

LINKING SCIENCE, EXTENSION, AND EDUCATION IN WATER QUALITY MONITORING

Niamh O' Leary¹, Max Pfeffer², A. Thomas Vawter¹, and Linda Wagenet²

¹ Wells College, Aurora, NY 13026

² Center for the Environment, Cornell University, Ithaca, NY 14853

Biographical Sketch of Authors

Niamh O' Leary is an Assistant Professor of Environmental Studies at Wells College where she is active in water quality monitoring research and education. She is also a member of the Community Outreach Committee of the Cayuga Lake Watershed Network, a citizens' organization whose mission includes education on watershed issues. Max Pfeffer is a Professor of Rural Sociology and at the Center for the Environment at Cornell University. His research program focuses on the relationship between conflicts of interests and values in environmental management with an emphasis on rural/urban fringe areas and watersheds. Tom Vawter is a Professor of Biology and Environmental Studies at Wells College. His research interests include population genetics, host-parasite systems, and water quality monitoring. He is the Chair of the Technical Committee of the Cayuga Lake Watershed Intermunicipal Organization, a coalition of municipalities that have led the development of a Restoration and Protection Plan for the Cayuga Watershed. Linda Wagenet is a Senior Extension associate at Cornell University's Center for the Environment. Her areas of expertise include environmental education, water pollution, and the integration of watershed science and management. She is also a member of the Technical Committee of the Cayuga Lake Watershed Intermunicipal Organization.

Abstract

Non-point source pollution in rural and agricultural areas requires comprehensive multi-site monitoring to identify its extent, but resources to conduct such extensive monitoring are often lacking. Citizen volunteers have the potential to meet this need by generating monitoring data in an economical and effective way, and sharing it with the relevant regulatory bodies. For such a scheme to be useful and meaningful, the data collected must be of sufficient quality and reproducibility to be acceptable to regulatory organizations. A research project was designed to determine the extent of supervision by trained scientists required, if any, to ensure collection of high quality water monitoring data. Faculty at a small, liberal arts, undergraduate college (Wells College) in the Cayuga Watershed of upstate New York collaborated with researchers at a nearby research institution (the Center for the Environment at Cornell University) to design the project. Citizens and undergraduate students joined the project in summer 2001. The nine participants were divided into four groups: scientists with expertise in water quality monitoring techniques, undergraduate interns with some experience (but less than the scientists), and two groups of citizen volunteers with no prior experience in water quality monitoring. Volunteers were trained to measure the extent of fecal coliform pollution in stream water, and were also trained to collect benthic macroinvertebrates, identify them to the family level, and generate an index from which overall water quality could be determined. All four groups collected and analyzed fecal coliform and benthic macroinvertebrate data independently at four different sites. Data from the different groups were compared for each site, and found to be similar overall, but with some differences. This small-scale project demonstrated that unsupervised citizen volunteers with only limited training are capable of collecting water quality data comparable to that collected by trained scientists.

Introduction

Nonpoint-source pollution in rural and agricultural areas requires comprehensive monitoring to identify its extent and sources, but resources to conduct such extensive monitoring are often lacking. Given such limitations, regulatory agencies and research organizations can benefit from low-cost means of identifying critical locations for siting sophisticated water monitoring efforts. Citizen volunteers, recruited by extension agencies or watershed associations, have the potential to provide this service. Biological monitoring of indicator species and monitoring of basic physicochemical parameters provides preliminary information about water quality. These water quality criteria are well-suited to public involvement because of the relative ease with which they can be measured. Abundance and diversity of biological indicator species such as fecal coliforms and benthic macroinvertebrates can be readily observed and quantified by citizen monitors and are of interest to aquatic scientists because of their usefulness as long range indicators of water quality (Heiman 1997; Kerans and Karr 1994).

A number of non-government organizations, academic institutions, and government agencies have published manuals on citizen monitoring. While many of these manuals can serve as useful resources on data collection methods, most are formulaic distillations of professional monitoring techniques. Few provide guidance on how to organize citizen monitoring programs. The EPA (1997), for example, has developed a series of manuals on implementing, and maintaining volunteer monitoring programs. Other examples are the Pacific Streamkeepers Federation (British Columbia) monitoring handbook and training modules (PSF 2001), the Streamkeeper's Field Guide from Adopt-A-Stream Foundation (Murdoch and Cheo 1996), and the Stream Waders Manual from Maryland (Maryland DNR 2001). While these manuals discuss data-gathering methods and address data quality concerns, they do not describe how to plan monitoring efforts in ways that link scientists with volunteers, nor do they assess the appropriate level of sophistication of data collection and analysis for volunteers.

