NEWSLETTER OF THE LAKES OF MISSOURI VOLUNTEER PROGRAM

The Water Line

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Zebra Mussels at the Lake of the Ozarks

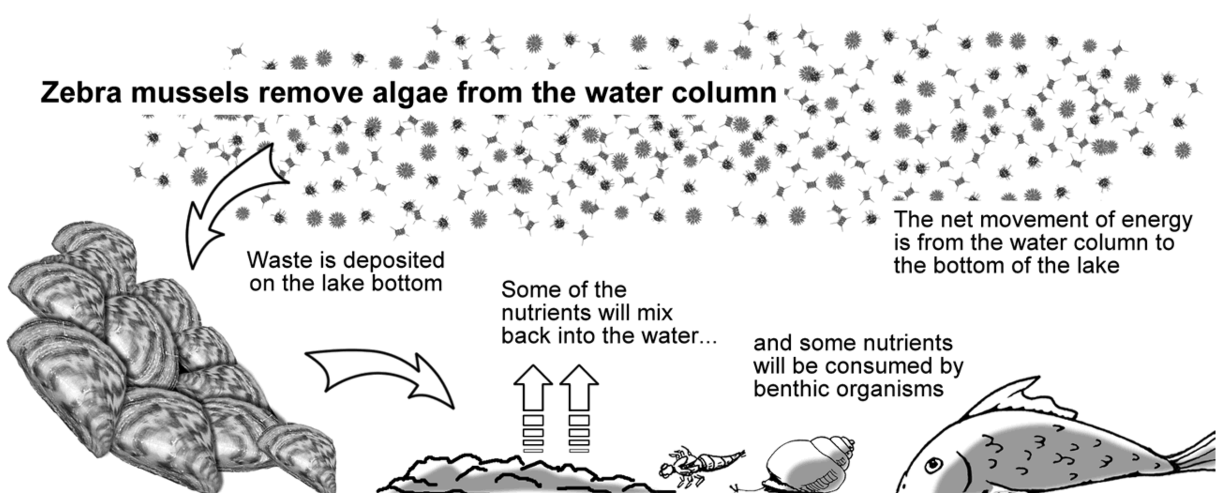
The Lake of the Ozarks had an unwanted visitor this summer, one that may never leave. Zebra mussels have arrived! Zebra mussels are an invasive species that are *very* difficult to control and *very* expensive to deal with. They can attach to just about anything than enters the water and thus are easily transported from waterbody to waterbody.

Originally from the Black Sea region of Eastern Europe, zebra mussels first came to the United States via the ballast waters of ships visiting the Great Lakes. Until this summer this invader had been confined to the Missouri, Mississippi and Meramec rivers in Missouri. Now they are moving into our lakes.

We've discussed the zebra mussel invasion in several issues of the Water Line (see the website for a complete list), so this article won't go into great detail about them. What we *haven't* discussed much is the ecological impact of zebra mussels.

