

NADP New Initiative 12-Point Plan: Litterfall Mercury (Hg) Monitoring

1. Description of New Initiative

1.1 Definitions and Premise

- Annually, litterfall consists of leaves and needles, reproductive structures such as flowers and seeds, and woody material such as twigs and bark that fall from the forest canopy to the forest floor. In predominately deciduous forest types, approximately 70 to 75 percent of the annual litterfall occurs in the autumn.
- The Hg in forest canopy material is believed to be nearly all atmospheric in origin and the Hg in autumn litterfall may represent much of the annual dry deposition of atmospheric Hg to the forest canopy. Litterfall is a dominant pathway for Hg dry deposition to the forest floor, where it then becomes part of an active soil cycle.
- The annual litterfall Hg deposition is part of the annual Hg deposition to a forest landscape. Some Hg in precipitation reaches the forest floor. Precipitation passing through a forest canopy can wash off dry deposited Hg and carry it to the forest floor. This additional Hg not already in precipitation above the canopy is termed net throughfall. Some of the Hg in wet deposition is retained in the canopy and reaches the forest floor in litterfall. Litterfall Hg deposition is part of the annual Hg dry deposition and net throughfall is another part.
- Methylmercury (MeHg) detected in litterfall has implications for studies of MeHg in terrestrial food chains of forest canopies and forest floors.
- NADP's AMNet sites measure concentrations of Hg species in the air. Dry deposition of these Hg species can be estimated with an inferential model, but dry deposition estimates currently are not a routine element of the AMNet operation. Monitoring Hg in litterfall is a method for measuring a substantial part of the actual Hg dry deposition in a forest landscape. Litterfall Hg data supplement and enhance data from AMNet and MDN sites, but do not duplicate data from these sites.
- Litterfall measurement and Hg analysis provide an insight into the range of Hg dry deposition estimates and can be compared with other model estimates of Hg dry deposition.

1.2 Objectives

- Measure Hg and MeHg in representative samples of annual litterfall at NADP sites.
- Compile monitoring data and estimate litterfall Hg dry deposition at NADP sites.
- Archive monitoring data in NADP online data base.
- Communicate monitoring summary information through NADP annual report.

1.3 Background

A pilot study of litterfall Hg dry deposition at MDN sites was approved by the NADP Executive Committee and was completed during 2007–2009 (Risch et al., 2012)^a with support from the USGS, USEPA, and the National Park Service. This pilot study indicated that litterfall Hg monitoring could be accomplished at MDN sites and would yield meaningful information about Hg dry deposition in predominately deciduous forests.

Proposed and ongoing emphasis on Hg in national and regional contexts necessitate that NADP prepare to provide more information on Hg dry deposition. Examples in 2011 include the national Hg

^a Risch, M.R., DeWild, J.F., Krabbenhoft, D.P., Kolka, R.K., and Zhang, L., 2012, Litterfall mercury dry deposition in the eastern USA, *Environmental Pollution*, v.161, p. 284-290 doi:10.1016/j.envpol.2011.06.005 <http://www.sciencedirect.com/science/article/pii/S0269749111003319>

emissions regulations, Hg monitoring legislation, the comprehensive Hg monitoring network- MercNet, and multi-media Hg synthesis research in the Great Lakes region.

1.4 Benefits

- Litterfall Hg monitoring is a low cost approach to measuring a substantial part of the Hg dry deposition at MDN sites. This new information can be used to support expansion of AMNet. Litterfall monitoring at more AMNet sites can offer new data to improve knowledge of the relation between Hg in air and Hg in litterfall.
- Litterfall Hg monitoring can provide a network of annual litterfall Hg deposition data that can be used to constrain, verify, and compare with Hg deposition models.
- Litterfall Hg deposition may approximate annual net dry deposition of gaseous elemental Hg to forest landscapes, which is important because elemental Hg is far more abundant than other atmospheric Hg species. Models of net dry deposition for gaseous elemental Hg have a high uncertainty. This uncertainty is a limitation of inferential models using atmospheric Hg concentrations from continuous monitoring and is also a limitation of regional- or continental-scale atmospheric Hg deposition models.
- Annual litterfall Hg dry deposition to forest landscapes helps to quantify atmospheric Hg loadings to soils and watersheds.
- Methylmercury concentrations in annual litterfall can help to explain MeHg accumulation in terrestrial ecosystems. Methylmercury in invertivore songbirds and bats has been found at levels of concern and is an area of expanding research.

2. How will the new initiative meet the Mission, Objective, and Philosophy of the NADP?

2.1 The NADP Mission and Philosophy

The NADP provides quality-assured data and information in support of research on the exposure of managed and natural ecosystems and cultural resources to acidic compounds, nutrients, Hg, and base cations in precipitation (NADP Quality Management Plan, 2011). Litterfall Hg monitoring will supplement and enhance the MDN and AMNet by adding a measurement of a large part of dry Hg deposition to support estimates of total deposition of atmospheric Hg (the sum of wet deposition and dry deposition). Litterfall Hg monitoring will expand the relevance of the NADP in its mission to assess the exposure of natural ecosystems to atmospheric Hg deposition and the resulting impacts on wildlife and human health.

