HOME COUNTRY PROJECT SUPPORTED BY

AMERICAN ASSOCIATION OF UNIVERSITY WOMEN (AAUW) IN 2002:

"**RUSSIAN CLEAN WATER PROJECT**"

(The Project of Biological Monitoring of Water Quality in South Russian Far East)

2003

Initiators:

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Project Description

History of Project's development

The idea of the present project was born in 1994 when Dr. J. Morse first visited Vladivostok and took part in a joint investigation of Russian Far East freshwaters, with special emphasis on water pollution problems. Later, when he was invited in 1999 to teach a course of freshwater ecology at Far East State University (FESU), the idea was formulated precisely and was supported by the head of the Ecology Department of FESU and the Director of the Institute of Biology and Soil Sciences, IBSS. It was decided to organize a special Laboratory on Water Quality Monitoring, could will provide extensive monitoring of freshwater in our region, develop rapid bioassesment methods for special agencies and groups of environmentalists, and teach new generations about water conservation.

Apparently, the ecological situation in the Primorye Region is becoming worse with every year. With the organization of the Laboratory of Water Quality Monitoring, we will be able to introduce new modern methods of biomonitoring freshwater ecosystems based on invertebrate organisms, prepare well-educated specialists, and attract public attention to the pressing need for restoring and protecting freshwaters in Russia.

Overall project goal or purpose

The goal of the project is to develop rapid bioassesment protocols suitable for monitoring freshwater ecosystems in Far East Russia, patterned after the protocols presently used in the United States. Use of these protocols will reveal the most serious sources of water pollution and allow development of mitigation strategies. The task will be accomplished in three main steps:

(a) organizing a special biomonitoring center responsible for scientific and practical monitoring in the region (based at IBSS);

(b) preparing qualified specialists who are able to conduct freshwater biomonitoring based on modern biological methods (based at FESU); and

(c) developing a special program for publicizing the problems of water pollution, patterned after the Cooperative Extension Service in the United States, in which a center for biomonitoring water quality has quick-response capability and a continuing education capacity that provides knowledge about advantages and methods for nature conservation (based on students and scientists social activities).

Anticipated project results or accomplishments

Results of our activity ultimately will be to obtain information about the water pollution situation in the Primorye Region, to prepare documents for local and state governments about the situation, and to develop a joint government and scientific program for improvement of the water quality in the Primorye Region and consequently of the health and well-being of the people in the Region.

Target audience for project

The target audience for the first step (establishing a biomonitoring center at IBSS) will be the young women introduced to freshwater biomonitoring by Dr. Morse and further trained by T. S. Vshivkova in the new Laboratory for Water Quality Monitoring at IBSS. The audience for the second step (training a new group of freshwater ecologists at FESU) will be students at FESU. The audience for the third step of the project will be recent and future generations of people populating Far East Russia.

We want to inform as many people as possible about the severe water pollution problems in Far East Russia using different kinds of activities and media: mass-media, public lectures, consultations, educational projects at Regional schools and other public institutions.

Demonstration of how the project will aid women and girls in my country

It is mainly women who are most vitally concerned about water pollution in Far East Russia, especially mothers worried about the health of their children and the predominantly female professional freshwater ecologists. Steps one and two will train young women at FESU and employ them in meaningful professional work at IBSS. Step three publicity will be most eagerly received and used by women (both working and homemaking). Some of the most effective assistance will come from school teachers (they are mainly women in Russia) who help promote health education and environmental concern in the schools where, again, the young girls will be most receptive.

Evidence of Project Need

Issue or problem the Project will address

The Project will begin from the investigation of the water pollution problem in a specific area of Primorye Region – the Razdolnaya River Basin. The River is the largest waterway of the Region and its basin covers the most densely populated area of the southern Far East, with intensely developed industry and agricultural systems in and around Ussuriisk City and Vladivostok. Its water is used for transportation, irrigation, fishing, and other human activities. This river accepts most waste material in the Region, both directly from factories located near Ussuriisk City (one of the large industrial centers of South Primorye) and from several polluted tributaries in the lower part of its catchment.

