



JANET T. MILLS
GOVERNOR

STATE OF MAINE
DEPARTMENT OF ENVIRONMENTAL PROTECTION



MELANIE LOYZIM
COMMISSIONER

VIA ELECTRONIC FILING

October 8, 2021

Ms. Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, D.C. 20426

RE: Comments on the Pre-Application Document and Study Requests for the Ripogenus (FERC No. 2572) and Penobscot Mills (FERC No. 2458) Hydroelectric Projects

Dear Secretary Bose:

The Maine Department of Environmental Protection (Department or DEP) received and reviewed a Pre-Application Document (PAD), submitted on June 11, 2021, by Great Lakes Hydro America, LLC (GLHA, applicant), a subsidiary of Brookfield Renewable, for the Ripogenus (FERC No. 2572) and Penobscot Mills (FERC No. 2458) Hydroelectric Projects (Projects). Department staff attended the joint agency meeting for the two Projects on September 9, 2021 and reviewed appropriate Project documents to prepare the following comments and study requests.

Authorities

Historically a Water Quality Certification (WQC) for Ripogenus was issued on April 23, 1993 by the Land Use Planning Commission (LUPC). As of a 1996 Executive Order of the Governor of the State of Maine, MDEP is the certifying agency for projects located wholly or partially in organized towns and cities. Each Project's current FERC license was issued on October 22, 1996. The proposed relicensing of the Ripogenus and Penobscot Mills Projects are subject to water quality certification provisions of Section 401 of the Federal Water Pollution Control Act (a.k.a. Clean Water Act). By the above-mentioned executive Order, the Department is the certifying agency for projects located wholly or partially in organized towns and cities, and as such has jurisdiction over the Projects.

Project Descriptions

The Ripogenus Project is located on the West Branch in Piscataquis County, Maine, with the approximately 30-mile-long transmission line also extending into Penobscot County, Maine. The principal features of the Ripogenus Project include: 1) a 795-foot-long concrete gravity dam; 2) a 3,850-foot-long tunnel; 3) a powerhouse, wqe known as McKay Station, containing three turbine-generator units with an authorized installed capacity of 37.5 megawatts (MW); 4) a 20.8-mile-

AUGUSTA
17 STATE HOUSE STATION
AUGUSTA, MAINE 04333-0017
(207) 287-7688 FAX: (207) 287-7826

BANGOR
106 HOGAN ROAD, SUITE 6
BANGOR, MAINE 04401
(207) 941-4570 FAX: (207) 941-4584

PORTLAND
312 CANCO ROAD
PORTLAND, MAINE 04103
(207) 822-6300 FAX: (207) 822-6303

PRESQUE ISLE
1235 CENTRAL DRIVE, SKYWAY PARK
PRESQUE ISLE, MAINE 04769
(207) 764-0477 FAX: (207) 760-3143

long impoundment having a normal full pond elevation of 941.59 feet with a surface area of 29,270 acres and Umbazooksus Lake with a surface area of 1,600 acres; 5) a 29.4-mile-long transmission line; and 6) a battery energy storage system sized at a capacity of 10 MW for up to 2 hours.

The Penobscot Mills Project is located on the West Branch and Millinocket Stream in Piscataquis and Penobscot Counties, Maine, and includes five developments, in descending order from upstream to downstream, Millinocket Lake Storage, North Twin, Millinocket, Dolby, and East Millinocket, with a total authorized installed capacity of 67.9 MW.

