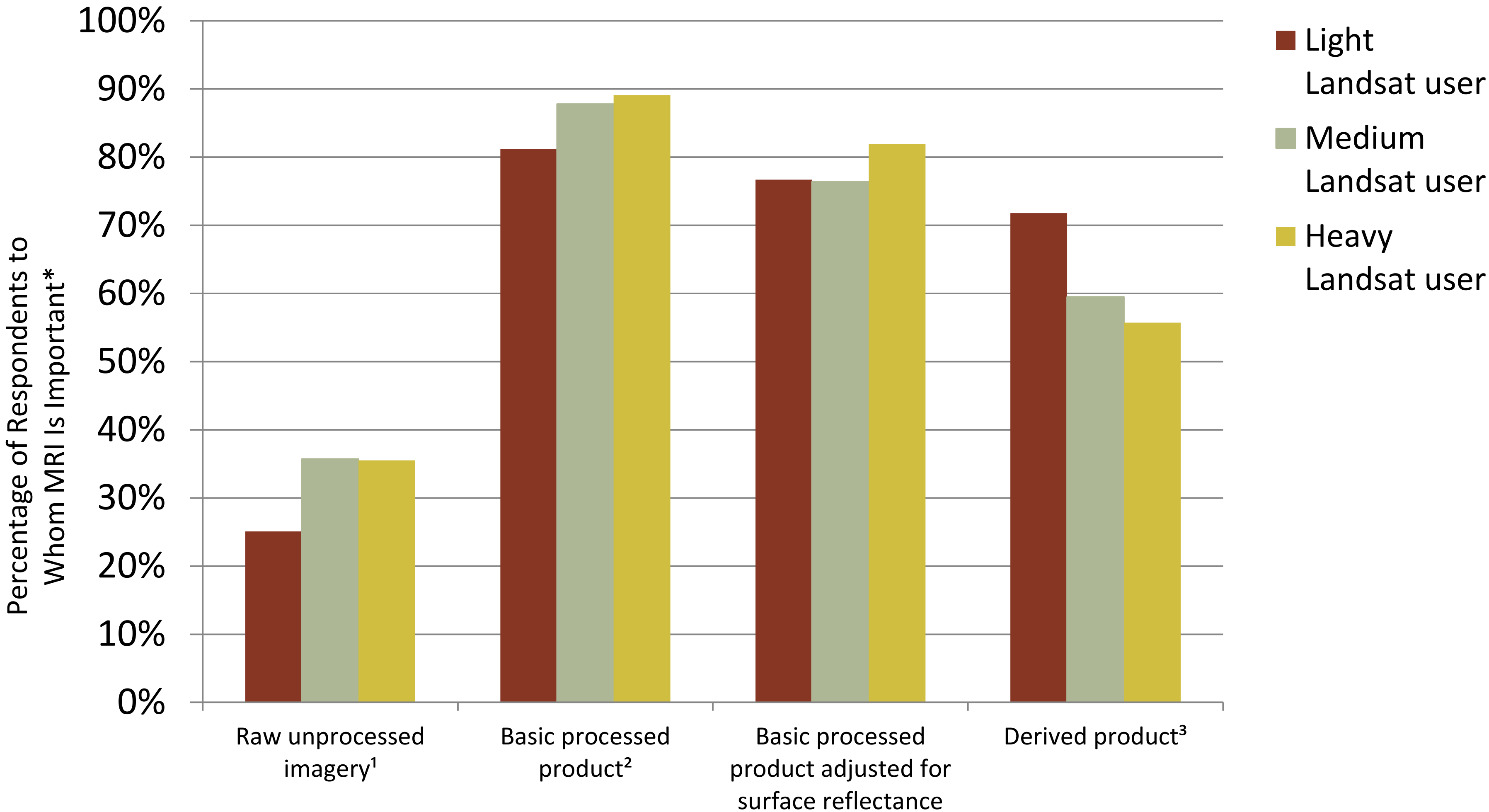
- The value depends on the uncertainty of the situation in which the information will be used, the importance of the outcome of the situation, the cost of using the information, and the cost of an appropriate substitute.
- Societal benefits can be difficult to measure economically, especially when the realized value is in relation to a nebulous, but important, concept like quality of life.
- The comprehensive value of Landsat may always be elusive, given the widespread use of the imagery in applications like Google Earth and the difficulty in finding all direct and indirect users of the imagery.

All of these factors emphasize the importance of measuring the value of information provided by Landsat imagery in multiple ways. We used four approaches to estimate the value of Landsat to this sample of Landsat users, two of which are reported here.

1. We explored the importance of Landsat imagery to respondents, as well as their satisfaction with the imagery.
2. We asked what respondents would do if Landsat imagery was no longer available and how it would impact their work.

Miller, H.M., Sexton, N.R., Koontz, L., Loomis, J., Koontz, S.R., and Hermans, C., 2011, The users, uses, and value of Landsat and other moderate-resolution satellite imagery in the United States—Executive report: U.S. Geological Survey Open-File Report 2011–1031, 42 p.