The total length of the river is 245 km and the catchment’s area is 16 830 sq. km. The river flows into Amursky Bay of the Sea of Japan, with the mouth about 20 km from Vladivostok, the largest city and principal seaport of eastern Russia. Presently, Amursky Bay is recognized as a zone of ecological crisis in Primorye.

Justification for the Project (examples of existing research demonstrating needs)

Investigation of pollution problems in Razdolnaya River Basin was started by T.S. Vshivkova and her colleagues from IBSS about 10 years ago. Information about the aquatic flora and fauna were obtained and preliminary data were accumulated to allow rough estimation of the most polluted areas of the basin. The present project will be based on those previous data. Because the Razdolnaya River and its tributaries will be so intensely studied, this basin will become a model river system for the southern regions of the Russian Far East.

This Project will be especially important because it will be the first to implement modern biomonitoring technology on a large river system in Russia. Therefore, it will serve as a first test in Russia of the bioassessment methods developed in the USA, providing a foundation for development of field and laboratory protocols appropriate for Russian waterways and Russian scientific infrastructure. For example, Chinese colleagues also have recently modified those bioassessment methods based on cooperative work with American ecologists, adapting them to the circumstances in their country. The experience of our American and Chinese colleagues will serve as a starting point for developing regional bioassessment methods and standards, which will be specific to the conditions and biota of our region of Russia.

Plan of Work

The principal objective of the three-year project will be to prioritize the most serious sources of pollution in the Razdolnaya River basin. About 30 sampling sites will be chosen throughout the catchment area to be sampled annually for two years. Sites will be sampled in the same season to reduce natural variability resulting from seasonal population changes. Each site will be sampled in those successive years to facilitate detection of pollution trends.

<u>Outline specific implementation steps, including timeline</u>

1 step: 2003, Winter - Spring**:** a) organization of the work group of the new Laboratory of Water Quality Monitoring; b) developing an explicit, preliminary program of sampling and analysis; c) teaching bioassessment methods to members of the working group through hands-on field and laboratory training; d) preparing necessary equipment and supplies for the sampling work.

2 step: 2003, Spring - Summer: a) sampling the 30 sites in the two-three weeks period of the end of June; b) preserving, sorting, and identifying specimens.

3 step: 2003, Autumn – Winter: a) finish identifying specimens, tabulating and analyzing results, and developing initial conclusions.

4 step: 2004, Spring – Summer - Fall: a) re-sampling the 30 sites in the two-three weeks period of the end of May-early June; b) preserving, sorting, and identifying specimens; c) refining initial conclusions, with additional observations regarding pollution trends.

5 step: 2004, Winter: a) preparing and submitting proposed strategies to regional and Municipal government authorities for mitigation of water pollution in the Razdolnaya River basin.

<u>Project's direct benefit to the community</u>

The direct benefits will be the discovery of the extent of water pollution in the Razdolnaya River basin (as a first step toward to wide-scale regional program of bioassessment) and the prioritization of pollution sources for government resolution, providing the people of southern Primorye improved healthful conditions.

Project will continue to have an impact beyond the initial grant period

The long-term benefits of the project will be to facilitate (1) development of rapid and inexpensive methods of bioassesments appropriate for the Far East Russian circumstances, thus enabling efficient and effective implementation of these methods in Russia for the first time, and (2) improvement of water quality throughout the Russian Far East.

We also plan to organize a Public Information Center (“Clean Water Center”) regarding water pollution, which will combine some of the responsibilities and practices of state regulatory agencies and public information agencies in the USA. Models for this center include the state water quality regulatory agencies in the USA (e.g., the South Carolina Department of Health & Environmental Control) and the state Cooperative Extension Services in the USA. This center will allow workers in Laboratory of Water Quality Monitoring (a) to react quickly to pollution events (e.g., spills, infrastructure failures, etc.) and to other negative situations very quickly and (b) to advise public media and individuals and government authorities about pollution problems. Thus, the Center will contribute to the improvement of environmental conditions in the Region.