1. The Millinocket Lake Storage Development includes: 1) an impoundment having a normal full pond elevation of 480.0 feet with a surface area of 8,640 acres; 2) a concrete and earth-filled dam, measuring approximately 635 feet in length, located at the outlet of Millinocket Lake; and 3) a pumping station containing two pumps, located approximately 6.2 miles from the dam, two 4-foot-6-inch-diameter steel pipes measuring approximately 544 feet in length, and a concrete outlet structure discharging to Ambajejus Lake (within the North Twin impoundment). No hydroelectric generating facilities are located at this development.
2. The North Twin Development includes: 1) an impoundment having a normal full pond elevation of 491.92 feet with a surface area of 17,790 acres; 2) a concrete and earth-filled dam measuring approximately 1,051 feet in length, including an intake structure and powerhouse containing three turbine-generator units and appurtenant equipment; 3) a series of six earthen dikes having a combined length of 2,530 feet, located upstream of the dam; 4) a 60 Hertz (Hz) substation containing six transformers; and 5) a transmission line approximately 4.2 miles in length that extends to the last transmission pole structure before entering GLHA's Millinocket Substation #4.
3. The Millinocket Development includes: 1) an impoundment having a normal full pond elevation of 458.7 feet with a surface area of 1,344 acres; 2) a concrete dam (Stone Dam) measuring approximately 1,262 feet in length; 3) a gatehouse located at the dam, containing ten gates and a sluiceway; 4) three earthen dikes in Quakish Lake with a total length of 1,854 feet; 5) five earthen dikes in Ferguson Pond with a total length of 3,195 feet, a "western" canal leading from the gatehouse to Ferguson Pond, and an "eastern" canal leading from Ferguson Pond to the intake structure, all of which are used to convey water from the gatehouse at Stone Dam to the intake structure located approximately 7,300 feet from Stone Dam; 6) an intake structure containing seven headgates, located at the entrance of the penstocks; 7) six 10-foot-diameter steel penstocks and one 11-foot-diameter steel penstock ranging in length from 1,007 feet to 1,024 feet; 8) a powerhouse containing seven operable turbine-generator units, of which five are located within the former Grinder Room and two are in the Generator Room; 9) two transformers, one having a rated capacity of 30/40/50 megavolt-amperes (MVA) and one at 24/34/40 MVA; and 10) two 60 Hz transmission lines approximately 300 feet in length (one 6.9 kilovolt [kV] and one 13.8 kV).

4. The Dolby Development includes: 1) an impoundment having a normal full pond elevation of 336.2 feet with a surface area of 2,048 acres; 2) a concrete and earth-filled dam measuring approximately 1,395 feet in length, including an intake structure and powerhouse integral with the dam containing four operable turbine-generator units and other appurtenant equipment; 3) a 60 Hz substation containing one transformer having a rated capacity of 15/20 MVA and a second transformer with a rated capacity of 5 MVA; and (4) a transmission line extending approximately 2 miles to the last transmission pole structure before entering GLHA's Powersville Substation.
5. The East Millinocket Development includes: 1) an impoundment having a normal full pond elevation of 287.2 feet with a surface area of 128 acres; 2) a concrete and earth-filled dam measuring approximately 717.5 feet long, including an intake structure and powerhouse integral with the dam containing six turbine-generator units; and 3) a tailrace measuring approximately 1,050 feet long.

The Project also contains two battery energy storage systems each sized at a capacity of 10 MW for up to 2 hours (or combined capacity of 20 MW for 2-hour duration) and are located at the Millinocket Substation #4 and Powersville Substation.

Water Quality Classifications and Standards

Water quality standards and the water quality classifications of all surface waters of the State have been established by Maine Legislature (Title 38 M.R.S. §§ 464-468). The following classifications apply to the waters of the West Branch of the Penobscot River and Millinocket Stream affected by the operation of the Ripogenus and Penobscot Mills Projects:

“From its confluence with Chesuncook Lake to Ripogenus Dam – GPA;

From Ripogenus Dam through Ripogenus Gorge to McKay Station – Class B;

From McKay Station to its confluence with Ambajejus Lake – Class A;

North Twin Impoundment – GPA;

Millinocket Lake Impoundment – GPA;

From the outlet of Elbow Lake to the outlet of Quakish Lake and Ferguson Pond to its confluence with Millinocket Stream (includes the Back Channel) – Class C;

From the confluence with Millinocket Stream to its confluence with the East Branch of the Penobscot River, including all impoundments – Class B;

West Branch of the Penobscot River – Tributaries (includes Millinocket Stream) – Class A;

Millinocket Stream, from the railroad bridge near the Millinocket-T3 Indian Purchase boundary to its confluence with the West Branch Canal – Class B;

Millinocket Stream from the confluence of the West Branch Canal to its confluence with the West Branch of the Penobscot River – Class B.”

Class GPA waters must be of such quality that they are suitable for the designated uses of drinking water after disinfection, recreation in and on the water, fishing, agriculture, industrial process and cooling water supply, hydroelectric power generation, navigation and as habitat for fish and other aquatic life. The habitat must be characterized as natural.

Class GPA waters must be described by their trophic state based on measures of the chlorophyll "a" content, Secchi disk transparency, total phosphorus content and other appropriate criteria. Class GPA waters must have a stable or decreasing trophic state, subject only to natural fluctuations, and must be free of culturally induced algal blooms that impair their use and enjoyment.

There may be no new direct discharge of pollutants into Class GPA waters¹.