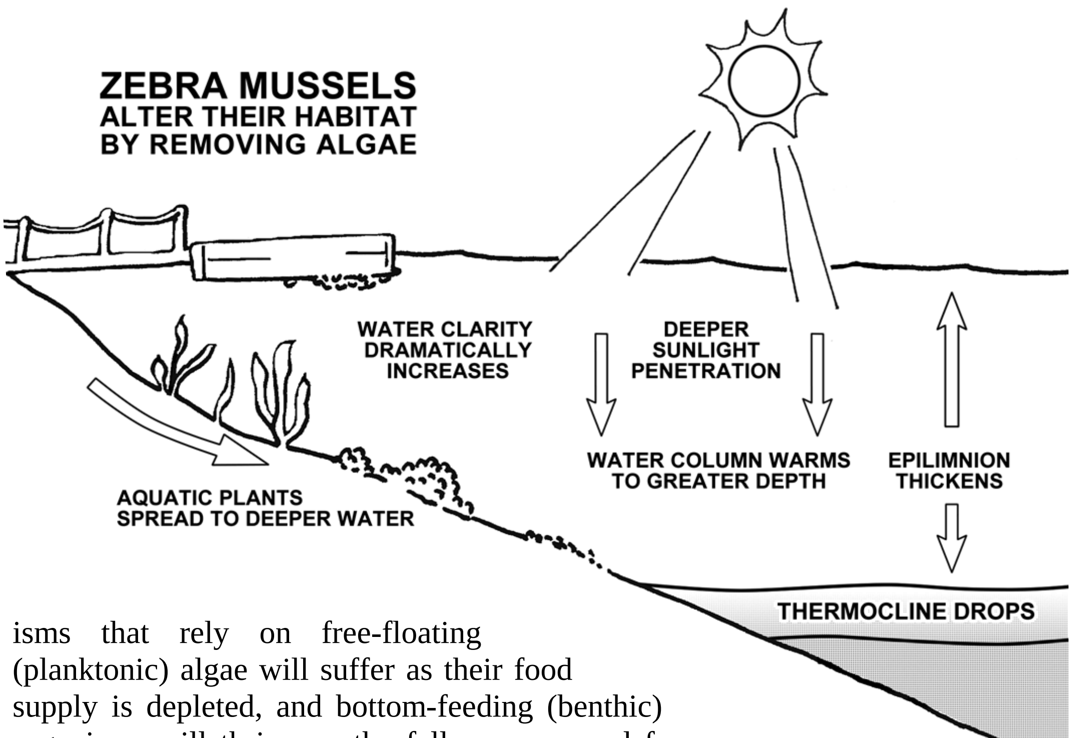
Zebra mussels are very prolific breeders, with adult females producing anywhere from 30,000 to 1.6 million eggs per year. The larval mussels (called veligers) can attach to nearly anything, including docks, boats, plants, people, crayfish and birds. Frequently the mussels attach to each other, which results in large colonies called druses. By forming druses, zebra mussel colonies can grow in three dimensions, not just two, allowing the number of mussels per square foot to skyrocket. A study of some Lake Michigan sites in Illinois and Wisconsin found that zebra mussel densities increased from an average of 14 mussels per square foot in 1991 to a minimum of 5,000 and a maximum of 25,000 per square foot *in just one year*.

The zebra mussel is a filter feeder, with each adult capable of clearing the algae from a quart of water each day. A thousand zebra mussels can thus filter 250 gallons of water each day. As the mussels filter algae out of the water, the water typically becomes considerably clearer. As they process the stuff they filter from the water, the zebra mussels deposit feces and pseudofeces (particles they capture, but can't ingest) on the lake bottom. The result is that the organ-



In This Issue:

Zebra Mussels at the Lake of the Ozarks, continued



isms that rely on free-floating (planktonic) algae will suffer as their food supply is depleted, and bottom-feeding (benthic) organisms will thrive on the fallen scraps and feces deposited by the zebra mussels.

Over time, even fish communities may be altered. Zooplankton, a common food for larval fish, will suffer as their food source is consumed by the zebra mussel. Fish that dine on benthic invertebrates will do well, especially if they can eat zebra mussels directly. Freshwater drum, catfish, sunfish and lake sturgeon are able to feed upon zebra mussels, though not heavily enough to significantly decrease the numbers.

Increased water clarity (thanks to zebra mussel filtration) exposes more of the lake's bottom to sunlight, resulting in more habitat for aquatic plants. The Lake of the Ozarks is mostly rocky on the bottom, but many of the coves have plenty of sediments capable of supporting plant life. As the quantity of vegetation increases, more nutrients will be taken out of the water column and be unavailable to algae. The increase in vegetation may be troubling to some lake users, as plants foul boat propellers and swimming areas. Additionally, zebra mussels attach quite readily to plants, so clearing the water can potentially increase the amount of surface area for zebra mussel attachment. More surface area means more zebra mussels and the cycle continues.

Another side effect of zebra mussel infestation is altered stratification. As the water becomes clearer, sunlight penetrates deeper into the water column, heating more water. Eventually, the oxygenated upper layer of water (epilimnion) becomes thicker. Since the cooler, bottom layer of water (hypolimnion) is often devoid of life-supporting oxygen, the result is a greater volume of "habitable" water.

If the zebra mussels thrive at the Lake of the Ozarks, the lake will change. Clearer water is often thought of as a good thing, but zebra mussels will displace our native mussels, alter habitat and food webs, and even change the stratification patterns in lakes. Ecologically speaking, they don't belong here. Nevertheless, the zebra mussel is here now, and they're probably here to stay.