A growing number of watershed associations, Extension educators, and professional watershed stewards are adopting citizen monitoring to improve decision-making about watershed management (EPA 2001). However, it is not clear if citizen volunteers are capable of collecting data of high enough quality to be widely used by regulatory organization. The main objective of our work was to determine if citizens with basic training in field and laboratory techniques could collect water quality data of a caliber similar to that collected by trained scientists. Successful citizen monitoring, however, calls for more than accurate data collection. It also requires increased capacity to interpret and use those data to inform behavioral and management decisions. Our project results have the potential to inform Extension programs that educate the public and sustain citizen monitoring efforts. Our integrated project team combined the strengths of university/college research and teaching faculty at two institutions with interns and citizen volunteers. As a result, our project also had a means to provide training and experiential learning opportunities to student interns in environmental studies.

Materials and Methods

During Summer 2001, we conducted a citizen monitoring project on Salmon Creek, a tributary of Cayuga Lake in upstate New York with a primarily agricultural watershed. The project involved nine personnel: two scientists with experience in biological and physicochemical assessment of water quality, two undergraduate interns with limited exposure to the techniques used in the assessment of water quality, and five volunteers recruited from the local area and with no experience in water quality testing. All nine personnel met a total of ten times for three hours on each occasion between June 28 and July 31, 2001. The first two meetings (June 28/29) were training sessions for the volunteers (the interns had been trained previously by the scientists). The remaining eight meetings took place on four sets of two consecutive days (July 9/10, 16/17, 23/24, 30/31) during which water quality testing of four different riffles in Salmon Creek was accomplished.

Training Volunteers and Interns. Volunteer training on the theory and application of monitoring for biological indicators was accomplished in the first two meetings. The scientists shared some information on water quality testing and the utility of indicator organisms such as benthic macroinvertebrates and fecal coliforms. Through a combination of demonstration and hands-on activities the volunteers were introduced to the standard techniques of benthic macroinvertebrate and fecal coliform sampling that were to be used during water quality monitoring. The techniques chosen are standard methods described in APHA (1995), and Barbour et al. (1999). Training was also provided in the use of instruments that measure the following physicochemical aspects of water quality: temperature, pH, dissolved oxygen concentration and specific conductance. Interns were trained before the project

began in the same way as the volunteers, except that the interns were given more opportunity to familiarize themselves with the benthic macroinvertebrate orders and families usually encountered in the Cayuga Lake watershed.

Water Quality Testing: Overall Design. Four riffles of Salmon Creek were sampled for benthic macroinvertebrates and fecal coliforms. Each riffle was sampled, and the benthic macroinvertebrate community and fecal coliform population from it examined, over two consecutive days in which all personnel met 5:00-8:00 pm on both days. The nine personnel worked in four groups: one group of two scientists, one group of two interns, and two groups of volunteers, one with two members and one with three members.

The four groups met at the selected riffle (riffle selection was done by the scientists in advance of each meeting). In order to prevent disruption of a group's samples by the sampling activities of other groups upstream, groups did not engage in sampling at the same time, but rather took their samples in sequence. The first group sampled downstream in the riffle and when their sampling was completed the second group began sampling upstream in the same riffle. Similarly, the remaining groups worked progressively upstream in the riffle. The order in which the four groups sampled on each day was determined randomly.

Water Quality Testing: Fecal Coliforms. Each group collected two or three water samples for fecal coliform analysis as described in standard methods (APHA 1995) and using the techniques introduced in the training sessions. Sampling of the benthic macroinvertebrate community occurred after water collection for fecal coliform analysis. Collection of water samples for fecal coliform analysis was done using sterile (autoclaved) bottles. As a quality assurance/quality control measure, each group collected two or three fecal coliform samples at the same time and in the same place. After all four groups had completed their sampling all personnel returned to a laboratory at Wells College where each group processed its own fecal coliform samples using a standard membrane filtration procedure and aseptic technique as described in APHA (1995). Fifty milliliters of sample water were passed through a 0.45 μ m filter. Sterile water was then used to rinse the filtration apparatus and itself passed through the filter. The filter was placed in a 47mm petri dish with a pad that contained mFC with rosolic acid, a medium that selects for fecal coliforms and differentiates them from the small number of non-fecal coliforms that typically break through during incubation. All groups worked independently of each other to process the samples they had collected from the field. Once processing was complete, the petri plates were placed in a Precision coliform incubator water bath set at 44.5°C for twenty-four hours (\pm two hours) of incubation.