2.2 The Link with the U.S. Department of Agriculture

The U.S. Department of Agriculture (USDA) is concerned with impacts on environmental quality in the nation's forests, and on the quality of food produced for U.S. consumption and export. The known bioaccumulation of MeHg in aquatic ecosystems and health risks for subsistence, commercial, and recreational fish harvests and consumption is a direct concern of the USDA and other federal agencies such as the U.S. Geological Survey (USGS), the Bureau of Land Management (BLM), the Fish & Wildlife Service (F&WS), the National Park Service (NPS), the Tennessee Valley Authority (TVA), and the Food and Drug Administration (FDA). Information on source-receptor relationships is necessary for all federal agencies with supervisory authority for Class I Wilderness Areas, including the BLM, F&WS, NPS and the USDA-Forest Service.

Other cooperating agencies in the NADP have specific needs to assess Hg in the environment. Mercury is specifically targeted as an air toxic for research, monitoring, and emissions control in the 1990 Clean Air Act and Clean Water Act, and is part of state Hg efforts, the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA-NMFS), and USGS's National Water Quality Assessment (NAWQA). The NADP has historically and successfully anticipated the monitoring requirements of its cooperating agencies, and seeks to do so again with litterfall Hg monitoring.

3. Information Added to the NADP

3.1 Litterfall Hg and MeHg Concentrations

Hg and MeHg concentrations will be determined in annual composite samples of litterfall from passive collectors in forest study plots near MDN and AMNet sites. Methods for litterfall sample, collection, preparation, and Hg/MeHg analysis are described in sections 5.1 and 5.2.

3.2 Litterfall Sample Catch

Dry weight of the litterfall sample catch from passive collectors will be measured by use of a method described in section 5.3.

3.3 Litterfall Hg Deposition

The “annual litterfall Hg deposition” at a site will be calculated as the product of litterfall Hg concentration and sample catch, by use of a method described in section 5.4.

4. Data Products

4.1 Online Database

NADP Litterfall Hg Monitoring will have an online database to archive data from study plots near MDN and AMNet sites. The litterfall Hg database will be affiliated with the NADP’s Hg databases and will be available free via the Internet. The online database will include Hg and MeHg concentrations and litterfall sample catch amounts from collectors at each site, along with annual litterfall Hg deposition values for each site. Supplementary information and explanatory notes also will be available.

4.2 Annual Summary

Litterfall Hg and MeHg concentrations, sample catch, and litterfall Hg deposition at MDN and AMNet sites will be summarized each year for the NADP annual report.

4.3 Quality Assurance

Field and laboratory quality-control measurements will be made to assess the accuracy, precision, and variance of litterfall Hg concentrations and litterfall sample catch. The quality-control data will be available in a supplementary document. With input from the NADP, selected quality assurance experiments addressing method uncertainty may be conducted and the findings presented in a supplementary document. Quality-assurance documents will be available through the online database.

5. Protocols

5.1 Litterfall Sample Collection: A forest study plot that is representative of the forest class and forest cover type in the vicinity of the MDN or AMNet site will be where litterfall samples are collected. In the study plot, a 16 meter by 16 meter sample area will be designated that is approximately 300 meters or less from the wet deposition collector. Each year, site operators will receive a sampling kit and instructions to randomly deploy 8 passive collectors in the sample area. Of the 8 collectors, 4 will be designated for samples for Hg/MeHg analysis. These collectors will be deployed for approximately a 3-6 month sampling season, depending on the study plot latitude, altitude, and forest type. Monthly litterfall samples from each collector will be retrieved by the operator and shipped to the laboratory. The operators will complete a field information form. Additional details about the passive collectors and protocols for litterfall sample collection are in the appendix Standard Operating Procedures.

5.2 Sample Preparation and Hg Analysis: Monthly samples will be frozen during the sampling season. After annual litterfall has ceased, 4 composite samples per site will be prepared for analysis. The composite samples will be freeze-dried, weighed, ground, homogenized, and subsampled, processed, and analyzed for Hg and MeHg analysis by methods identified in Risch et al. (2012).

5.3 Calculation of Litterfall Hg Deposition: Annual litterfall Hg dry deposition will be calculated with the monitoring data from a site as the product of the litterfall Hg concentrations and the litterfall sample

catch, as described in Risch et al. (2012) and the appendix Standard Operating Procedures. Units will be micrograms per square meter.

