Responsive Management

USE OF, SATISFACTION WITH, AND REQUIREMENTS FOR IN-SITU TURBIDITY SENSORS

Conducted for the Alliance for Coastal Technologies

by Responsive Management

2005

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Responsive Management National Office

Mark Damian Duda, Executive Director
Peter E. De Michele, Ph.D., Director of Research
Martin Jones, Research Associate
Andrea Criscione, Research Associate
Chad Craun, Research Associate
Tim Winegord, Survey Center Manager
Alison Lanier, Business Manager
Steven J. Bissell, Ph.D., Qualitative Research Associate
James B. Herrick, Ph.D., Research Associate

130 Franklin Street
Harrisonburg, VA 22801
Phone: 540/432-1888 Fax: 540/432-1892
E-mail: mark@responsivemanagement.com
www.responsivemanagement.com

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EXECUTIVE SUMMARY

This study was conducted for the Alliance for Coastal Technologies (ACT) to gather data about the use of in-situ turbidity sensors. The study entailed a telephone survey of professionals in the coastal resources field, such as biologists, researchers, and coastal managers, who are currently involved in measuring turbidity in coastal and near-coastal waters. The telephone survey questionnaire was developed cooperatively by Responsive Management and the ACT. Responsive Management conducted a pre-test of the questionnaire, and revisions were made to the questionnaire based on the pre-test.

Interviews were conducted Monday through Friday from 9:00 a.m. to 9:00 p.m., Saturday noon to 5:00 p.m., and Sunday from 3:00 p.m. to 9:00 p.m., all local time. The survey was conducted in April and May 2005. Responsive Management obtained a total of 50 completed interviews. The software used for data collection was Questionnaire Programming Language 4.1. The analysis of data was performed using Statistical Package for the Social Sciences software as well as proprietary software developed by Responsive Management.

TURBIDITY AND AQUATIC AREAS OF INTEREST

- Overwhelmingly, respondents listed their primary sensor deployment area of interest as research (76%); 10% listed resource management, and 10% listed regulatory compliance/permitting as their primary sensor deployment area of interest.

- A majority of respondents (68%) did not have any additional sensor deployment areas of interest. Most commonly, the other sensor deployment area of interest was resource management (22%).

- The top aquatic environment of interest is coastal/near shore (50%), followed by rivers/lakes/freshwater wetlands (42%).

SPECIFIC PROCEDURES/ASPECTS OF MEASURING NUTRIENTS

- A majority of coastal professionals (66%) define turbidity as the decrease in transparency of water due to presence of suspended solids and some dissolved substances.

- About a quarter of respondents (24%) are required to use specific approved analytical techniques and procedures; EPA standards were the most commonly used. About a quarter of respondents (26%) said their sensor needs or requirements are non-standard.

- A majority of coastal professionals (60%) measure turbidity using NTU (nephelometric turbidity units), while 12% measure turbidity using mg/l (milligrams per liter).

- A majority of the sample of coastal professionals (64%) currently use in-situ turbidity sensors, and these are typically commercial products.

- Of those who currently use in-situ turbidity sensors, 59% use multiple sensors, while 41% use only one sensor.

- A majority of those who currently use in-situ turbidity sensors (78%) use a package of sensors to acquire a turbidity reading in conjunction with other measurements; 22% use an independent turbidity sensor to measure turbidity only.

- The most common application for turbidity sensors is as a deployed sensor on a remote platform for continuous in-situ measurements (66%).

- Most commonly, those who use in-situ turbidity sensors take measurements more often than hourly (38%); however, the next most common measurement interval is monthly (25%).

- All 50 respondents were asked to rate the importance of turbidity sensor characteristics. The performance characteristics of most importance are reliability, accuracy, product support/warranty/vendor reputation, range/detection limits, precision, and calibration life.
  - There was little variation of mean ratings of importance for each characteristic among those who currently use in-situ turbidity sensors and those who do not currently use in-situ turbidity sensors.
  - Reliability, precision, and calibration life were the sensor characteristics for which individual ratings of importance varied by approximately 20 percentage points or more

among those who currently use in-situ turbidity sensors and those who do not currently use in-situ turbidity sensors.

- Of those who do not currently use in-situ turbidity sensors, 56% currently measure turbidity using other methods.
  - 60% of those who currently measure turbidity using other methods use light attenuation/nephelometry to measure turbidity, and 30% use the filtration/total suspended solid method.

- The most common measurement intervals among those who do not currently use in-situ turbidity sensors are more often than hourly, hourly, and varying regularity (22% each).

- An overwhelming majority of those who do not currently use in-situ turbidity sensors (72%) use in-house sample analyses to conduct turbidity measurements; 11% do not currently measure turbidity.

LIMITATIONS OF SENSORS AND ANALYSES

- Most commonly, those who currently use in-situ turbidity sensors said the sensors have no limitations or areas in which they do not meet expectations or needs (41%). Nonetheless, range/detection limits is the top area in which current in-situ nutrient sensors have limitations, do not meet expectations, or do not meet needs.

- Degree of automation is the top area in which in-house sample analyses have limitations, do not meet expectations, or do not meet needs.

PURCHASING NEW SENSORS

- A majority of respondents (62%) indicated plans to purchase new commercial sensors within the next 2 years.
  - Of those who use in-situ sensors and who plan to purchase a new commercial sensor, the majority (63%) indicated that they will consider a different type of sensor than the one they are currently using.

- Common reasons for planning to purchase new commercial sensors include the availability of new technology and to replace old sensors.

- Satisfaction with current sensors is the top reason for not planning to acquire a new commercial sensor or a different sensor type.

- Of those who use in-situ turbidity sensors, who plan to purchase new commercial sensors in the next 2 years, and who will consider a different type of sensor than the one they are currently using, the majority (60%) will have a trained person on staff to operate the new sensor.

- The majority of those who do *not* currently use in-situ turbidity sensors and who plan to purchase new commercial sensors within the next 2 years will have a trained person on staff to operate the new sensor (71%).

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INTRODUCTION AND METHODOLOGY

This study was conducted for the Alliance for Coastal Technologies (ACT) to gather data about the use of in-situ turbidity sensors. The study entailed a telephone survey of professionals in the coastal resources field, such as biologists, researchers, and coastal managers, who are currently involved in measuring turbidity in coastal and near-coastal waters. Specific aspects of the research methodology are discussed below.

A central polling site at the Responsive Management office allowed for rigorous quality control over the telephone interviews and data collection. Responsive Management maintains its own in-house telephone interviewing facilities. These facilities are staffed by interviewers with experience conducting computer-assisted telephone interviews on the subject of natural resources. The telephone survey questionnaire was developed cooperatively by Responsive Management and the ACT. Responsive Management conducted a pre-test of the questionnaire, and revisions were made to the questionnaire based on the pre-test.

To ensure the integrity of the telephone survey data, Responsive Management has interviewers who have been trained according to the standards established by the Council of American Survey Research Organizations. Methods of instruction included lecture and role-playing. The Survey Center Managers conducted project briefings with the interviewers prior to the administration of the survey. Interviewers were instructed on type of study, study goals and objectives, handling of survey questions, interview length, termination points and qualifiers for participation, interviewer instructions within the survey instrument, reading of the survey instrument, skip patterns, and probing and clarifying techniques necessary for specific questions on the survey instrument. The Survey Center Managers randomly monitored telephone workstations without the interviewers' knowledge to evaluate the performance of each interviewer. After the surveys were obtained by the interviewers, the Survey Center Managers and/or statisticians edited each completed survey to ensure clarity and completeness.

Interviews were conducted Monday through Friday from 9:00 a.m. to 9:00 p.m., Saturday noon to 5:00 p.m., and Sunday from 3:00 p.m. to 9:00 p.m., all local time. A five-callback design was used to maintain the representativeness of the sample, to avoid bias toward professionals easy to reach by telephone, and to provide an equal opportunity for all to participate. When a respondent could not be reached on the first call, subsequent calls were placed on different days of the week and at different times of the day. The survey was conducted in April and May 2005. Responsive Management obtained a total of 50 completed interviews.

The software used for data collection was Questionnaire Programming Language 4.1 (QPL). The survey data were entered into the computer as each interview was being conducted, eliminating manual data entry after the completion of the survey and the concomitant data entry errors that may occur with manual data entry. The survey instrument was programmed so that QPL branched, coded, and substituted phrases in the survey based on previous responses to ensure the integrity and consistency of the data collection. The analysis of data was performed using Statistical Package for the Social Sciences software as well as proprietary software developed by Responsive Management.

Note that some results may not sum to exactly 100% because of rounding.

TURBIDITY AND AQUATIC AREAS OF INTEREST

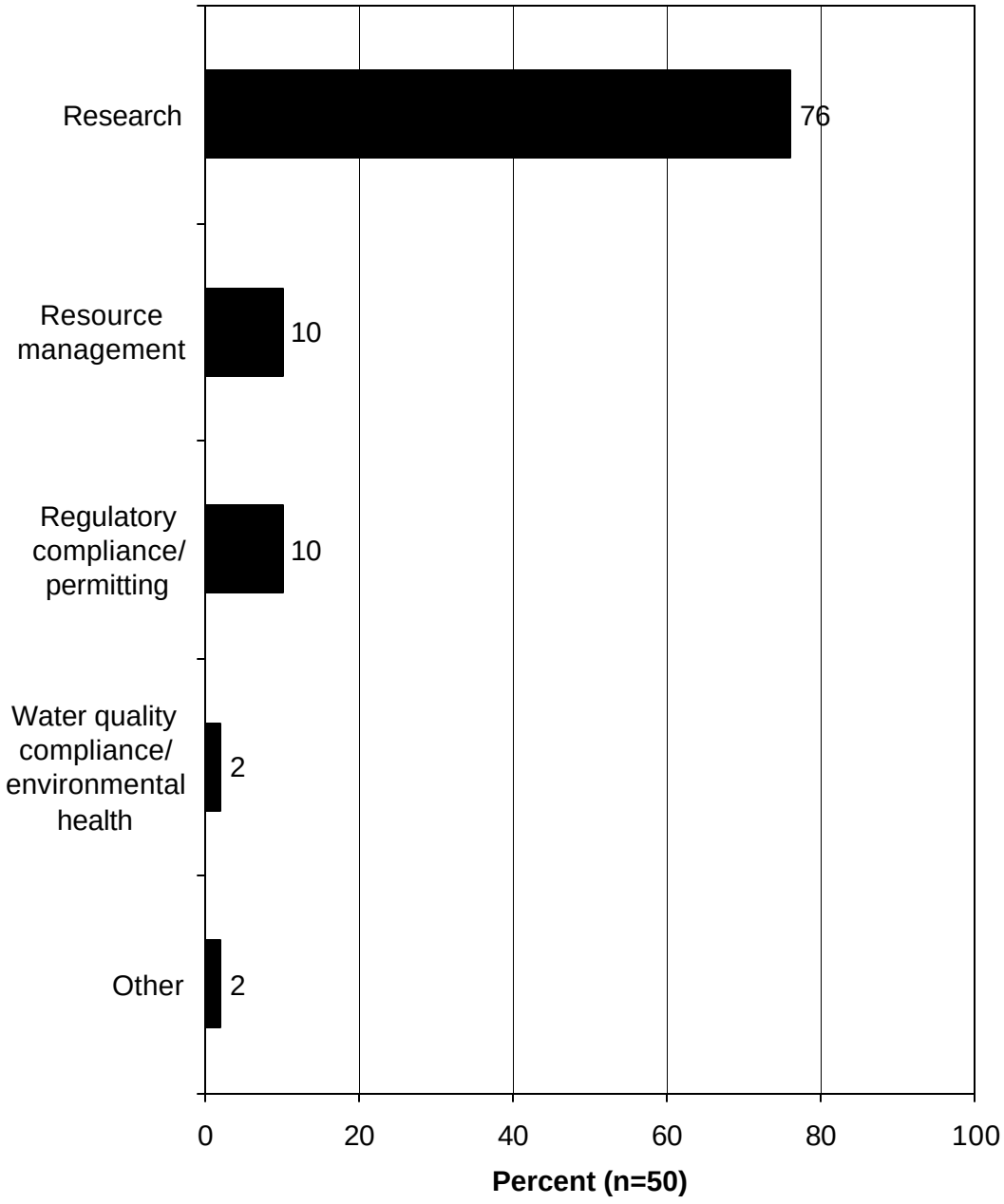
- Overwhelmingly, respondents listed their primary sensor deployment area of interest as research (76%); 10% listed resource management, and 10% listed regulatory compliance/permitting as their primary sensor deployment area of interest.

- A majority of respondents (68%) did not have any additional sensor deployment areas of interest. Most commonly, the other sensor deployment area of interest was resource management (22%). Other additional sensor deployment areas of interest were regulatory compliance/permitting (12%), research (6%), water quality compliance/environmental health (4%), and potable water treatment (2%).

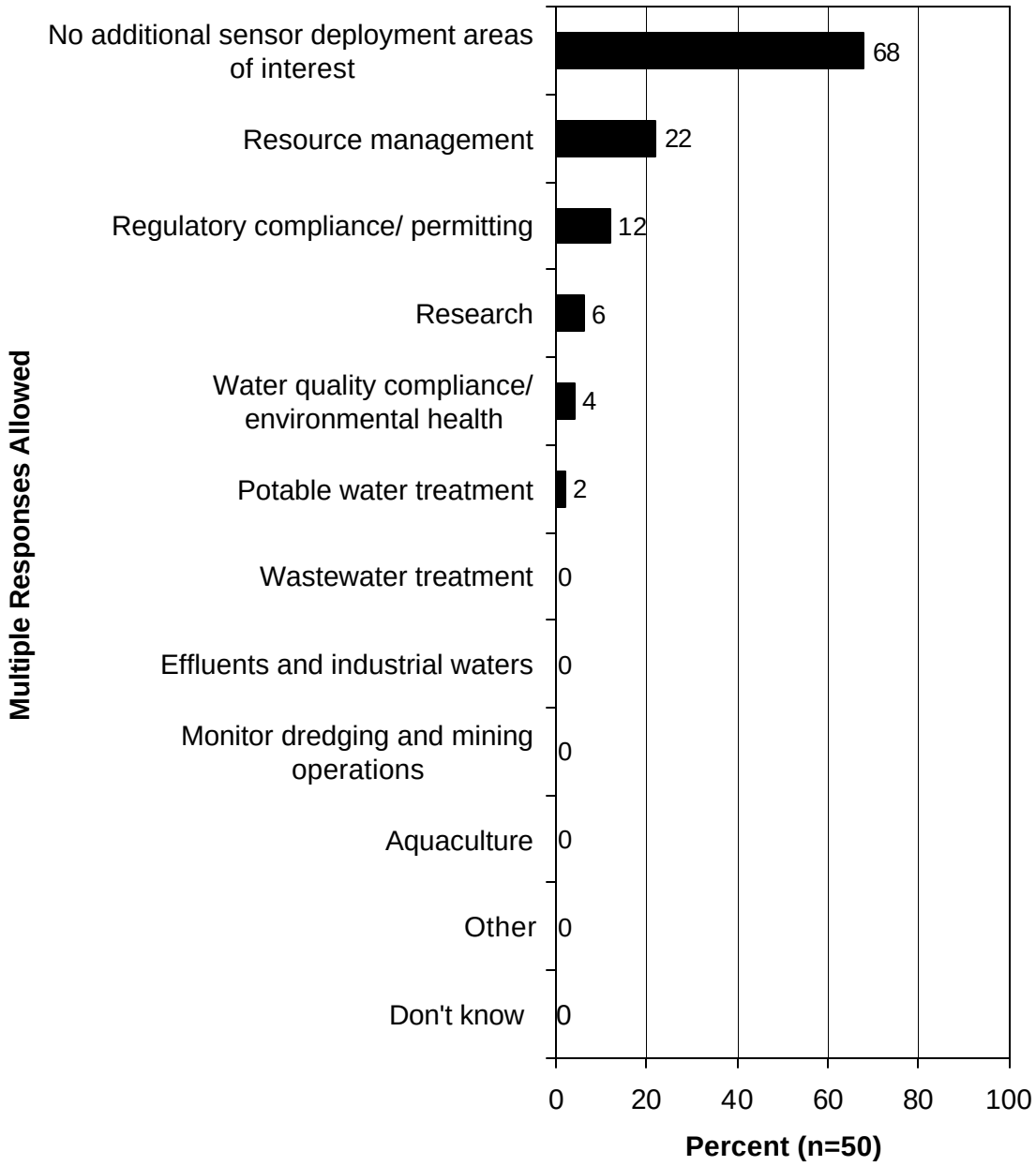
- The top aquatic environment of interest is coastal/near shore (50%), followed by rivers/lakes/freshwater wetlands (42%), estuarine (32%), shallow water (22%), and bluewater/marine (14%).

- The organizations of the respondents, which shed light on the areas of interest, are listed in the section of this report titled, "Characteristics of Sample."

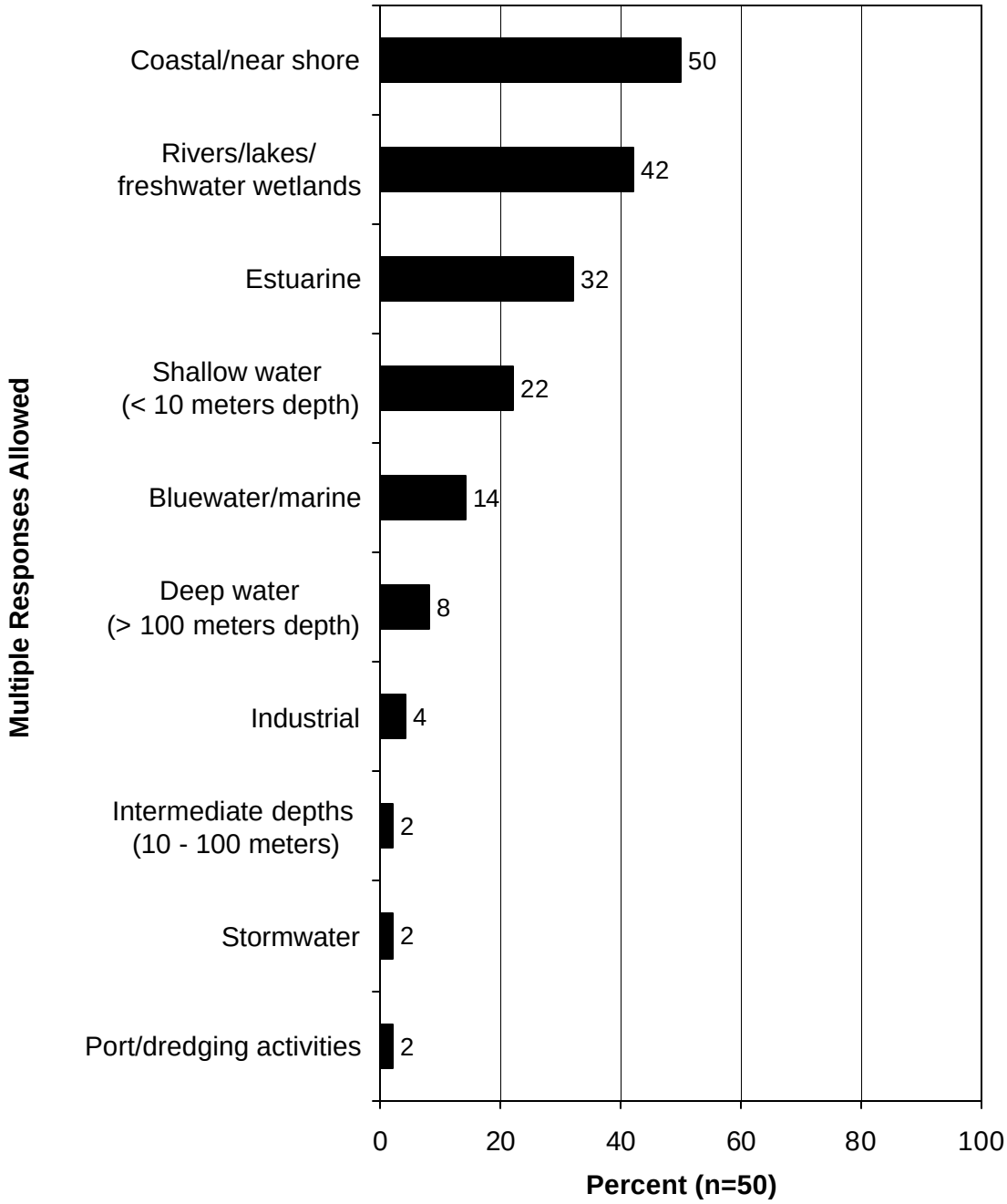
Q20. Which of the following best represents your primary sensor deployment area of interest or application concern?



Q23. Which of the following represent any additional sensor deployment areas of interest or application concern for you?



Q26. Which of the following represent your primary investigation/monitoring environments?



SPECIFIC PROCEDURES/ASPECTS OF MEASURING TURBIDITY

MEASURING TURBIDITY

- A majority of coastal professionals (66%) define turbidity as the decrease in transparency of water due to presence of suspended solids and some dissolved substances.
  - 34% define turbidity as the amount of suspended particles only.

- About a quarter of respondents (24%) are required to use specific approved analytical techniques and procedures.
  - EPA standards were the most commonly used (42% of those required to use specific approved analytical techniques), followed by USGS standards (17%).
  - 42% of respondents required to use specific procedures use other approved analytical techniques and procedures (a tabulation shows the descriptions of the other techniques and procedures used).

- About a quarter of respondents (26%) said their sensor needs or requirements are non-standard (a tabulation shows the descriptions of non-standard needs).

- A majority of coastal professionals (60%) measure turbidity using NTU (nephelometric turbidity units), while 12% measure turbidity using mg/l (milligrams per liter).
  - 22% of respondents measure turbidity in other units of measurement.

- Most commonly, those who measure turbidity in NTU said the typical range they measure is one other than any of the response options provided (37%), typically because their turbidity range includes more than one of the categories that were provided as an answer.
  - 27% said the typical range they measure is more than 100 NTU, while 13% answered each 10 to 100 NTU (13%) and 1 to 10 NTU (13%).
  - A tabulation shows the other typical ranges measured in NTU.

- About a third (33%) of those of those who measure turbidity using mg/l said the typical range they measure is more than 100 mg/l, and another third (33%) said the typical range they measure is 10 to 100 mg/l; 17% said the typical range they measure is 1 to 10 mg/l.