Assessment/Dissemination

We are planning to prepare brochures, pamphlets, books, posters and other informative material for the public using mass media including newspaper articles, radio, and television; cooperation with “Green Peace” volunteers and other environmental activists in public and social affairs in order to alert the citizenry, especially women, to problems of polluted waters in Far East Russia and means for their solution.

STUDY AREA

Razdolnaya River

The Razdolnaya River is one of the largest and important watercourses of Southern Primorye. It begins in the East Manchurian Mountains, China and flows 191 km on the Russian territory discharging into the Sea of Japan. Located in a region with a high density of human population and a high concentration of the industrial enterprises and extensive agriculture, especially near Ussuriisk City, this river is strongly polluted in lower its lower reaches. The Razdolnaya River fall into Amursky Bay near Vladivostok, which was recently recognized as a zone of ecological crisis (Fig. 1)

Fig. 1. South Primorye and Razdolnaya River Basin.

The upper 54 km of the Razdolnaya River are located in China. The middle and lower 191 km are in the southern Far East of Russia. The total length of the river is 245 km. The catchment's area is 16830 km^2 (6820 km^2 in Russia) and the overall slope is 2.13% (0.45% in Russia). The headwaters is 800 m above sea level.

The upper part of the river, near the Novogeorgievka village, is located within the spurs of the East Manchzhurian Mountains. The river width is approximately 100 m, the current speed ranges between 0.4 and 0.8 m s^{-1} and the maximal depth is 1.5 m. The main channel has the typical series of riffles and pools, and the river bed is composed of coarse sediments, such as gravels and pebbles, scattered among sandy substratum covered by fine layer of silt. The summer water temperature is as high as 24-25^{0}C.

From Novogeorgievka, the river goes toward the Suifun Plain, which is an extension of the Khanka Depression, where the river's width ranges between 60 and 150 m. There are numerous shallows and spits. Riffles are developed with intervals of 300-500 m, their average depth is 0.4-0.8 m, and the current speed ranges from 2-2.5 m s^{-1}. The depth of pools reaches 1.5-2.0 m and the current speed is 0.5-0.8 m s^{-1}. The substrate of riffles is stony on a sandy and silty matrix with silt and that of pools is sandy with silt. The deposition of silt is sometimes heavy, especially near shore. The summer water temperature is about 22-25^{0}C and raises up to 28-32^{0}C. The lower part of the river has a large flood plain with many cutoffs, which provide numerous slow-flowing and stagnant habitats for aquatic organisms.

The water of Razdolnaya River is very turbid near Ussuriisk: the average turbidity is 150 g $m^{3.}$ During flood seasons the turbidity increases by a factor of 20. The water hardness ranges between 0.31 and 0.96 mg-eq l^{-1}. Floods are common and water overflows the in summer, but catastrophic floods happen approximately every 7 years.

Komarovka River

The Komarovka River rises on the south slopes of Przhevalsky ridge and flows into Razdolnaya River about 94 km from its mouth near Ussuriisk City. The length of the river is 67 km, a square of drainage system is 1490 km^2, the source is situated at an altitude of 360 m, average slope 5.8%. The upper part of the basin is situated in a zone of foothills (240-400 m) and the lower one on the undulating Suifun Plain. Physiographically the upper 25 km of the river is rithral and below it is a river of the plain. The upper 16 km is within the limits of the Ussurisky Nature Reserve.

SAMPLING SITES

The studied area with sampling sites is shown on fig. 2.