5.4 Data Management: Individual sample data and site data will be compiled in an excel workbook or other suitable format and provided to the Program Office for the online database. Supplementary documentation will include sample information, study plot information, and quality assurance data. Examples are included in the appendix Standard Operating Procedures.

6. Quality Assurance and Quality Control

Quality assurance will include field and laboratory quality-control measurements to assess the accuracy, precision, and variance of litterfall Hg concentrations and litterfall sample catch. As directed by the NADP, selected quality assurance experiments addressing method uncertainty may be conducted.

6.1 Field Quality Control

The variance in litterfall Hg concentrations and sample catch at an MDN site will be measured as the Relative Standard Deviation (RSD, the standard deviation divided by the mean) among the collectors at a site. RSD control limits will be used to assess the representativeness of the data from a site. For Hg concentration, 4 collectors will be used; for sample catch, 8 collectors will be used.

6.2 Laboratory Quality Control

The precision of litterfall Hg concentrations will be measured as the Relative Percent Difference (RPD, the absolute difference divided by the mean) between laboratory replicates of a sample. The accuracy of litterfall Hg concentrations will be measured as the percent recovery of standard reference materials.

7. Data Quality Criteria

Data quality acceptance criteria will be established, including individual sample quality rating codes and completeness criteria for inclusion of site data in the online database and in annual summary reports. The sample coding will be similar to that used for the MDN (A, B, C rating) where for example A is complete and acceptable, B is incomplete but acceptable, and C is invalid.

8. Demands on the NADP Program Office, the Mercury Analytical Laboratory, and Field Operators

8.1 NADP Program Office

A 5-year transition program for NADP Litterfall Hg Monitoring can be operated by the USGS and will require the following from the Program Office:

- Accept funds transfers from non-Federal and Federal site sponsors for annual fees for the Litterfall Hg Monitoring Option.
- Enter into a Collaborative Agreement with the USGS and maintain compliance with terms of the Agreement.
- Serve the online database of monitoring data provided by USGS.
- Review the quality assurance results from the transition program litterfall monitoring.
- Accept the annual summary of the Litterfall Hg Monitoring Option from USGS for the NADP annual report.

Long term, if NADP Litterfall Hg Monitoring operation was transferred to the HAL, the Program Office would:

- Accept annual fees from site sponsors and manage the contract with the HAL.
- Serve the online database of monitoring data provided by the HAL.
- Oversee quality assurance activities and results.
- Prepare the annual summary of the Litterfall Hg Monitoring Option for the NADP annual report.

8.2 The Mercury Analytical Laboratory (HAL)

The HAL would not be affected by a transition program operated by the USGS.

Long term, the HAL could become responsible for program operation as part of the NADP contract, including the following:

- Communication with site sponsors and site operators.
- Assembly and distribution of sampling kits.
- Litterfall sample processing and analysis.
- Operate a quality assurance program.
- Data preparation for online database.

8.3 NADP Member Agencies and Field Operators

Any NADP member agency that sponsors participation of a site in the Litterfall Hg Monitoring agrees to an annual fee and to provide site observer services for collector deployment and sample retrieval.

9. Potential Funding Sources

The cost for a site to participate in the Litterfall Hg Monitoring will be funded by an annual fee. For the transition program, the annual fee will be determined by USGS in consultation with NADP. The annual fee will help to cover the cost of sample collectors, supplies, shipping, sample preparation and analysis, quality assurance, data management, and program operation.

10. Funds Transfers

Funds transfers for the Litterfall Hg Monitoring will be handled through the Program Office. Non-Federal agencies sponsoring sites transfer funds for annual fees through their existing individual Memoranda of Agreement. Federal agencies sponsoring sites transfer funds for annual fees through the NADP Interagency Agreement. The Program Office can use a Collaborative Agreement with the USGS for operation of the Litterfall Hg Monitoring transition program.

11. How will the new initiative operate within the NADP committee structure?

The Litterfall Hg Monitoring will need to be approved by the Executive Committee. Prior to approval of the New Initiative, a Review Committee appointed by the Executive Committee will help to improve the New Initiative 12-Point Plan and recommend to the Executive Committee regarding the New Initiative. If the New Initiative is approved by the Executive Committee and during the transition program (if it is operated), the Review Committee may continue to provide oversight of the transition program, if requested by the Executive Committee. The Network Operations Subcommittee will review issues related to sample collection, data management, and quality assurance. The Ecological Response and Outreach Subcommittee will evaluate outreach needed for the litterfall Hg monitoring.

12. Transitional needs

NADP Litterfall Mercury Monitoring can begin operation in 2012 as a 5-year transition program operated by the USGS.

The following steps are needed to establish the transition program:

- 1) The NADP new initiative 12-point plan for the Litterfall Hg Monitoring needs to be accepted by the Executive Committee, typically after consideration of the review team's findings.
- 2) The NADP Program Office and USGS need to confirm a Collaborative Agreement for operation of the Litterfall Hg Monitoring transition program.
- 3) Site sponsors will decide about participation in Litterfall Hg Monitoring, leading to commitments of site operator support and funds transfer for annual fees.