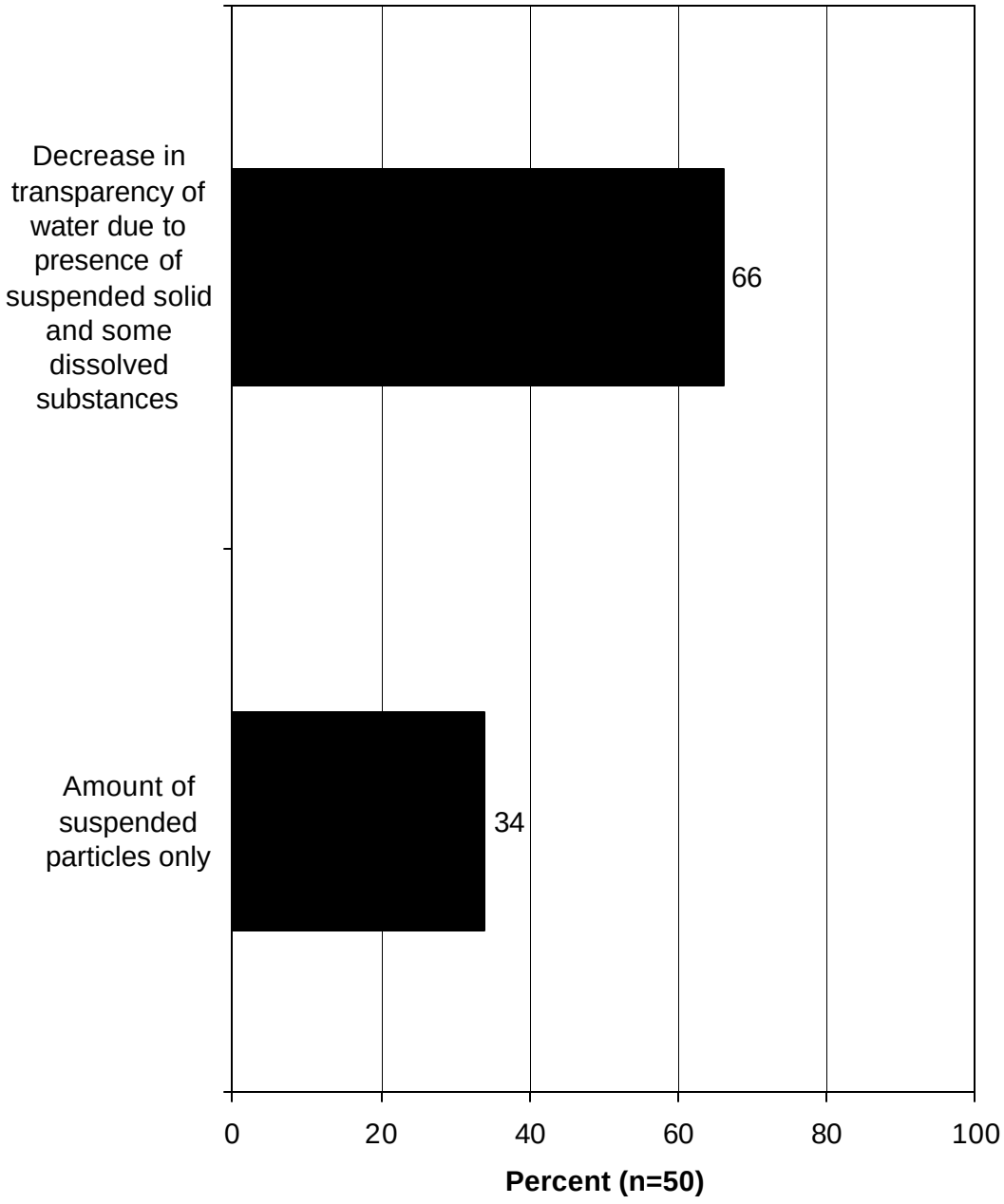
- Fourteen percent of respondents indicated that there are detection limits and/or ranges for turbidity measurements that are set by regulations or other needs of the data.
  - A tabulation shows the required detection limits and/or ranges for turbidity measurements.

- A majority of the sample of coastal professionals (64%) currently use in-situ turbidity sensors, and these are typically commercial products (these graphs are shown in the subsection of the report titled, "In-Situ Turbidity Sensors").

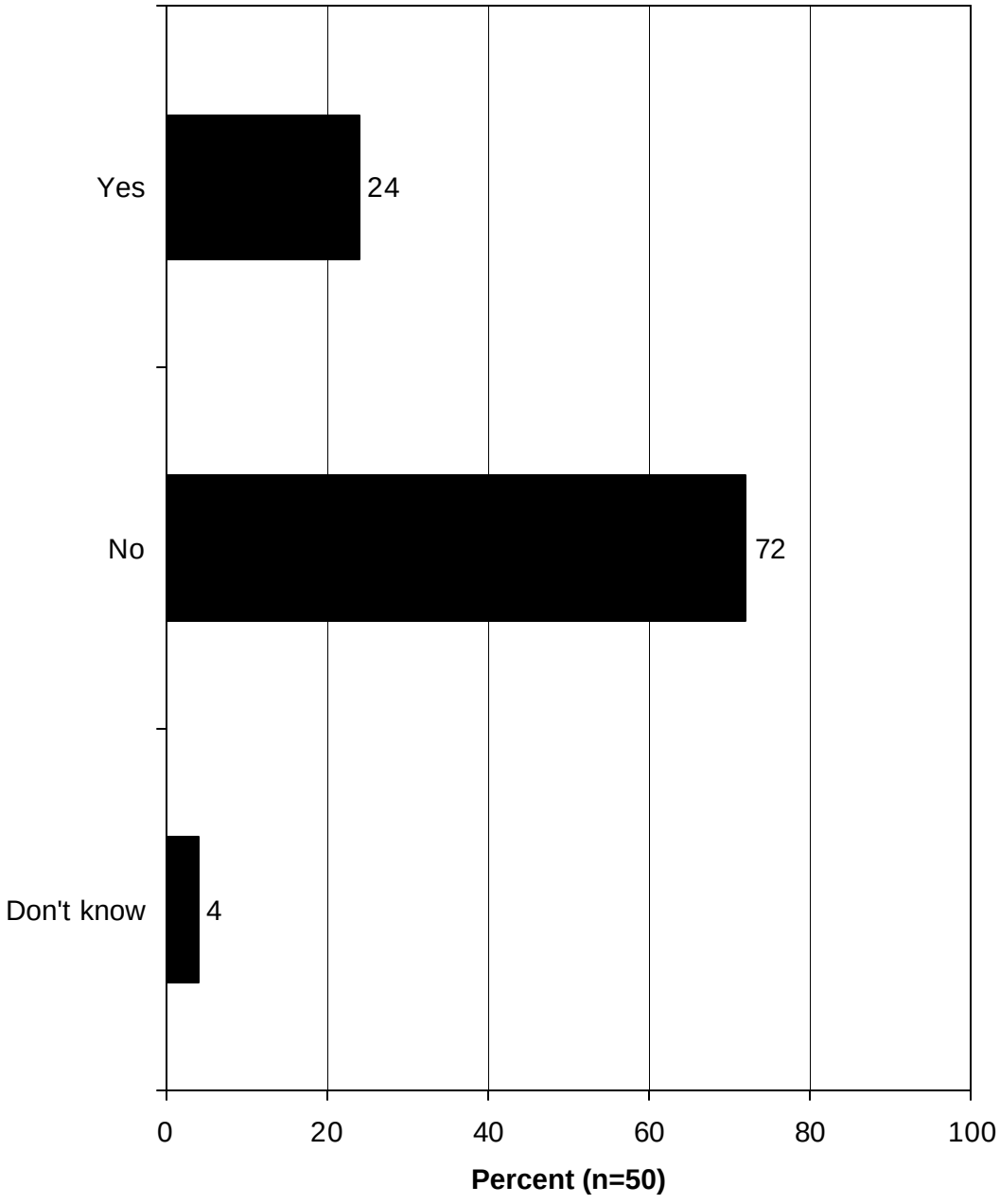
- Of those who do not currently use in-situ turbidity sensors, 56% currently measure turbidity using other methods (this graph is shown in the subsection of the report titled, "Other Methods Used to Measure Turbidity").

- An overwhelming majority of those who do not currently use in-situ turbidity sensors (72%) use in-house sample analyses to conduct turbidity measurements; 11% do not currently measure turbidity (this graph is shown in the subsection of the report titled, "Other Methods Used to Measure Turbidity").

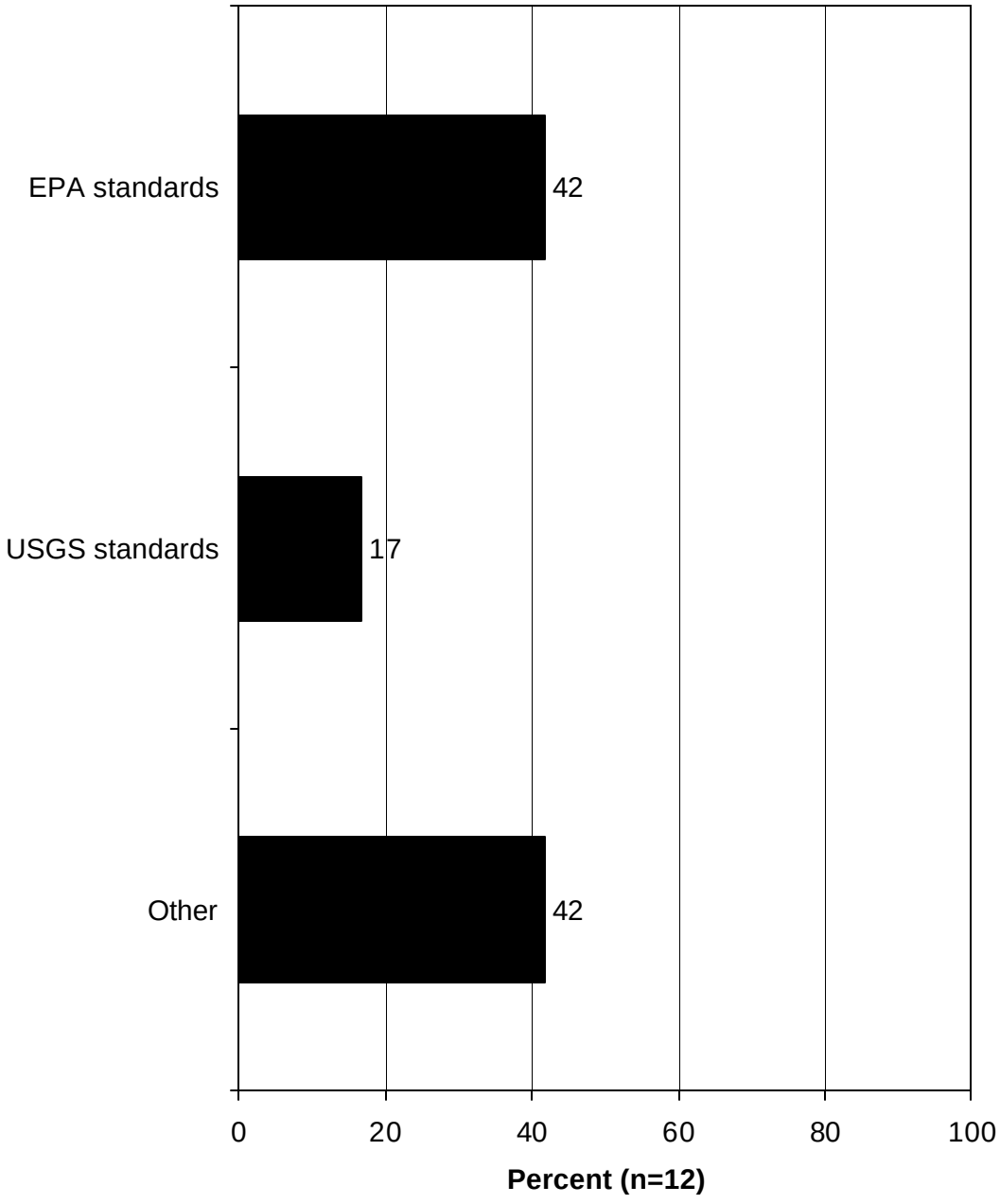
Q7. How do you define turbidity?



Q18. Are you required to use any specific approved analytical techniques and procedures?



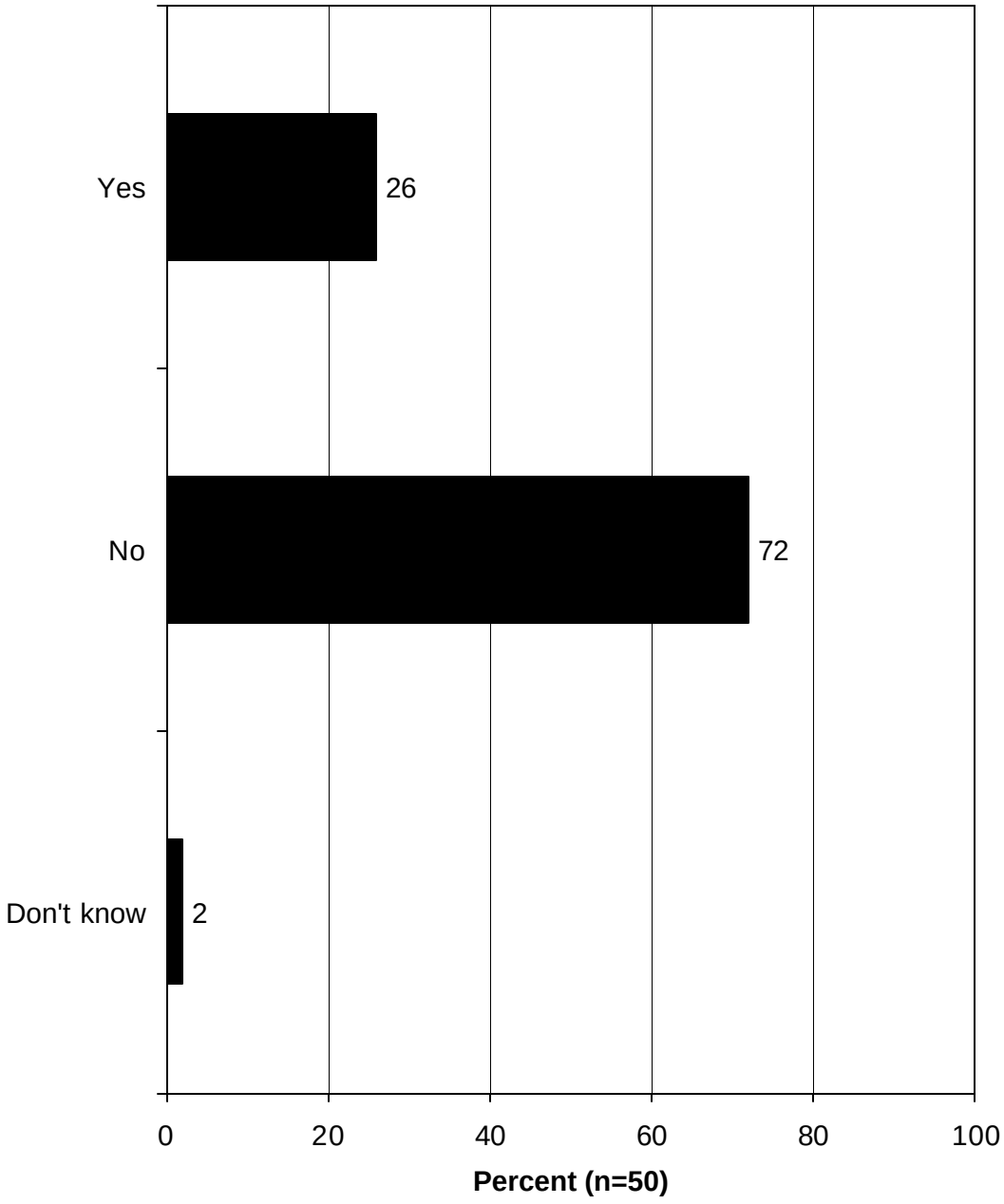
Q19. What specific approved analytical techniques and procedures are you required to use? (Asked of those who are required to use specific approved analytical techniques and procedures.)



Q19. What specific approved analytical techniques and procedures are you required to use? (Among those who use specific approved analytical techniques and procedures but who do not use EPA or USGS standards.)

Other analytical techniques	Number of respondents
ASTM standards	1
In-line turbidity instrument	1
Required to meet the NTU regulations	1
Sediments	1
YSI 6600 approved methods	1

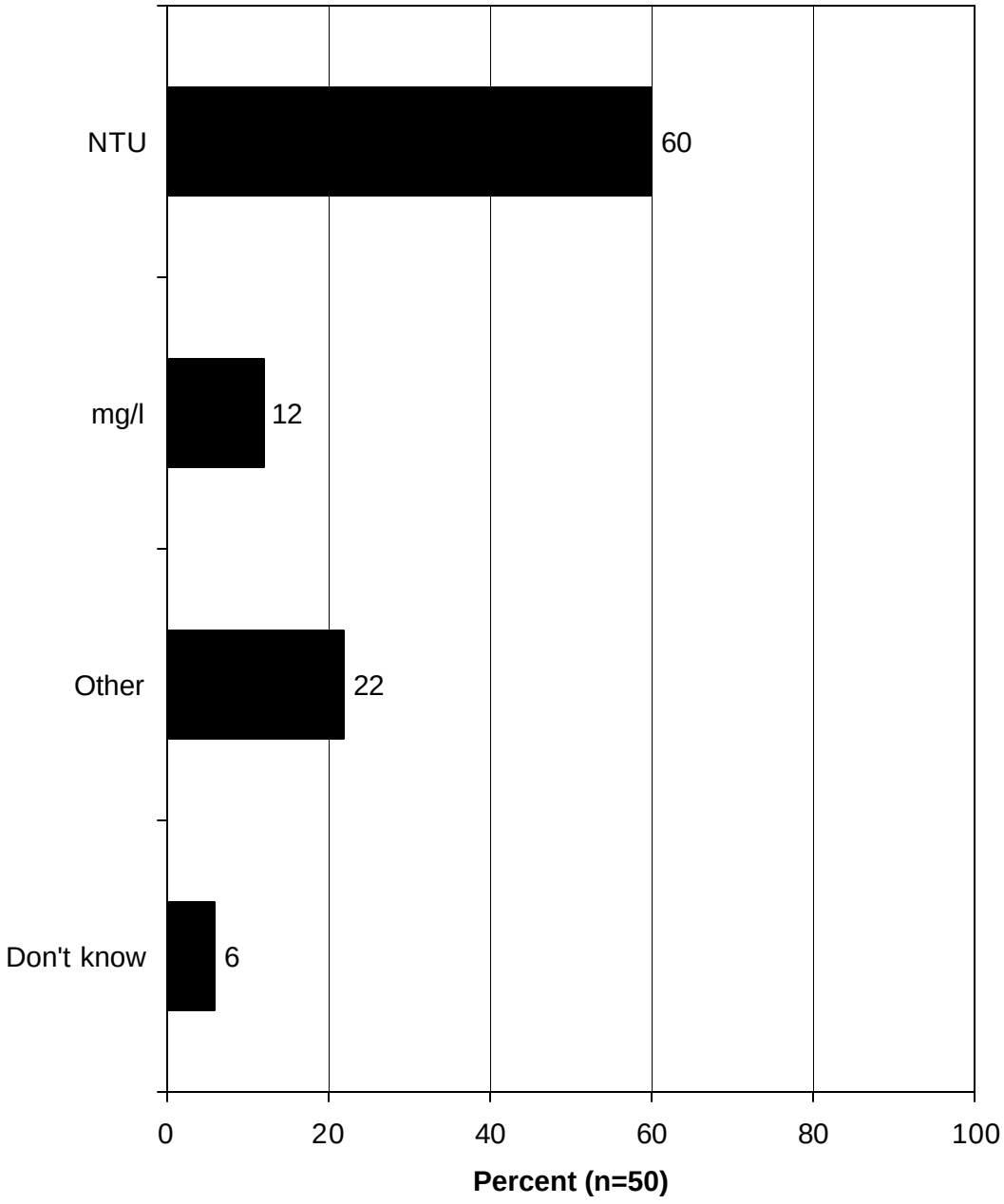
Q123. Relative to the sensor system characteristics we just discussed, are any of your sensor needs or requirements 'non-standard' or custom?



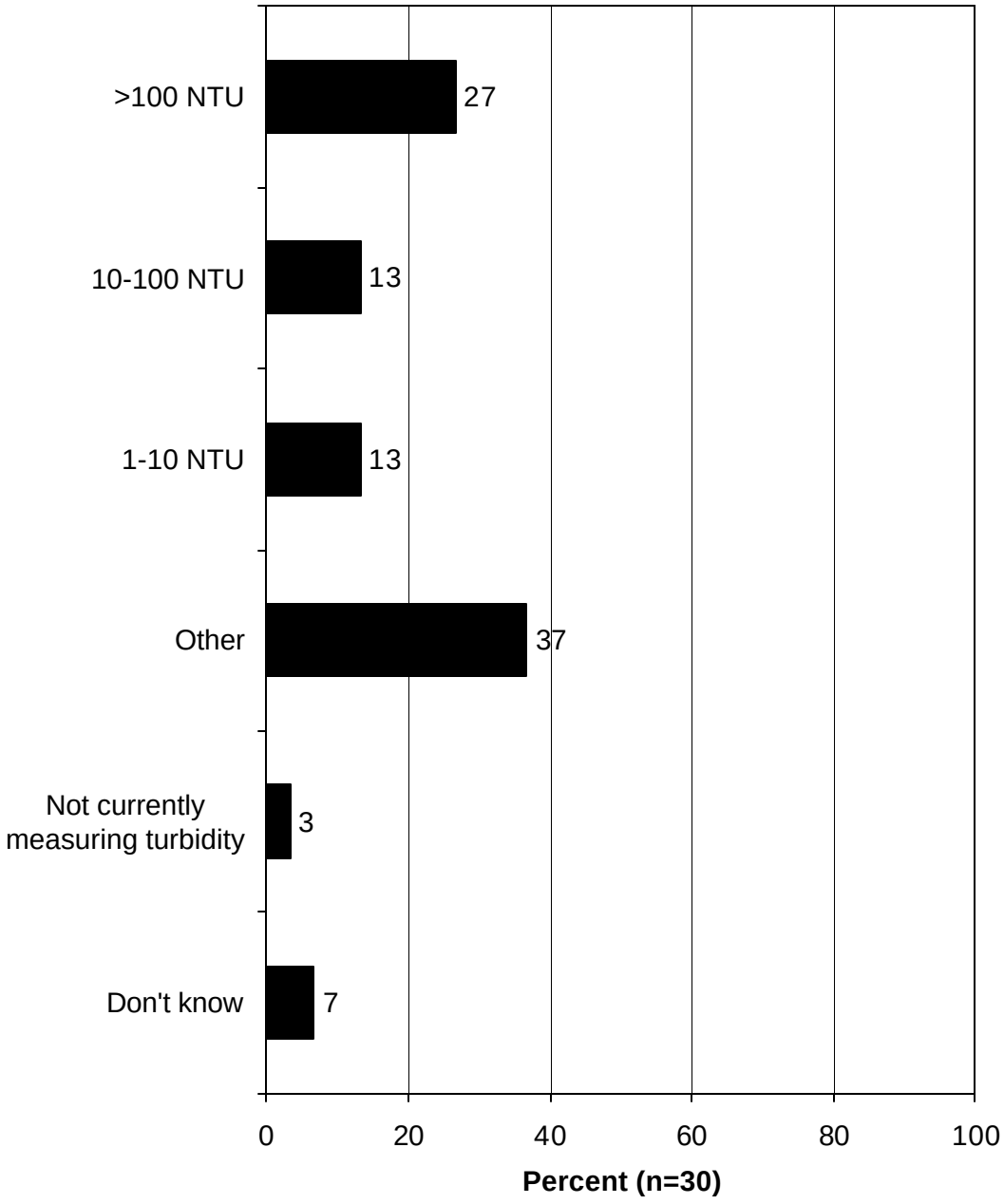
Q124. Which of your sensor needs or requirements are "non-standard" or custom? (Asked of those who said they had sensor needs and requirements that were non-standard.)