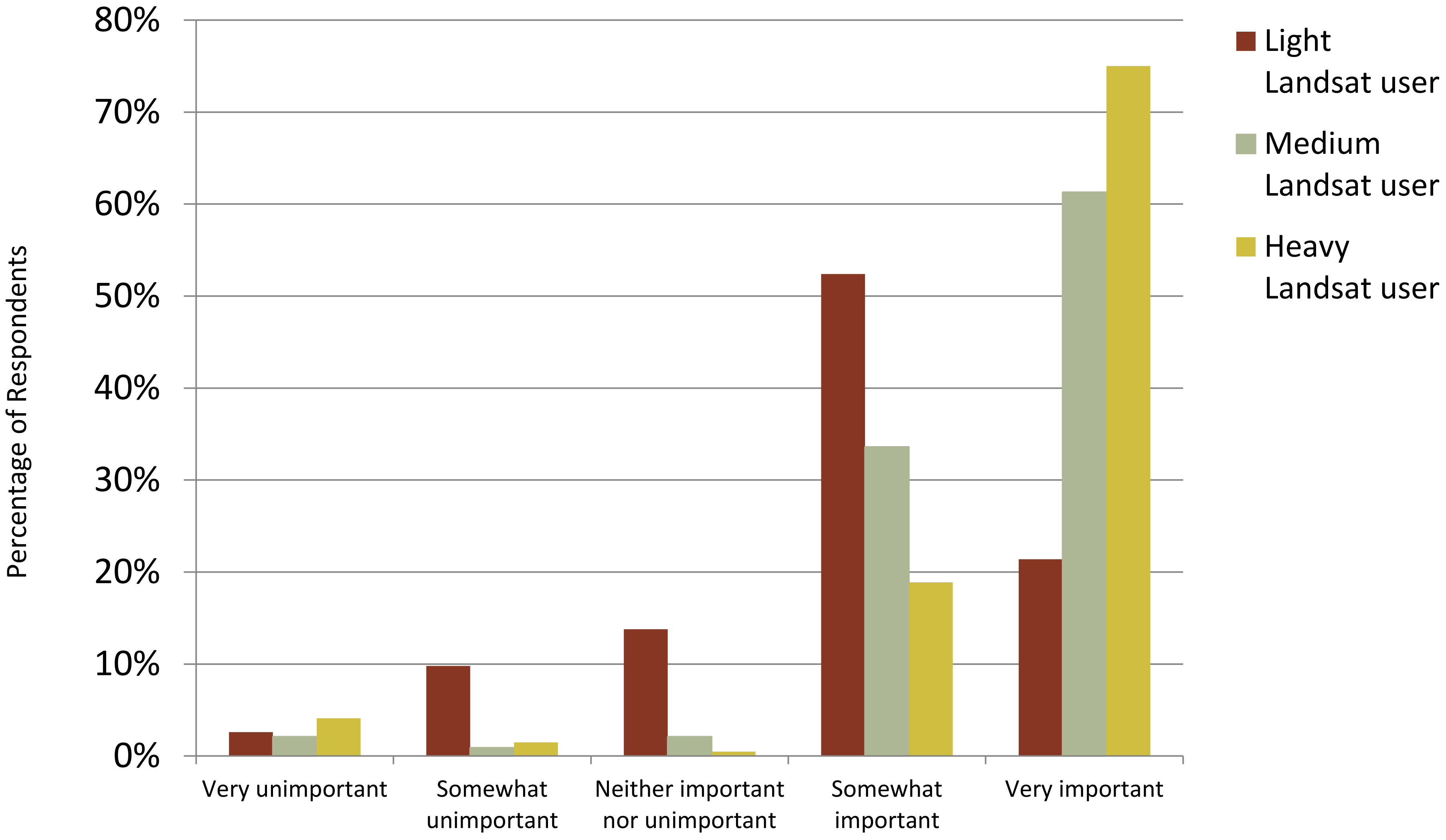
Importance of Types of Moderate-Resolution Imagery



[1]χ^2 = 43.58; Cramer's V = 0.104
[2]χ^2 = 41.39; Cramer's V = 0.101
[3]χ^2 = 46.17; Cramer's V = 0.106

*Percentage of respondents who indicated that a type of imagery was "Somewhat important" or "Very important" to their work.

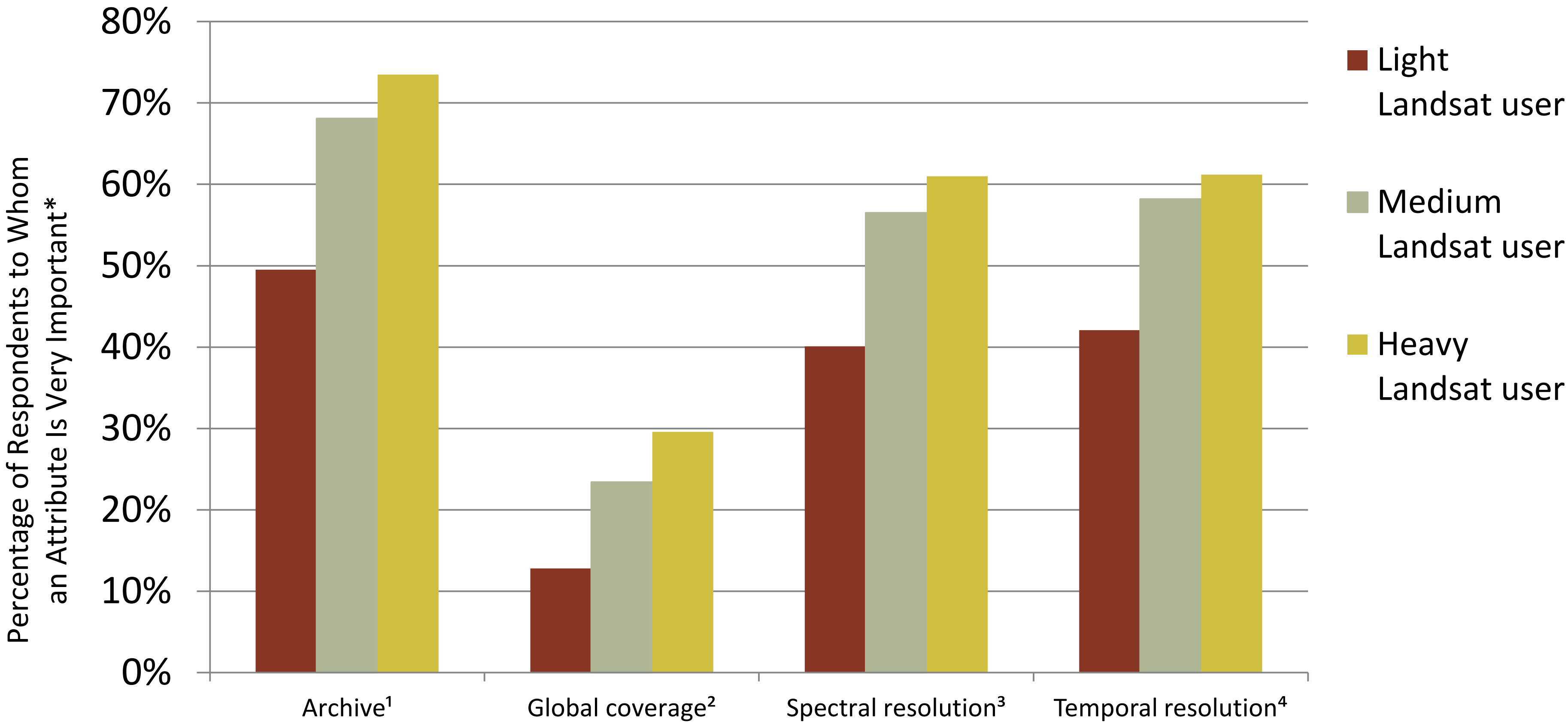
Importance of Landsat Imagery in Work



χ^2 = 304.56; Cramer's V = 0.279

Miller, H.M., Sexton, N.R., Koontz, L., Loomis, J., Koontz, S.R., and Hermans, C., 2011, The users, uses, and value of Landsat and other moderate-resolution satellite imagery in the United States—Executive report: U.S. Geological Survey Open-File Report 2011–1031, 42 p.