Each group retrieved their fecal coliform samples at the end of the twenty-four hour incubation period. On mFC with rosolic acid medium, fecal coliforms appear as dark blue colonies. Each group counted the number of fecal coliform colonies and recorded their results as colony forming units (cfu) per 100ml.

Water Quality Testing: Benthic Macroinvertebrates. Sampling and analysis of benthic macroinvertebrates were carried out at the same locations and on the same days as the fecal coliform sampling. The methods of sampling and analysis were slightly modified from those of Barbour et al. (1999). Beginning at the downstream end of a reach of riffle habitat, each group collected forty kick samples of macroinvertebrates by moving along transects across the stream in a slightly upstream-tending diagonal. The kick samples were collected in a standard aquatic D-net by disturbing the substrate within a distance of about 0.5m of the mouth of the net and then moving to the next station. The kick samples of all members of a group were combined in a single bottle of ninety-five percent ethanol with a label identifying the location, data and collectors.

In the laboratory on the day following the collections, each group cleaned its benthic macroinvertebrate samples and drained the alcohol by washing them in a fine-mesh sieve. Large, inorganic particulate matter was removed from the sample after thorough washing to remove any attached organisms, and the sample was transferred to a white enamel or plastic tray on which a grid of 5cm by 5cm squares had been inscribed. By this method we collected nearly all the invertebrate animals in each sample and always achieved a sample close to one hundred organisms.

Each group sorted its own sample of invertebrates, first into groups representing orders, then into families. Although our protocol required identifying organisms only to family, we made note of putative species differences if organisms of the same family had noticeably different appearances. Taxonomic identification of each invertebrate animal was made to the taxonomic level of the family by reference to simplified keys in Kellogg

(1994) and a guide to families of aquatic macroinvertebrates prepared by Barbara Peckarsky and based largely on Peckarsky et al. (1991). Four primary metrics were calculated from the taxonomic data:

1. Species richness (= the total number of taxa identified). In most cases this was equivalent to family richness.
2. Percent dominant family: the percent of the total sample made up of the most numerous family.
3. EPT (Ephemeroptera, Plecoptera, Trichoptera) index: the sum of the number of species of mayflies, stoneflies and caddisflies in the sample. In most cases this was equivalent to the number of families of these groups.
4. FBI or Family Biotic Index (after Hilsenhoff, 1988): calculated by multiplying the number of each taxon found in the sample by a tolerance score. The tolerance scores were taken from Bode (1991)

These primary metrics were then combined into a single index, the IBI or Index of Biotic Integrity by attaching a value score to each of the primary metrics (Bode, 1991) and calculating the sum. The IBI score was then assigned to one of four water-quality ratings based on a conversion table from Bode (1991).

Water Quality Testing: Physicochemical Parameters. In addition to the biological sampling described above, each group also collected data on basic physicochemical qualities of the riffle water. Water temperature and pH were measured with a YSI, Inc., Model 57 dissolved oxygen meter, and pH was measured with a pHTestr2™ digital pH meter (Oakton® Instruments), respectively. Specific conductance, a measure of the ionic content of the water, was measured with a Cole-Palmer PCM-1 conductivity meter. With the exception of Site 1 (sampled on July 9), when time constraints prevented measurement of these parameters, data were collected by each group at each site.

Results

Fecal Coliforms. Table 1 shows the fecal coliform cfu/100ml recorded by each individual at each site, and also means from each site for each of the four groups. For each site, all four groups had mean fecal coliform counts of the same order of magnitude, with the exception of the V1 group mean for Site 2 which was substantially higher than the numbers recorded by other groups. Statistical analysis using the chi square goodness of fit test revealed a significant difference ($p=0.05$) between the group means for all sites except Site 1. The V1 group identified Site 2, sampled on July 16, to have had the highest counts. With the exception of the V1 group, the data from all three other groups identify Site 3, sampled on July 23, to have had the highest fecal coliform counts. The regulatory standards for fecal coliform levels in recreational water in Tompkins County, NY, where the data were collected, specify that no single plate should have more than one thousand fecal coliform cfu/100ml. In no case did any of the groups differ from each other when that standard is applied, i.e., all groups showed that the water at all sites was in compliance with regulatory standards and had fecal coliform levels well below the regulatory limits. Generally the results for individuals within a group taken at the same time and place at a site (internal field duplicates) are comparable. This suggests that adequate quality assurance/quality control procedures were employed.