"Non-standard" or custom sensor needs and requirements	Number of respondents
All are	1
Constructed self-operating turbidity sensor	1
Dependant on customer	1
Depth analyzers	1
Half of our needs are non-standard	1
Laser work	1
Optical sensors	1
Optimizing of parameters	1
Putting them on gliders	1
Real small space intervals	1
High sampling rate	2

Q9. Which units do you use to measure turbidity?



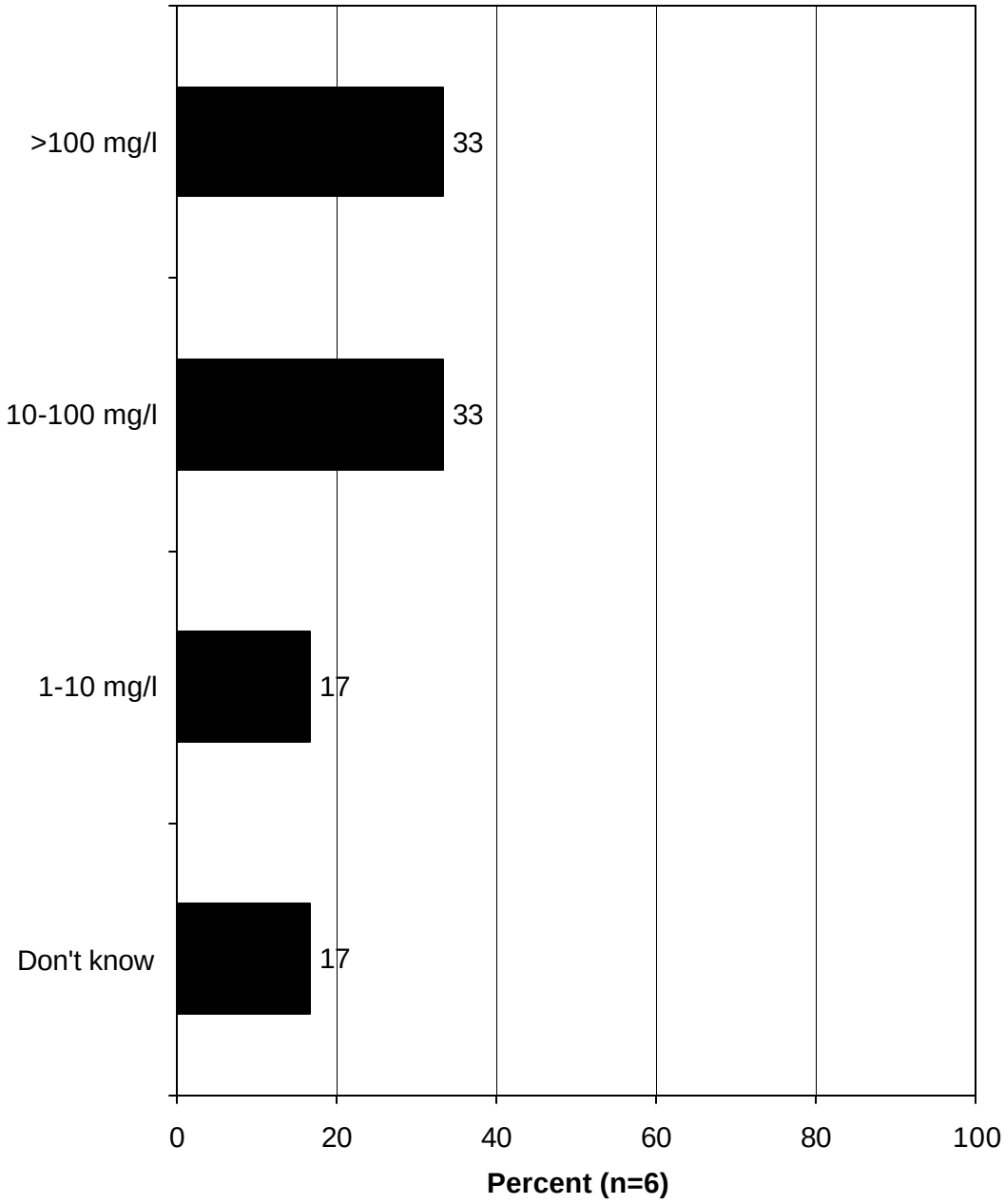
Q11. What is the typical range of turbidity NTU you are currently measuring? (Asked of those who measure turbidity in NTU.)



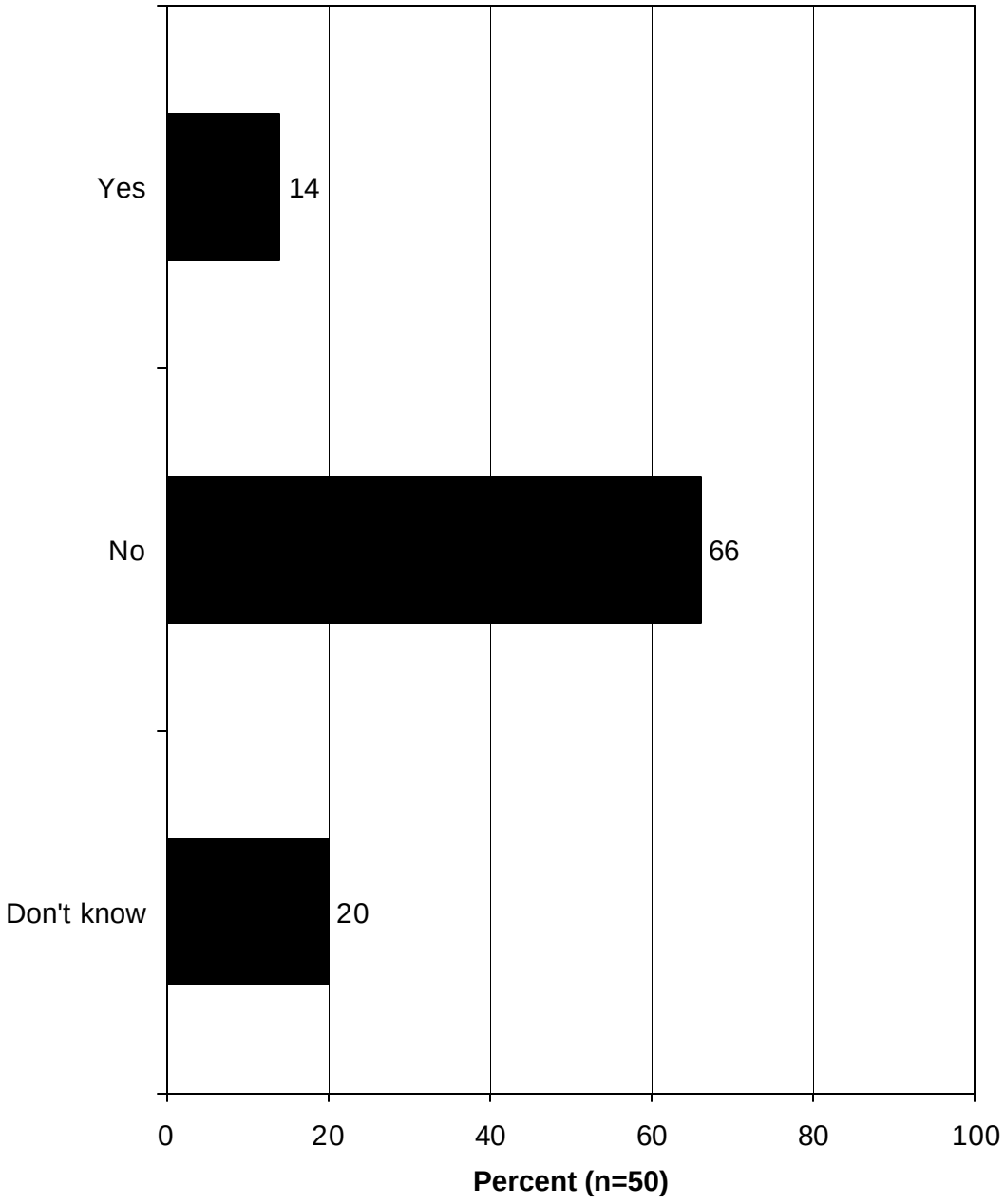
Q11. What is the typical range of turbidity NTU you are currently measuring? (Asked of those who measure turbidity in NTU.)

Other typical ranges of NTU	Number of respondents
0-20	1
0-100	1
0-200	1
0-1000	1
0-1000, 1000-1500	1
50-1000	1
0-1600	1
0-2000	3

Q13. What is the typical range of mg/l you are currently measuring? (Asked of those who measure turbidity in mg/l.)



Q16. Are there any required detection limits and/or ranges, such as limits required by regulations, for the turbidity measurement?



Q17. What are the required detection limits and/or ranges for the turbidity measurement? (Asked of those with required detection limits and/or ranges.)

Required detection limits and/or ranges	Unit of measurement	Number of respondents
0.1 for 15-minute period	NTU	1
95% less than 0.3 NTU	NTU	1
In flux right now	NTU	1
100	mg/l	1
EPA standards	mg/l	1

IN-SITU TURBIDITY SENSORS

- A majority of the sample of coastal professionals (64%) currently use in-situ turbidity sensors, and these are typically commercial products.
  - Of those who currently use in-situ turbidity sensors, 88% use a commercial product alone, 3% use a custom-designed and custom-made sensor, and 9% use a combination of commercial and custom-made.

- Of those who currently use in-situ turbidity sensors, 59% use multiple sensors, while 41% use only one sensor.

- A majority of those who currently use in-situ turbidity sensors (78%) use a package of sensors to acquire a turbidity reading in conjunction with other measurements; 22% use an independent turbidity sensor to measure turbidity only.

- The most common application for turbidity sensors is as a deployed sensor on a remote platform for continuous in-situ measurements (66%).
  - A quarter of those who use in-situ turbidity sensors use one sensor as part of a suite of instruments used for profiling.

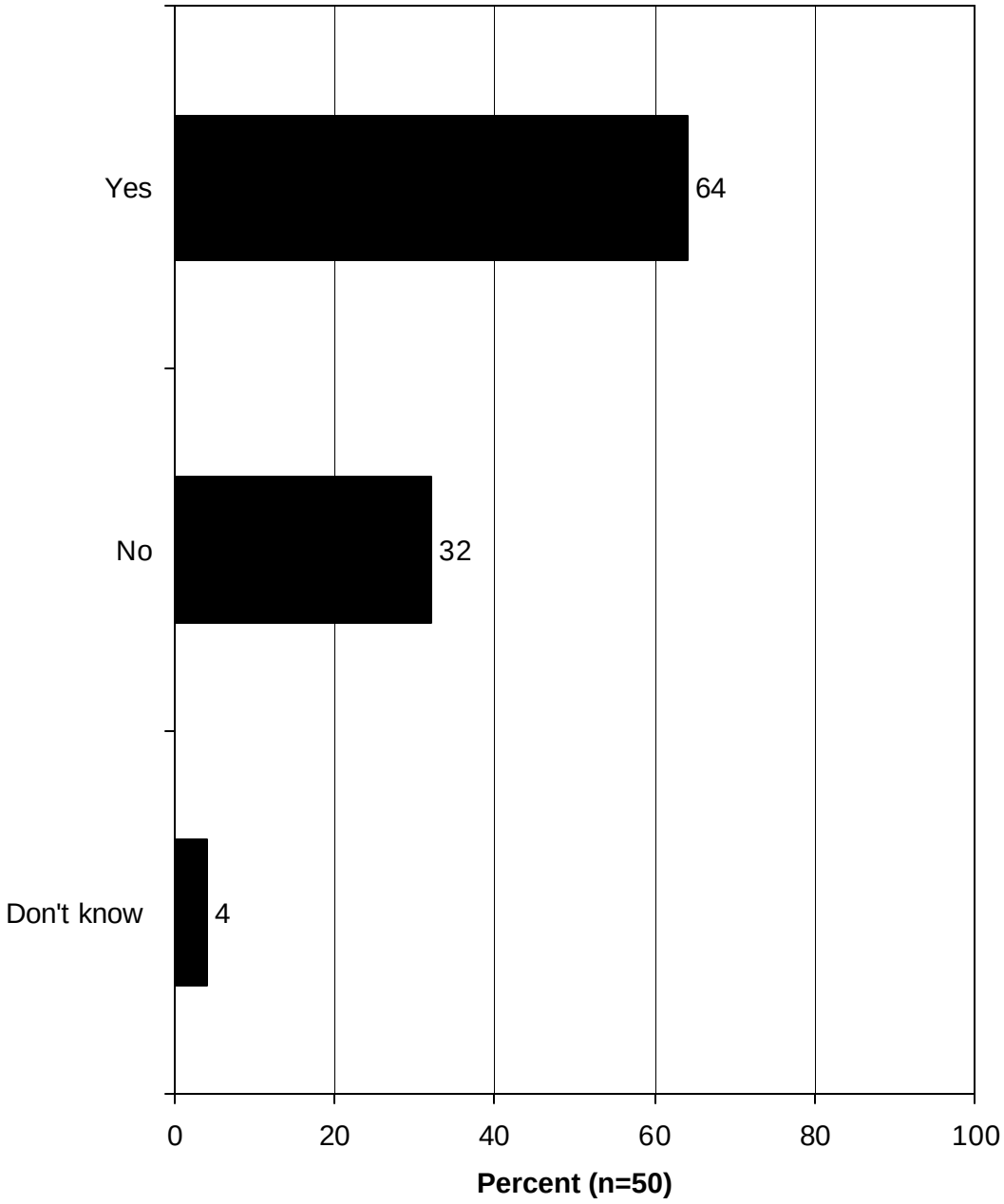
- Most commonly, those who use in-situ turbidity sensors take measurements more often than hourly (38%); however, the next most common measurement interval is monthly (25%).

- All 50 respondents were asked to rate the importance of turbidity sensor characteristics. The performance characteristics of most importance are reliability, accuracy, product support/warranty/vendor reputation, range/detection limits, precision, and calibration life.
  - There was little variation of mean ratings of importance for each characteristic among those who currently use in-situ turbidity sensors and those who do not currently use in-situ turbidity sensors.
  - Reliability, precision, and calibration life were the sensor characteristics for which individual ratings of importance varied by approximately 20 percentage points or more

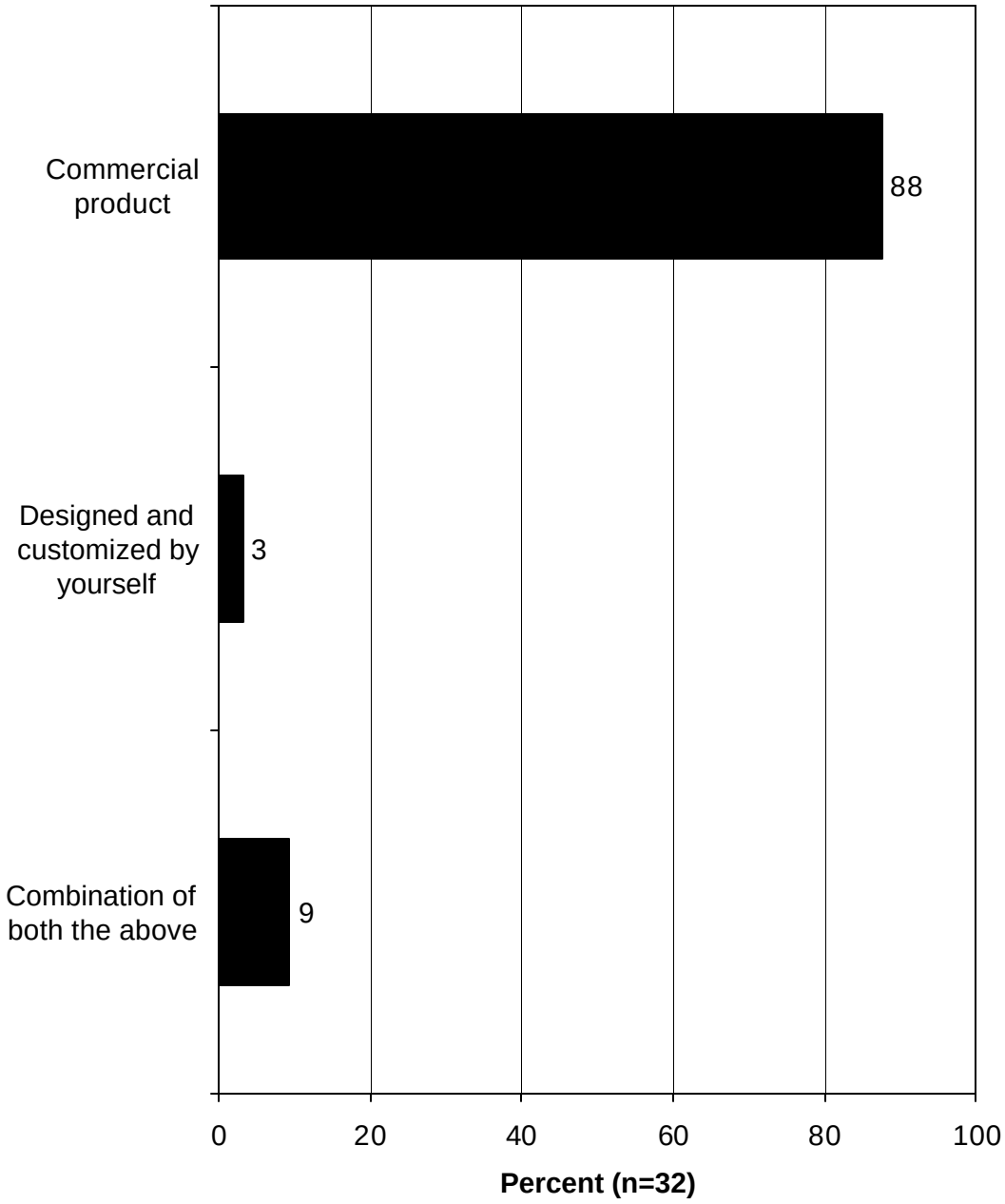
among those who currently use in-situ turbidity sensors and those who do not currently use in-situ turbidity sensors.

- Those who are currently using in-situ turbidity sensors were *more* likely to rate the importance of reliability as a 5 (very important) than were those who do not currently use in-situ turbidity sensors (94% compared to 69%).
- Those who are currently using in-situ turbidity sensors were *less* likely to rate the importance of precision as a 5 (very important) than were those who do not currently use in-situ turbidity sensors (35% compared to 56%).
- Those who are currently using in-situ turbidity sensors were *more* likely to rate the importance of calibration life as a 4 or 5 than were those who do not currently use in-situ turbidity sensors (82% compared to 63%).

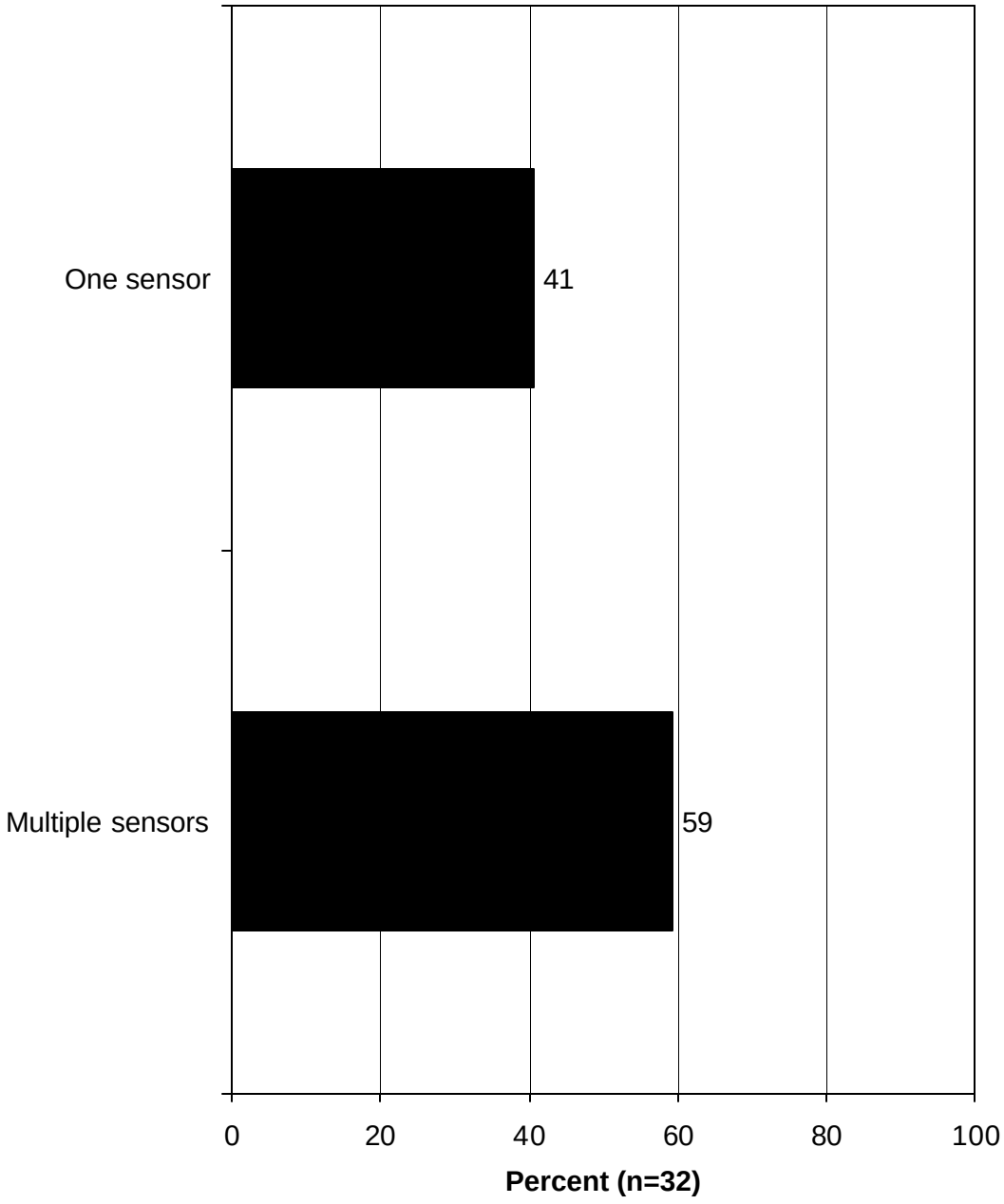
Q28. Do you currently use in-situ turbidity sensors?