Class A waters must be of such quality that they are suitable for the designated uses of drinking water after disinfection; fishing; agriculture; recreation in and on the water; industrial process and cooling water supply; hydroelectric power generation, except as prohibited under Title 12, section 403; navigation; and as habitat for fish and other aquatic life. The habitat must be characterized as natural.

The dissolved oxygen (DO) content of Class A water shall not be less than 7 parts per million or 75% of saturation, whichever is higher. The aquatic life and bacteria content of Class A water shall be as naturally occurs.

Except as provided in statute², direct discharges to these waters licensed after January 1, 1986 are permitted only if, in addition to satisfying all the requirements of this article, the discharged effluent will be equal to or better than the existing water quality of the receiving waters.

Class B waters must be of such quality that they are suitable for the designated uses of drinking water after treatment; fishing; agriculture; recreation in and on the water; industrial process and cooling water supply; hydroelectric power generation; navigation; and as habitat for fish and other aquatic life. The habitat must be characterized as unimpaired.

The DO content of Class B waters may not be less than 7 parts per million or 75% of saturation, whichever is higher, except that for the period from October 1st to May 14th, in order to ensure spawning and egg incubation of indigenous fish species, the 7-day mean DO concentration may

¹ M.R.S § 465-A(1)(C)

² M.R.S. § 465 (2)(C)

not be less than 9.5 parts per million and the 1-day minimum DO concentration may not be less than 8.0 parts per million in identified fish spawning areas³.

Discharges to Class B waters may not cause adverse impact to aquatic life in that the receiving waters must be of sufficient quality to support all aquatic species indigenous to the receiving water without detrimental changes in the resident biological community.

Class C waters must be of such quality that they are suitable for the designated uses of drinking water supply after treatment; fishing; agriculture; recreation in and on the water; industrial process and cooling water supply; hydroelectric power generation, navigation; and as a habitat for fish and other aquatic life.

The DO content of Class C water may not be less than 5 parts per million or 60% of saturation, whichever is higher, except that in identified salmonid spawning areas where water quality is sufficient to ensure spawning, egg incubation and survival of early life stages, that water quality sufficient for these purposes must be maintained in order to provide additional protection for the growth of indigenous fish⁴.

Discharges to Class C waters may cause some changes to aquatic life, except that the receiving waters must be of sufficient quality to support all species of fish indigenous to the receiving waters and maintain the structure and function of the resident biological community.

Antidegradation

The State's antidegradation policy provides that water quality certification may be approved only if the applicable standards of classification of the affected water body are met and existing in-stream uses and the level of water quality necessary to protect those existing uses are maintained and protected. The policy also provides that, where the actual quality of any classified water exceeds the minimum standards of the next highest classification, that higher water quality classification shall be maintained and protected.⁵

Comments on the Pre-Application Document (PAD)

The Department appreciates the effort of the applicant to prepare the PAD. The PAD provides an understanding of the Project facilities, the surrounding resources, and current and proposed project operations. The PAD also provides information from which issues related to relicensing can be readily identified. After review of the available documents, the Department has the following comments on the PAD:

- (1) The Department acknowledges that a UAA was issued in 1992 for the Ripogenus Project and was referenced in the PAD document. A UAA typically requires studies, reports data and discusses the impacts of impoundment drawdowns on impoundment habitat. UAAs often cover extended drawdown of impoundments. As a result of the Ripogenus

³ M.R.S § 465 (3)(B)

⁴ M.R.S. § 465(4)(B)(1) & (2)

⁵ See Title 38 M.R.S.A §464(4)(F)

Development changing jurisdiction as described above in the Authorities section of this letter, the Department does not have sufficient documentation of the UAA associated with the Ripogenus Project⁶. Though the Department understands the document likely remains in effect at the Ripogenus Project⁷, the Department requires the Applicant to submit the UAA for Department review and further studies on the impoundment aquatic habitat may be required in the Ripogenus Development as described below.

- (2) In the PAD, the Applicant summarizes many historical water quality studies in Section 5.3.9 and asserts that water quality standards are being met throughout several impoundment and riverine sections of the West Branch of the Penobscot River related to the Ripogenus and Penobscot Mills Projects. To date, GLHA has not provided (1) the studies referenced in the PAD; or (2) operations data for any of the projects. In the PAD the Applicant states “...GLHA maintains that a full suite of new studies is not needed, that the vast body of information on which today’s certifications and licenses are soundly based and should be relied upon for these relicensings. In addition, consistent with the Commission’s criteria for study requests, the scope and extent of any new study be focused on addressing specific data gaps necessary to inform the development of license requirements.”