- 4) The Program Office accepts funds transfers of annual fees for sites participating in the Litterfall Hg Monitoring through existing Memoranda of Agreement or the Interagency Agreement.
- 5) USGS completes assembly and delivery of sampling kits to participating site operators for a 2012 sampling period.
- 6) USGS will continue the transition program with NADP during 2013–2016.

Appendix
Standard Operating Procedures
For USGS Transition Program
NADP Litterfall Mercury Monitoring
Version 1.0 May 2012

1. Site liaison and laboratory. The USGS site liaison will communicate with the MDN site sponsors, site operators, NADP Program Office, NADP Committees, and the USGS Mercury Research Laboratory. The laboratory will not communicate routinely with these entities.

2. Study plot location. The MDN site sponsor and site operator will consult with the site liaison when selecting the location for the forest study plot at a MDN site to assure it is representative of the forest land cover near the MDN site. The center of the sample plot should be less than 300 m (984 ft) from the MDN precipitation sampler. The study plot should be in a representative forest type for the area around the MDN site. For example, if the majority of the natural forest land cover in the vicinity of the MDN site is deciduous oak-hickory forest, but a stand of planted white pine is also nearby, the forest study plot should be located in the oak-hickory forest, not the white pine stand. Similarly, if the majority of the natural forest land cover in the vicinity of the MDN site consists of relatively mature trees more than 12 inches in breast height diameter, but a stand of relatively young trees of the same species less than 4 inches in diameter is also nearby, the forest study plot should be located in the stand of mature trees. Ideally, the forest study plot should be located where it is unlikely to be disturbed by foot and vehicle traffic and is away from game trails.

3. Site information. The site operator will receive a sample kit with a field form for recording descriptive information about the forest study plot, including a site diagram. **Figure 1** shows an example diagram of a typical forest study plot. **Figure 2** is the site information form.

4. Sample area. The litterfall sample collectors will be deployed in a 16-m by 16-m sample area within the forest study plot. The sample area should be more than 32 m from the edge of the forest study plot and should not include a creek, gully, ravine or other feature of uneven terrain. It should be an area that looks like most of the study plot.

Supplies included in the sample kit for defining the sample area boundaries are an 8-m piece of line on two stakes and 4 marker flags. Pick the center of the sample area, such as a prominent tree that can serve as a future reference mark. Using the 8-m line and the other 4 flags, mark the middle of the 4 sides of the sample area. For a plan view of the sample area, refer to **figure 3**.

5. Sample collectors. A total of 8 litterfall sample collectors are deployed in a sample area. The sample collector is intended to passively capture and hold litterfall coming to the forest floor. Each sample collector has a removable, plastic sample box supported by a wooden base (**figure 4**). The sample box is 0.25 m² and has 15 cm side walls. The box has a replaceable 0.6-mm mesh screen bottom to retain small particles while allowing water to drain. Each sample box has an ID number etched on the sides. Sample boxes are shipped to a site, pre-cleaned, and each one in a plastic bag.

Each sample collector has a wooden base that holds the bottom of the box 3 cm off the ground to avoid soil contact and to allow the sample box to drain water through the mesh bottom. The wooden base holds the sample box tightly and is heavy enough to provide stability in the wind or if a small animal investigates. Each wooden base is placed in the sample area once and not moved during the sampling season.

One shipping carton with the 8 sample boxes, sample area supplies, and instructions, plus two shipping cartons with 4 bases each are shipped to a site at the start of the sampling season. Sites do not return the bases at the end of the season if they plan to participate in the litterfall mercury monitoring the next year.

6. Placement of sample collectors. The locations for placement of the 8 sample collectors in the sample area are randomly selected for each forest study plot. The sample area has a grid of 16 cells, each with 1-m by 1-m sides and numbered as shown in [figure 3](#). A random number generator assigns a number for each cell. The eight lowest random numbers designate the cells in the sample area where the collectors will be placed. An alternate cell is identified with the ninth lowest random number. A diagram with the assigned cells for the sample collectors is included with the instructions in the sample kit. Typically, a collector will be placed somewhere within the assigned cells. Collectors should not be placed in a cell with thick understory if it would prevent litterfall from entering the collector. A cell that is obstructed by a fallen log, stump, or boulder should be avoided. If possible, place the sample collectors on a Tuesday, consistent with the MDN schedule. Place the 8 wooden bases in the assigned cells of the sample area.

Take the sample boxes to the study plot in their plastic bags and fit each sample box snugly in the wooden bases. Save the plastic bags and shipping carton for returning the sample boxes with the last samples of the season. Save the other shipping cartons to store or return the wooden bases between sampling seasons.