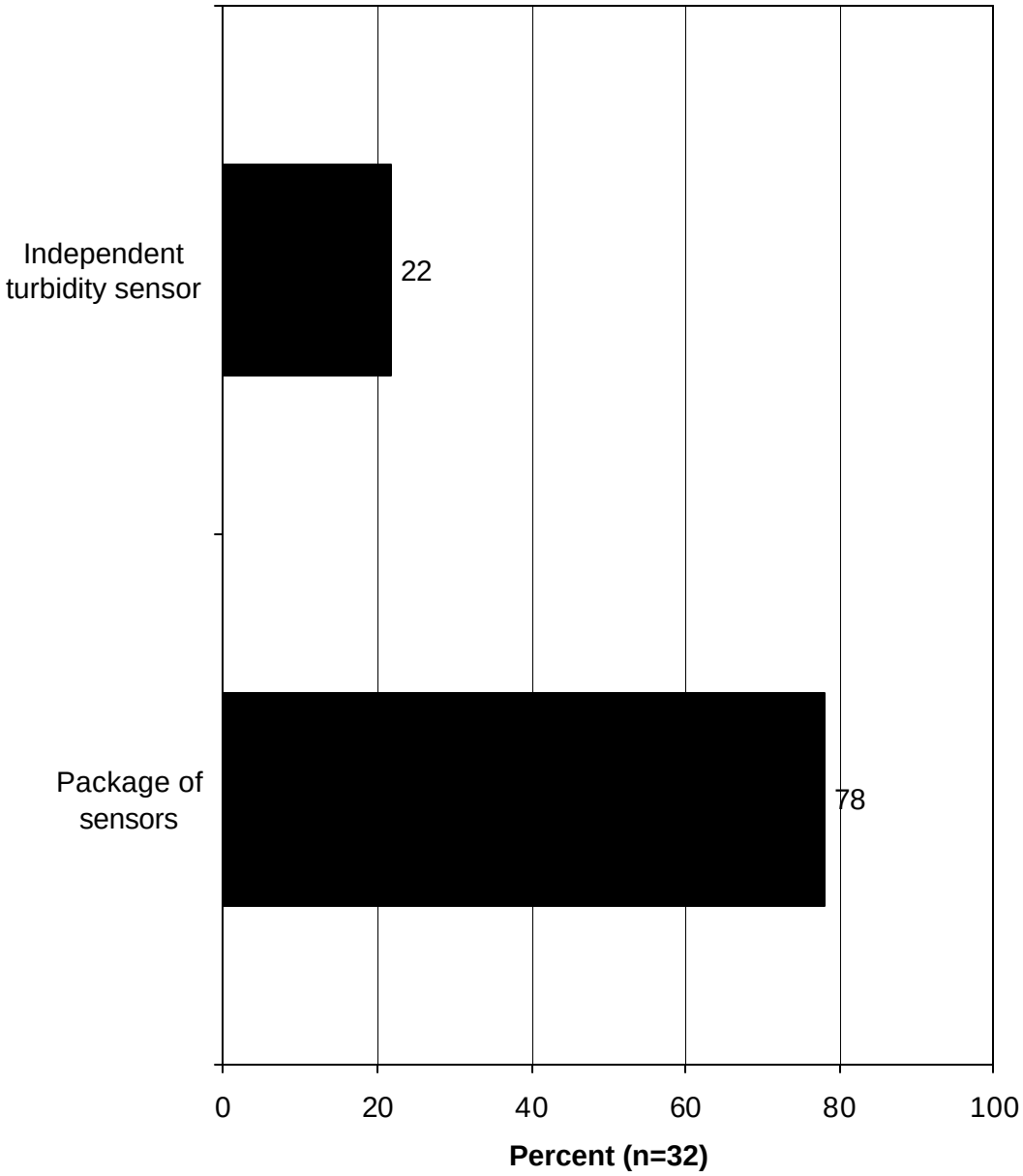
Q31. Are your current sensors commercial product, designed and customized by yourself, or a combination of both? (Asked of those who currently use in-situ turbidity sensors.)



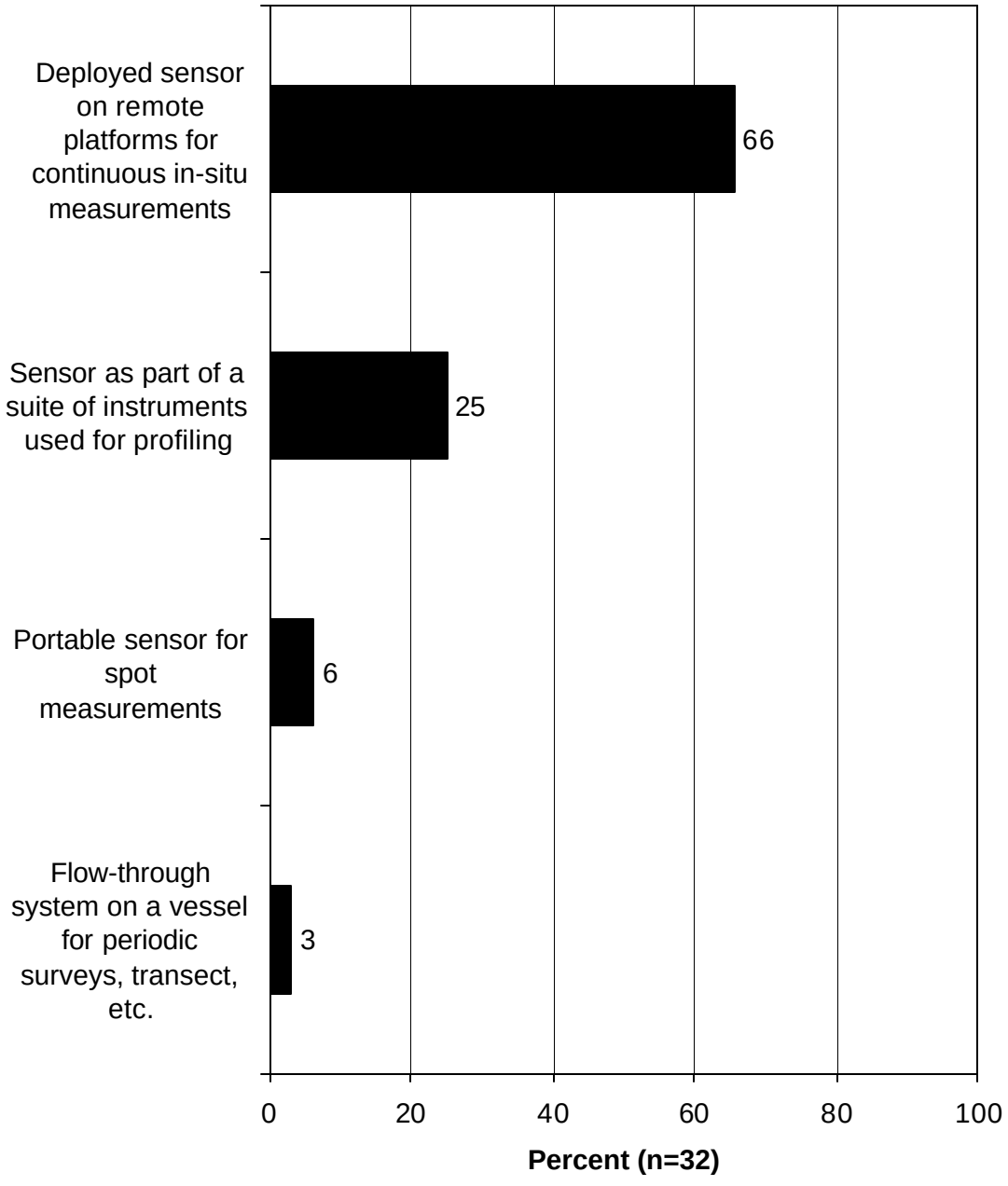
Q32. Do you use one turbidity sensor or do you use multiple turbidity sensors? (Asked of those who currently use in-situ turbidity sensors.)



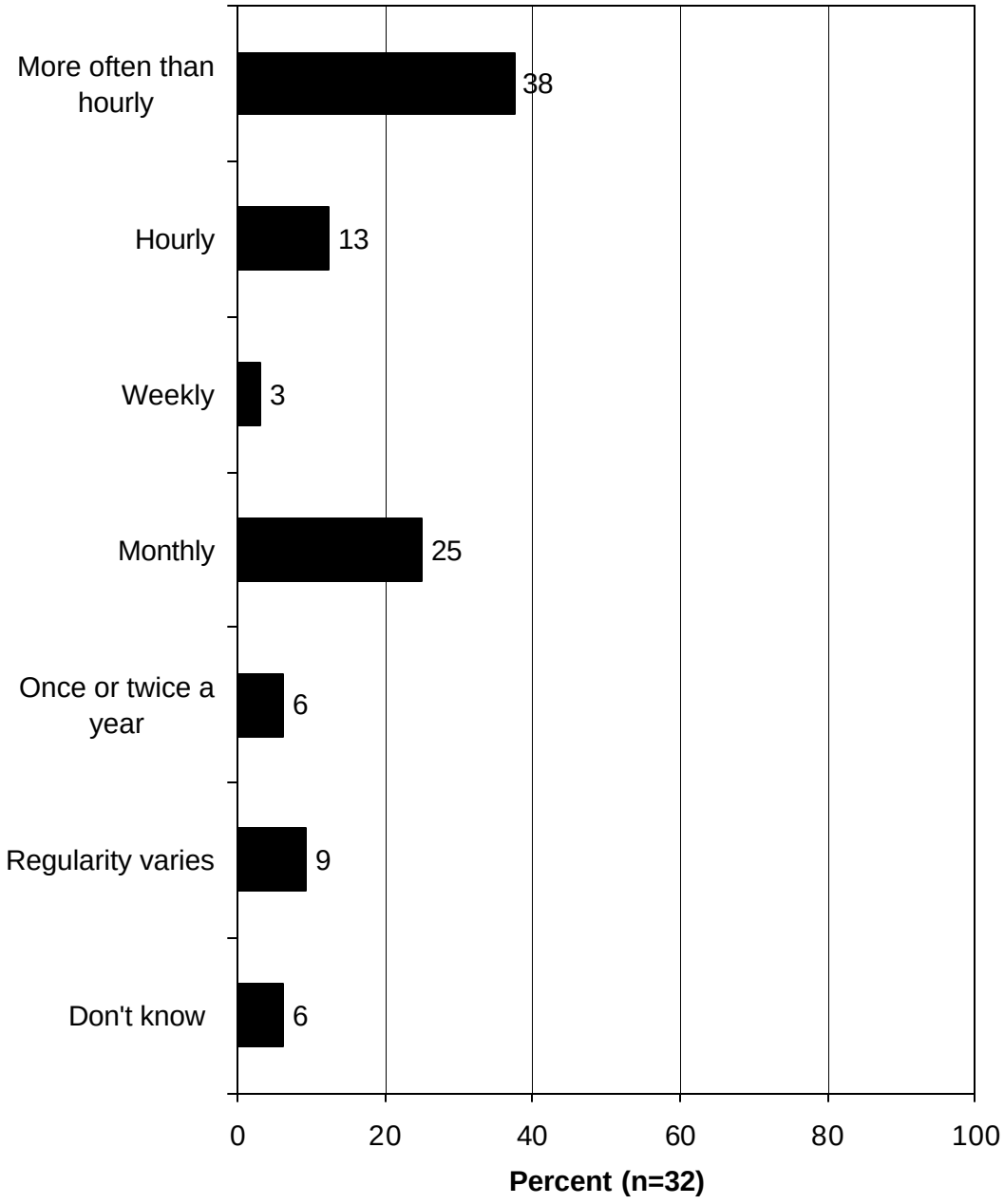
Q33. Do you use an independent turbidity sensor to measure only turbidity, or do you use a package of sensors to acquire a turbidity reading in conjunction with other measurements, such as temperature, salinity, or fluorescence? (Asked of those who currently use in-situ turbidity sensors.)



Q29. What is your most common application? (Asked of those who currently use in-situ turbidity sensors.)



Q35. How often do you need to do turbidity measurements? (Asked of those who currently use in-situ turbidity sensors.)

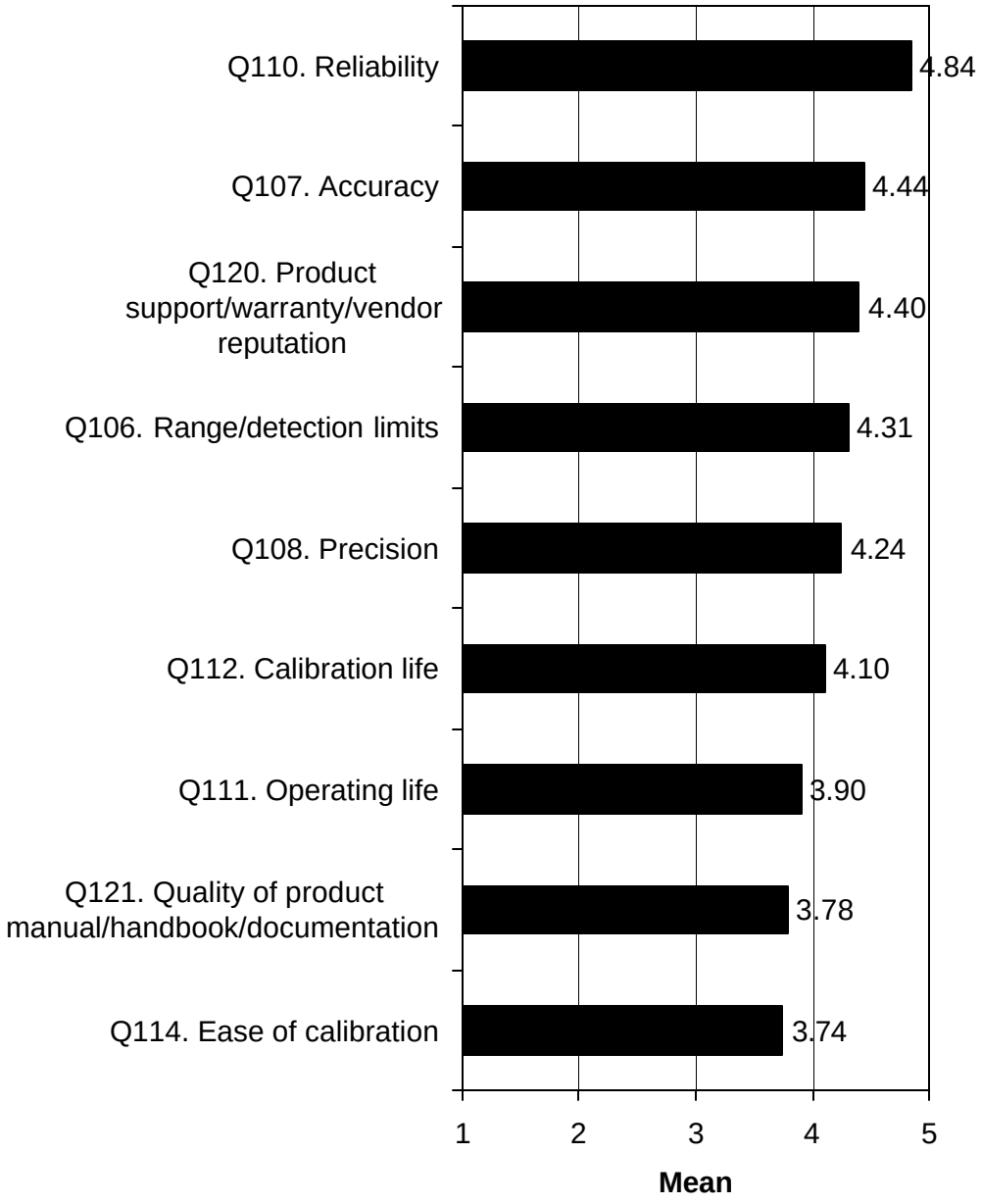


Ratings of the Importance of the Following Performance Characteristics

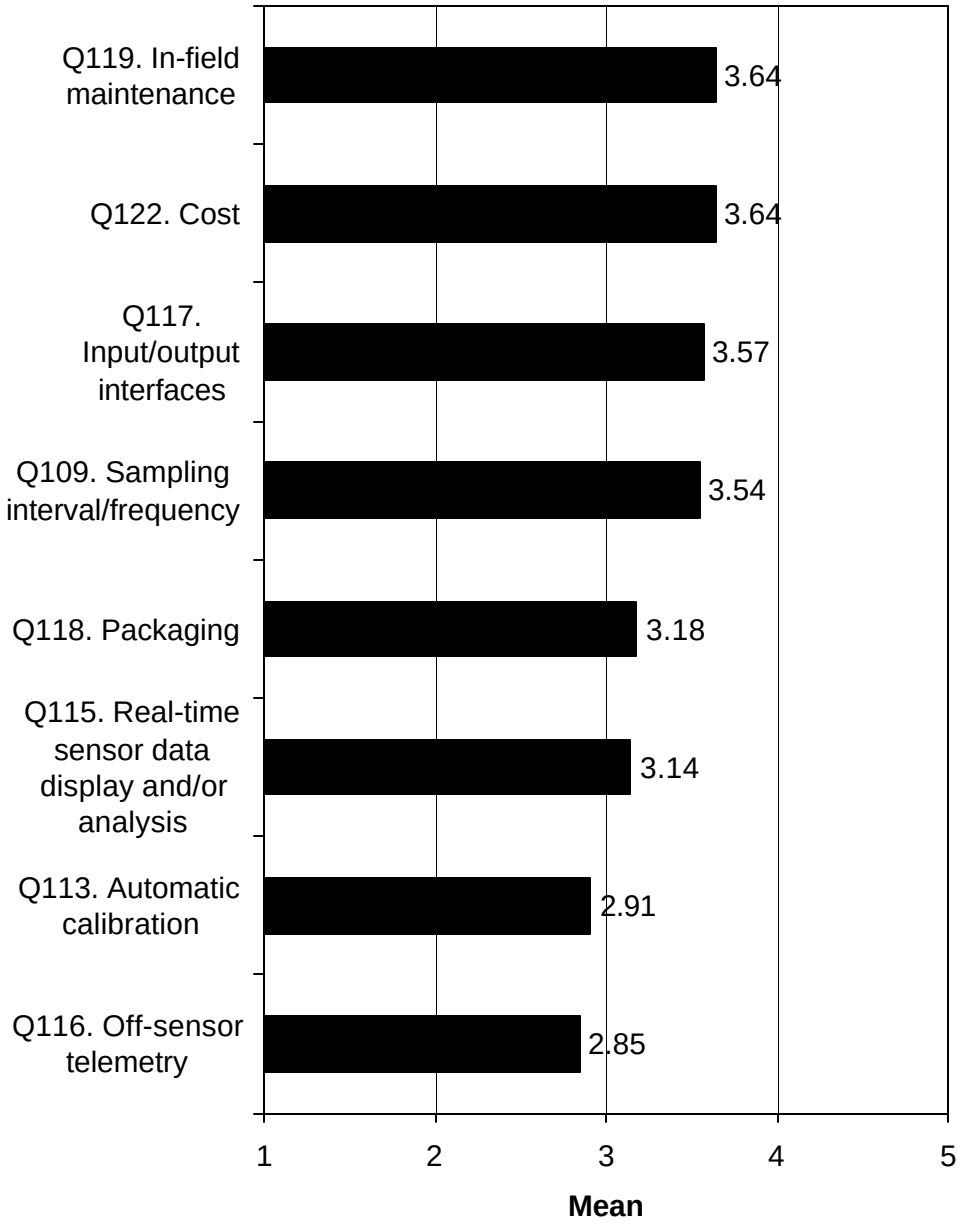
Performance Characteristic **(sorted by mean)**	**Percent Rating Item the Highest in Importance (5)**	**Percent Rating the Item Low in Importance (1, 2, or 3)**	**Mean**
Q110. Reliability	86	2	4.84
Q107. Accuracy	56	10	4.44
Q120. Product support/ warranty/vendor reputation	50	10	4.40
Q106. Range/detection limits	49	14	4.31
Q108. Precision	41	14	4.24
Q112. Calibration life	38	26	4.10
Q111. Operating life (i.e., life expectancy of the instrument)	28	36	3.90
Q121. Quality of product manual/handbook/documentation	20	30	3.78
Q114. Ease of calibration	24	38	3.74
Q119. In-field maintenance	24	46	3.64
Q122. Cost	18	50	3.64
Q117. Input/output interfaces	18	43	3.57
Q109. Sampling interval/ frequency	24	54	3.54
Q118. Packaging	12	60	3.18
Q179. Real-time sensor data display and/or analysis	18	57	3.14
Q113. Automatic calibration	12	68	2.91
Q116. Off-sensor telemetry	13	65	2.85
	Mean is: 31.24	*Mean is: 36.65*	*Mean is: 3.78*

Scale is 1 to 5, with 5 being the highest importance.