Effects of Zebra Mussels on Lakes

- Reduced algae in the water column (lower chlorophyll concentration)
- Increased water clarity (greater Secchi depth)
- Potential changes in the algae community (more attached algae, more blue greens)
- Aquatic plants will thrive as more of the lake bottom is exposed to sunlight (due to increased clarity).
- The thermocline will be deeper as light penetrates more deeply into the water column.
- Fish communities will shift to favor benthic (bottom dwelling) species.

Evaluation of Volunteer Data Quality

Last issue, we mentioned how some folks question the quality of data collected through volunteer programs (Winter 2006 issue of The Water Line). At that time LMVP staff were evaluating the reliability of LMVP data, with plans of presenting the findings at the National Monitoring Conference. The analyses are done, graphs are made, the slide show presented, and results indicate that data generated by the LMVP are reliable. What follows is a short review of the methods used to evaluate LMVP data and the results.

Comparison of Annual Averages

We compared data collected through the LMVP to data generated by other University of Missouri water quality monitoring projects. To qualify for this analysis a site had to be sampled at least three times during a summer by both the LMVP and MU. The result was a total of 178 comparisons (each comparison was an individual site during an individual year) representing 41 different sites from 29 lakes. Each comparison was statistically analyzed to determine if the LMVP average for a given site/year differed from the MU average.

Statistical analysis indicated that 164 (92%) of the total phosphorus comparisons were not significantly different. Results for the other parameters were even better and are presented in the following table.

Figure 1 shows the annual average total phosphorus data plotted out. The horizontal and vertical axes represent the MU and LMVP values, respectively. Each symbol denotes one of the 178 comparisons, and the dashed line is the 1:1 line (if LMVP and MU values were exactly the same the symbol would fall on the line). As you can see, most of the symbols are located near the 1:1 line indicating close agreement between LMVP and MU data. Most of the comparisons that fall farther away from the 1:1 line were sites with higher phosphorus values (>50 ug/L). This is to be expected because lakes that have higher nutrient levels also have higher variability.

Should we be concerned with the comparisons that were not in agreement? Given that Missouri lakes tend to be quite variable, differences in the timing of sample collection by LMVP and MU accounts for some of the differences in average values. Also, on some of the large reservoirs (Lake of the Ozarks, Table Rock, etc.) the location of LMVP and MU sites were not perfectly matched. We feel that given the gradients in water quality found in large reservoirs, even a few miles difference between sample sites can lead to differences in average values.

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A Brief Word on Statistical Differences

The seasonal values generated by the LMVP and MU for a given lake are almost never the exact same. This is expected, since water quality fluctuates on a day to day basis (see Fall 2004 and Spring 2005 newsletters), and samples are collected on different days for the two projects. We use statistics to determine if the differences we find are acceptable. Statistics use the variability within the two data sets (LMVP and MU) as well as the overlap between the data sets to determine 'statistical' differences. A statistical difference means the data sets being compared are dissimilar enough that they can not be considered as equal.

If a statistical difference is not found, it means the data sets being compared are so similar that we can not consider them to be different.

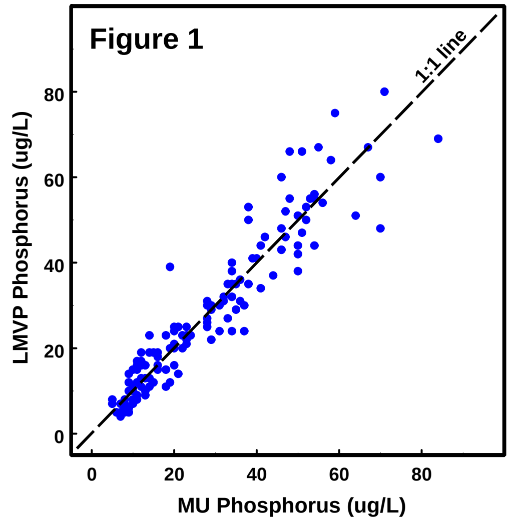
For split sample comparisons the statistical analysis is a little different. Here we are dealing with values that should be the same in theory, but will differ a little because nothing is perfect, even in science. The differences should be relatively small and random as to which of the two values (LMVP or MU) is higher. Statistical analysis in this case determines nonrandom trends. For example, if the LMVP phosphorus values were all a little higher than the MU values, statistical analysis would indicate a difference in the data.