7. Site record. The site information form ([figure 2](#)) included in the kit has a numbered grid of the sample area that should be used to record the ID numbers of the sample boxes placed in the 8 cells.

8. Sample collection. Litterfall samples will be retrieved once every 4 weeks on a Tuesday. Depending on the latitude and altitude of the MDN site, the length of the litterfall sampling season will require that samples will be collected 2 to 6 times at 4-week intervals until litterfall is over. The sample kit contains a set of large ziploc bags, one for each 4-week sample. In each large bag are 8 small ziploc bags, one for each of the 8 sample collectors. Each small bag is labeled with the ID number on the sample box.

Take the large bag to the sample area. At each collector, match the bag ID with the collector ID. Either pour the contents of the sample box into its labeled ziploc bag, or use a gloved hand to transfer the contents into the bag. Disposable gloves are in the sample kit. Wet litterfall samples can be submitted. Avoid including substantial amounts of frozen precipitation. If a sample box is empty, keep its ID-labeled, empty ziploc bag with the other sample bags. Whether they are empty or contain litterfall, place the 8 small ziploc bags in the large ziploc bag and label the large bag with the sample date. The sampling kit includes shipping pouches with a pre-addressed shipping label. Use one of the pouches to send the 4-week samples to the USGS Indianapolis office, where they will be stored in a freezer until the end of the litterfall sampling season.

9. Sample information. The sample information form ([figure 5](#)) included in the kit should be used for recording information about the litterfall samples. Include the completed form with the sample boxes shipped at the end of the season.

10. Retrieval of sample collectors. For the last sample of the season, remove the sample box and place it in one of the clean plastic bags in which it was shipped. Close the bag with a rubber band or tape so it won't open during shipping. Return the sample box in a bag, even if the sample box is empty. It is expected that the plastic bag will retain the litterfall collected by the sampler during shipment. Remove the wooden base at the end of the sampling season. Mark the center of the sample area to use next season. Place the 8 sample boxes with the litterfall samples into the shipping carton that was provided. Make a copy of the field information form. Enclose the completed field form in a plastic bag and put it in the carton. Use the pre-addressed Federal Express label for shipping. Store the wooden bases in their two shipping cartons until next season.

11. Annual litterfall samples. An annual litterfall sample consists of all the 4-week samples from the 8 collectors at an MDN site. The samples shipped to USGS, including the last one of the season, are stored in a freezer until they are inventoried, weighed, labeled, and shipped to the laboratory. Empty bags will not be included in the lab shipment. Each small bag of litterfall obtained from each sample collector every 4 weeks will be freeze dried, weighed, and the weight recorded. These data will be used to compute the total litterfall dry mass and the variability of the litterfall sample catch from 2 m^2 (8 collectors x 0.25 m^2)

of the sample area. Empty sample collectors and missing samples will be included in the data computation.

12. Sample inventory. The inventory of the samples is based on the sample box ID and includes the sample date, wet weight, litterfall description, and dry weight.

13. Sample analysis. In a sample area, 8 sample collectors are used so that in an ideal situation, data on the total amount and variability of the litterfall sample catch will be obtained from all 8 collectors. The dried litterfall from all of the 4-week samples from 4 of the collectors will be composited, ground, homogenized, and analyzed for mercury. The 4 collectors whose samples will be composited for analysis will be based on the four lowest random numbers assigned to the 8 collectors. If some of the 4-week subsamples from one or more collectors are lost or incomplete, all of the samples from at least 4 of the 8 collectors will be complete and suitable for analysis. Collectors with missing samples will be skipped and the collector with the next lowest random number will be used for mercury analysis. A proportional subsample from the 4 litterfall samples analyzed for mercury will be composited and analyzed for methylmercury. A proportional subsample accounts for differences in the litterfall mass among the four samples and obtains a proportionally higher amount from the sample with the higher mass.

14. Quality assurance. Sample boxes are pre-cleaned before they are shipped to a MDN site. Cleaning is a detergent solution scrub, deionized water rinse, and dilute hydrochloric acid rinse. Boxes are dried in a HEPA work station and placed in a new plastic bag.

The USGS Mercury Research Laboratory will follow its Quality Assurance Plan for mercury and methylmercury analysis. Certified reference materials will be analyzed for mercury to evaluate analytical accuracy for litterfall, based on percent recovery. At least 1 of every 5 litterfall samples will have two laboratory split replicate samples prepared and analyzed for mercury to evaluate analytical precision, based on relative percent difference. Spatial variability in litterfall mercury concentrations and litterfall sample catch at a site will be evaluated using data from the 4 sample collectors (concentration) or 8 sample collectors (catch) at a MDN site, based on relative standard deviation. At least 1 of every 20 sample boxes will have a field blank prepared for mercury analysis by rinsing the inside with mercury-free blank water from the USGS Laboratory and collecting the rinseate in a sample container.