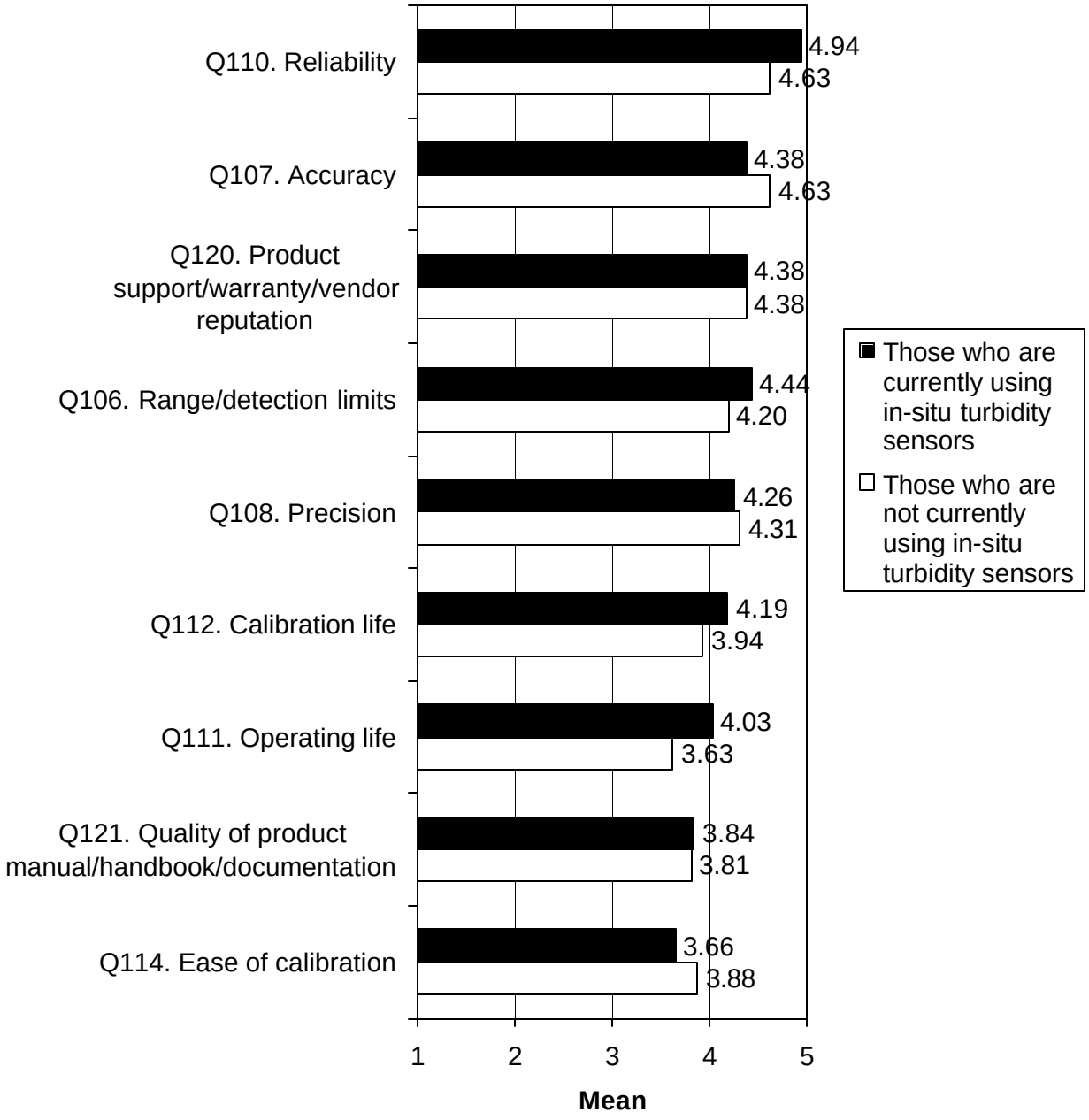
Q106-Q122. Means of importance of characteristics in a turbidity sensor on a scale of 1 to 5, where 1 is not at all important and 5 is very important. (Part 1)



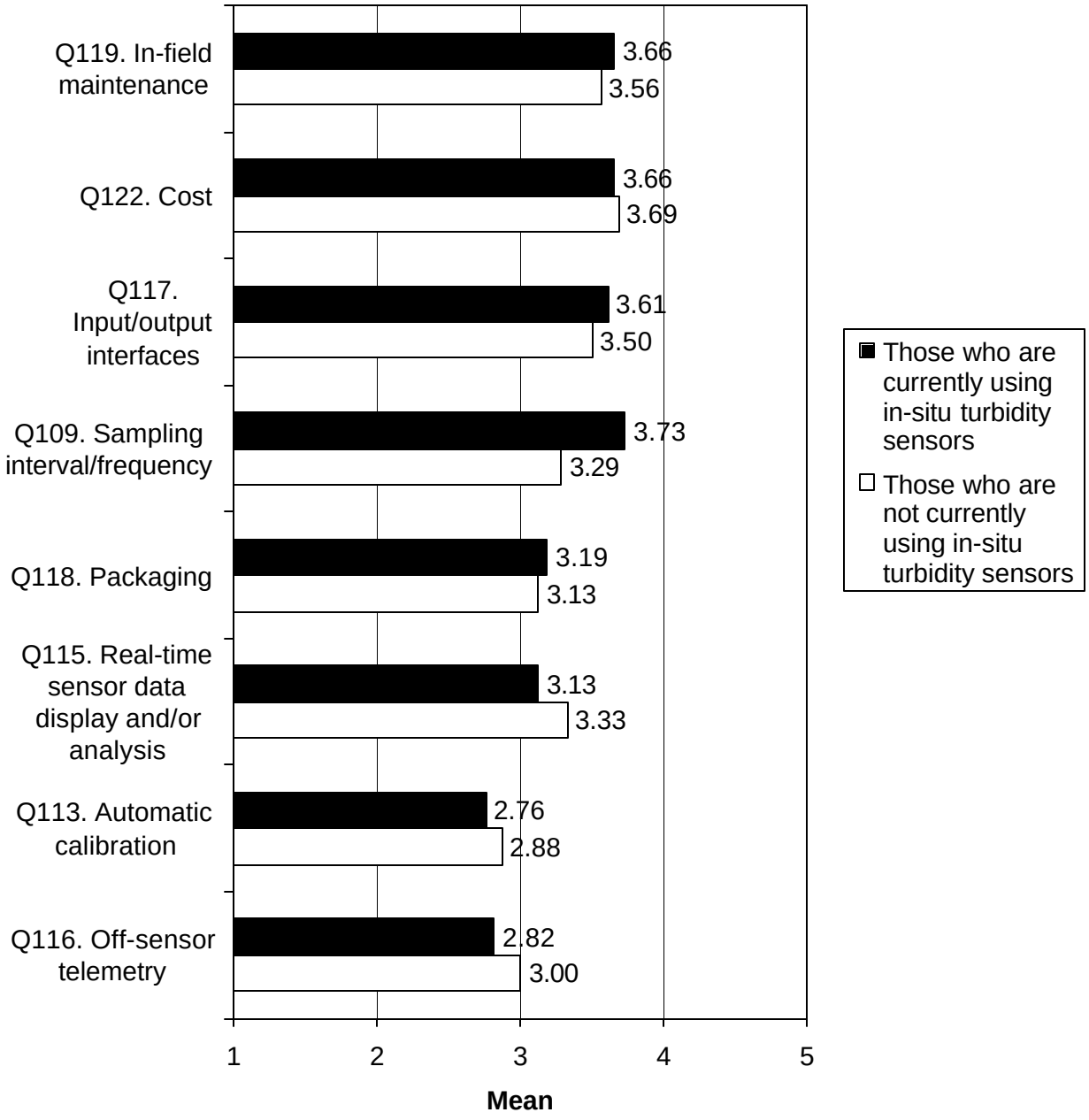
Q106-Q122. Means of importance of characteristics in a turbidity sensor on a scale of 1 to 5, where 1 is not at all important and 5 is very important. (Part 2)



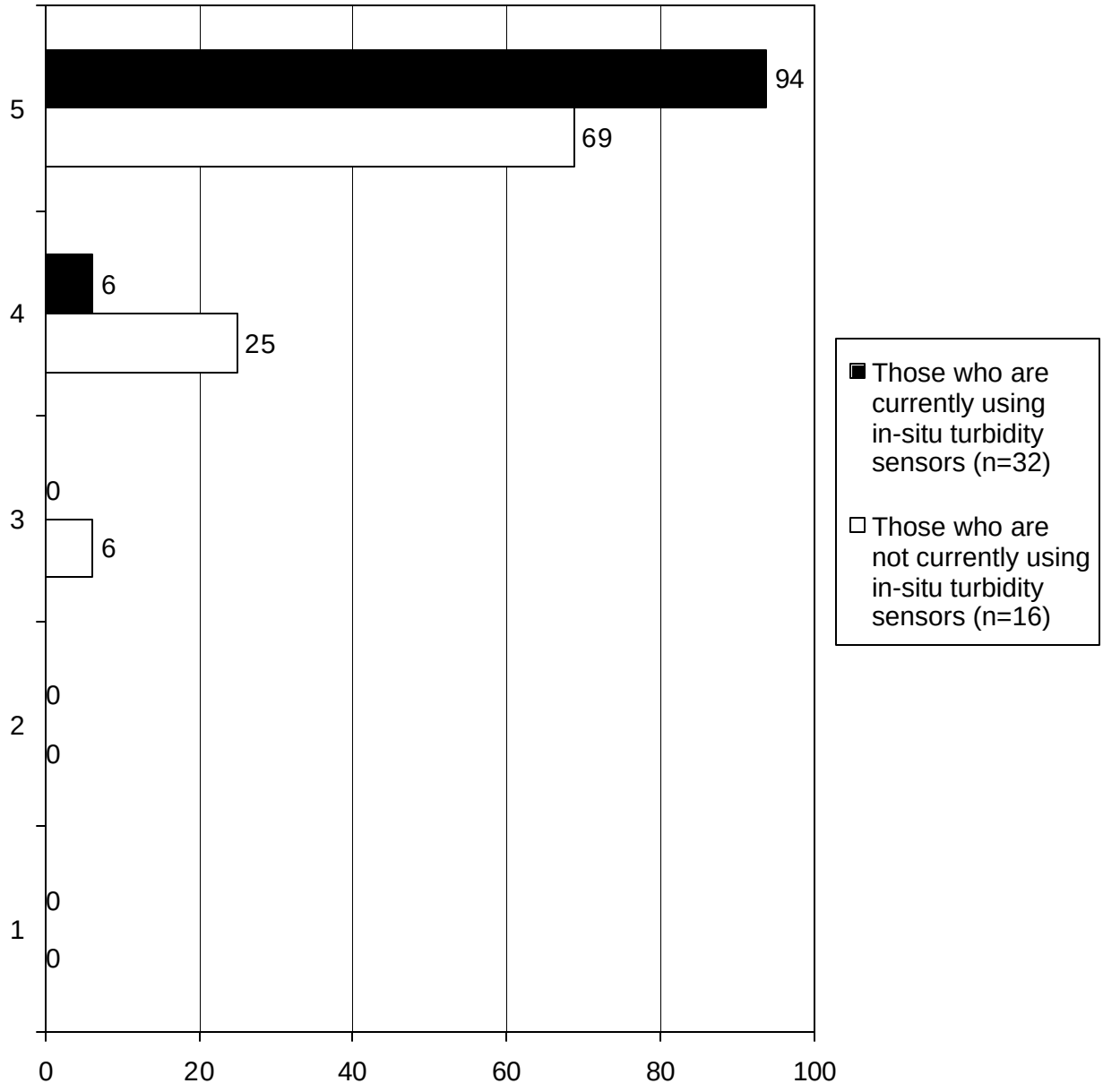
Q106-Q122. Means of importance of characteristics in a turbidity sensor on a scale of 1 to 5, where 1 is not at all important and 5 is very important. (Part 1)



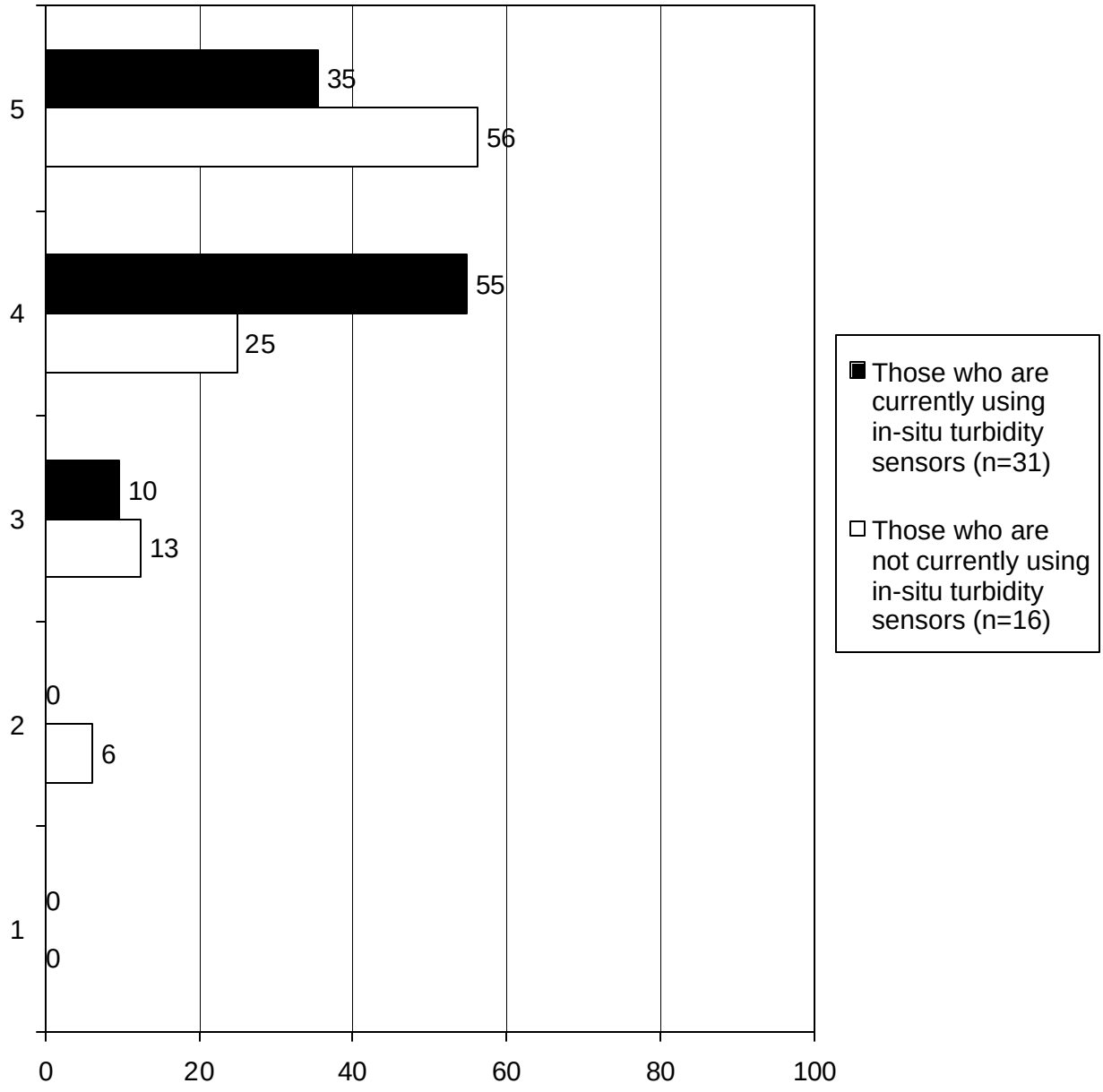
Q106-Q122. Means of importance of characteristics in a turbidity sensor on a scale of 1 to 5, where 1 is not at all important and 5 is very important. (Part 2)



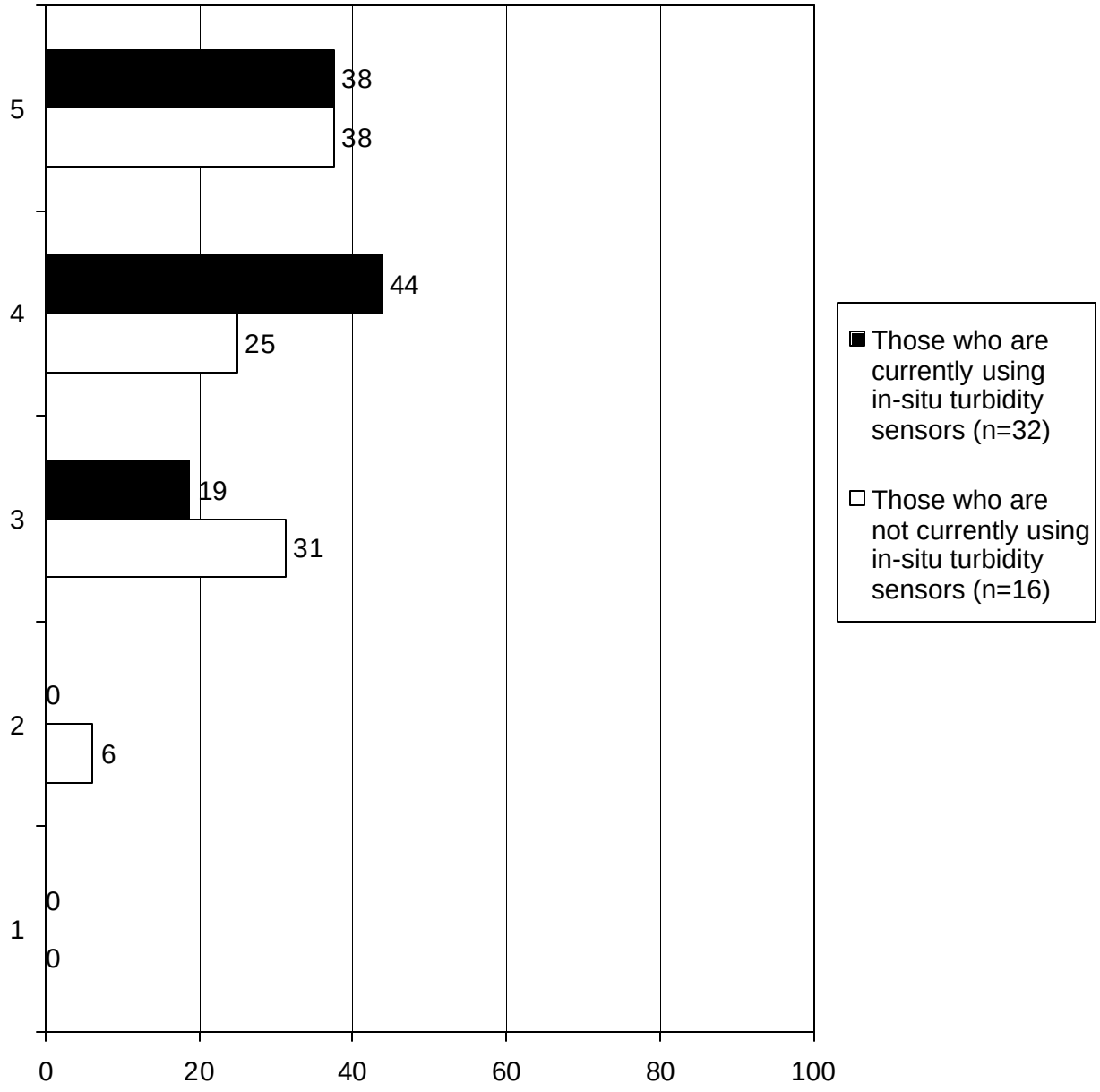
Q110. How would you rate reliability on a scale of 1 to 5, where 1 is not at all important and 5 is very important?



Q108. How would you rate precision on a scale of 1 to 5, where 1 is not at all important and 5 is very important?



Q112. How would you rate calibration life on a scale of 1 to 5, where 1 is not at all important and 5 is very important?



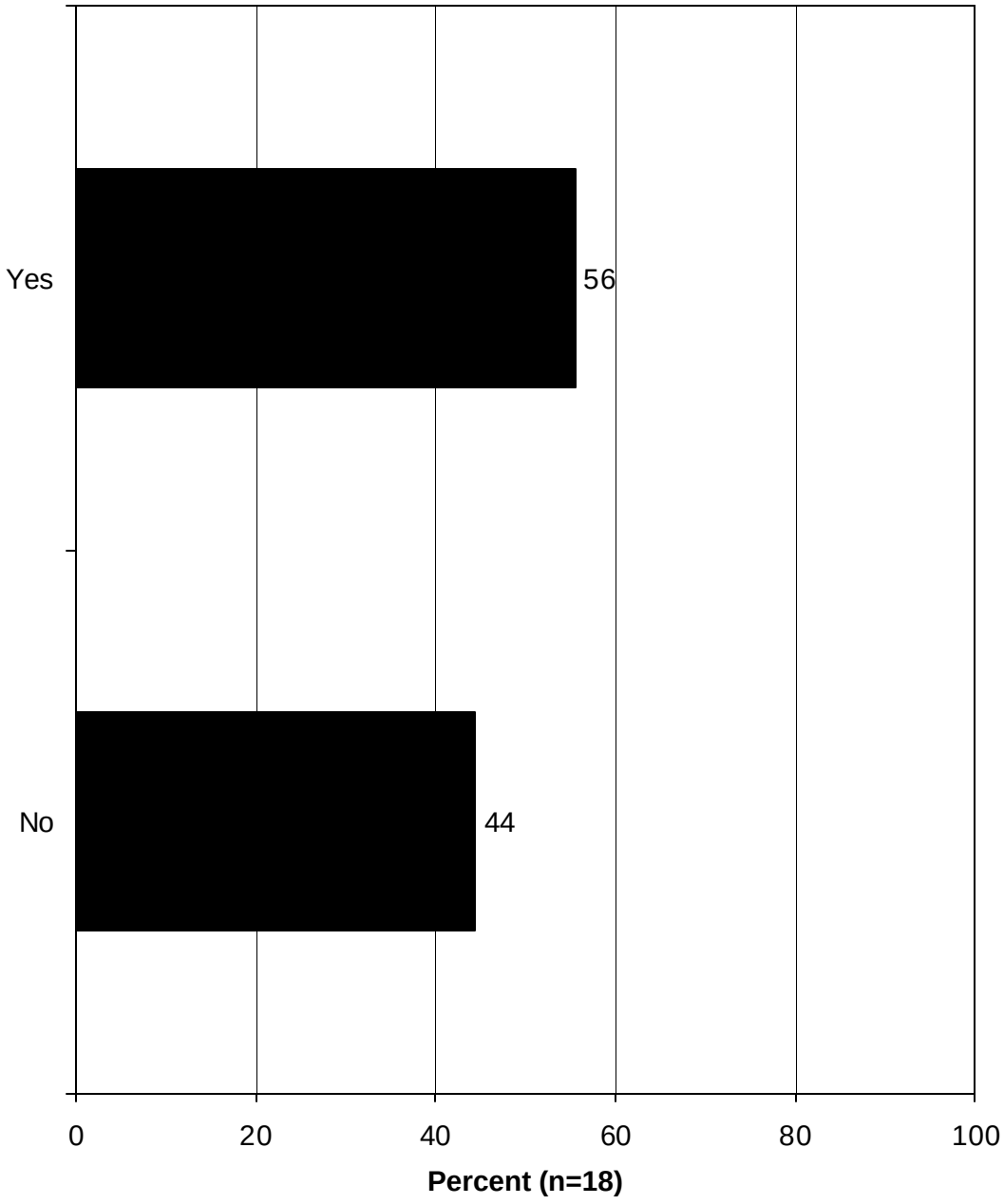
OTHER METHODS USED TO MEASURE TURBIDITY

- Of those who do not currently use in-situ turbidity sensors, 56% currently measure turbidity using other methods; 44% do not currently measure turbidity using other methods.
  - 60% of those who currently measure turbidity using other methods use light attenuation/nephelometry to measure turbidity, and 30% use the filtration/total suspended solid method.
  - A majority (71%) of those who do not currently use in-situ turbidity sensors and who do not currently measure turbidity using other methods said they would use light attenuation/nephelometry if they measured turbidity.