While broad summaries of the studies performed during the last relicensing were provided in the PAD, a synthesis of the data was not, nor were any data gaps identified by the Applicant. The Department has determined that studies previously conducted are not sufficient to demonstrate that Water Quality standards are being met at the Projects today, and that the data presented in the PAD is only a high-level summary. Without the original studies, and without operations data for each dam, MDEP cannot identify existing data gaps to inform their respective Study Requests or their PAD comments. Therefore, the Department respectfully disagrees that the data on file demonstrates that they meet Classification Standards today and requests that the Applicant provide the Department with each study referenced in the PAD.

Water Quality Study Requests

Proposed WQ Studies

In the PAD in Tables 6.2-1 and 6.2-2 the Applicant proposes water quality studies to be conducted for both Projects.

For the Ripogenus Project, the Applicant proposes lake trophic sampling and tailwater sampling of temperature and DO at one station between the Ripogenus dam and McKay Station. GLHA proposes macroinvertebrate sampling below McKay Station as an additional study.

⁶ Caribou Lake, Ripogenus Lake, Black Pond, Brandy Pond, Umbazokus Lake, Chesuntcook Lake figure 4.2-2

⁷ Section 464 9-A(A)

For the Penobscot Mills Project, the Applicant identifies Millinocket Lake (deep area upstream of dam), the North Twin impoundment (deep area of Elbow Lake), the Millinocket impoundment (deep area of Ferguson Pond), the Dolby impoundment (deep area upstream of dam), and the East Millinocket impoundment (deep area upstream of dam) as study locations to conduct lake trophic sampling. Further proposed studies include tailwater temperature and DO sampling at one location in each of the riverine/tailwater areas: Millinocket Stream downstream of the Millinocket Lake Dam and the West Branch in the North Twin tailrace, downstream of Stone Dam, the Millinocket tailrace, the Dolby tailrace, and the East Millinocket tailrace. Lastly, they identify Millinocket Stream downstream of the dam, the North Twin tailrace, the Millinocket tailrace, the Dolby tailrace, and the East Millinocket tailrace as locations to sample macroinvertebrates. All studies are proposed according to MDEP protocols.

Study Requests

The Department has determined that GLHA has not proposed sufficient studies to demonstrate that either Project meets WQ standards. Further no habitat studies are proposed in any of the Project impoundments or downstream of these Projects.

It has been the Department's practice to determine the metrics, methods, timing, and duration of water quality monitoring necessary to ensure that the water quality studies meet data quality objectives. The Department requests that the applicant conduct water quality studies that include the following parameters and adhere to the Department's established sampling protocols in support of water quality certification. Formal study requests following FERC's Integrated Licensing Process (ILP) criteria are attached to this comment letter.

Impoundment Trophic State Study - The purpose of trophic state study is to determine if the Project impoundment and its associated basins have a stable or improving trophic state subject only to natural fluctuations and are free of algal blooms that impair the impoundment use or enjoyment. The objective of this study is to determine if the Project impoundment and its basins meets Maine Water Quality Standards, including dissolved oxygen criteria, and the designated use of recreation in and on the water. The PAD presents summarized data collected in 1991, however, these studies are insufficient to demonstrate that the various impoundment basins exhibit a stable or improving trophic state. The applicant proposes some Trophic State Studies outlined above to demonstrate whether the Project meets water quality standards.

Ripogenus

The Department requires an Impoundment Trophic State Study be conducted in the Ripogenus impoundment, including the waters of Ripogenus Lake, Caribou Lake, Brandy Pond, Black Pond, Chesuncook Lake, Umbazokus Lake. Assessment of the above-mentioned criteria provides information to evaluate the health and impact of the dam structure and operation on the West Branch of the Penobscot River. The Department requires GLHA to conduct their sampling at the deepest part of each basin identified above according to the *DEP Sampling Protocol for Hydropower Studies* (March 2021) to determine if Maine's water quality standards are met.

Penobscot Mills

The Department requires an Impoundment Trophic State Study be conducted in the Penobscot Mills impoundment, including the waters of Millinocket Lake, North Twin Development (including Ambajejus Lake, Pemadumcook Lake, and South Twin Lake), Quakish Lake and Ferguson Pond, and Dolby Pond. Similarly, the Department requires GLHA to conduct their sampling at the deepest part of each basin identified above according to the *DEP Sampling Protocol for Hydropower Studies* (March 2021) to determine if Maine's water quality standards are met.