Importance of Attributes of Moderate-Resolution Imagery†



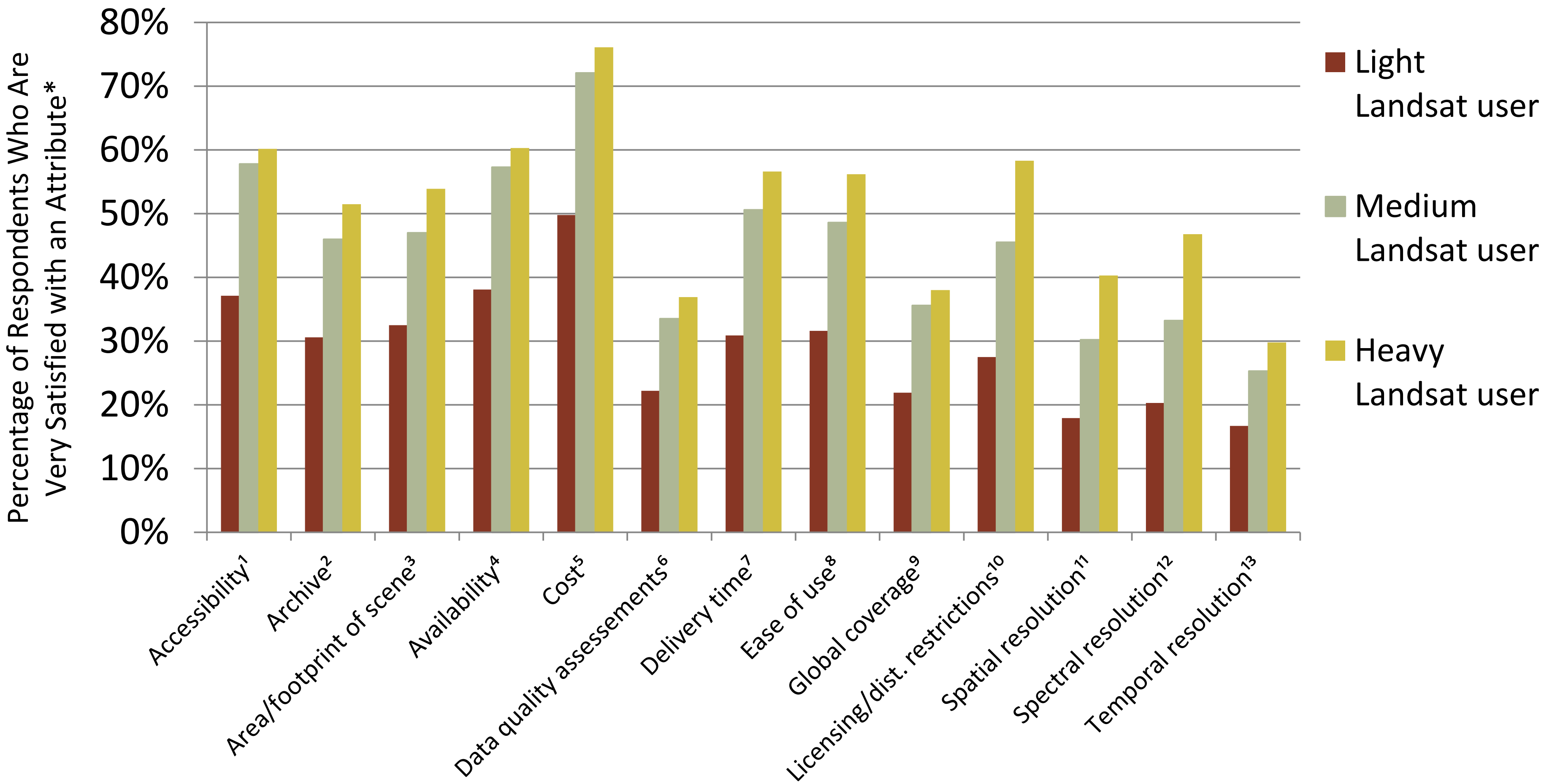
[1] $\chi^2 = 80.13$; Cramer's V = 0.141
[2] $\chi^2 = 73.32$; Cramer's V = 0.135
[3] $\chi^2 = 74.53$; Cramer's V = 0.136
[4] $\chi^2 = 53.84$; Cramer's V = 0.115

*Percentage of respondents who indicated that an attribute was "Very important" in deciding which kind of moderate-resolution imagery to use for a project.

†No significant differences were found regarding the importance of other attributes, including accessibility, area/footprint of a scene, availability, cost, data quality assessments, delivery time, ease of use, licensing/distribution restrictions, and spatial resolution.

Miller, H.M., Sexton, N.R., Koontz, L., Loomis, J., Koontz, S.R., and Hermans, C., 2011, The users, uses, and value of Landsat and other moderate-resolution satellite imagery in the United States—Executive report: U.S. Geological Survey Open-File Report 2011–1031, 42 p.

Satisfaction with Attributes of Landsat Imagery†



[1] χ^2 = 117.26; Cramer's V = 0.169
[2] χ^2 = 87.76; Cramer's V = 0.147
[3] χ^2 = 84.95; Cramer's V = 0.144
[4] χ^2 = 97.83; Cramer's V = 0.155
[5] χ^2 = 122.34; Cramer's V = 0.174
[6] χ^2 = 76.93; Cramer's V = 0.138
[7] χ^2 = 119.78; Cramer's V = 0.172
[8] χ^2 = 111.55; Cramer's V = 0.166
[9] χ^2 = 79.85; Cramer's V = 0.141
[10] χ^2 = 123.71; Cramer's V = 0.176
[11] χ^2 = 107.37; Cramer's V = 0.163
[12] χ^2 = 108.82; Cramer's V = 0.164
[13] χ^2 = 68.50; Cramer's V = 0.130

*Percentage of respondents who indicated that they were "Very satisfied" with an attribute of Landsat imagery.
†No significant differences were found regarding the satisfaction with other attributes, including area/footprint of a scene, availability, and ease of use.

Miller, H.M., Sexton, N.R., Koontz, L., Loomis, J., Koontz, S.R., and Hermans, C., 2011, The users, uses, and value of Landsat and other moderate-resolution satellite imagery in the United States—Executive report: U.S. Geological Survey Open-File Report 2011–1031, 42 p.