Razdolnaya River (Suifun)

Station S-1. Downstream of the Russian-Chinese boundary

Station S-2. Upstream of Phadeyevka Village

Station S-3. Downstream of Phadeyevka Village

Station S-4. Upstream of Novogeorgievka Village

Station S-5. Downstream of Novogeorgievka Village

Station S-6. Upstream of Sinelnikovo Village

Station S-7. Downstream of Sinelnikovo Village

Station S-8. Upstream of Pokrovka Village

Station S-9. Downstream of Pokrovka Village

Station S-10. Upper Ussuriisk City

Station S-11. At Ussuriisk City (upstream of the confluence of Komarovka R. with Razdolnaya R.)

Station S-12. Downstream of industrial and municipal discharge points of Ussuriisk

Station S-13. At Ussuriisk City (downstream of the confluence of Komarovka R. with Razdolnaya R.)

Station S-14. Upstream of Krasnyi Yar Village

Station S-15. Downstream of Terekhovka Village

Station S-16. At Razdolnoye Village

Station S-17. At mouth of Razdolnaya

Komarovka River

Station K-18. Downstream of Ussurisky Nature Reserve boundary (St. 8)

Station K-19. Downstream of Kondratenovka Village

Station K-20. Downstream of Dubovyi Kluch Village

Station K-21. Upstream of the cellulose factory sewage

Station K-22. Downstream of the cellulose factory sewage

Station K-23. Upstream of the confluence with Razdolnaya River

Rakovka River

Station R-24. Upstream of Rakovka Village

Station R-25. Downstream of Rakovka Village

Borisovka River

Station B-26. Upstream of Borisovka Village

Station B-27. Downstream of Borisovka Village

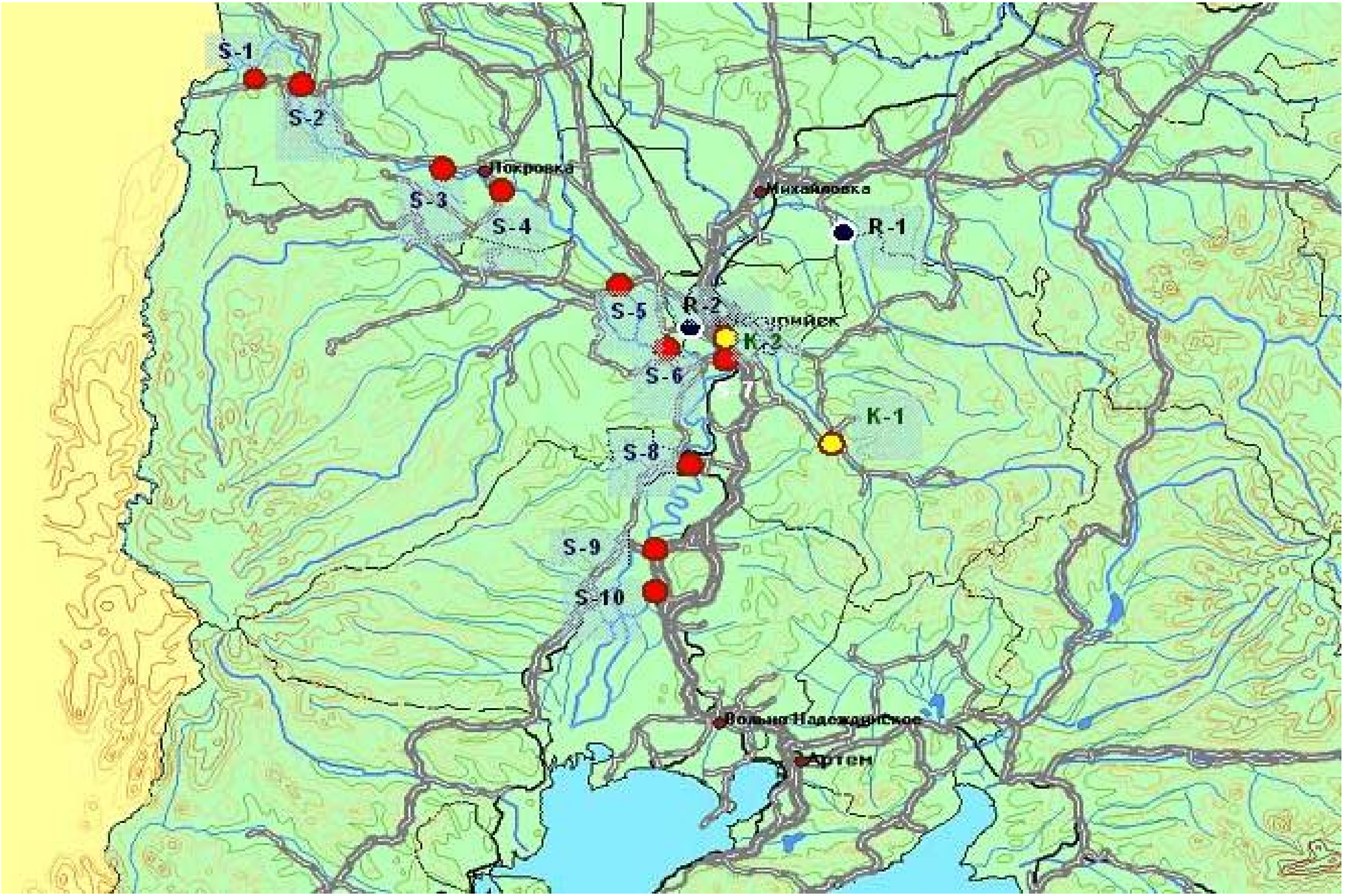

Fig. 2. Scheme of hydrobiological station in Razdolnaya River Basin

SAMPLING PROTOCOL

FRESHWATER SAMPLING TECHNIQUES

ABIOTIC CHARACTERS

BIOTIC CHARACTERS

Algae

Macroinvertebrates:

Both a semi-quantitative and qualitative method of sampling will be used to collect aquatic macroinvertebrates. The qualitative method was modeled after SCDHEC (1998) while the quantitative methods were adapted from Barbour et. al.(1999). The above two documents should be consulted for a more detailed overview of these methods.

Timed-qualitative Multiple Habitat Sampling Protocol (after SCDHEC 1998)

A timed-qualitative, multiple habitat sampling protocol (MHSP) will be used to collect macroinvertebrates. Multiple habitat sampling of some type is widely used by many regulatory and non-regulatory agencies both in the United States and abroad (Barbour, et al., 1997; USEPA, 1997; Marchant, et al., 1997). The greatest benefit from using the MHSP is that it enables benthic biologists to collect representative macroinvertebrate taxa from the wide variety of natural habitats in a stream. Since macroinvertebrates occupy all habitat types, many taxa may not be collected when selected habitats are sampled by specific sampling devices (e.g. Surber net, Ponar dredge, etc.). This can lead to exclusion of a variety of taxa and inaccurate water quality assessments.

At ambient monitoring sites, a team of two or three biologists (never less than two) samples for aquatic macroinvertebrates for approximately three man-hours (three man-hours represent three biologists sampling for one hour, or two biologists sampling for one and one half hours). With the aid of a D-frame dip net, kick net, hand sieve, white plastic pan and a fine mesh sampler, all the available natural habitats are sampled. Macroinvertebrates are also collected directly from the habitat with forceps. All macroinvertebrates are placed in jars or vials filled with 85% ethanol (EtOH) and labeled with the station number, collector, and collection date.