Benthic Macroinvertebrates. At three of the four sites (Sites 1, 3 and 4), the interns (I) and one of the volunteer groups (V2) agreed on the water-quality ratings, while the other volunteer group (V1) assigned a slightly lower water quality value to those sites. At the remaining site (Site 2), volunteer group V1 agreed with the scientists, while the interns and group V2 assigned a slightly higher value to water quality (Table 2). At three of the four sites (Sites 1, 3 and 4), the scientists (S) had the highest IBI score and, therefore, the best water quality.

Results: Physicochemical Parameters. As evidenced by relatively low spread to mean ratios there is, in general, good agreement between the data collected by the different groups at each site for the physicochemical parameters measured (Table 3). Dissolved oxygen is the parameter that shows the most variation between groups at each site and temperature is the parameter that exhibits the least. Data collected at Site 4, sampled on July 30, show more variation between the groups than data collected at the other sites (Table 3). The relatively variable results for Site 4 could reflect real differences in microhabitats within that riffle. The variability between groups in the results of the dissolved oxygen test likely reflect the difficulties experienced by participants in using and reading the dissolved oxygen meter, which does not have a digital scale.

Discussion

This project demonstrated that it is possible, in a relatively short time, to educate citizen volunteers in the techniques needed to collect and process fecal coliform samples. The data collected by the four monitoring arrangements were statistically significantly different on three out of four occasions. The origin of the outlying data recorded by the V1 group at Site 2 is not clear (Table 1). It is possible that it is the result of excessive disturbance of the sediment during sample water collection, and hence the release of a high number of sediment-borne fecal coliforms into the stream flow..

It was also demonstrated that volunteers with only a modest amount of training, when provided with appropriate taxonomic keys, can collect macroinvertebrate samples, identify organisms to family, and calculate appropriate metrics. Overall, the four groups arrived at similar assessments of water quality at all the sites in Salmon Creek (Table 2). We are currently engaged in re-evaluating the voucher samples saved from each site and identifying organisms to genus and species where possible. This analysis will allow us to begin to identify how far volunteers can go in accurately classifying organisms. As well, we will be able to calculate more precise IBIs and assignments of water-quality status. We will thus be able to evaluate the accuracy of taxonomic assignments made by each group. The volunteers in this pilot study were given only six hours of orientation. In any continuation of this work, volunteers might be given more intensive orientation and training in taxonomic identifications of macroinvertebrates. They might also be supplied with a synoptic collection of voucher specimens by which to verify their taxonomic assignments.

Overall the project will serve as a good basic model for larger scale studies and programs that seek to link scientists and volunteers. Execution of the project described here demonstrated that necessary training of interns and inexperienced volunteers can be successfully accomplished in a short period of time, and that these groups can then collect data of acceptable quality. The feasibility of coordinating simultaneous water sampling by multiple independent groups was demonstrated. The observed levels of time commitment and technical expertise contributed by the volunteers will serve as guidelines for future projects.

The project allowed opportunities for aspects of the environmental studies curriculum at Wells College to be strengthened and augmented in two major ways. First, in their capacity as interns working on the project, participating undergraduates learned the theory and practice of water quality monitoring techniques. Such hands-on field experience is becoming increasingly rare in academic training. The undergraduates also gained valuable professional experience working directly with citizen volunteers in collaboration with faculty scientists. The practical experience they gained represents an important part of a strong undergraduate environmental studies curriculum, a part that cannot be replicated in the traditional classroom. Second, the experience provided by the internship formed the basis of an undergraduate's senior capstone project and resulting senior thesis.