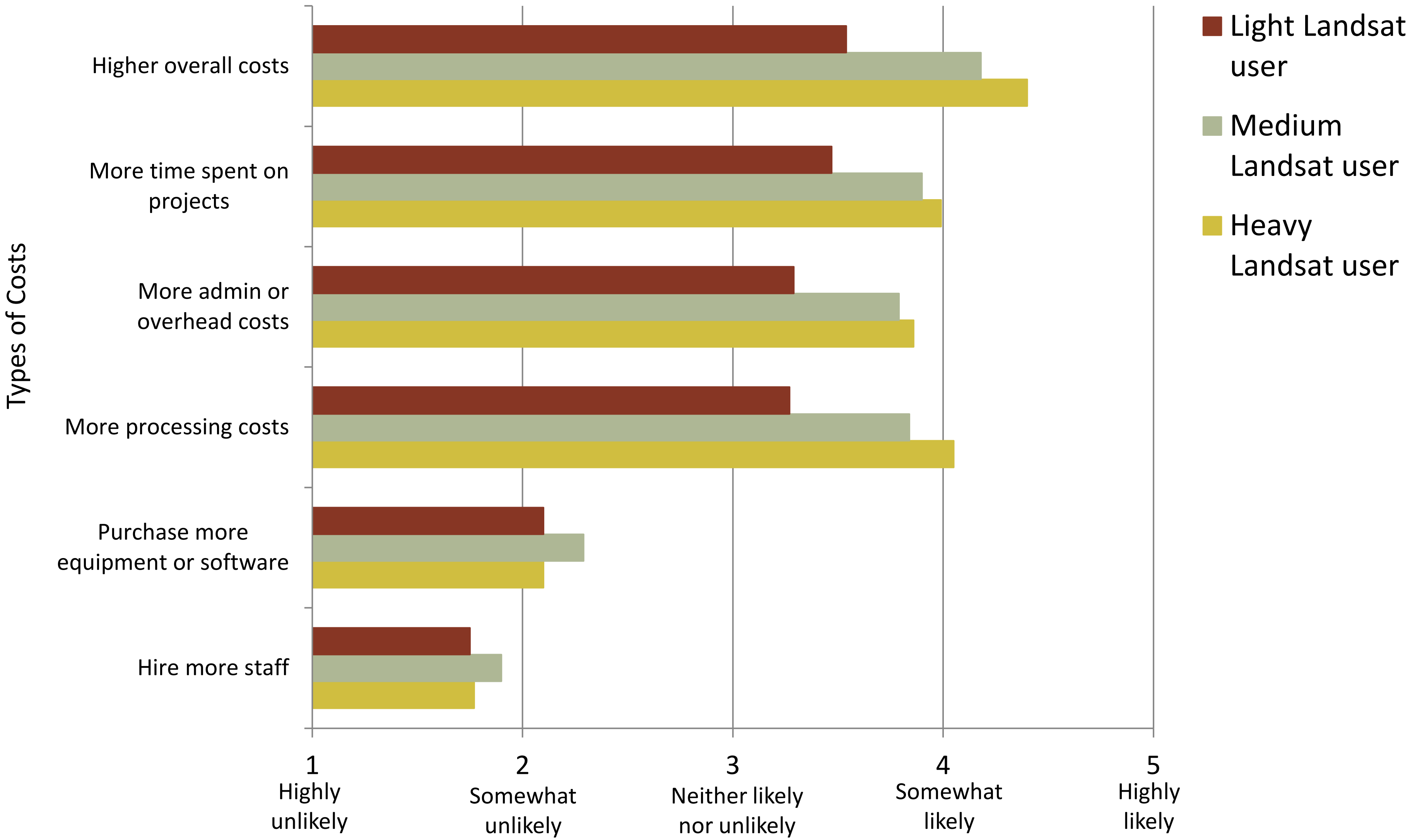
How Work Would Be Impacted If Landsat Was No Longer Available

At least 1% of work would be…	Level of Use	Yes*	No*	Don't know*
…substituted with other imagery or info	Light	74%	4%	22%
	Medium	86%	3%	11%
	Heavy	81%	5%	14%
…discontinued	Light	45%	32%	23%
	Medium	63%	25%	12%
	Heavy	66%	20%	14%
…continued without substituting other imagery or info	Light	42%	31%	27%
	Medium	54%	31%	15%
	Heavy	53%	33%	14%

*Cells contain percentages of respondents in each level of use group who would (Yes), would not (No), or were not sure (Don't Know) if they would take each action (using substitute imagery/information, discontinuing work, or continuing without substituting).

Miller, H.M., Sexton, N.R., Koontz, L., Loomis, J., Koontz, S.R., and Hermans, C., 2011, The users, uses, and value of Landsat and other moderate-resolution satellite imagery in the United States—Executive report: U.S. Geological Survey Open-File Report 2011–1031, 42 p.