The goal of the sampling team is to collect as many different macroinvertebrate taxa as possible during the allotted time. Although the MHSP is a qualitative method, the actual collection of samples is a disciplined procedure designed to ensure that all the habitats present at a site are thoroughly sampled, irrespective of what type habitat is available or where the sample is collected. Rivers and streams from the mountains to coastal plain vary in habitat type and amount available for colonization by macroinvertebrates. For example, mountain sites are dominated by rock/gravel riffle stream substrate, woody debris, and root banks, while coastal sites may be dominated by aquatic vegetation, root banks, woody debris, and sandy to muddy stream substrate. Regardless of what region or what kind of habitat is being sampled, the MHSP insures that a good representation of the macroinvertebrate community is obtained. The following is a discussion of the MHSP with detailed steps on how to properly collect macroinvertebrate samples from the variety of stream habitats.

A. Chironomidae and Small Macroinvertebrate Collection Procedure

A very important component of the macroinvertebrate community is the midge family Chironomidae. Midges generally account for at least 50% of the total species diversity in most systems (Merritt and Cummins, 1996). Since midges are relatively small, they are collected with fine mesh samplers. The fine mesh samplers are made with Nytex (micro-screen cloth material) that has a mesh size of 300 m. One sampler is a mesh bag, 0.5 m by 1.0 m, made from a folded sheet of Nytex sewn together on two sides. This bag is used to collect midges from the sand. The other sampler is a 13.0 cm long by 10.0 cm diameter piece of PVC pipe with a Nytex covering on one end. This is used to strain water from the bucket in which midges are washed from the habitats. Although the objective of the fine mesh net is to collect midges, it can also collect other small macroinvertebrates.

Collection Steps:

1. Fill a 19.0 liter bucket approximate one half full with water.
2. Collect two or three samples of all the habitat types present at a stream site by hand (rocks, sticks, leaf packs, root banks, etc.) and rinse in the bucket to remove midges and other macroinvertebrates. Attached root banks (wads) and vegetation may be rinsed directly in the bucket without detachment.
3. Since some midge taxa are sand dwellers, select a sandy bottom site in the stream and collect midges by placing the small mesh bag on the bottom with the open end facing upstream. Disturb approximately a 1.0 m^2 area of the sand upstream of the bag and let the sand and midges drift into the bag. Collect three sand samples from three different areas of the stream. The bag is only used when there are sandy bottom areas available.

4. Empty the contents of the bag into the same bucket of water that contains the other habitat washes and rinse the bag up and down in the bucket to remove the attached midges.
5. Rinse and remove by hand as much of the larger debris as possible from the bucket and discard. Stir the water in the bucket and strain through the Nytex covered pipe.
6. Remove small portions of the detritus left in the bottom of the Nytex pipe and place in a white pan 1/4 filled with water. Spread the detritus evenly in the pan by hand so that the macroinvertebrates can be seen against the white background. With the aid of forceps and an eye dropper, collect the midges and other small macroinvertebrates and preserve them in a jar filled with 85% EtOH.
7. Repeat step 6 until all the detritus in the Nytex pipe has been examined.

Do not collect more than 100 midges, but collect them in relative proportion to the size classes present. Other macroinvertebrates are sampled proportional to the relative abundance in each pan picked. Although the emphasis of the fine mesh sampler is to collect small macroinvertebrates, larger macroinvertebrates are collected as they are encountered.

B. D-frame Dip Net Collection Procedure

The habitat type most often sampled with the dip net is root bank habitat. Root banks are usually present at all stream sites and they support a variety of small caddisflies and other taxa. Aquatic vegetation, when present, is also sampled with the dip net.

Collection Steps:

1. Root banks are sampled by repeatedly jabbing a D-frame dip net (500 m mesh size) into the root wads along a stretch of bank until the net is about 1/4 full of detritus and root debris. Several root wads are washed down by hand into the dip net to remove firmly attached macroinvertebrates. Aquatic vegetation is sampled by sweeping the dip net through the vegetation two or three times.
1. 2. Rinse the bottom of the dip net in the stream to remove excess mud and silt. Remove small portions of the detritus left in the net and spread them evenly in a white pan 1/4 filled with water. Do not attempt to sort through so much detritus that the bottom of the pan is obscured.
2. Using forceps, remove macroinvertebrates from the pan and place in jar of 85% EtOH.