Impoundment Aquatic Habitat Studies - The purpose of this study is to determine the effect of drawdowns on the impoundment or basin's littoral zone and the ability of those water bodies to support fish and other aquatic life. Measurements of Secchi disk transparency and bathymetric data are applied to determine the extent of the littoral zone in the impoundments and an assessment of the volume and surface area dewatered under normal operating conditions, to determine if at least 75% of the littoral zone remains watered at all times. The PAD references but does not present any information regarding littoral habitats associated with the various Project impoundments and the Applicant does not propose to conduct habitat assessment studies.

Ripogenus

The Ripogenus Project is operated as a water storage facility with an impoundment and multiple basins; therefore, normal operations may impact the littoral zone of the impoundment and these basins. As described above in the PAD comments section of this letter, the 1992 UAA may established that the Ripogenus Development meets the aquatic habitat and life standards for GPA waters. However, the Department requires the Applicant submit the UAA that remains in effect at the Ripogenus Project for review. The Applicant must consult with the Department during preparation of the Proposed Study Plan to determine if the Impoundment Aquatic Habitat Studies in the Ripogenus Development must be conducted.

If required, the Applicant should conduct the Impoundment Aquatic Habitat Study following the "Habitat Study" protocol under "Lakes, Ponds, and Impoundments" in the *DEP Sampling Protocol for Hydropower Studies* (March 2021), which is attached to this comment letter. The Department requests that this study be conducted in the Ripogenus impoundment, including the waters of Ripogenus Lake, Caribou Lake, Brandy Pond, Black Pond, Chesuncook Lake, Umbazokus Lake.

Penobscot Mills

The Penobscot Mills Project is operated as a water storage facility with an impoundment and multiple basins; therefore, normal operations may impact the littoral zone of the impoundment and these basins. The Applicant does not propose to conduct habitat assessment studies. The Applicant should conduct the Impoundment Aquatic Habitat Study following the "Habitat Study" protocol under "Lakes, Ponds, and Impoundments" in the *DEP Sampling Protocol for Hydropower Studies* (March 2021), which is attached to this comment letter. The Department

requests that this study be conducted in the waters of Millinocket Lake, North Twin Development (including Ambajejus Lake, Pemadumcook Lake, and South Twin Lake), Quakish Lake and Ferguson Pond, and Dolby Pond. Information will be used to evaluate whether the project meets Maine's habitat and aquatic life criteria, and the designated use of habitat for fish and other aquatic life

Downstream Temperature and Dissolved Oxygen - Temperature and DO must be monitored downstream of the Project dams to ensure that discharges from the hydropower projects are sufficient to maintain the resident biological community in the downstream habitats of the Ripogenus and the Penobscot Mills Developments. Dissolved oxygen concentrations in waters downstream of each Project dam must meet Maine water quality criteria as classified in 38 M.R.S. § 467. The Project PAD indicates that water quality in the West Branch of the Penobscot River meets all applicable water quality standards, however such assertions are based on samples collected in 1991, prior to an application for a new FERC license for the Project and may not be representative of current water quality conditions. The PAD indicates that temperature and DO monitoring is planned for these Projects.

Ripogenus

The Department requires temperature and DO to be sampled downstream of the Ripogenus dam and downstream of McKay Station. Assessment of temperature and DO data in the downstream reaches will be used to determine if the hydropower project currently meets Maine Water Quality Standards including Class B and Class A DO criteria, respectively. Data must be collected in accordance with the Department's "Temperature and Dissolved Oxygen Study" protocol under "Rivers and Streams" in the *DEP Sampling Protocol for Hydropower Studies* (March 2021), which is attached to this comment letter. As noted in the protocol, the applicant will need to consult with the Department to verify representative sampling locations as the study plan is developed.

Penobscot Mills

The Department requires temperature and DO to be sampled downstream of the Millinocket Lake Storage Development dam and the North Twin Development dam, downstream of the Stone dam⁸, in Millinocket Stream within the tailrace of the Millinocket Development dam, downstream of the Dolby Development dam and downstream of the East Millinocket Development dam. Assessment of temperature and DO data in the downstream reaches will be used to determine if the hydropower project currently meets Maine Water Quality Standards including Class A, Class B and Class C DO criteria, in accordance with classification standards established within 38 M.R.S. § 467. Data must be collected in accordance with the Department's "Temperature and Dissolved Oxygen Study" protocol under "Rivers and Streams" in the *DEP Sampling Protocol for Hydropower Studies* (March 2021), which is attached to this comment letter. As noted in the protocol, the applicant will need to consult with the Department to verify representative sampling locations as the study plan is developed.