Mean Likelihood of Costs Increasing if Landsat Was No Longer Available



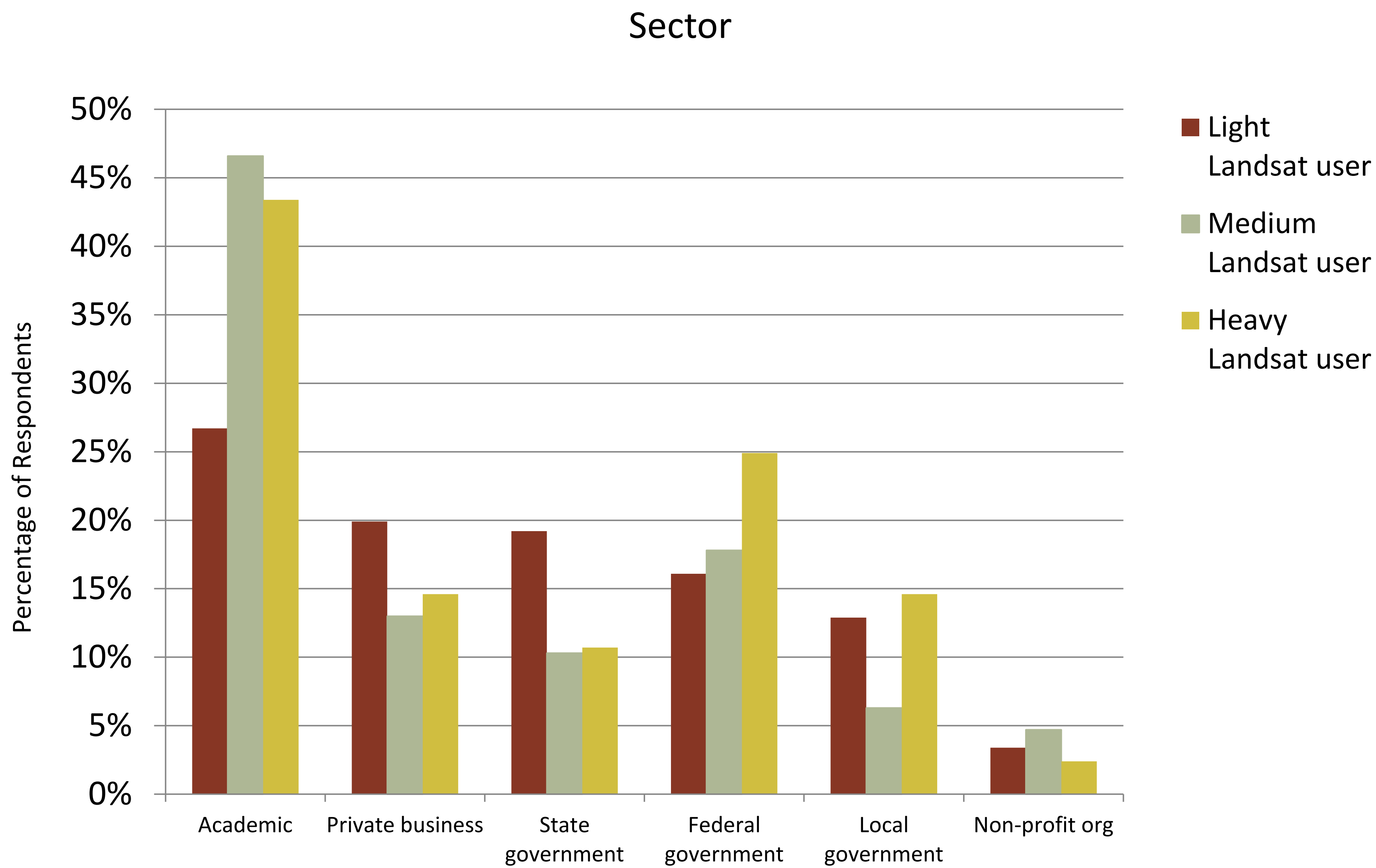
Miller, H.M., Sexton, N.R., Koontz, L., Loomis, J., Koontz, S.R., and Hermans, C., 2011, The users, uses, and value of Landsat and other moderate-resolution satellite imagery in the United States—Executive report: U.S. Geological Survey Open-File Report 2011–1031, 42 p.

Demographics

To explore possible demographic differences within the sample, the following information was collected.

- Sector
- Education
- Membership in a remote sensing/GIS professional organization
- Gender
- Age
- Ethnicity and race

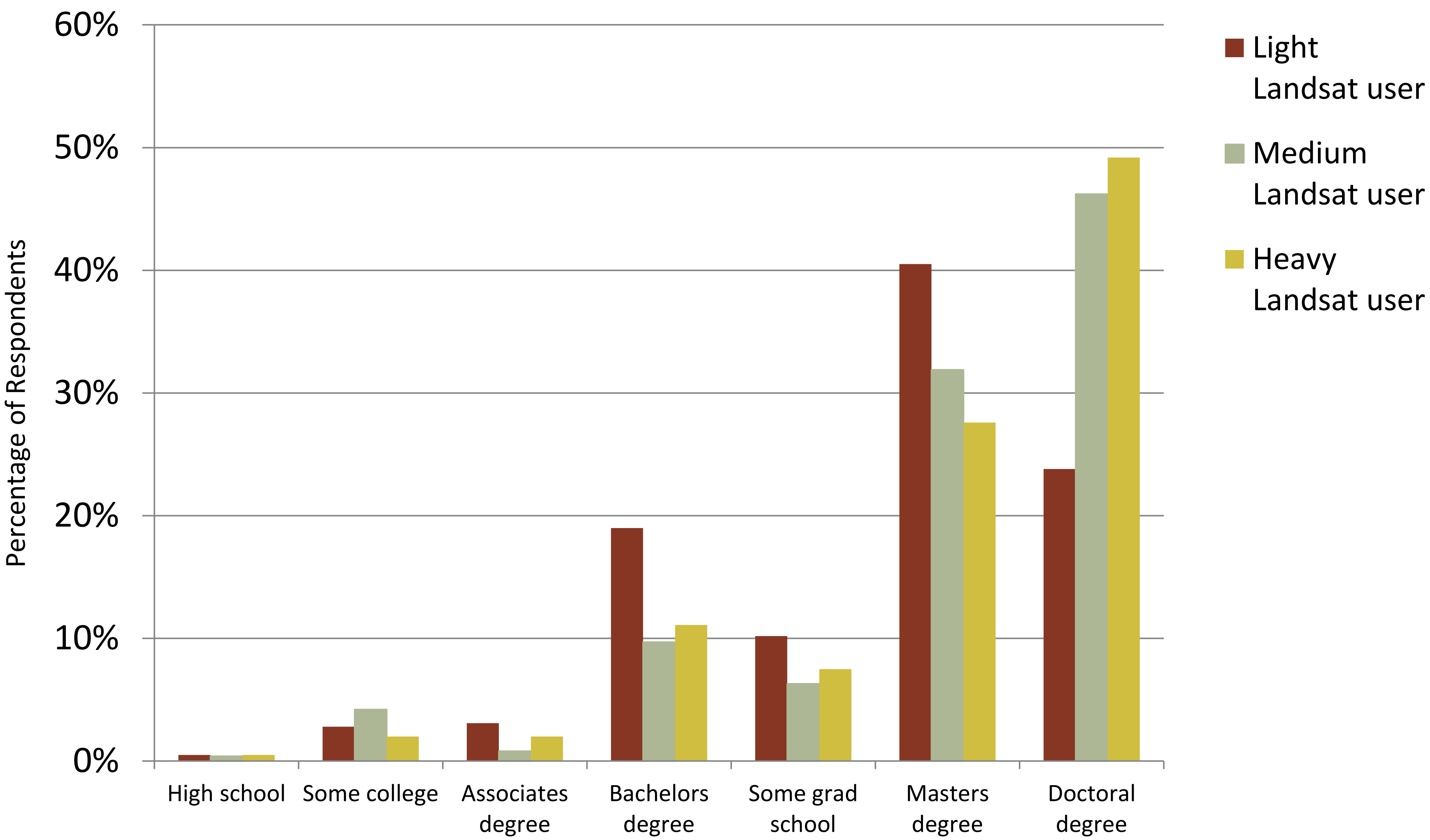
Miller, H.M., Sexton, N.R., Koontz, L., Loomis, J., Koontz, S.R., and Hermans, C., 2011, The users, uses, and value of Landsat and other moderate-resolution satellite imagery in the United States—Executive report: U.S. Geological Survey Open-File Report 2011–1031, 42 p.