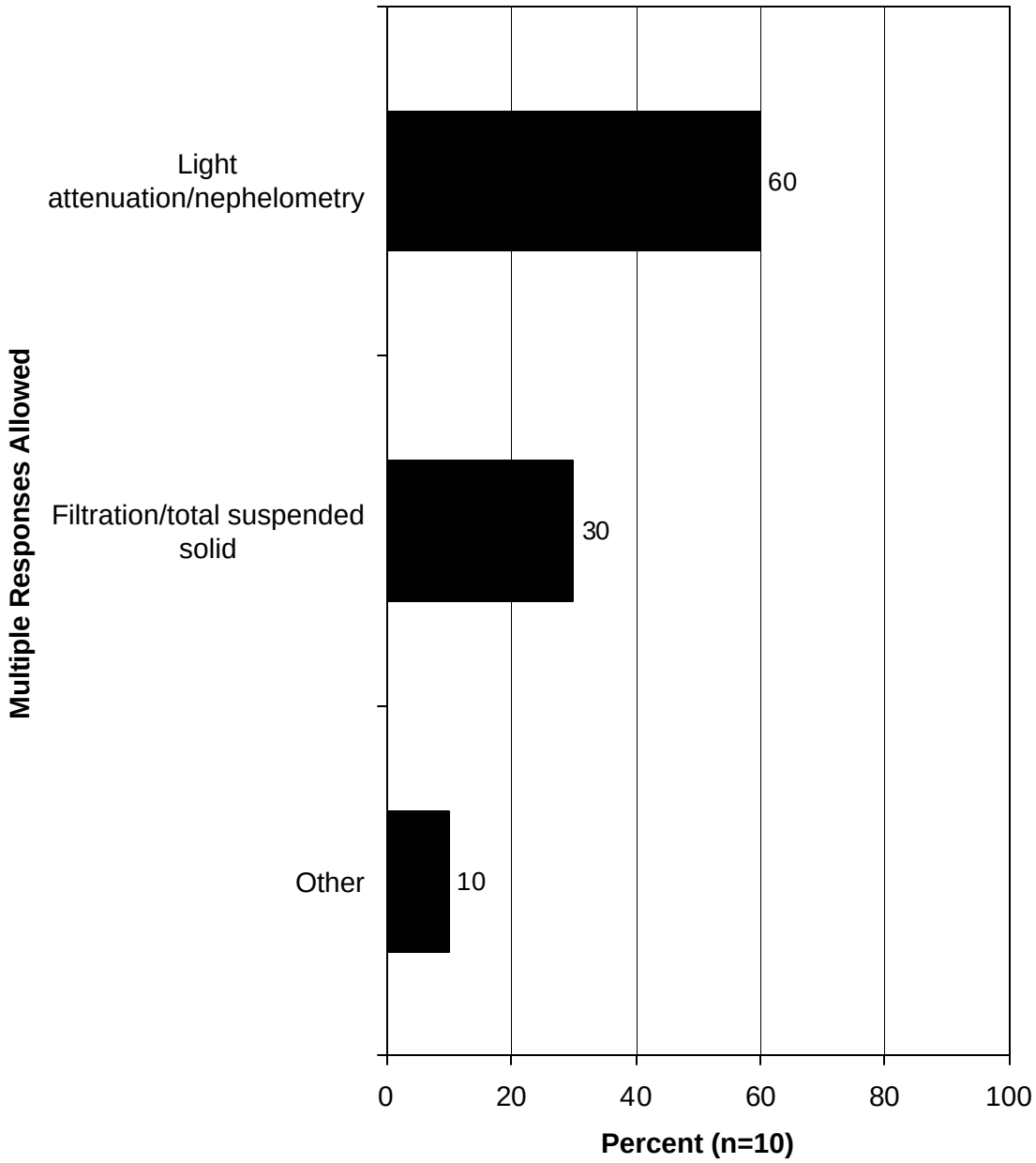
- The most common measurement intervals among those who do not currently use in-situ turbidity sensors are more often than hourly, hourly, and varying regularity (22% each).

- An overwhelming majority of those who do not currently use in-situ turbidity sensors (72%) use in-house sample analyses to conduct turbidity measurements; 11% do not currently measure turbidity.

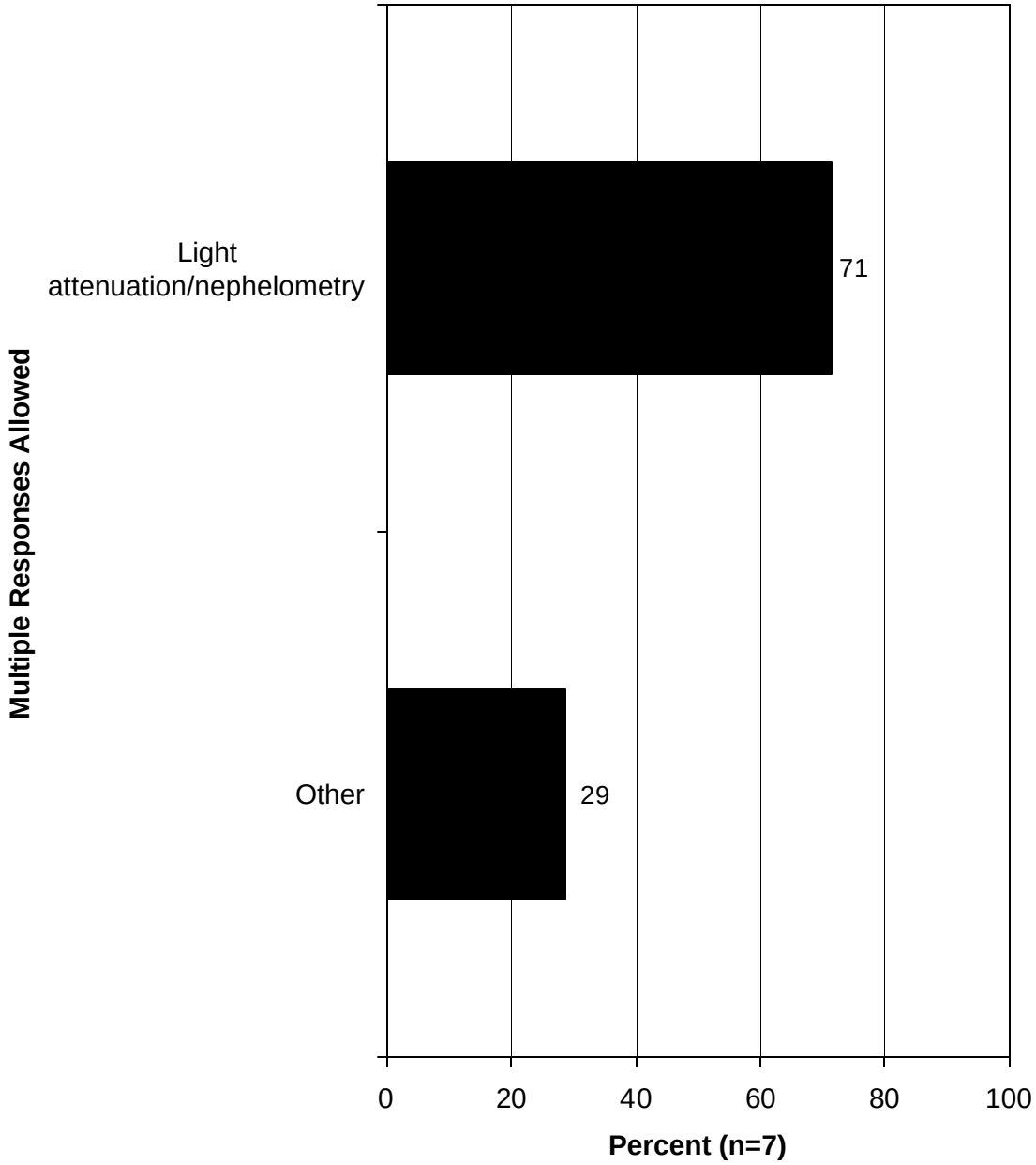
Q71. Do you currently measure turbidity using other methods? (Asked of those who do not currently use in-situ turbidity sensors.)



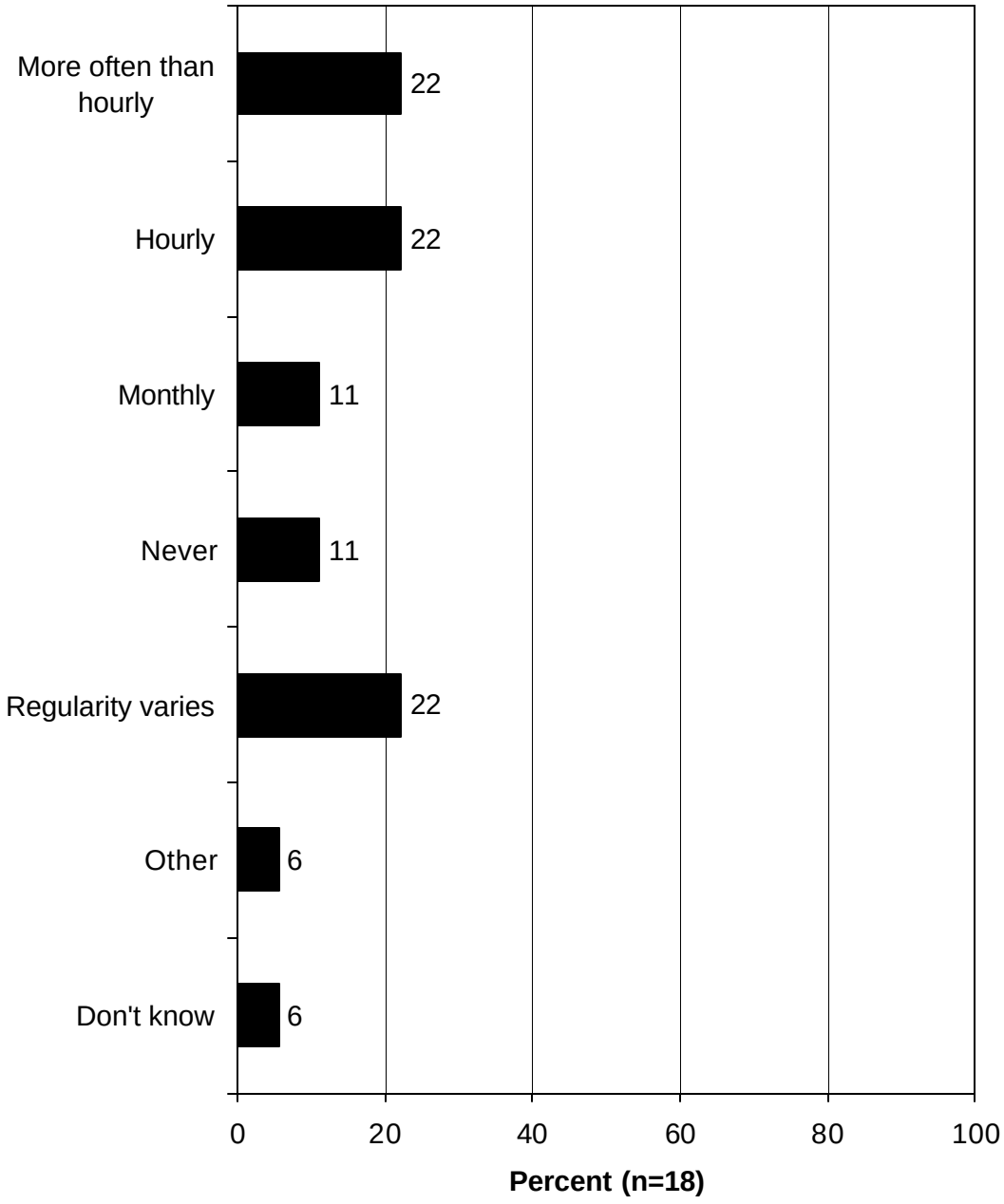
Q74. What method do you use to measure turbidity? (Asked of those who do not currently use in-situ turbidity sensors, but who measure turbidity using other methods.)



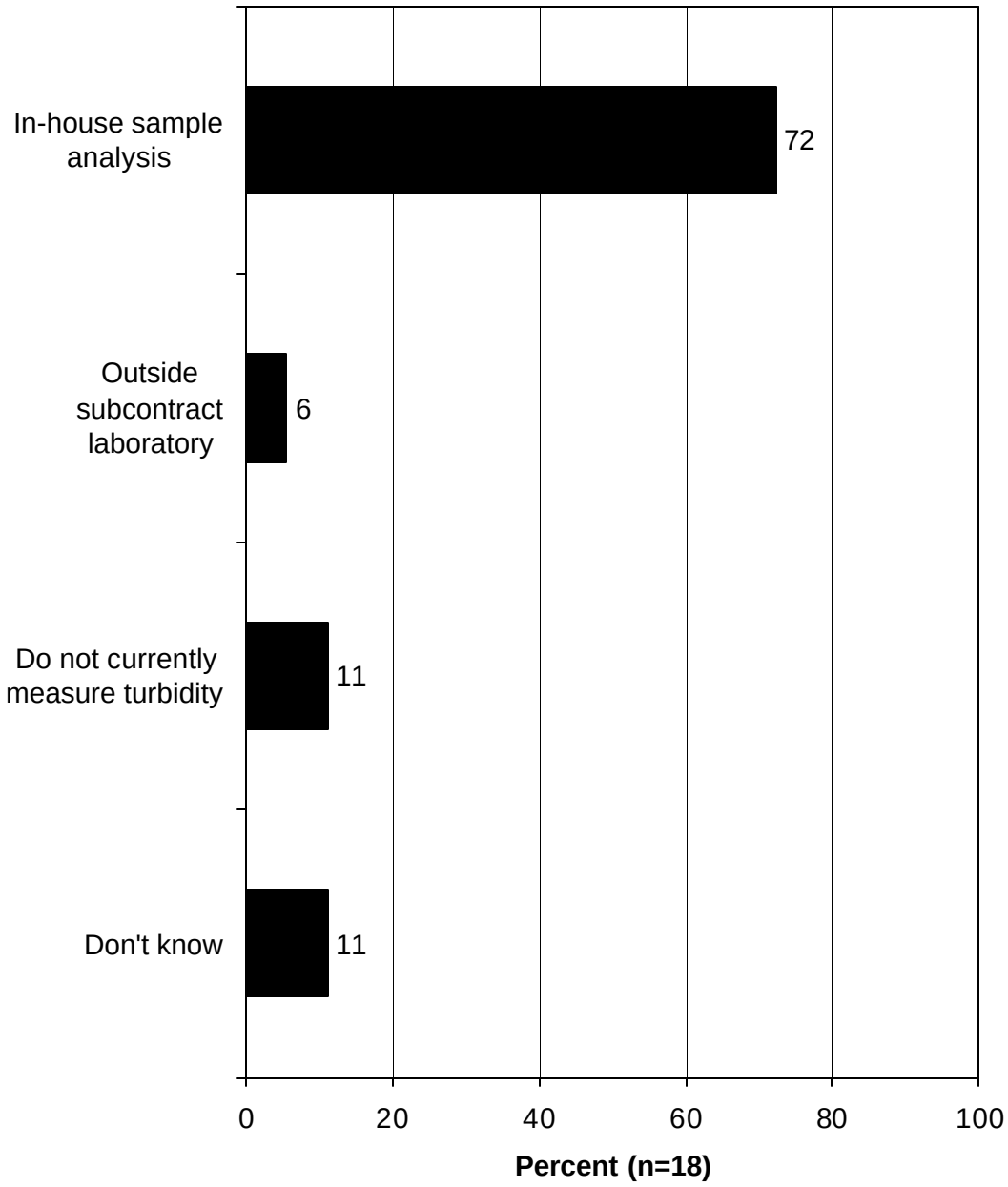
Q74A. If you measured turbidity, what method would you use? (Asked of those who do not currently measure turbidity.)



Q75. How often do you need to provide and/or acquire turbidity measurements data? (Asked of those who do not currently use in-situ turbidity sensors.)



Q77. How do you currently conduct turbidity measurements? Do you use an in-house sample analysis, or an outside subcontract laboratory? (Asked of those who do not currently use in-situ turbidity sensors.)

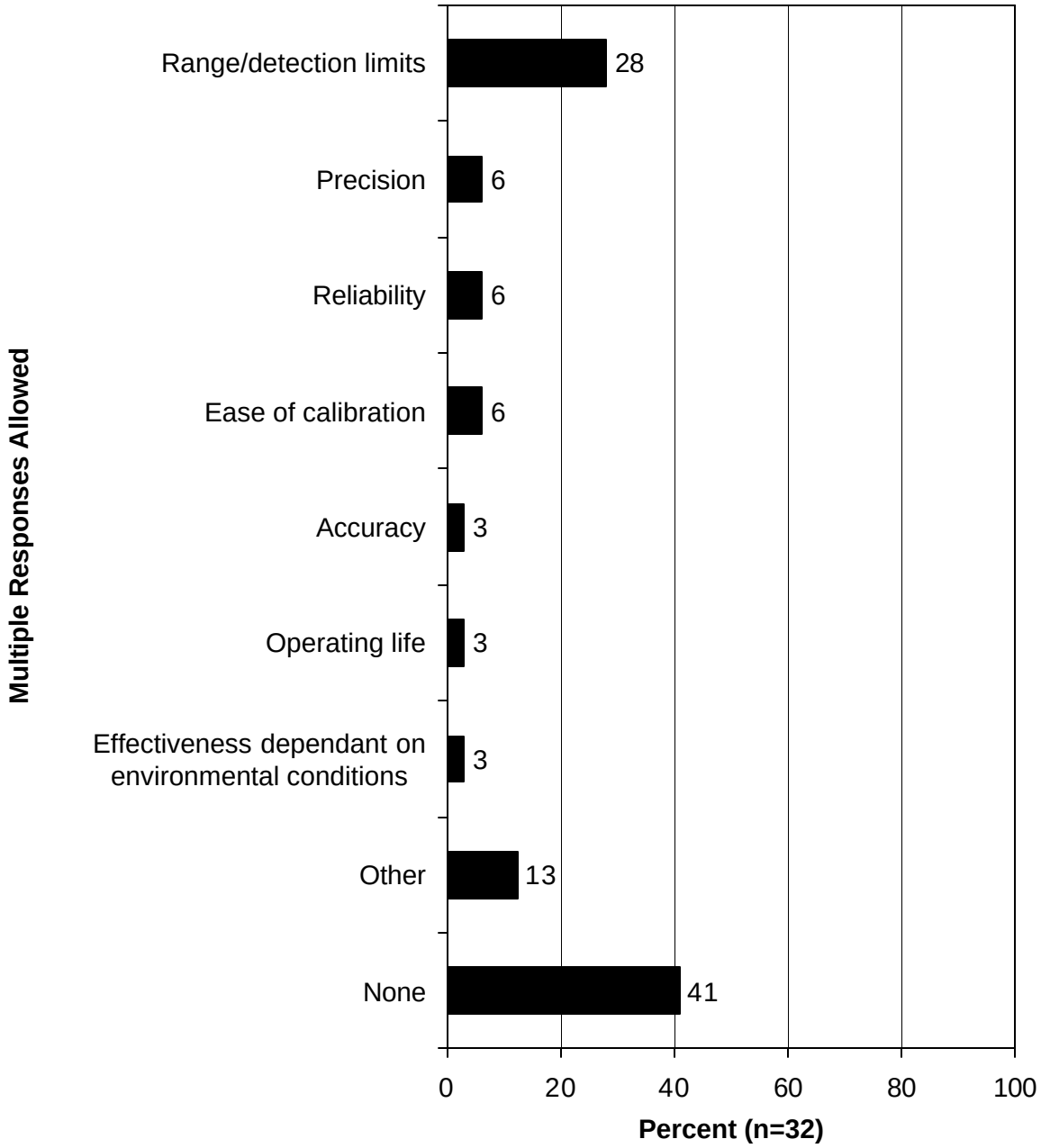


LIMITATIONS OF SENSORS AND ANALYSES

LIMITATIONS OF IN-SITU TURBIDITY SENSORS

- Most commonly, those who currently use in-situ turbidity sensors said the sensors have no limitations or areas in which they do not meet expectations or needs (41%). Nonetheless, range/detection limits is the top area in which current in-situ nutrient sensors have limitations, do not meet expectations, or do not meet needs.
  - 13% gave other areas in which the sensors have significant limitations; those other areas in which the sensors have limitations were biofouling and resolution.