15. Data management. Analytical data for mercury and methylmercury analysis will be combined with data on litterfall sample catch in an Excel spreadsheet. The USGS site liaison will assign each sample a quality rating of A, B, or C that is similar to the MDN system. For each MDN site, three values will be calculated: mean annual litterfall mercury concentration for a representative 1-m² sample; total annual sample catch for a representative 1-m² sample; annual litterfall mercury deposition per m². In addition, the litterfall methylmercury concentration will be included.

16. Data access. The Excel spreadsheet of annual sample and mercury data and a separate spreadsheet with the litterfall mercury site information will be submitted to the Program Office to be posted on the NADP MDN web site. An example of the spreadsheet information is in [figure 6](#).

List of figures.

Figure 1. Diagram of a typical forest study plot

Figure 2. Litterfall monitoring site information form

Figure 3. Diagram of litterfall sample area

Figure 4. Photo of a sample collector

Figure 5. Litterfall sample information form

Figure 6. Litterfall sample, mercury, and site information spreadsheet example

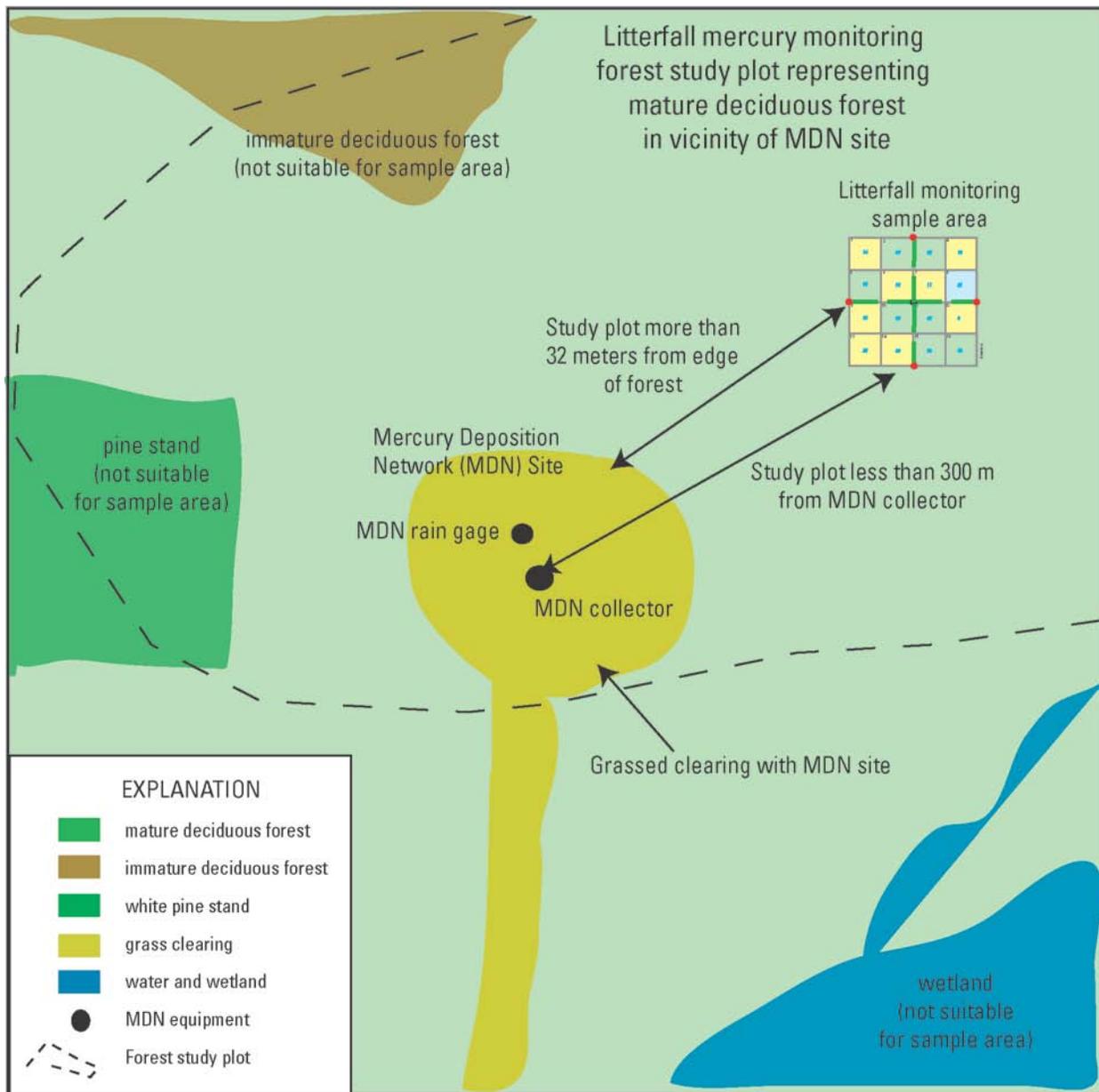


Figure1. Diagram of a typical forest study plot

Litterfall Mercury Monitoring Site Information Form

MDN Site ID _____ MDN Site Name _____

Site operator name _____

Site operator phone _____ Site operator email _____

Other atmospheric mercury monitoring at or near MDN site (such as AMNet, surrogate surface, throughfall) _____

