Vision and Change for Undergraduate Geoscience Education

Why Vision and Change Project?

- Sense that many of our programs were not thriving
- Understanding that we are not producing graduates to meet national demand
  - The graduates we do have do not reflect the gender/ethnic mix of the nation
- Sense that employer needs were shifting drastically, without the curriculum responding
  - Dramatic relative shift away from oil and gas
- Best practices in pedagogy shifting, without comparable response by faculty on a day-to-day basis
- Expectations that graduates also have competencies in essential non-technical skills
- If anything, these reasons have only been magnified since the work was begun
- Departments struggling to respond

Goals

- Develop a consensus document on the Future of Geoscience Education which has stature due to the broad reach of input
  - Convince faculty of need for change
  - A tool for working with university officials
- Provide a roadmap for academic departments to work from

Input from Academia

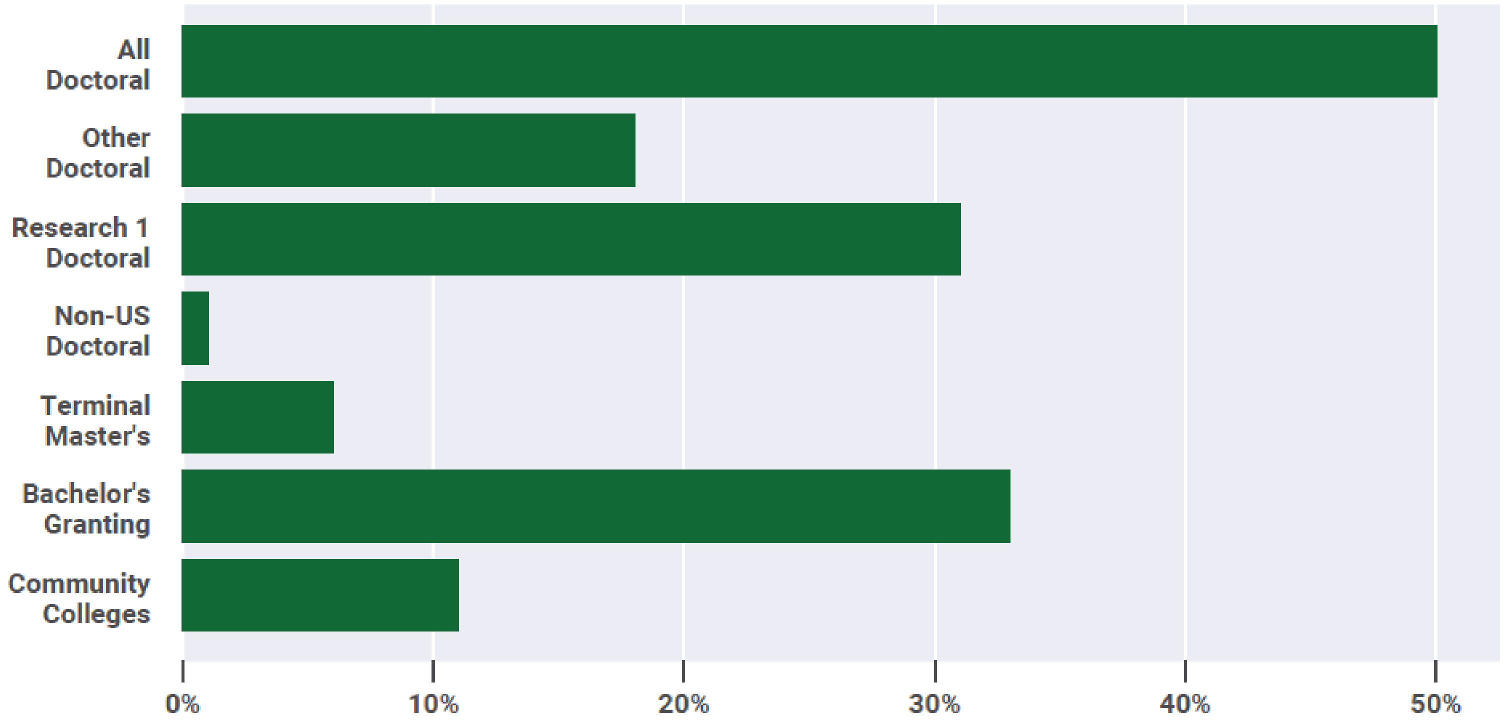

Figure 2.1: Contributed Input Levels by Institution Type
Inputs from academia

Input from Employers

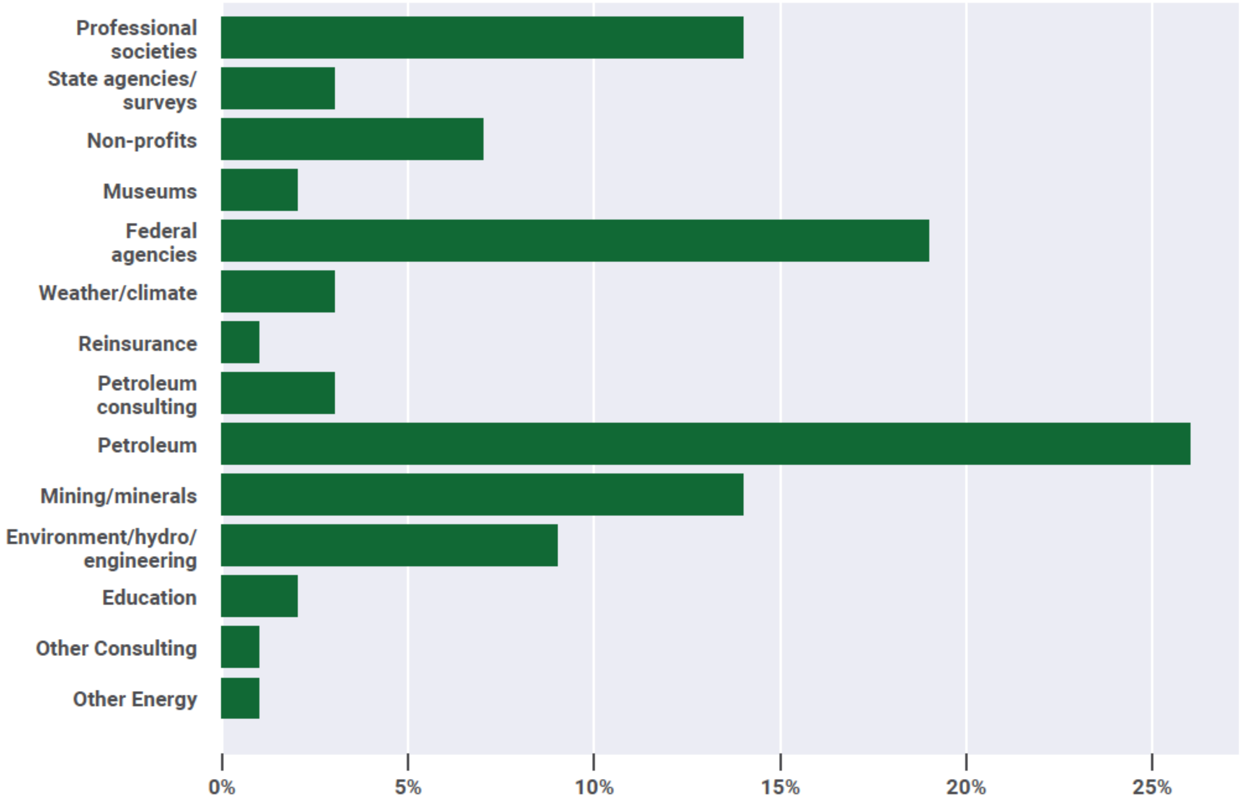

Figure 2.2: Contributed Input Levels by Employer Type
Sources of employer input

Concepts, Skills and Competencies

- Geoscience Concepts
- Geoscience Skills
- Science Skills
- Non-Technical Skills
- Recommendations for Curriculum and Pedagogy