Evaluation of Volunteer Data Quality, continued

Bottom: Percent agreement between annual values derived from LMVP and MU lake site data.
*ISS = Inorganic Suspended Solids. Not all LMVP lakes monitor this parameter, thus the lower number of comparisons

Figure 1 - Right: Annual LMVP vs. MU data

Parameter	# Comparisons	# Agreement	% Agreement
Phosphorus	178	164	92
Nitrogen	178	167	94
Chlorophyll	178	171	96
Secchi	178	166	93
ISS*	117	116	99



Comparison of Long Term Averages

If a lake site used in the previous analysis was sampled by both LMVP and MU during four or more years, the lake was included in this analysis. The comparison of long term averages emphasizes year-to-year variation as opposed to the sample-to-sample variation that was the focus of the annual average comparisons. Aggregation of data into a long term average reduces the influence of extreme values and provides a better assessment of a lake sites true water quality.

A total of 23 different sites from 11 lakes were compared, with individual sites being monitored between 4 to 10 years. None of the comparisons made in this analysis were significantly different for any of the five parameters. This means that once sample-to-sample variability is reduced through aggregation of data, the LMVP and MU data were extremely comparable. The comparability of the long-term phosphorus averages can be seen in Figure 2 (note how close to the 1:1 line the symbols fall).

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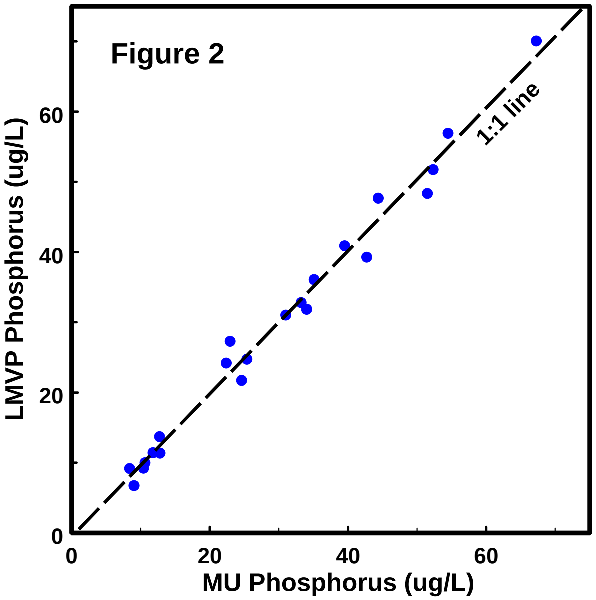
Kurt measures water for analysis

Figure 2 - Right:
Comparison of MU and LMVP long-term average phosphorus concentrations.



Evaluation of Volunteer Data Quality, continued

Split Samples

This analysis evaluates how the processing and storage methods of the LMVP compares to those of MU. Split sampling involves LMVP staff accompanying volunteers as they sample. The volunteer collects composite samples as they normally would, and after they have filled their sample bottle LMVP staff fills another bottle from the same composite container. In theory, both the volunteer and staff person should have the same water. Volunteers process and store their sample as they normally would while the LMVP staff brings their sample back to the University to process and store following lab procedures.

A total of 27 sites were involved in split sampling from 18 lakes in the program during 1998 and 2005. Statistical analysis involves comparing the 27 different Volunteer values to the 27 Staff values for a given parameter. Results for phosphorus, nitrogen and inorganic suspended solids indicated no significant difference between Volunteers and Staff data. There was a difference in the chlorophyll data. When we look at the graph (Figure 3) we find that Staff values were higher than the Volunteer values for the 8 highest chlorophyll readings (based on Staff value). Most of the values were very similar, but because all the points on this end of the plot fall on the same side of the 1:1 line, the statistical test indicated a difference.

This is not the first time that we have done split sampling. When we look at results from 1995 we find the opposite pattern, with all of the higher chlorophyll values being on the other side of the 1:1 line. When we combine the data we find no difference between the Volunteer and Staff data sets (Figure 4). We believe the results from the 1998 and 2005 split samples are simply an anomaly in the data (as were the 1995 data) and do not truly represent a difference in the data.