Classify the dominant forest cover within 1 km (0.6 mi) of MDN collector (the forest study plot)

Deciduous Coniferous Mixed Deciduous/Coniferous

Other (describe) _____

Pick the dominant forest type within 1 km (0.6 mi) of MDN collector (the forest study plot)

oak-hickory maple-bech-birch aspen-birch oak-gum-cypress

white-red-jack pine loblolly-shortleaf pine

The sample area is where the litterfall sample collectors are placed. List the tree species in the sample area (in order of abundance, use common or scientific name)

Understory species in sample are that contribute to litterfall sample (if any)

Starting at the MDN collector, identify

The compass direction to the center of litterfall sample area _____

The distance to the center of the litterfall sample area _____

Date litterfall collectors installed _____

Date litterfall collectors removed _____

Please see opposite side.

04/12

Figure 2. Litterfall monitoring site information form

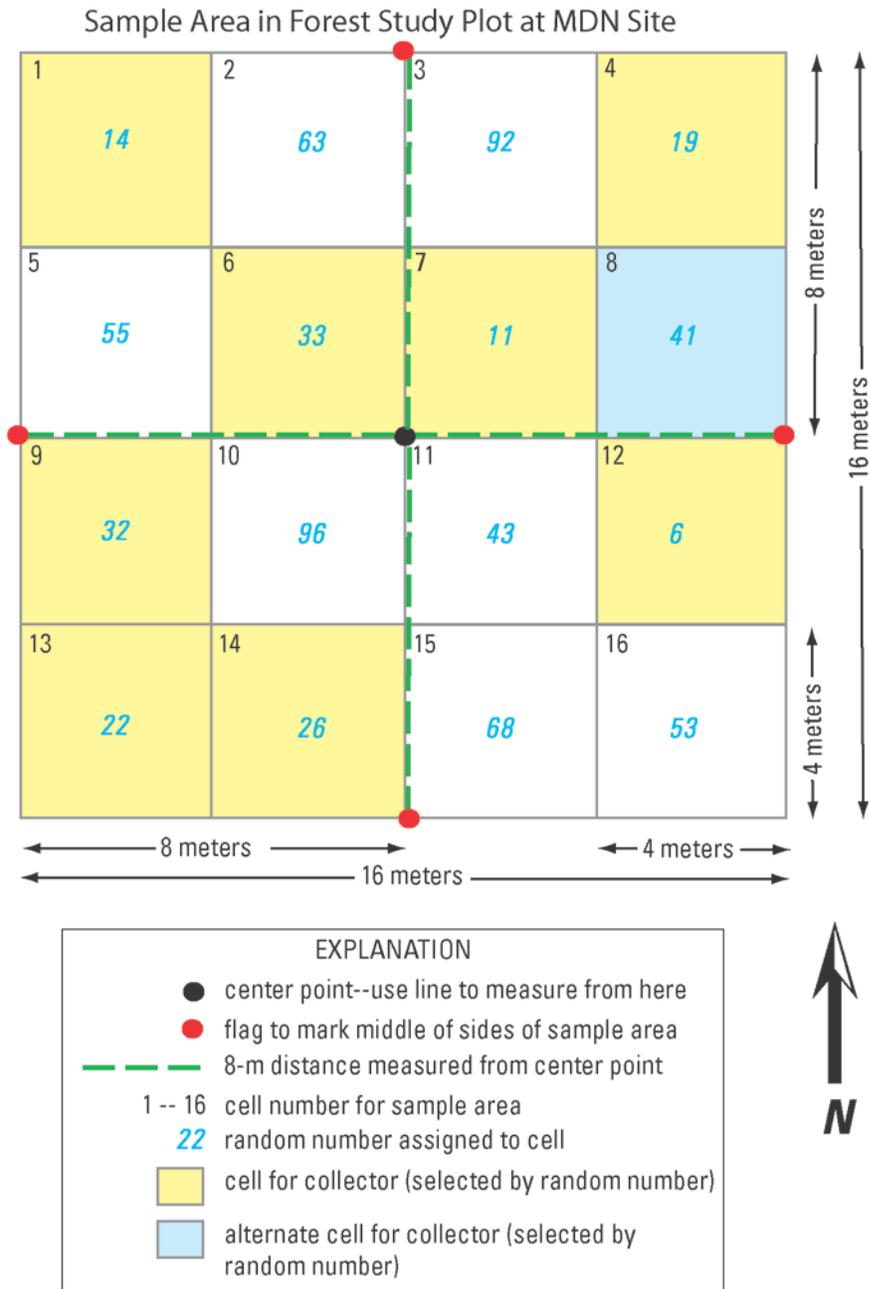


Figure 3. Diagram of litterfall sample area



Figure 4. Photo of a sample collector

Diagram the MDN collector, sample area, and other important features within 1 km (0.6 km)

List the litterfall sample box ID number in the cell where it was placed.