References

- APHA. 1995. Standard Methods for the Examination of Water and Wastewater. 19th Edition. American Public Health Association. Washington, D. C.
- Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid bioassessment protocols for use in streams and wadeable rivers: periphyton, benthic macroinvertebrates and fish, second ed. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water. Washington, D.C.
- Bode, R. W., M. A. Novak, and L. E. Abele. 1991. Methods for rapid biological assessment of streams. Stream Biomonitoring Unit. Division of Water, NYSDEC, Albany, NY.
- EPA. 1997. Volunteer Stream Monitoring: A Methods Manual. Washington, DC: EPA. Available from the Internet. URL: <http://www.epa.gov/owow/monitoring/volunteer/stream/vms10.html>.
- EPA. 2001. "Monitoring Water Quality – Volunteer Monitoring." Available from the Internet. URL: <http://www.epa.gov/owow/monitoring/vol.html>.
- Heiman, Michael. 1997. Science by the People: Grassroots Environmental Monitoring and the Debate Over Scientific Expertise. Journal of Planning Education and Research 16(4):291-299.
- Hilsenhoff, W. L. 1988. Rapid field assessment of organic pollution with a family level biotic index. Journal of the North American Benthological Society 7(1):65-68.
- Kellogg, L. L. 1994. Monitor's Guide to Aquatic Macroinvertebrates. The Isaak Walton League of America; Gaithersburg, MD.
- Kerans, B. L. and J. R. Karr. 1994. A Benthic Index of Biotic Integrity for Rivers of the Tennessee Valley. Ecological Applications 4(4):768-785.
- Maryland Department of Natural Resources (DNR). 2001. Stream Waders Volunteer Monitoring Manual. Website: http://www.dnr.state.md.us/streams/mbss/mbss_volun.html
- Murdoch, T. and M. Cheo (with K. O'Laughlin). 1996. The Streamkeeper's Field Guide: Watershed Inventory and Stream Monitoring Methods. Everett, WA: the Adopt-A-Stream Foundation.
- Pacific Streamkeepers Federation (PSF). 2001. Streamkeepers Handbook and Modules. Vancouver, BC: Pacific Streamkeepers Federation. Available from the Internet: URL: <http://www-heb.pac.dfo-mpo.gc.ca/PSkF/home.htm>.
- Peckarsky, B. L., P. R. Fraissinet, M. A. Penton, and D. J. Conklin. 1990. Freshwater Macroinvertebrates of Northeastern North America. Cornell Univ. Press, Ithaca, NY

Table 1
Fecal coliform cfu/100ml recorded for four sites in Salmon Creek

| | Site and Date Sampled | | | |
|-------------------|-----------------------|----------------|----------------|----------------|
| | Site 1 7/9 | Site 2 7/16 | Site 3 7/23 | Site 4 7/30 |
| Scientists (S) | 56 | 50 | 296 | 42 |
| | 42 | 46 | 294 | 20 |
| S group mean | 49 | 48 | 295 | 31 |
| Interns (I) | 38 | 44 | 308 | 42 |
| | 40 | 58 | 380 | 70 |
| I group mean | 39 | 51 | 344 | 56 |
| Volunteers 1 (V1) | 28 | 118 | 252 | 44 |
| | 52 | 530 | 374 | 34 |
| | 48 | 546 | 390 | 46 |
| V1 group mean | 43 | 398 | 339 | 41 |
| Volunteers 2 (V2) | 36 | 44 | 552 | 22 |
| | 64 | 106 | 346 | - |
| V2 group mean | 50 | 75 | 449 | 22 |

Table 2
Summaries of water quality metrics for each site in Salmon Creek

Site 1. July 9, 2001

| | Scientists (S) | Interns (I) | Volunteer (V1) | Volunteer (V2) |
|--------------------------|----------------|-------------|----------------|----------------|
| Species Richness | 13 (6) | 13 (6) | 8 (3) | 11(6) |
| FBI | 3.0 (12) | 3.1 (12) | 3.6 (12) | 3.7 (12) |
| % dom. family | 48 (12) | 72 (6) | 65 (6) | 66 (6) |
| EPT Index | 8 (9) | 7 (9) | 3 (6) | 4 (6) |
| IBI Score | 39 | 33 | 27 | 30 |
| H ₂ O Quality | Good | Good | Fair | Good |