χ^2 = 104.93; Cramer's V = 0.159

Miller, H.M., Sexton, N.R., Koontz, L., Loomis, J., Koontz, S.R., and Hermans, C., 2011, The users, uses, and value of Landsat and other moderate-resolution satellite imagery in the United States—Executive report: U.S. Geological Survey Open-File Report 2011–1031, 42 p.

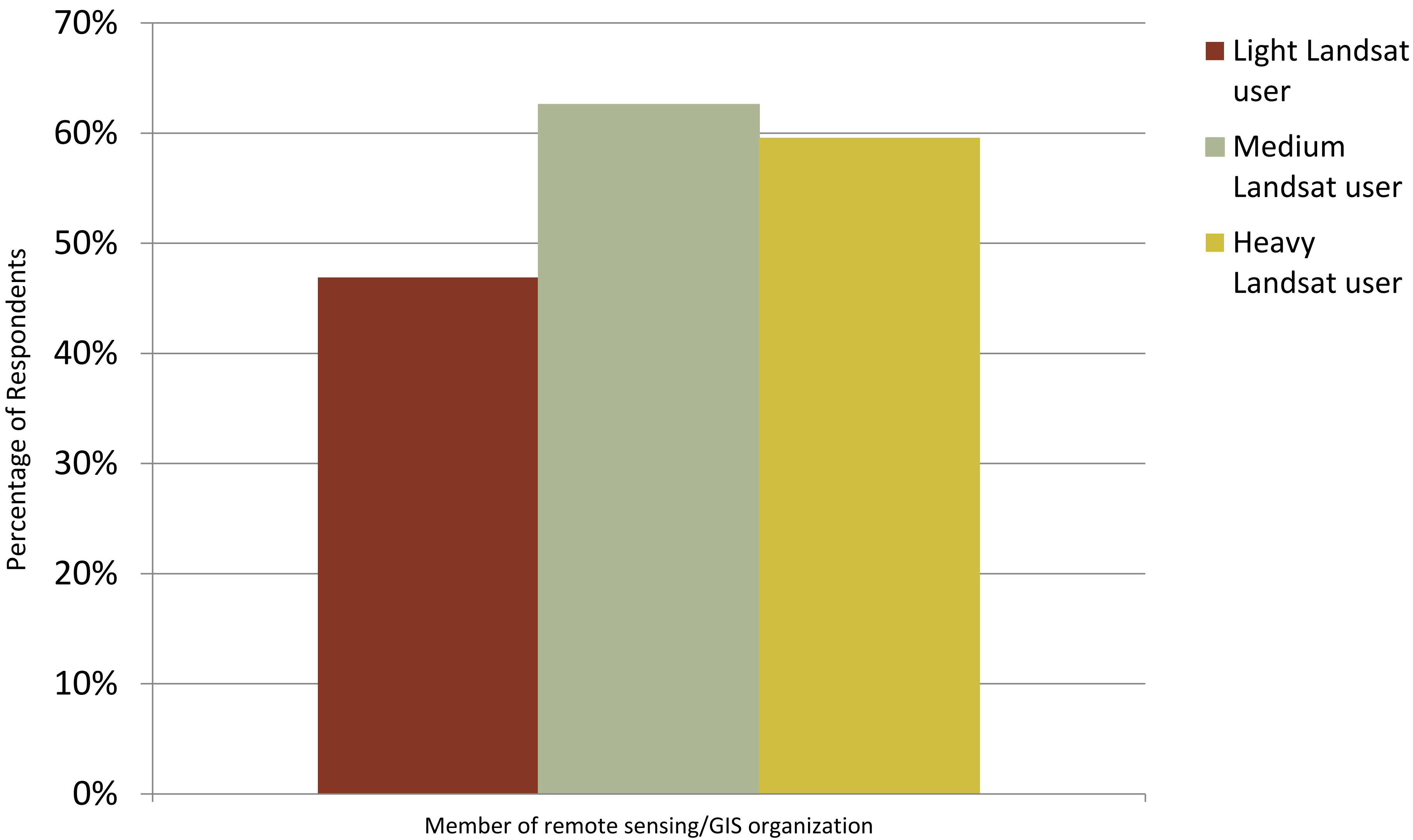
Highest Level of Education



$\chi^2 = 110.57$; Cramer's V = 0.168

Miller, H.M., Sexton, N.R., Koontz, L., Loomis, J., Koontz, S.R., and Hermans, C., 2011, The users, uses, and value of Landsat and other moderate-resolution satellite imagery in the United States—Executive report: U.S. Geological Survey Open-File Report 2011–1031, 42 p.

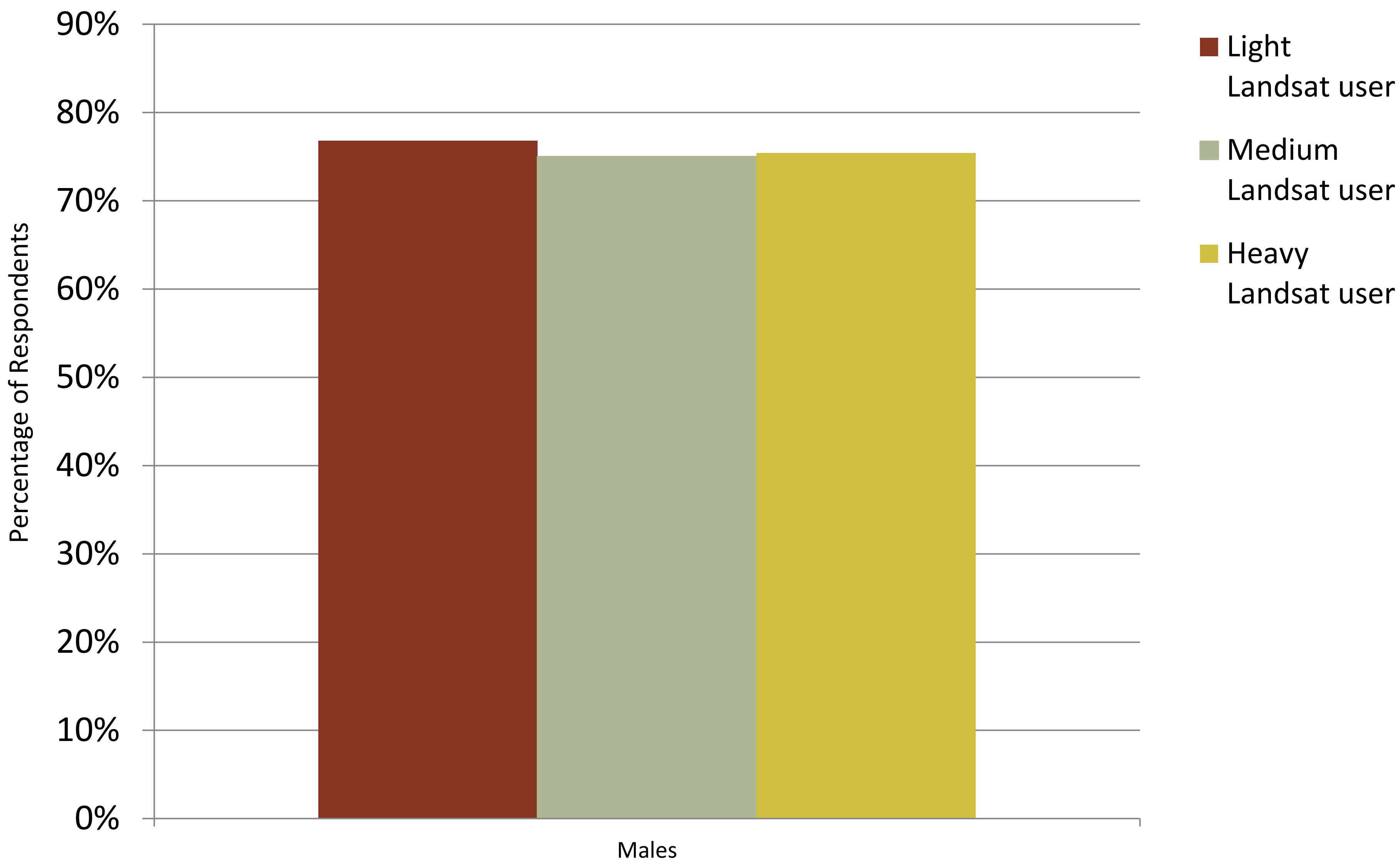
Membership in Remote Sensing/GIS Organizations