SITE ID/NAME: _____ DATE: _____

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16



OPERATOR:
 The yellow cells are where the litterfall samplers should be installed.
 The blue cell is an alternate, if needed.
 Please mark the litterfall sample box ID number in the cell where it was installed.

04/12

Figure 5. Litterfall sample information form

Figure 6. Litterfall sample, mercury, and site information spreadsheet example (next 3 pages)

MDN Litterfall Mercury Monitoring Data -- USGS Transition Program
 [example data spreadsheet for one MDN site for one sampling season]

I. Litterfall Sample Catch

MDN Site ID	Sample Box ID	Sample Date	Subsample number	Sample catch in bag	Sample bag weight	Sample catch wet weight	Sample catch dry weight	Percent moisture	Sample box annual catch dry weight	MDN site annual sample catch
XXnn	10	9/4/2012	1	A	B	C	D	E	F	
		10/2/2012	2							
		10/30/2012	3							
		11/27/2012	4							
	11	9/4/2012	1							
		10/2/2012	2							
		10/30/2012	3							
		11/27/2012	4							
	12	9/4/2012	1							
		10/2/2012	2							
		10/30/2012	3							
		11/27/2012	4							
	13	9/4/2012	1							
		10/2/2012	2							
		10/30/2012	3							
		11/27/2012	4							
	14	9/4/2012	1							
		10/2/2012	2							
		10/30/2012	3							
		11/27/2012	4							
	15	9/4/2012	1							
		10/2/2012	2							
		10/30/2012	3							
		11/27/2012	4							
	16	9/4/2012	1							
		10/2/2012	2							
		10/30/2012	3							
		11/27/2012	4							
	17	9/4/2012	1							
		10/2/2012	2							
		10/30/2012	3							
		11/27/2012	4							
	18	9/4/2012	1							
		10/2/2012	2							
		10/30/2012	3							
		11/27/2012	4							
							I	J	H	G

Data item	Calculation/Explanation	Units
A	wet weight of 4 week sample and bag	grams
B	tared weight of empty bag	grams
C	A - B	grams
D	dry weight of sample without bag	grams
E	$[(C - D) / C] \times 100$	percentage
F	D1 + D2 + D3 + D4 where D is subsample dry weight for subsample number	grams/year
G	$(F10 + F11 + \dots + F18) / 2$ where F is annual catch for sample box ID	grams/square meter/year
	note that each box is 0.25 square meter and 8 boxes are 2 square meter;	
	divide by 2 to get unit of 1 square meter;	
	this value is used to compute annual litterfall mercury deposition	

supplementary statistics	
H	mean and standard deviation of sample catch dry weight in 8 sample boxes in MDN site litterfall sample area for the season
I	accumulation of litterfall sample catch every 4 weeks in each box thru season
J	mean and standard deviation of sample catch moisture for the season
K	distribution of annual litterfall sample catch in 8 sample boxes in MDN litterfall sample area for the season (show in box plot)

2. Litterfall Mercury Concentration					
MDN Site ID	Sample Box ID	Sample start date	Sample end date	Number of subsamples in composite	Total Hg concentration
XXnn	10	9/4/2012	11/27/2012	4	L
	14	9/4/2012	11/27/2012	4	L
	15	9/4/2012	11/27/2012	4	L
	18	9/4/2012	11/27/2012	4	L
					M
					N

Data item	Calculation/Explanation
L	4 of the 8 sample boxes were randomly selected for Hg analysis of sample in this example, a total of (4) 4-week samples from a box were composited Hg concentration, nanograms per gram, dry weight (ng/g)
M	mean total Hg concentration in 4 sample boxes (ng/g) at MDN site standard deviation of Hg concentration at MDN litterfall sample area
N	methylmercury concentration (ng/g) in proportional composite of litterfall from 4 sample boxes at MDN site

3. Litterfall Mercury Deposition						
MDN Site ID	Sample Box ID	Sample start date	Sample end date	Mean total Hg concentration	Annual litterfall sample catch	Annual litterfall Hg deposition
XXnn	10	9/4/2012	11/27/2012	L	M	O

Data item	Calculation/Explanation
O	$L * M$ is the annual litterfall Hg deposition in the MDN site litterfall sample area, in nanograms per square meter per year convert to micrograms per square meter per year for comparison with annual Hg wet deposition at MDN site