Important Geoscience Concepts

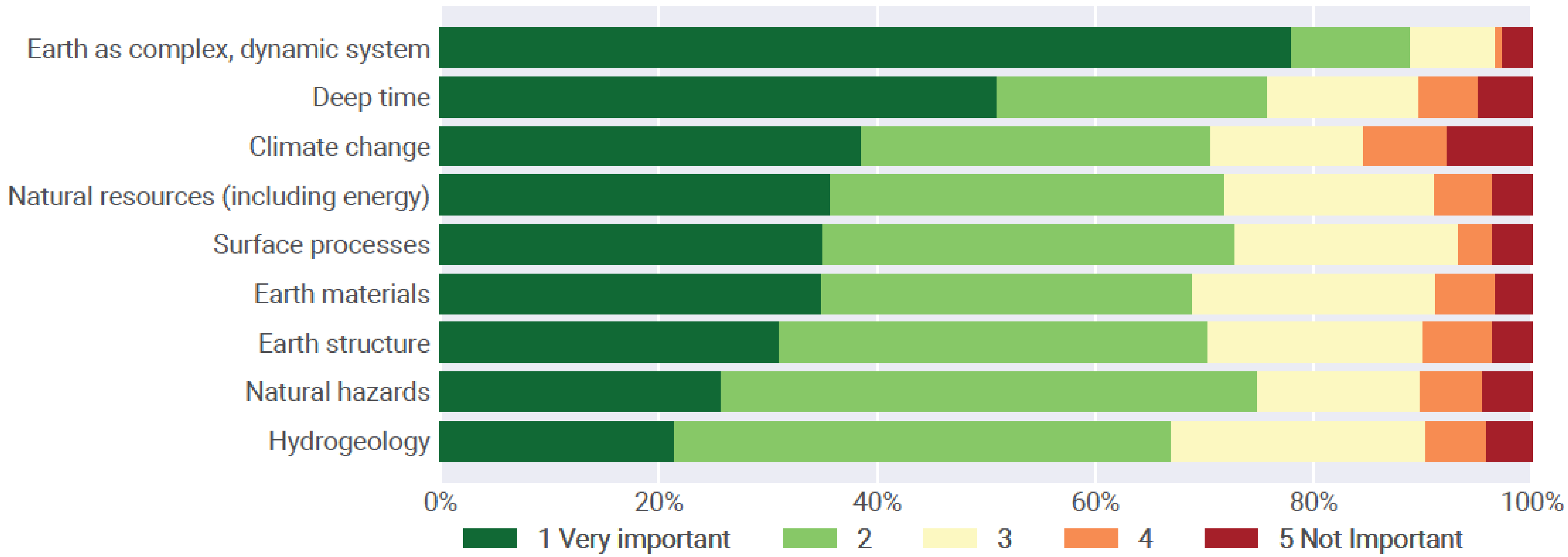

Figure 3.1: Geoscience Concepts Importance

Survey Question: The Summit report identifies the following concepts as critical to undergraduate education. For each, please indicate the importance from your perspective of these concepts for undergraduate-level curricula.

Perspectives on Geoscience Concepts

- Academics and employers both on the same page regarding these concepts
- The employers focused on developing an understanding of broad concepts — i.e., the processes and their impacts and deemphasized the importance of memorization of terms, definitions, classifications, and other material that is easily referenced online.
- How well do our programs emphasize Earth as a complex dynamic system? Fragmented across too many courses? Not enough emphasis on Atmo/Ocean/human influences?