⁸ In the original channel of the West Branch of the Penobscot River, also referred to as the Back Channel.

Aquatic Habitat Cross-Sectional Flow Study - The purpose of this study is to evaluate whether current Project operations affect attainment of habitat standards for fish and other aquatic life in the river below the Ripogenus and Penobscot Mills Developments. An aquatic habitat cross-section flow study measures depth, velocity, and wetted width along established transects at various discharges to determine flows where at least 75% of the stream cross-sectional area has enough water to provide sufficient habitat for fish and other aquatic organisms. Agency file review indicates data is insufficient and the Applicant does not propose to conduct downstream habitat assessment studies.

Ripogenus

The Department requires that the Applicant assess aquatic habitat downstream of the Ripogenus dam. Data will be evaluated to determine if the downstream waters provide sufficient quantity of water to maintain riverine aquatic habitat in the bypass and tailrace reaches. The Applicant must conduct the Cross-Sectional Flow Study following the “Habitat and Aquatic Life Studies” protocol under “Rivers and Streams” in the *DEP Sampling Protocol for Hydropower Studies* (March 2021), which is attached to this comment letter.

Penobscot Mills

The Department requires that the Applicant assess aquatic habitat downstream of the Penobscot Mills dams at Millinocket Lake, North Twin Development, Quakish Lake (Stone dam) and Ferguson Pond (powerhouse tailrace in Millinocket Stream), Dolby Development dam and East Millinocket Development dam. The Applicant must conduct the Cross-Sectional Flow Study following the “Habitat and Aquatic Life Studies” protocol under “Rivers and Streams” in the *DEP Sampling Protocol for Hydropower Studies* (March 2021), which is attached to this comment letter.

Downstream Benthic Macroinvertebrates Study- Assessment of the benthic macroinvertebrate community is required to determine whether current in-stream flow releases are affecting attainment of habitat and aquatic life criteria in the waters downstream of these Projects. The assessment provides biological data to evaluate potential impacts caused by project operations. Replicate benthic macroinvertebrate sample collectors are deployed for a 28-day study period in the tailrace reach of the hydropower project during low flow, high temperature conditions. Agency file review indicates data is insufficient to evaluate the current aquatic community in the bypass and tailrace reaches downstream of the Project Development dams. The PAD indicates that a study of this nature is planned for the project. Sample location must be determined in coordination with the Department.

Ripogenus

The Department requires sampling of macroinvertebrates in the West Branch of the Penobscot River below the Ripogenus dam and downstream of the McKay Station powerhouse to determine whether current in-stream flow releases affect attainment of Maine habitat and aquatic life

criteria for Class B and Class A waters. The applicant must conduct this study following DEP's standard protocol in *Methods for Biological Sampling and Analysis of Maine's River and Streams* (April 2014), attached to this comment letter.

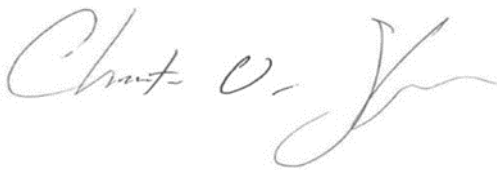
Penobscot Mills

The Department also requires sampling of macroinvertebrates in Millinocket Stream and in the West Branch of the Penobscot River downstream of the Millinocket Lake Storage Development dam, downstream of the North Twin Development dam, downstream of the Stone dam⁹, in Millinocket Stream within the tailrace of the Millinocket Development dam, downstream of the Dolby Development dam and downstream of the East Millinocket Development dam. This will allow the Department to determine if current in-stream flow releases affect attainment of Maine habitat and aquatic life criteria the applicable Class A, Class B and Class C waters. The applicant must conduct this study following DEP's standard protocol in *Methods for Biological Sampling and Analysis of Maine's River and Streams* (April 2014), attached to this comment letter.

MDEP supports study requests prepared by other natural resource agencies, including but not limited to, Maine Department of Inland Fish and Wildlife (MDIFW), Maine Department of Marine Resources (MDMR), US Fish and Wildlife (USFWS), National Marine Fisheries Service (NMFS), and New Hampshire state agencies.