Based on the quality of the root banks and/or aquatic vegetation, collect one or two dip net samples in the root banks and two or three samples in the aquatic vegetation.

C. Kick Net Collection Procedure

The kick net is a 1.0 m^2 sheet of Nytex (500 m mesh size) attached on two sides to 1.5 m long poles. The kick net is used to sample rock/gravel riffles and snags/leaf packs.

Collection Steps:

1. Place the kick net slightly downstream of the area to be sampled (snags/leaf packs and/or rock/gravel riffle). Disturb about 1.0 m^2 of the habitat and catch the debris and macroinvertebrates that drift into the net.
2. Spread the kick net out on a sand bar or a flat area on the bank and collect macroinvertebrates from the net with forceps and preserve them in a jar of 85% EtOH.

If the habitat is mostly snags/leaf packs, a minimum of two kick net samples are taken. If the habitat is a mix of both rock/gravel riffle and snags/leaf packs, a minimum of one kick net sample is taken from each habitat. In streams that are mostly rock/gravel riffle, a minimum of two kick net samples are taken in the riffle areas. One kick net sample is taken from a high velocity riffle area and the other is taken from a low velocity riffle area.

D. Hand Sieve Collection Procedure

Hand sieves are used to sample all habitat types and are also used during visual collections. Hand sieve sizes used are the U.S. #30 (0.6 mm openings) and the U.S. #10 (2.0 mm openings). The #10 sieve is used primarily in the sand while the #30 is used on all habitat types. The hand sieve enables the biologist to sample large amounts of habitat quickly and is invaluable for collecting sediment-dwelling taxa such as: Odonata (dragonflies), Gastropoda (snails), Pelecypoda (clams, mussels), Polycentropodidae (burrowing caddisflies), sand case building and burrowing caddisflies (Molannidae, Sericostomatidae, Dipseudopsidae, Odontoceridae), and Ephemeridae (burrowing mayflies). The hand sieve can be used effectively in the same habitat types that are sampled with the dip net and kick net.

Collection Steps:

1. Visually inspect the sand and mud for signs of macroinvertebrate activity. For example, the movement of burrowing odonates and mussels leaves trails in the sand. Small holes can be seen in the mud, clay, or sand in areas where burrowing mayflies are found. The tubes of *Phylocentropus* sp. caddisfly larvae can be seen extending above the substrate when they are present.

2. With either the #10 or #30 sieve, sample the mud or sand where there are signs of macroinvertebrate activity (use #10 sieve primarily for sand substrates). Sift the excess sand, mud, silt, and detritus in the stream to trap macroinvertebrates in the sieve.
3. Collect macroinvertebrates from the sieve and place them in jar of 85% EtOH.
4. With the #30 sieve, sample root bank and snag sites and process as above.

F. Visual Collection Procedure

The collection procedure described above is the minimum sampling effort conducted at each stream site. For an additional 1.5 man-hours, stream habitats are visually searched for macroinvertebrates, and collected directly from the habitat with forceps and placed in jars filled with 85% EtOH. For example, rocks and logs are searched for taxa such as the retreat building *Psychomyia* sp. (caddisfly) and for retreat building Hydropsychidae (caddisfly). The undersides of rocks are examined for macroinvertebrates such as Ephemeroptera (mayflies), Plecoptera (stoneflies), Gastropoda (snails), Psephenidae (water pennies) and Megaloptera (hellgrammites). The crevices in rocks and logs are searched for caddisflies such as *Nyctiophylax* sp., *Pycnopsyche* sp., and *Ceraclea* sp. Decaying logs are picked apart to reveal midges and other taxa. Aquatic vegetation, sticks, and limbs are visually searched for small caddisflies (Hydroptilidae and Brachycentridae) and other macroinvertebrates. Mature leaf packs, snags, and root banks are sampled with a #30 sieve to collect a variety of other macroinvertebrates.