Important Science Skills

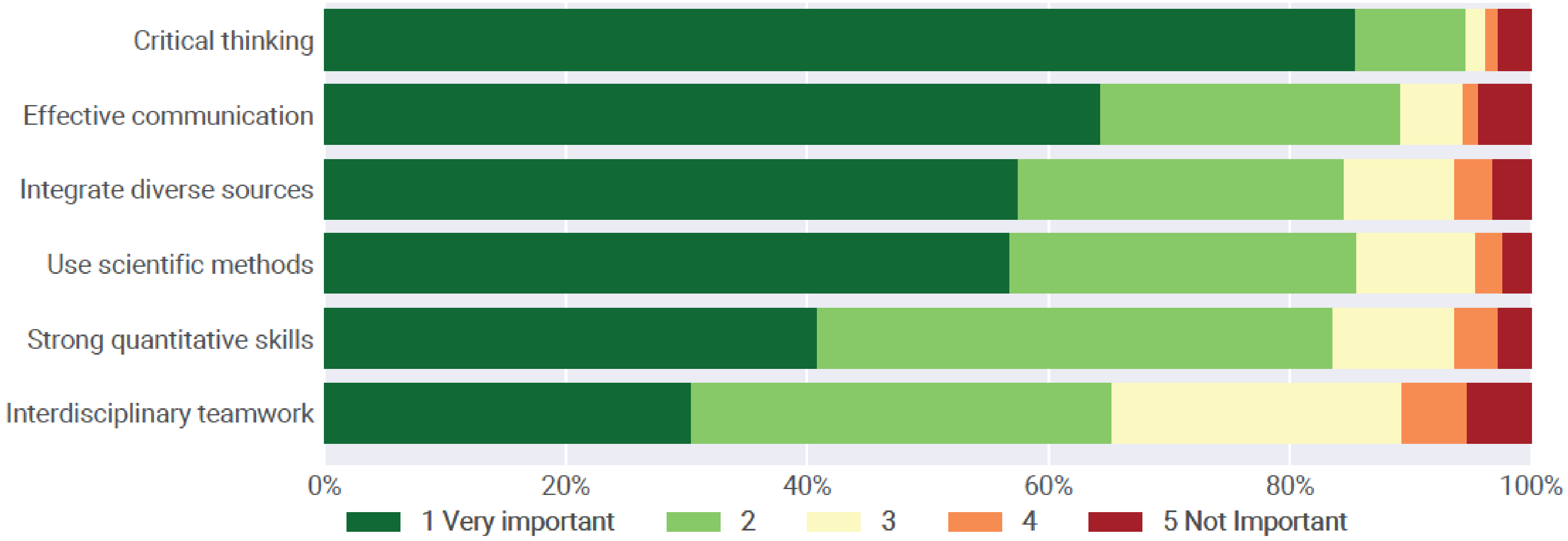

Figure 3.2: Science Skills Importance

Survey Question: The Summit report identifies the following concepts as critical to undergraduate education. For each, please indicate the importance from your perspective of these concepts for undergraduate-level curricula.

Important Science Skills - Perspectives

- Employers agreed students should be both proficient in these skills and have experience applying them.
- Employers felt the capability to access and integrate information from different sources while continuing to learn was something students needed to master.
- The 2014–2015 survey results showed that a substantial majority of both academics and employers (84–95%) viewed these science skills as important or very important
- Exceptions: working in interdisciplinary teams and across cultures where a smaller majority (65%) agreed