$\chi^2 = 38.79$; Cramer's V = 0.170

Miller, H.M., Sexton, N.R., Koontz, L., Loomis, J., Koontz, S.R., and Hermans, C., 2011, The users, uses, and value of Landsat and other moderate-resolution satellite imagery in the United States—Executive report: U.S. Geological Survey Open-File Report 2011–1031, 42 p.

Gender



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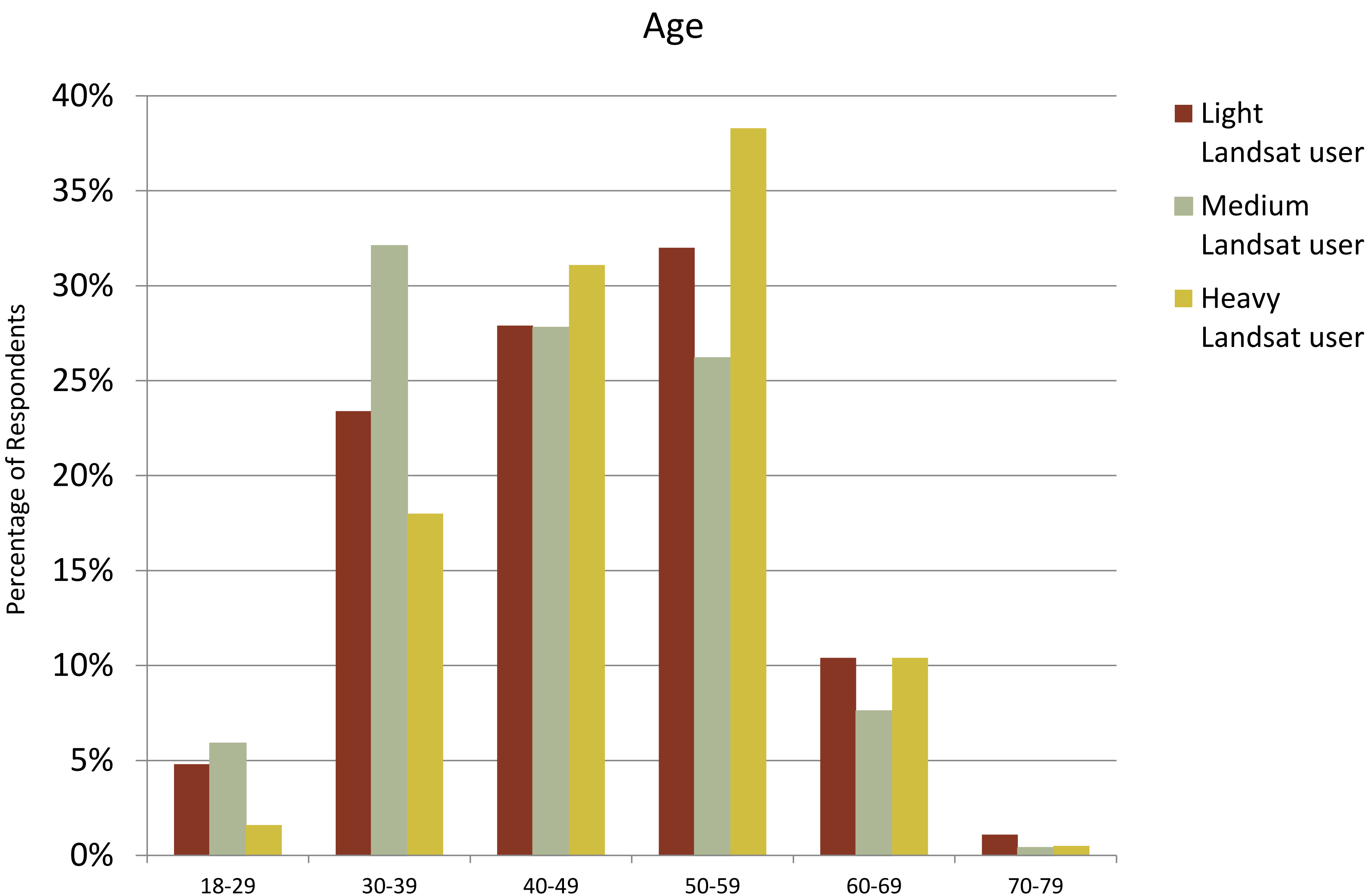