Site 2. July 16, 2001

| | Scientists (S) | Interns (I) | Volunteer (V1) | Volunteer (V2) |
|--------------------------|----------------|-------------|----------------|----------------|
| Species Richness | 9 (3) | 12 (6) | 9 (3) | 15 (6) |
| FBI | 2.8 (12) | 3.2 (12) | 3.9 (10) | 4.0 (10) |
| % dom. family | 57 (6) | 44 (9) | 55 (6) | 28 (12) |
| EPT Index | 4 (6) | 6 (9) | 5 (6) | 6 (9) |
| IBI Score | 27 | 36 | 25 | 37 |
| H ₂ O Quality | Fair | Good | Fair | Good |

Site 3. July 25, 2001

| | Scientists (S) | Interns (I) | Volunteer (V1) | Volunteer (V2) |
|--------------------------|----------------|-------------|----------------|----------------|
| Species Richness | 17 (6) | 11 (6) | 10 (3) | 11 (6) |
| FBI | 2.9 (12) | 3.4 (12) | 4.1 (10) | 5.2 (6) |
| % dom. family | 44 (9) | 52 (6) | 37 (9) | 35 (9) |
| EPT Index | 5 (6) | 4 (6) | 5 (6) | 6 (9) |
| IBI Score | 33 | 30 | 28 | 30 |
| H ₂ O Quality | Good | Good | Fair | Good |

Site 4. July 30, 2001

| | Scientists (S) | Interns (I) | Volunteer (V1) | Volunteer (V2) |
|--------------------------|----------------|-------------|----------------|----------------|
| Species Richness | 16 (6) | 12 (6) | 7 (3) | 11 (6) |
| FBI | 3.8 (10) | 3.9 (10) | 4.6 (8) | 4.8 (6) |
| % dom. family | 56 (5) | 43 (9) | 46 (9) | 37 (9) |
| EPT Index | 6 (9) | 4 (6) | 2 (6) | 3 (6) |
| IBI Score | 31 | 31 | 26 | 29 |
| H ₂ O Quality | Good | Good | Fair | Good |

(Numbers in parentheses contribute to the Index of Biological Integrity (IBI) score)

Table 3
Summaries of Physicochemical Parameters for Each of Three Sites at Salmon Creek

Site 2. July 16, 2001

| | Water Temperature (°C) | Specific Conductance (mS) | Dissolved Oxygen (ppm) | pH |
|--------------------------------|------------------------|---------------------------|------------------------|-----|
| Scientists (S) | 23.8 | 4.70 | 10.0 | 8.6 |
| Interns (I) | 23.4 | 4.72 | 8.8 | 8.4 |
| Volunteers (V1) | 24.0 | 4.65 | 8.8 | 8.2 |
| Volunteers (V2) | 24.5 | 4.77 | 8.6 | 8.2 |
| Spread | 1.1 | 0.12 | 1.4 | 0.8 |
| Mean | 23.9 | 4.71 | 9.1 | 8.4 |
| Spread as a Percentage of Mean | 4.6 | 2.5 | 15.4 | 4.8 |

Site 3. July 25, 2001

| | Water Temperature (°C) | Specific Conductance (mS) | Dissolved Oxygen (ppm) | pH |
|--------------------------------|------------------------|---------------------------|------------------------|-----|
| Scientists (S) | 25.7 | 4.35 | 7.5 | 8.3 |
| Interns (I) | 25.0 | 4.56 | 7.3 | 8.4 |
| Volunteers (V1) | 25.0 | 4.44 | 7.0 | 8.3 |
| Volunteers (V2) | 25.5 | 4.60 | 7.8 | 8.1 |
| Spread | 0.7 | 0.25 | 0.8 | 0.3 |
| Mean | 25.3 | 4.49 | 7.4 | 8.3 |
| Spread as a Percentage of Mean | 2.8 | 5.6 | 10.8 | 3.6 |

Site 4. July 30, 2001

| | Water Temperature (°C) | Specific Conductance (mS) | Dissolved Oxygen (ppm) | pH |
|--------------------------------|------------------------|---------------------------|------------------------|------|
| Scientists (S) | 25.0 | 4.20 | 10.8 | 9.1 |
| Interns (I) | 25.5 | 4.73 | 11.2 | 8.7 |
| Volunteers (V1) | 26.0 | 4.39 | 11.1 | 7.7 |
| Volunteers (V2) | 26.5 | - | 8.9 | 8.6 |
| Spread | 1.0 | 0.53 | 2.3 | 1.4 |
| Mean | 25.8 | 4.44 | 10.5 | 8.5 |
| Spread as a Percentage of Mean | 3.4 | 11.9 | 21.9 | 16.5 |