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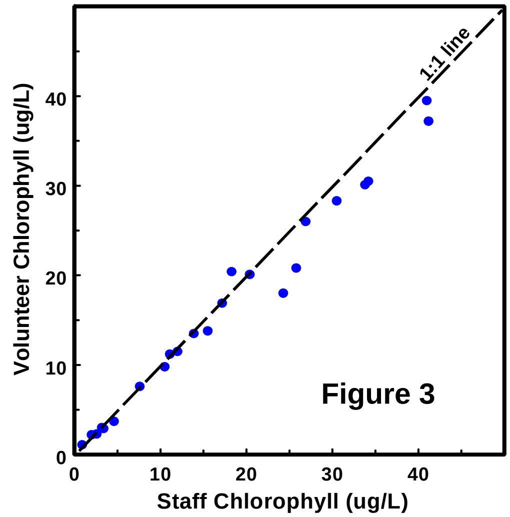
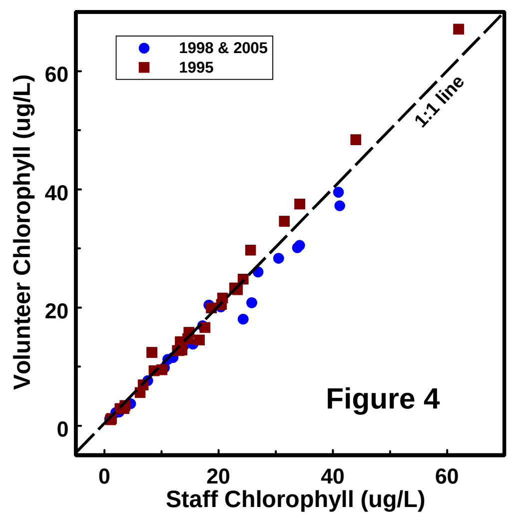


Figure 3: Above. Chlorophyll results from 1998 and 2005 Split Samples.

Figure 4: Below. Same as Figure 3, with 1995 data added. Note that the “skew” disappears when the 1995 data are added. We don’t believe that the skew seen in Figure 3 is related to data quality.



Left. The process of filtering is identical for both the Lakes of Missouri Volunteer Program and the University of Missouri

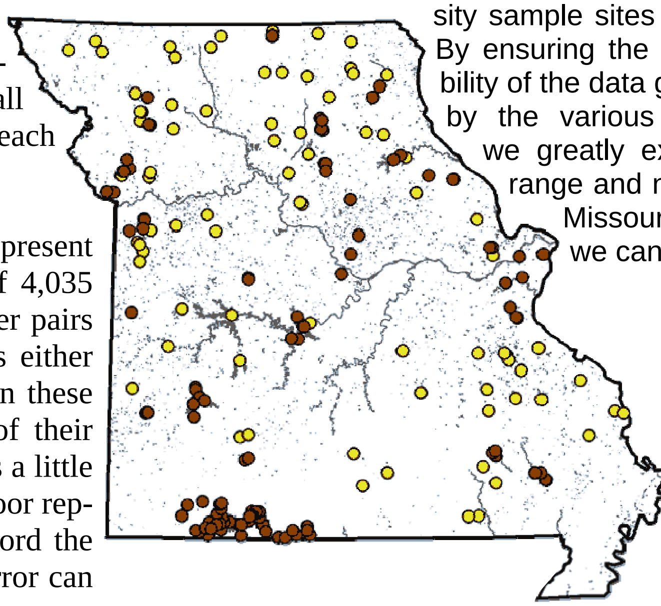
Evaluation of Volunteer Data Quality, continued

Filter Replication

In 1996 we introduced a method for gauging how well volunteers process their samples by looking at the replication of filter pairs (LMVP volunteers process two chlorophyll filters per sample). For this comparison we looked not only at how well LMVP filters replicate, but also how well MU filters replicate (all MU projects prepare two chlorophyll filters from each sample).

We used differences of 5%, 10% and 15% to represent excellent, good, fair and poor ratings. A total of 4,035 filter pairs were compared for MU and 3,947 filter pairs for LMVP. MU had 93% of filter pairs rated as either excellent or good, while LMVP had 89% rated in these two categories (Figure 5). Volunteers had 6% of their filter pairs rated as poor replication, a value that is a little higher than we would like to see. In most cases, poor replication occurs because the volunteer fails to record the correct volume of water on the filtration sheet. Error can also occur when samples are analyzed at the lab.

Laboratory error during processing is probably responsible for the bulk of the 3% of MU filter pairs rated as "poor." It is safe to assume that a similar proportion of LMVP filter pairs are also rated poor due to lab error.