Q38/Q40. In which of the following areas does the in-situ turbidity sensor/system you are using have significant limitations, not live up to specifications or expectations, or not meet your needs? (Asked of those who currently use in-situ turbidity sensors.)



- Issues with each of the performance characteristics of the sensor are shown in the tabulations that follow.

Q43. What were the issues with range/detection limits that had significant limitations or did not live up to specifications or expectations? (Asked of those who currently use in-situ turbidity sensors.)

Issues with range/detection limits	Number of respondents
Bio-fouling	1
Instrument saturates/saturated	2
Not high enough	1
Not low enough for drinking standards and not high enough for rivers	1
On the high end	1
Range in streams	1
Top out at 2000	1

Q44. What were the issues with accuracy that had significant limitations or did not live up to specifications or expectations? (Asked of those who currently use in-situ turbidity sensors.)

Issue with accuracy	Number of respondents
Needs to be more accurate	1

Q45. What were the issues with precision that had significant limitations or did not live up to specifications or expectations? (Asked of those who currently use in-situ turbidity sensors.)

Issue with precision	Number of respondents
Needs to be more accurate	1

Q47. What were the issues with reliability that had significant limitations or did not live up to specifications or expectations? (Asked of those who currently use in-situ turbidity sensors.)

Issues with reliability	Number of respondents
A lot of high values	1
Needs to be more accurate	1

Q48. What were the issues with operating life that had significant limitations or did not live up to specifications or expectations? (Asked of those who currently use in-situ turbidity sensors.)

Issue with operating life	Number of respondents
Can only run for so long and then have to move to another sensor	1

Q52. What were the issues with ease of calibration that had significant limitations or did not live up to specifications or expectations? (Asked of those who currently use in-situ turbidity sensors.)

Issues with ease of calibration	Number of respondents
Not accurate enough	1
Sensitive to the environment they are placed in	1

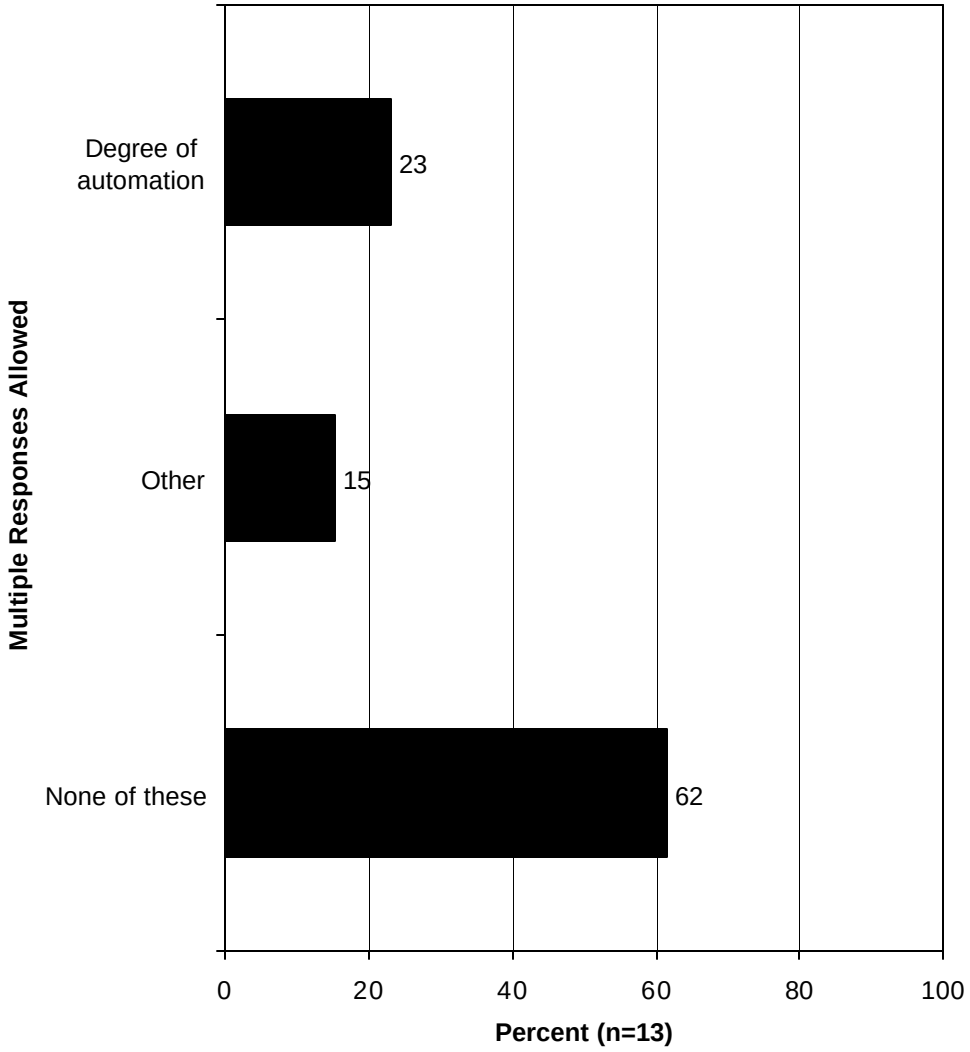
Q60. What were the issues with biofouling that had significant limitations or did not live up to specifications or expectations? (Asked of those who currently use in-situ turbidity sensors.)

Issues with biofouling	Number of respondents
Can't leave out for more than a week	1
How long they can stay out	1
Limited time to clean	1

LIMITATIONS OF OTHER ANALYSES

- Degree of automation is the top area in which in-house sample analyses have limitations, do not meet expectations, or do not meet needs (23% of those who currently conduct turbidity measurements using an in-house analysis).

Q80. In which of the following areas does the in-house analytical system you are using have significant limitations, not live up to specifications or expectations, or not meet your needs? (Asked of those who currently conduct turbidity measurements using an "in-house" sample analysis.)



Q81. What other areas have significant limitations, have not lived up to specifications or expectations, or have not met your needs? (Asked of those who currently conduct turbidity measurements using an "in-house" sample analysis.)

Other area	Number of respondents
Repeatability	1

Q86. What were the issues with degree of automation that had significant limitations or did not live up to specifications or expectations? (Asked of those who currently conduct turbidity measurements using an "in-house" sample analysis.)

Issues with degree of automation	Number of respondents
Get real time	1
Labor intensive process	1
Takes a long time to process	1

REASONS FOR NOT USING IN-SITU TURBIDITY SENSORS

- The tabulation below shows reasons why respondents do not currently use in-situ turbidity sensors.

Q69. Why don't you use an in situ turbidity sensor? (Asked of those who do not currently use in-situ turbidity sensors.)

Reason	Number of respondents
Don't know	4
Make our own sensor	2
Cost	1
It depends on the study	1
Looking at suspended particles	1
Mostly lab work	1
No projects funded right now	1
Not appropriate for what we do	1
Not in my field	1
Not using over last several months	1
Trust our sensors	1
Using YSI	1

PURCHASING NEW SENSORS

- A majority of respondents (62%) indicated plans to purchase new commercial sensors within the next 2 years.
  - Of those who use in-situ sensors and who plan to purchase a new commercial sensor, the majority (63%) indicated that they will consider a different type of sensor than the one they are currently using.

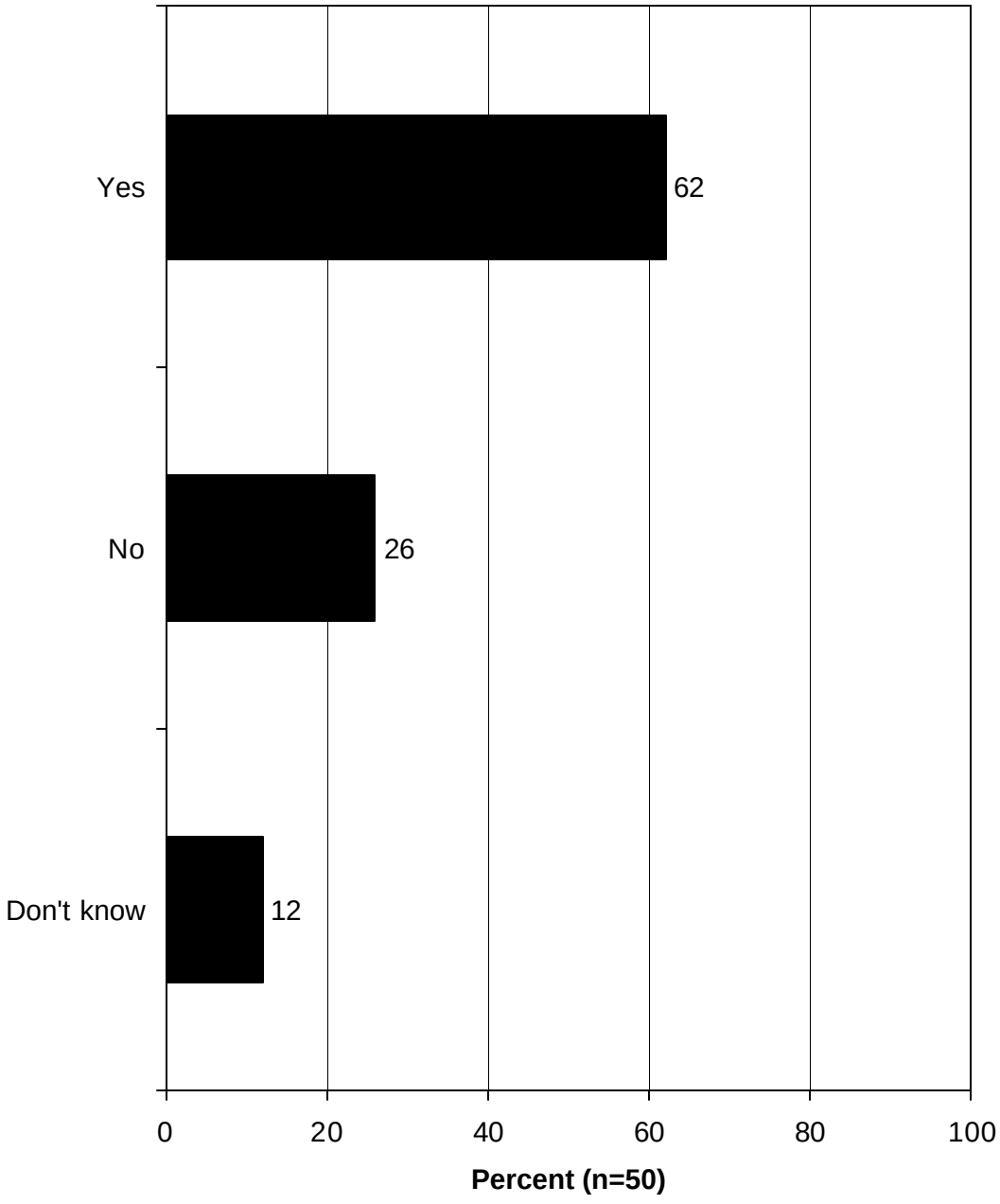
- Common reasons for planning to purchase new commercial sensors include the availability of new technology and to replace old sensors.

- Satisfaction with current sensors is the top reason for not planning to acquire a new commercial sensor or a different sensor type.

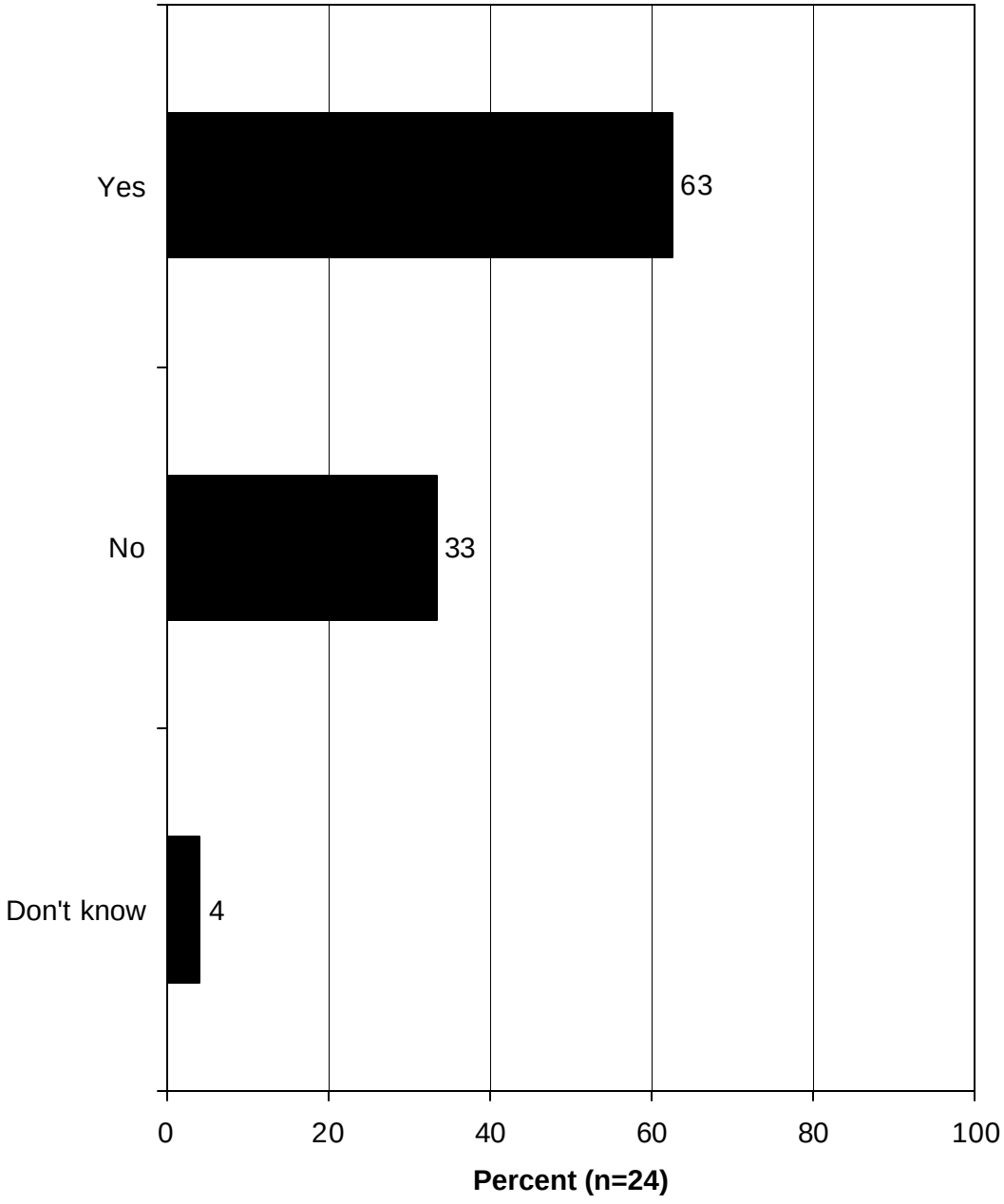
- Of those who use in-situ turbidity sensors, who plan to purchase new commercial sensors in the next 2 years, and who will consider a different type of sensor than the one they are currently using, the majority (60%) will have a trained person on staff to operate the new sensor.

- The majority of those who do *not* currently use in-situ turbidity sensors and who plan to purchase new commercial sensors within the next 2 years will have a trained person on staff to operate the new sensor (71%).

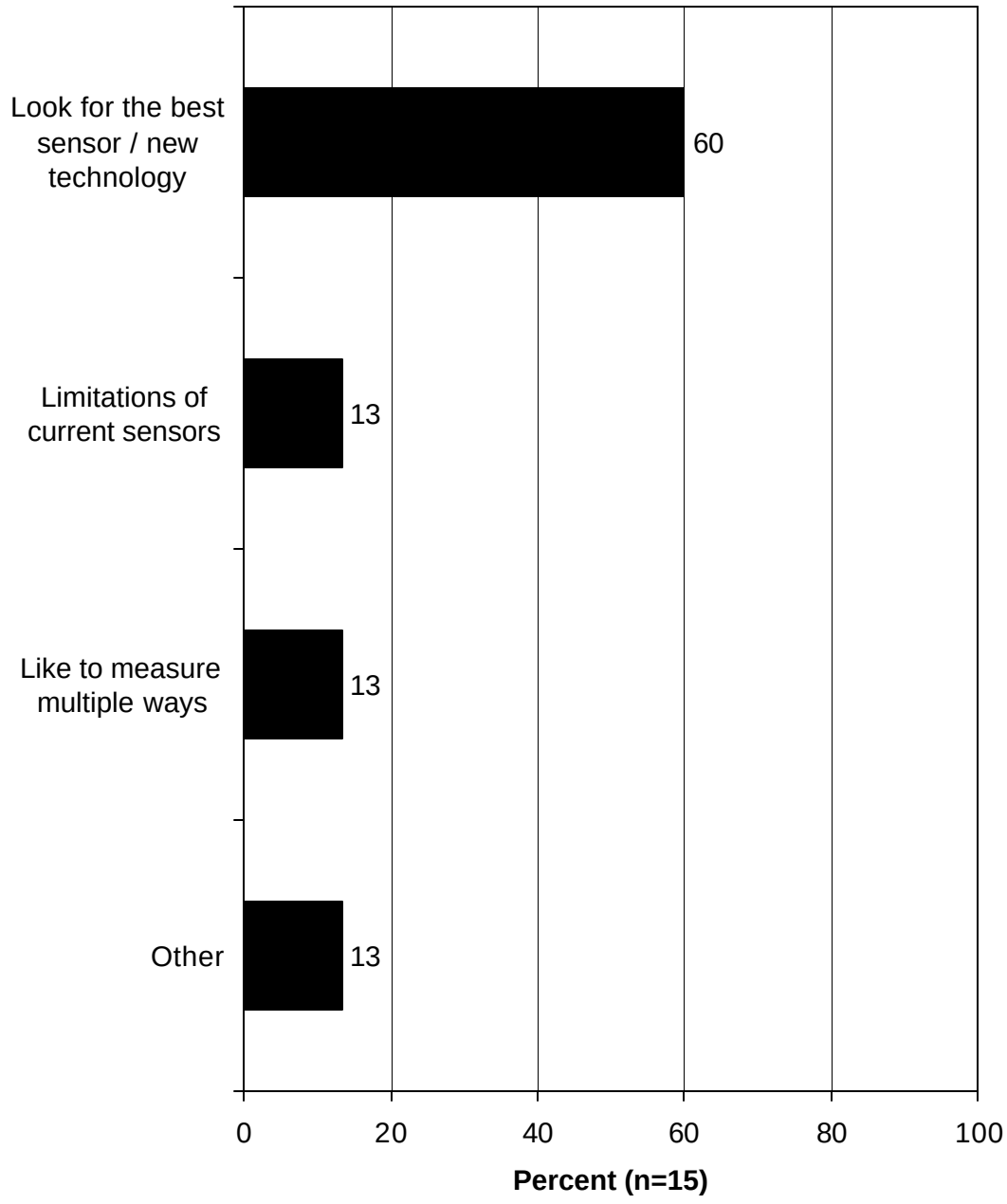
Q62. Do you plan on acquiring new commercial sensors within the next 2 years?



Q63. Will you consider a different sensor type than the one you are currently using to measure in-situ turbidity? (Asked of those who currently use in-situ turbidity sensors and who plan on acquiring new commercial sensors within the next 2 years.)



Q64. Why will you consider a different sensor type? (Asked of those who currently use in-situ turbidity sensors and who will consider a different sensor type.)

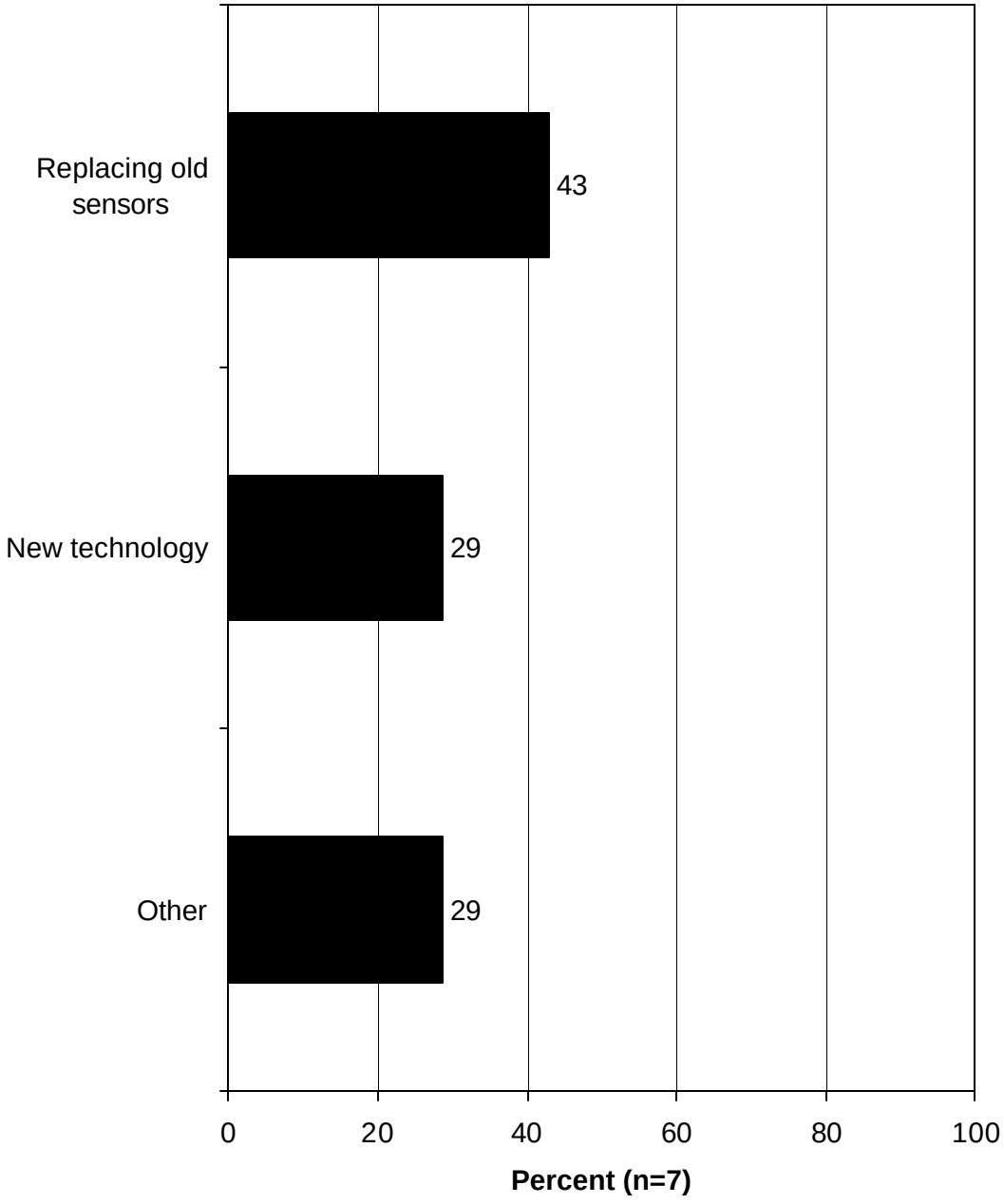


Please note that respondents' answers were categorized as shown in the previous graph after the data were collected. Respondents' answers prior to categorization are shown in the tabulation below.