Important Geoscience Skills

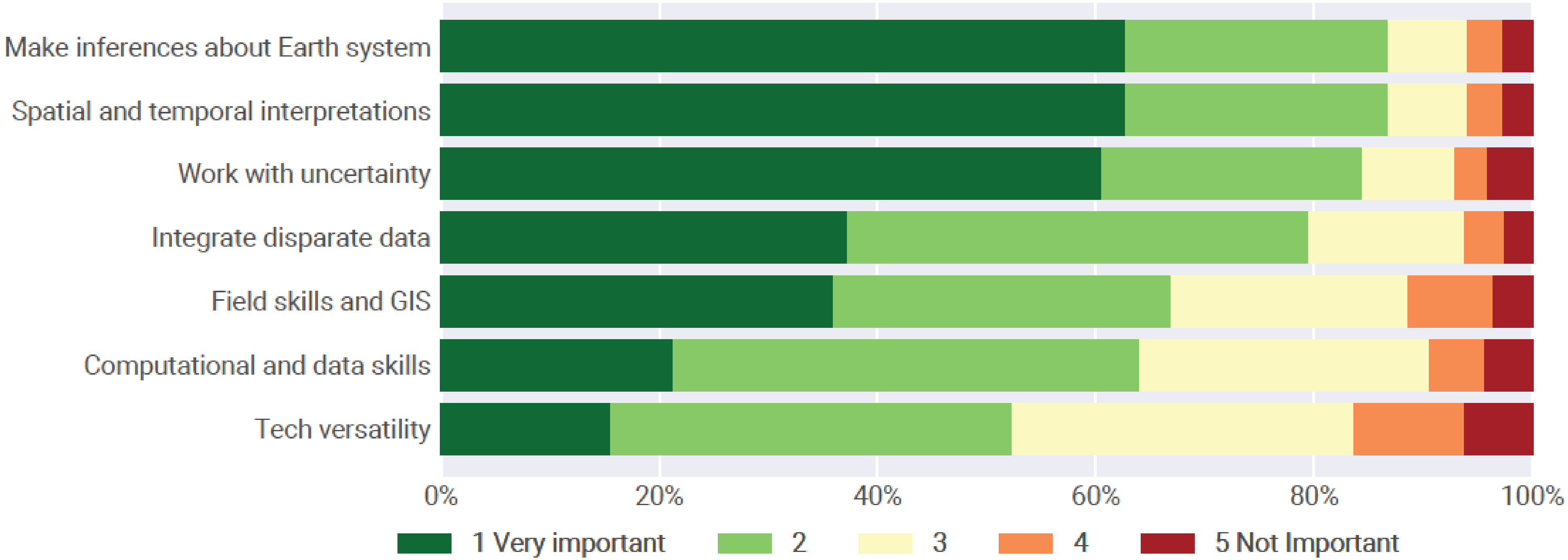

Figure 3.3: Geoscience Skills Importance

Survey Question: The Summit report identifies the following concepts as critical to undergraduate education. For each, please indicate the importance from your perspective of these concepts for undergraduate-level curricula.

Perspectives on Geoscience Skills

- Of these seven geoscience skills, 80–87% of 2014–2015 *survey participants* saw the first four as either very important or important while 52–67% viewed the last three as very important or important
- Participants in the 2015 Geoscience *Employers Workshop* felt that students should have mastered #s 1, 2, 3, 5, 7) by completing a project or thesis.
  - For the other two (field skills, GIS, tech versatility), they expected proficiency through application of these skills in their coursework or projects.

Challenge: Sufficient Quantitative Skills

- Most geoscience undergraduates are not prepared for the math, quantitative skills, data analysis, and computational skills recommended by the employers.
  - At the undergraduate level, only about 25% of the graduates, and about half of advanced degree recipients, have taken substantial math beyond Calculus II
- Students need to be able to manage data and use numeric data systematically full understanding of the limits of accuracy and precision
  - The rapid growth of data-intensive applications requires more advanced experiences with statistics, spatial statistics, GIS, etc.
- Approach: intentionally incorporate more quantitative work in geoscence courses, interact with cognate disciplines on campus

Important Non-Technical Skills

- *Ethical behavior* and adhering to codes of conduct for professions, institutions, and employers is critical for trustworthy scientific results that guide decision-making in a societal context.
- Awareness of implicit biases and the components of an inclusive environment promotes a productive workplace, including working with people from different cultures
- *Professionalism*, demonstrating a commitment to doing an effective job, being responsible, dependable, honest, confident, committed to effective performance, time management, and generally having a professional appearance.
- *Leadership* skills
- *Business acumen*, or some knowledge of the business environment that provides the ability to make good business decisions
- *Risk Management* - most geoscience careers involve making decisions that include financial, environmental, structural, or other types of risks.

Recommendations

- Provide students through their courses and activities the opportunity to develop an understanding of broad concepts, including processes and impacts, to build a working framework for knowledge gained during their education and future career
- Incorporate instruction and practice in geoscience skills identified by employers and academics across multiple classes to ensure students gain sufficient competency in these skills
- Provide students with authentic experiences that incorporate geoscience and systems thinking and problem-solving (e.g., field experiences, research projects, in class exercises with real data, etc.)

Recommendations

- Incorporate the development of key professional skills (communication to diverse audiences, teamwork, project management, etc.) and those skills more closely aligned with the discipline into your undergraduate program
- Identify the key quantitative reasoning skills required for your graduates and incorporate practice in these skills at multiple points in their degree program
- Provide students experience and practice in acquiring and analyzing real data using multiple methods and tools to solve geoscience problems (if practical for your institution) and handling large data sets, with full understanding of accuracy, limitations, and uncertainty

How?

- Backwards Design and “Matrix” Strategies (Chapter 4 of V&C)
  - Develop department consensus on learning outcomes and design the course work from there
  - Learn about and build on learning outcomes of cognate courses/disciplines as well as the university – it’s not all on the department!
  - Takes time, but can be very rewarding

Conclusion/Vision

“Geoscience programs will grow and thrive when their graduates can demonstrate that their knowledge and skills are grounded in innovative thinking and have prepared them well for their role in a dynamic society”