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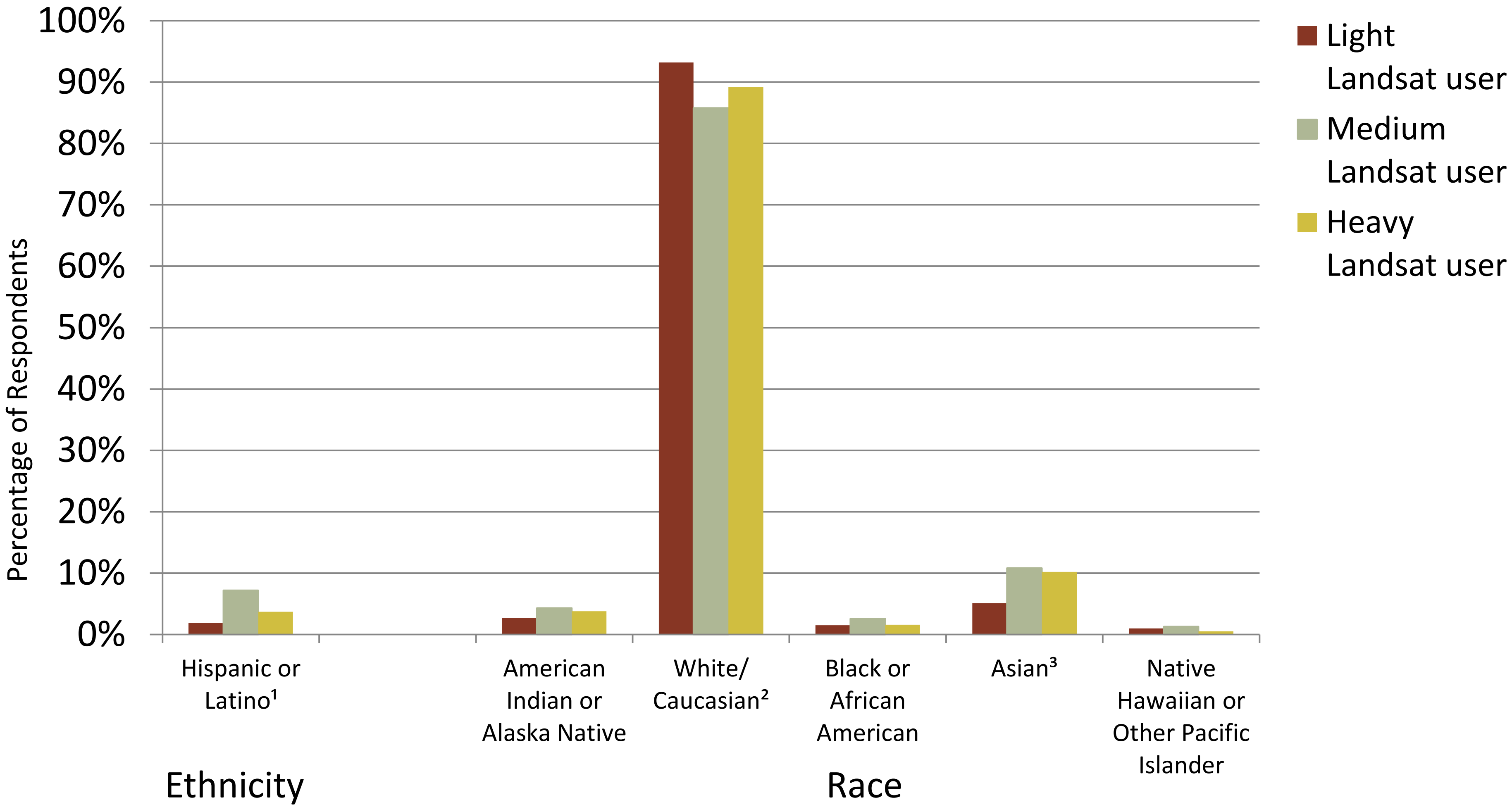
Ethnicity and Race



[1] χ^2 = 17.00; Cramer's V = 0.115
[2] χ^2 = 14.00; Cramer's V = 0.105
[3] χ^2 = 13.60; Cramer's V = 0.103

Additional Information about Statistics

Chi-Square (χ^2)

Chi-square tests compare the expected and actual distribution of data across categories (i.e., gender, work sector). For instance, if you had a sample which was half female and half male and wanted to know if the distribution of males and females across a work sector, such as government or private business, was the same as the overall distribution in the sample, you would use a chi-square. The expected distribution for the sector would be 50% female and 50% male, but the actual distribution could be 60% males and 40% females. The chi-square statistic is a sum of the differences between the expected and actual distribution. The greater the difference between the expected and actual distribution, the larger the chi-square statistic is. Whether the difference is statistically significant (as shown by the p-value) is based on both the size of the chi-square and the number of people in the sample.

T-tests

T-tests are used to determine differences between the means (or averages) of two continuous variables (i.e., age, years of education). They can be used to compare means of the same variable from two different groups of people (i.e., mean income of men versus mean income of women) or between the same group of people at two different times (i.e., mean weight before beginning a diet program versus mean weight after completing the diet program). T-tests take into account both the absolute difference between the means, as well as the distribution of data within each group. Given the same absolute difference in means, the more the distributions of data from each group overlap, the less significant the difference is between them. T-statistics can be positive or negative. A positive t-statistic indicates that the mean of group 1 (or time 1) is larger than the mean of group 2 (or time 2) and a negative t-statistic indicates the opposite. Whether the difference is statistically significant is based on the size of the t-statistic and the number of people in the sample.

Additional Information about Statistics

P-value

Statistical significance for these test statistics is determined by the p-value. The p-value indicates whether the difference between the data is real or simply a chance finding. The p-value threshold is set before analysis begins and is based on the characteristics of the study. Typically, a p-value of 0.05 or smaller is used in social science research to indicate significance. This means that there is a 5% chance of incorrectly finding a significant difference when there actually is none. However, p-values are sensitive to sample size and analysis of data from a large sample will often yield many significant differences. For this study, we decided on a threshold of 0.001, meaning there is one chance in a thousand that we will find a significant difference when there is none. Even with this conservative threshold, we felt calculating effect sizes was necessary to identify meaningful differences.

Effect Size

Effect sizes, or measures of association, reveal the differences in data regardless of sample size. They demonstrate practical or meaningful differences, rather than simply statistical differences. Effect size can be thought of as a measurement of the amount of impact an independent variable has on a dependent variable (Murphy and Myors, 1998, p. 12). To return to our earlier example of gender and work sector, the effect size would reveal whether gender was a significant factor in determining in which sector a person worked. Effect sizes are generally reported as small, medium, or large. To illustrate what these levels mean in a practical sense, Cohen (1988, p. 25–27, 79–80) provides the following examples for interpreting the effect sizes phi and Cramer's V:

- a small effect (0.01) = the difference in mean height between 15- and 16-year-old girls,
- a medium effect (0.03) = the difference in mean height between 14- and 18-year-old girls, and
- a large effect (0.05) = the difference in mean height between 13- and 18-year-old girls.

Following Cohen's recommendations on the interpretation of effect size for behavioral and psychological studies (1988, p. 25), we consider a statistically significant measure with a small effect size or greater to indicate a meaningful difference for this study.

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