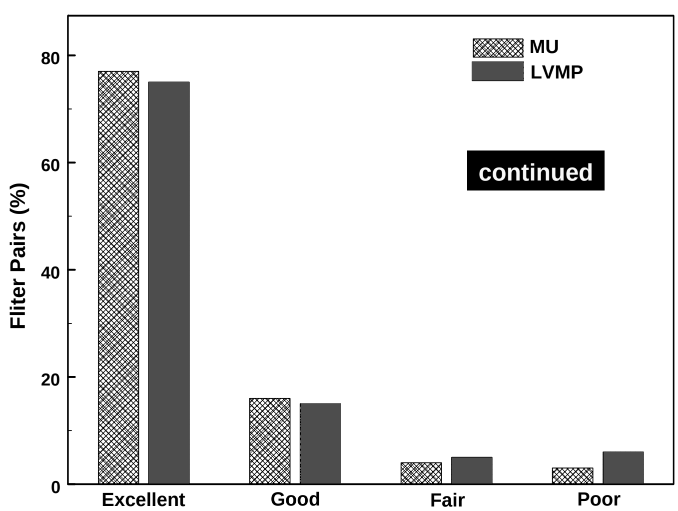


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Figure 5. Break down of chlorophyll filter replication for both MU and LMVP.

This map shows LMVP and University sample sites for 2005. By ensuring the comparability of the data generated by the various projects, we greatly extend the range and number of Missouri lakes we can monitor.

Summary

The results from the analyses suggest that data generated from samples collected by volunteers and those collected by MU staff are very comparable. Some differences occurred in the annual average comparisons, but given the variable nature of the data and the fact that our samples sites did not always match perfectly in terms of location, some differences should be expected. When we aggregate the data and look at long term values we find no differences between LMVP and MU data for any of the parameters. Split sampling did not suggest any differences in the data and therefore no differences in procedures, with the exception of chlorophyll where a statistical difference was found. A review of the past split sample data suggests that the statistical difference was due to the coincidental grouping of a few data points. LMVP volunteers had chlorophyll filter replication that was extremely comparable to MU.

END

World Water Monitoring Day - October 18, 2006

Do you want to participate this year?
Grab a sample sometime between September 18 and October 18 - Tony will submit the data for you.

World Water Monitoring Day is a global event celebrated each year on October 18, following a month-long monitoring window that starts September 18. LMVP sampling ends around this time, so if you are a volunteer and you want to participate, be sure to collect a sample sometime after September 18.

Tony will personally submit the LMVP data to the World Water Monitoring Day staff, so you don't need to do anything else to participate. If you want to enter your own data, please let us know so your numbers aren't submitted twice. You can visit the WWMD website at: www.worldwatermonitoringday.org. At the website you can read reports from the previous years and find out more about the event.

> "World Water Monitoring Day was created with two major purposes in mind. First, to serve as an educational platform to introduce people to the importance of water monitoring and connect them personally with efforts to protect and preserve their local watersheds, and second, as a means of expanding the base of information available about the health of each watershed over time."
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> - From the WWMD website at www.worldwatermonitoringday.org

A Summary of World Water Monitoring Day, 2005

- World Water Monitoring Day is a worldwide event, with 4,917 sites monitored in 47 countries during 2005.
- 3,867 of those sites were in the United States.
- Missouri monitored 100 sites in 2005, making it the 11th ranked state in the U.S.
- The LMVP submitted data from 62 sites.
- Iowa and Virginia were in a different league, with 923 and 565 sites monitored, respectively. We have a long way to go before we reach that level of involvement!
- Other countries involved in 2005:
  Argentina, Armenia, Australia, Azerbaijan, Bangladesh, Belgium, Brazil, Bulgaria, Burkina Faso, Canada, Chile, China (PRC), Colombia, Costa Rica, Czech Republic, Ecuador, Ghana, Haiti, India, Indonesia, Israel, Italy, Japan, Kyrgyzstan, Latvia, Macedonia, Malaysia, Malawi, Mexico, Micronesia, Moldova, Nepal, Netherlands, Nigeria, Norway, Pakistan, Palestinian National Authority, Philippines, Romania, Serbia and Montenegro, Singapore, South Africa, Sri Lanka, Taiwan (Republic of China), United Kingdom and Uzbekistan.