Q64. Why will you consider a different sensor type? (Asked of those who currently use in-situ turbidity sensors and who will consider a different sensor type.)

Reason	Number of respondents
Always look for the best	1
Always looking for better approaches	1
Always looking for new technology	1
Always open	1
Current ones are obsolete	1
Different sensors get different results	1
If something works better	1
Like to know what is out there	1
Maybe	1
Multiple ways of measuring is best	1
Open to new technology	1
Some areas of our current sensor are not guaranteed	1
Technology may allow better range	1
To experience new technology	1
Wavelength more appropriate	1

Q101. Why do you plan on acquiring new commercial sensors within the next 2 years? (Asked of those who do not currently use in-situ turbidity sensors and who plan on acquiring new commercial sensors within the next 2 years.)

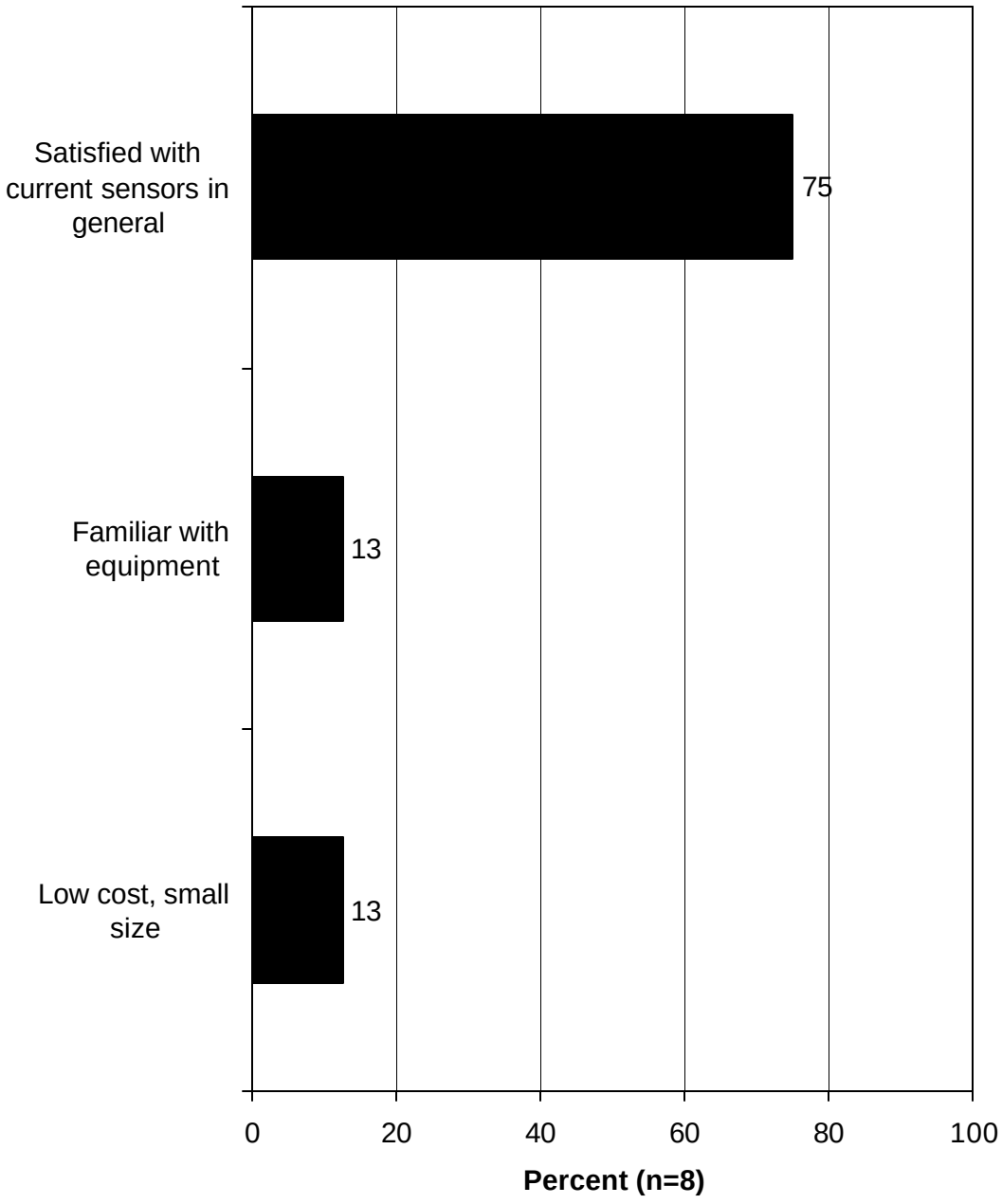


Please note that respondents' answers were categorized as shown in the previous graph after the data were collected. Respondents' answers prior to categorization are shown in the tabulation below.

Q101. Why do you plan on acquiring new commercial sensors within the next 2 years? (Asked of those who do not currently use in-situ turbidity sensors and who plan on acquiring new commercial sensors within the next 2 years.)

Reason	Number of respondents
Due to limitations	1
Evolving field	1
Maybe	1
New systems being built	1
Old sensors	1
Replacing old ones	1
They need replacing after a while	1

Q65. Why won't you consider a different sensor type? (Asked of those who currently use in-situ turbidity sensors and who won't consider a different sensor type.)

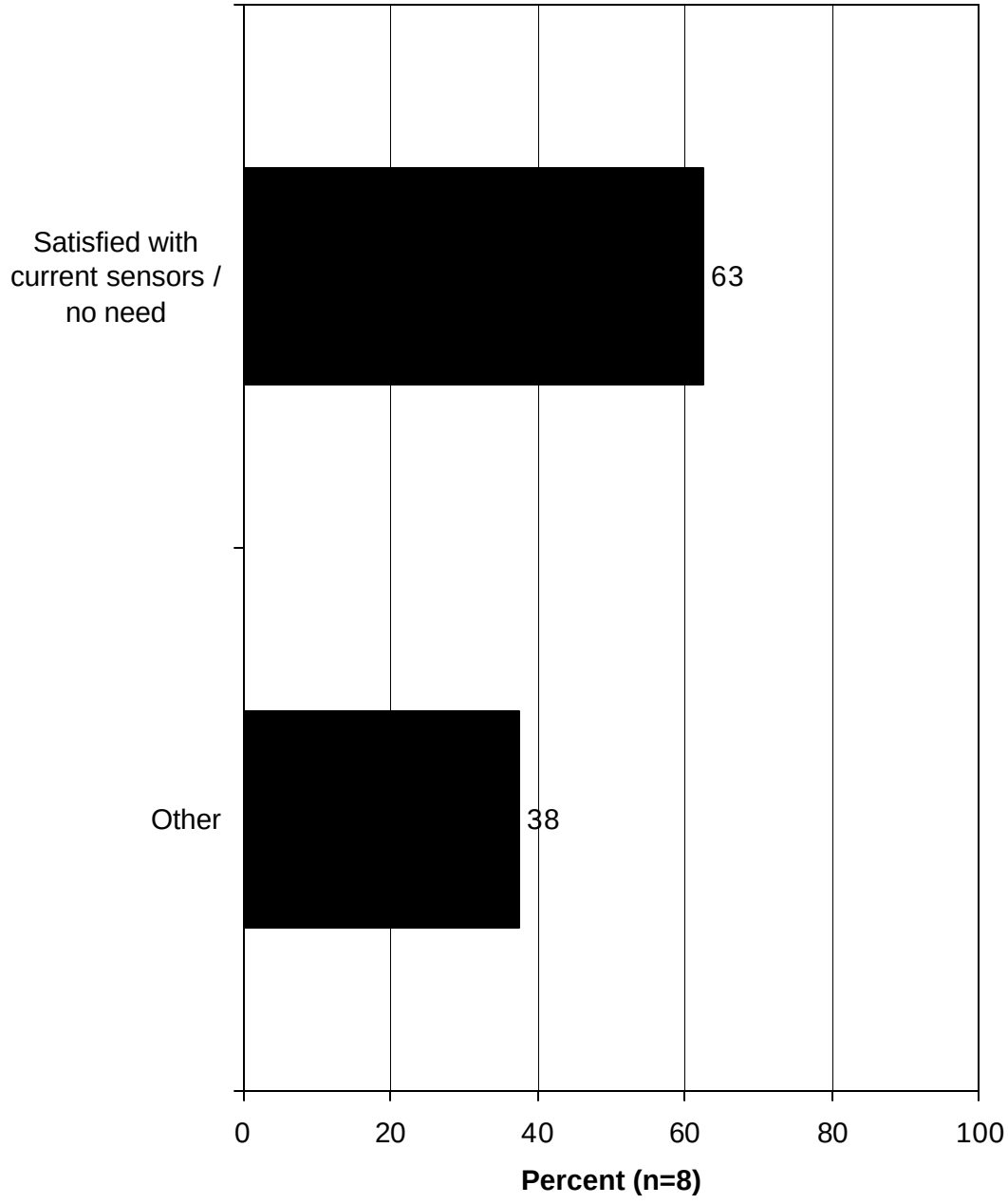


Please note that respondents' answers were categorized as shown in the previous graph after the data were collected. Respondents' answers prior to categorization are shown in the tabulation below.

Q65. Why won't you consider a different sensor type? (Asked of those who currently use in-situ turbidity sensors and who won't consider a different sensor type.)

Reason	Number of respondents
Familiar with equipment	1
Happy with current sensors	1
Happy with what they have	1
Is happy with current sensor	1
Low cost, small size	1
Satisfied with current sensors	1
Stay with same company	1
Sticking with YSI	1

Q102. Why don't you plan on acquiring new commercial sensors within the next 2 years? (Asked of those who do not currently use in-situ turbidity sensors and who don't plan on acquiring new commercial sensors within the next 2 years.)

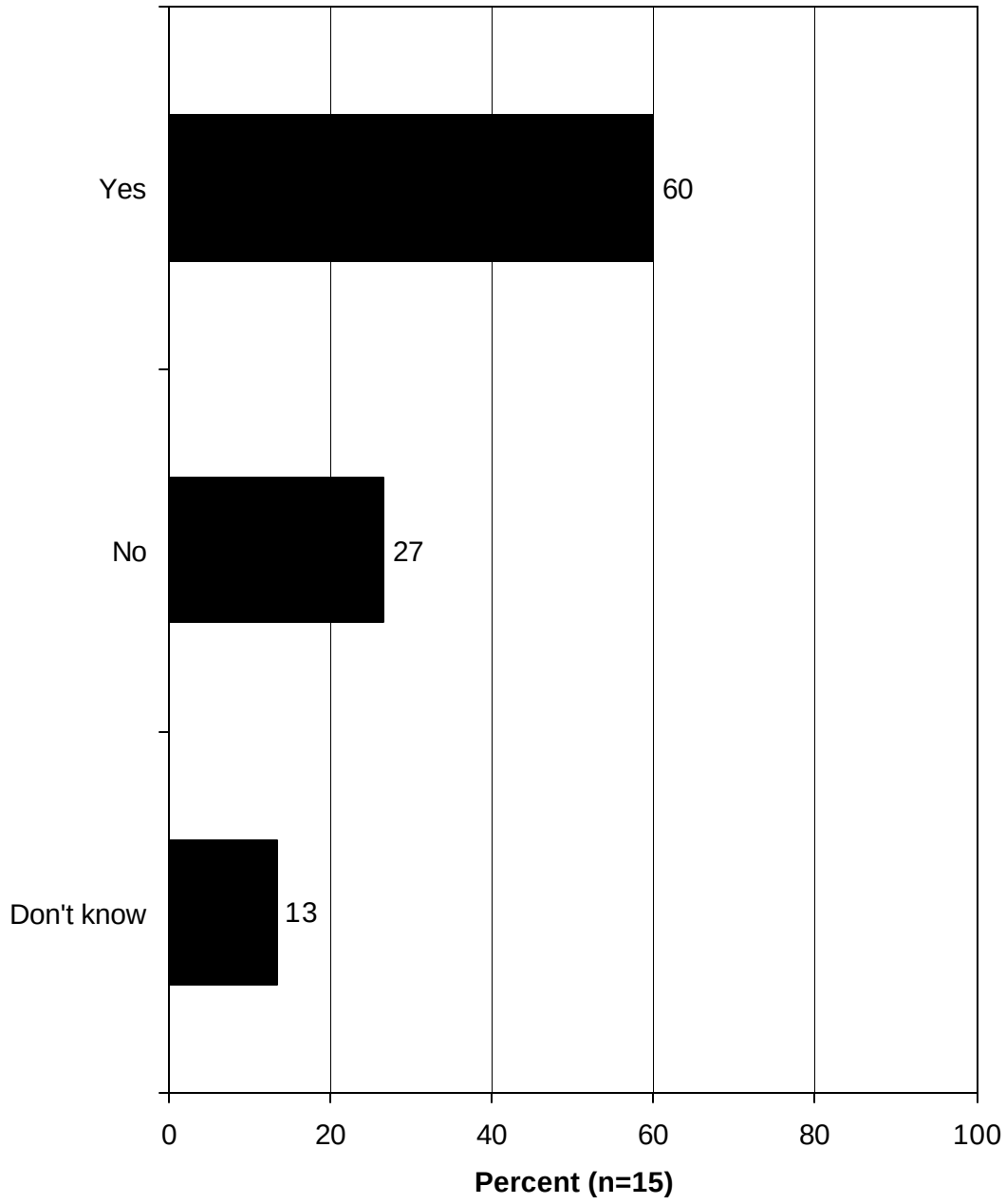


Please note that respondents' answers were categorized as shown in the previous graph after the data were collected. Respondents' answers prior to categorization are shown in the tabulation below.

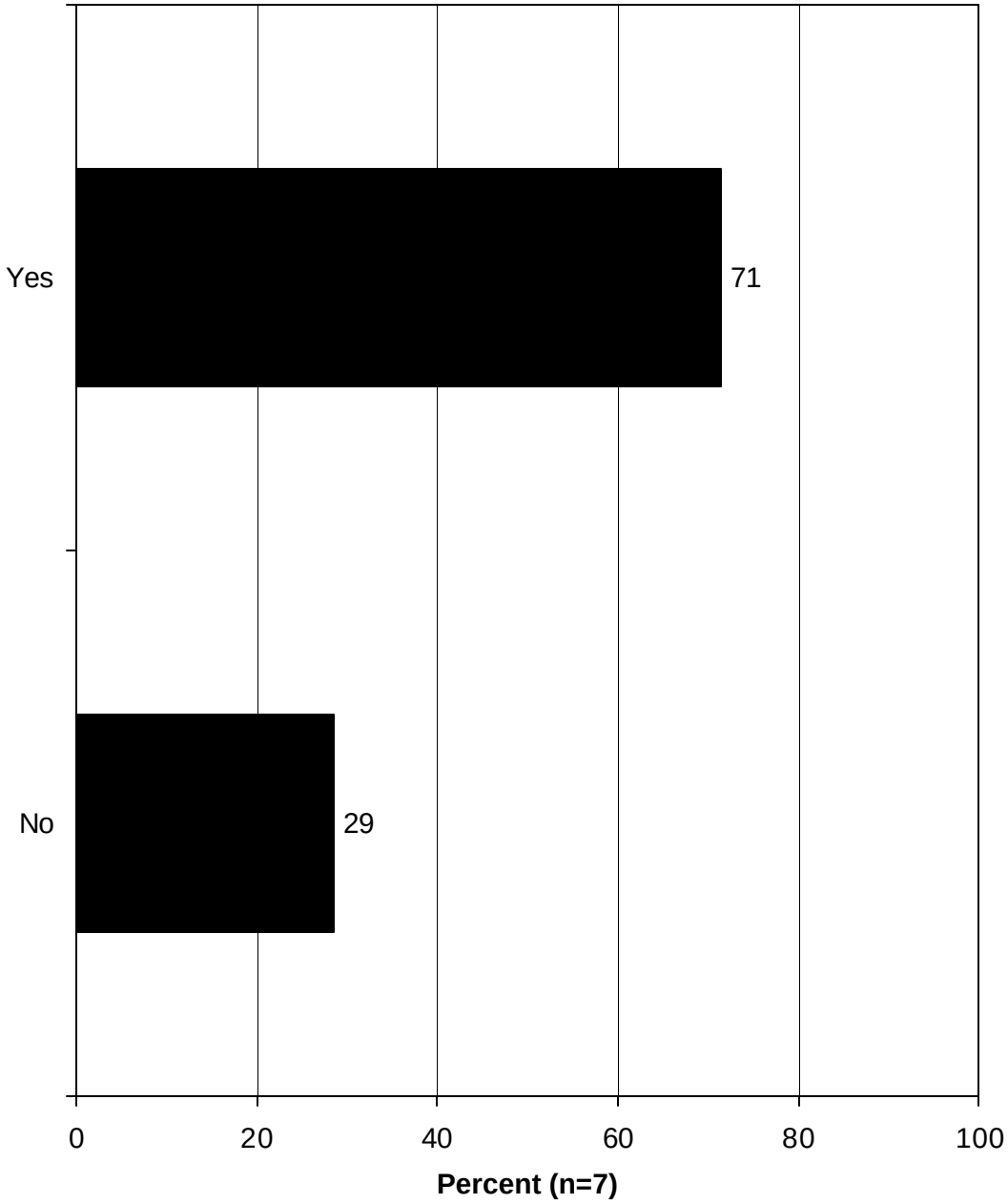
Q102. Why don't you plan on acquiring new commercial sensors within the next 2 years? (Asked of those who do not currently use in-situ turbidity sensors and who don't plan on acquiring new commercial sensors within the next 2 years.)

Reason	Number of respondents
Don't really need to	1
Happy with current ones	1
Make their own	1
No analytical requirements	1
No need	3
Use own acoustic method	1

Q66. Would you have a trained person to operate the newly acquired commercial in-situ turbidity sensor? (Asked of those who currently use in-situ turbidity sensors, who plan on acquiring new commerical sensors within the next 2 years, and who will consider a different sensor type.)



Q103. Would you have a trained person to operate the newly acquired commercial in-situ turbidity sensor? (Asked of those who do not currently use in-situ turbidity sensors and who plan on acquiring new commercial sensors within the next 2 years.)



- Finally, the tabulation below shows comments regarding current shortfalls/future desires in terms of in-situ turbidity sensors (all respondents were asked; 27 responded).
  - 3 respondents mentioned calibration.
  - 3 respondents want resistance to or control of biofouling.
  - 3 respondents specifically mentioned self-cleaning.

Q125. Based on your experience with in situ turbidity analyzers, are there any shortfalls in current designs or additions you'd like to see in future designs?

Always room for improvement
Better accuracy and reliability
Better acoustic sensors
Better calibration
Better defined sample volume
Better low and high end range detections
Better range
Blue water self-cleaning sensor
Ease of calibration
Comparability between measurements taken with different sensors
Consistency of calibration
Control of sampling volume and biofouling
Expanded range; improvements in self-cleaning
Having something to actually measure sediment concentration
Improvement in stability
Longer life; self-cleaning
Measurement cover wider body of water
New ones don't allow burst samplings
No standard geometry measurement
Particle sizing
Precision
Resistance to biofouling and drift
Resistance to biofouling
Some sensors don't meet our needs
To receive the sensor already calibrated from the manufacturer
Units standardized
Wider dynamic range

CHARACTERISTICS OF SAMPLE

- The sample contained coastal professionals associated with the following organizations:

Organization	Number of respondents
Aquavision	1
Campbell Scientific	1
DRL Software Ltd.	1
EPA (Environmental Protection Agency)	1
Fish and Wildlife-Alaska, Kachemak Bay Research Reserve	1
Fondriest Environmental, Inc.	1
Forest Technology Systems	1
Global Water Instrumentation, Inc.	1
Grand Canyon Monitoring and Research Center	1
Holland Water Plant	1
Horn Point Lab, Center for Environmental Science	1
Muskegon Board of Civil Service Commissioners	1
Louisiana State University, Dept. of Oceanography	1
Louisiana State University, Coastal Studies Institute	1
Napa County Resource Conservation District	1
NOAA (National Oceanic and Atmospheric Administration)	1
NPS (Naval Postgraduate School)	1
New Mexico Environmental Dept., Surface Water Quality Bureau	1
North Coast Regional Water Quality Control Board	1
Padilla Bay National Estuarine Research Reserve	1
Salisbury University, Dept. of Biological Sciences	1
Sandia National Labs	1
San Francisco Estuary Institute	1
Science Applications International Corp.	1
SCDNR-ACE Basin National Estuarine Research Reserve	1
Stanford University	1
U.S. Bureau of Land Management	1
U.S. Bureau of Reclamation	1
U.S. Bureau of Reclamation, Great Lakes Environmental Research Lab.	1
U.S.G.S. Center for Coastal and Watershed Studies	1
U.S.G.S. Water Resources of California	1
University of California Davis, Bodega Marine Lab.	1
University of California Davis, Center for Ecological Health Research	1
University of Delaware, Delaware Water Resources Agency	1
University of Hawaii	1
University of Leeds, School of Earth and Environment	1
University of Maine/ACT	1
University of Maine, School of Marine Sciences	1
University of New Hampshire, Ocean Process Analysis Lab.	1

University of South Carolina	1
University of Washington	3
Virginia Institute of Marine Science	1
Wells National Estuarine Research Reserve	1
Wetlabs	1
Woods Hole Oceanographic Institution	3
YSI, Inc.	1

- The sample was 88% male.

Q128. Respondent's gender (not asked, but observed by interviewer).