G. Collection Procedures Summary

No attempt is made to collect all specimens encountered. If a taxon can be reliably identified in the field, only 10-15 specimens are collected, other taxa are collected in approximate proportion to their abundance in each sampling method (net, pan, sieve, etc.). Since the emphasis of the MHSP method is to collect different taxa, abundance is considered only in a relative sense (see Data Analysis). Some taxa are not collected including: Nematoda, Collembola, semiaquatic Coleoptera, and all Hemiptera except Naucoridae, Belostomatidae, Corixidae, and Nepidae. These are not collected because they are most often found on the water surface or on the banks, and are not truly benthic.

There is no established distance of stream reach sampled at any particular site. If there is good, fairly evenly distributed natural habitat, approximately 100 m of stream (both sides) is routinely sampled. In streams where there is sparse habitat, the distance covered may be more than 100 m. Most sites are accessed at road bridges and are sampled upstream of the bridge, however, some situations may warrant sampling downstream (e.g. access and/or habitat limitations).

As previously noted, the MHSP is a three man-hour sampling effort. Approximately one hour is devoted to use of the kick net and dip net, while about one half hour is devoted to the fine mesh samplers. The rest of the time (one and one half hours) is spent using hand sieves and forceps to make visual collections of all habitat types present.

As a general rule, when a team of biologists sample a site, each one independently uses one of the three sampling devices (dip net, kick net, fine mesh nets) to sample the appropriate habitat. Upon completion, visual collections are begun and the hand sieve is used extensively. It is helpful for the sampling team to discuss the kinds and numbers of taxa present and absent at a site. This results in more efficient sampling.

The sampling methodology described above requires that freshwater streams and rivers be wadeable for efficient sample collection. High water conditions can impair sampling efficiency by making some critical habitats inaccessible due to water depth and clarity. An underestimate of taxa richness may lead to an incorrect assessment of water quality. If high water levels and turbid conditions make sampling difficult, it is better to return to the site under more amenable sampling conditions.

Generally, nonwadeable rivers are not sampled for macroinvertebrates. However, when necessary, a boat is used to access the natural habitats for sampling. The sampling methodology remains the same but the duration may be increased to insure that all the natural habitats have been adequately sampled. In low water areas, the river is sampled as a wadeable stream. Otherwise, the available natural habitat is sampled from the boat with dip nets and hand sieves and/or by dragging logs, sticks, root banks, etc., into the boat.

Equipment

1. D-frame dip net
2. Kick net
3. Hand sieves (U.S. #   s 10 and 30)
4. 13.0 cm (length) by 10.0 cm (dia) PVC fine mesh sampler
5. Fine mesh bag
6. 19.0 liter bucket
7. White pan
8. Forceps
9. Collection vials and jars filled with 85% EtOH
10. Collection labels and EtOH-proof pen or pencil

11. Chest Waders

<u>Semi-Quantitative Approach: 1 Meter Kick Net (after Barbour et. al. 1999)</u>

This method was designed under the assumption that macroinvertebrate diversity and abundance are usually highest in cobble substrate (riffle/run) habitats and that these standardized methods results in increased precision (Barbour et. al. 1999). This method was developed for streams in which the cobble substrate represents more than 30% of the sampling reach in reference streams.

Collection Steps:

1. Select an approximately 100 m reach that is representative of the stream or river.
2. Draw a rough sketch of the steam noting physical characteristics such as bends and location of riffles and runs.
3. Using a 1 m kick net take 2 or 3 kicks in various velocities of the selected riffle.
4. Composite the samples in 95% ethanol in a container large enough to cover the organisms and any associated debris. Label the container with the appropriate collection information.
5. Perform habitat assessment as outlined in Barbour et. al. (1999).

The semi-quantitative method should be performed before the qualitative method.

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