Thank you for the opportunity to comment on the PAD for the Ripogenus and Penobscot Mills Hydroelectric Project. If you have any questions, please contact me by phone at (207) 446-1619 or by email at Christopher.Sferra@maine.gov.

Sincerely,



Christopher O. Sferra
Hydropower Program, Project Manager
Maine Department of Environmental Protection

Attachment:

DEP sampling Protocol for Hydropower Studies (March 2021)
Methods for Biological Sampling and Analysis of Maine's River and Streams (April 2014)

⁹ In the original channel of the West Branch of the Penobscot River, also referred to as the Back Channel.

Maine Department of Environmental Protection
Study Request
Ripogenus Hydropower Project (FERC No. 2572)

Impoundment Trophic State Study

1. Describe the goals and objectives of each study proposal and the information to be obtained.

Trophic state is an important indicator of water quality within the impoundment. Assessment of this criteria provides information to evaluate the health of the Ripogenus impoundment, including the waters of Ripogenus Lake, Caribou Lake, Brandy Pond, Black Pond, Chesuncook Lake, Umbazokus Lake and the impact of the dam structure and operation on the West Branch of the Penobscot River. The objective of this study proposal is to determine if the project impoundment meets Maine Water Quality Standards, including dissolved oxygen criteria, and the designated use of recreation in and on the water. This study will assess whether the trophic state of the impoundment is stable or improving.

2. If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.

The resource management goal is to ensure attainment of Maine Water Quality Standards pursuant to the provisions of the *Water Classification Program*, 38 M.R.S. Sections 464-468 and to certify attainment of such, with any necessary conditions, under Section 401 of the Federal Water Pollution Control Act (a.k.a. Clean Water Act).

3. If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.

Requestor is a resource agency.

4. Describe existing information concerning the subject of the study proposal, and the need for additional information.

The PAD presents summarized data collected in 1991, and the applicant proposes to conduct Trophic State Studies to demonstrate whether the Project meets water quality standards. As described in the Department's PAD comment letter, the applicant will need to demonstrate that the project operation meet dissolved oxygen and other water quality standards in the impoundment and that the trophic state is stable or declining in order to obtain water quality certification.

5. Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.

Data collected will identify trophic state and may identify stratification effects on the impounded water and habitat. Information will be used to evaluate whether the project meets Maine designated uses, habitat and aquatic life criteria, and dissolved oxygen criteria, which will inform the water quality certification process.

6. **Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.**

The DEP Sampling Protocol for Hydropower Studies (March 2021) was established by Department staff and has been used successfully throughout the State by the DEP and others. A copy of the Department protocol is attached to the PAD comment letter.

7. **Describe considerations of level of effort and cost, as applicable, and why proposed alternative studies would not be sufficient to meet the stated information needs.**

Trophic state samples are collected twice each month for five consecutive months during open water season. An impoundment aquatic habitat study can be completed in one field season. Costs are considered reasonable given that this study is required for Maine water quality certification and is routinely completed at hydropower projects being relicensed in the State. No alternatives to this study are proposed.

Maine Department of Environmental Protection
Study Request
Penobscot Mills Hydropower Project (FERC No. 2458)

Impoundment Trophic State Study

1. Describe the goals and objectives of each study proposal and the information to be obtained.

Trophic state is an important indicator of water quality within the impoundment. Assessment of this criteria provides information to evaluate the health of the Penobscot Mills impoundments, including Millinocket Lake, North Twin Development (including Ambajejus Lake, Pemadumcook Lake, and South Twin Lake), Quakish Lake and Ferguson Pond, and Dolby Pond, and the impact of the dam structures and operations on Millinocket Stream and on the West Branch of the Penobscot River. The objective of this study proposal is to determine if the project impoundments meet Maine Water Quality Standards, including dissolved oxygen criteria, and the designated use of recreation in and on the water. This study will assess whether the trophic state of each of the Project impoundments is stable or improving.

2. If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.

The resource management goal is to ensure attainment of Maine Water Quality Standards pursuant to the provisions of the *Water Classification Program*, 38 M.R.S. Sections 464-468 and to certify attainment of such, with any necessary conditions, under Section 401 of the Federal Water Pollution Control Act (a.k.a. Clean Water Act).

3. If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.

Requestor is a resource agency.

4. Describe existing information concerning the subject of the study proposal, and the need for additional information.

The PAD presents summarized data collected in 1991, and the applicant proposes to conduct Trophic State Studies to demonstrate whether the Project impoundments meet water quality standards. As described in the Department's PAD comment letter, the applicant will need to demonstrate that the project operation meet dissolved oxygen and other water quality standards in the impoundment and that the trophic state is stable or declining in order to obtain water quality certification.

5. Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.

Data collected will identify trophic state and may identify stratification effects on the impounded water and habitat. Information will be used to evaluate whether the project

meets Maine designated uses, habitat and aquatic life criteria, and dissolved oxygen criteria, which will inform the water quality certification process.

- 6. Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.**

The DEP Sampling Protocol for Hydropower Studies (March 2021) was established by Department staff and has been used successfully throughout the State by the DEP and others. A copy of the Department protocol is attached to the PAD comment letter.

- 7. Describe considerations of level of effort and cost, as applicable, and why proposed alternative studies would not be sufficient to meet the stated information needs.**

Trophic state samples are collected twice each month for five consecutive months during open water season. An impoundment aquatic habitat study can be completed in one field season. Costs are considered reasonable given that this study is required for Maine water quality certification and is routinely completed at hydropower projects being relicensed in the State. No alternatives to this study are proposed.

Maine Department of Environmental Protection
Study Request
Ripogenus Hydropower Project (FERC No. 2572)

Impoundment Aquatic Habitat Study

1. Describe the goals and objectives of each study proposal and the information to the obtained.

The objective of this study proposal is to determine if the project impoundments, including the waters of Ripogenus Lake, Caribou Lake, Brandy Pond, Black Pond, Chesuncook Lake and Umbazokus Lake meet Maine Water Quality Standards including habitat and aquatic life criteria. Measurements of Secchi disk transparency and bathymetric data are applied to determine the extent of the littoral zone in the impoundments and an assessment of the volume and surface area dewatered under normal operating conditions, to determine if at least 75% of the littoral zone remains watered at all times. Assessment of the shoreline littoral environment is necessary to evaluate the impact of Project operations on habitat there to determine if the Project attains Maine's aquatic life criteria, a narrative water quality standard.

2. If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.

The resource management goal is to ensure attainment of Maine Water Quality Standards pursuant to the provisions of the *Water Classification Program*, 38 M.R.S. Sections 464-468 and to certify attainment of such, with any necessary conditions, under Section 401 of the Federal Water Pollution Control Act (a.k.a. Clean Water Act).

3. If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.

Requestor is a resource agency.

4. Describe existing information concerning the subject of the study proposal, and the need for additional information.

The PAD references and existing 1992 UAA but does not present any information regarding maintenance of the littoral habitats associated with the various Ripogenus impoundments and the applicant does not propose to conduct habitat assessment studies. Through changes in jurisdiction of the Project through the LUPC and MDEP, the Department does not have adequate documentation of the UAA and the Department requests that the UAA be submitted for Department review. As described in the PAD comments, the Impoundment Habitat Studies may need to be conducted in each of the Project impoundments to demonstrate that the Project impoundments meet habitat and aquatic life criteria under the proposed operating conditions.

5. Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.

Data collected will identify any drawdown effects on the littoral zone habitats in each of the Project impoundments. Information will be used to evaluate whether the project meets Maine's habitat and aquatic life criteria, and the designated use of habitat for fish and other aquatic life, which will inform the water quality certification process.

- 6. Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.**

The DEP Sampling Protocol for Hydropower Studies (March 2021) was established by Department staff and has been used successfully throughout the State by the DEP and others. A copy of the Department protocol is attached to the PAD comment letter.

- 7. Describe considerations of level of effort and cost, as applicable, and why proposed alternative studies would not be sufficient to meet the stated information needs.**

The Impoundment Aquatic Habitat Study can be completed in one field season, and can be designed as a desktop study utilizing data collected in the Trophic State Study. Costs are considered reasonable given that this study is required for Maine water quality certification and is routinely completed at hydropower projects being relicensed in the State. The Applicant must submit the existing UAA and must consult with the Department concerning this study as they prepare their PSP.

Maine Department of Environmental Protection
Study Request
Penobscot Mills Hydropower Project (FERC No. 2458)

Impoundment Aquatic Habitat Study

8. Describe the goals and objectives of each study proposal and the information to the obtained.

The objective of this study proposal is to determine if the project impoundments, including Millinocket Lake, North Twin Development (including Ambajejus Lake, Pemadumcook Lake, and South Twin Lake), Quakish Lake and Ferguson Pond, and Dolby Pond meet Maine Water Quality Standards including habitat and aquatic life criteria. Measurements of Secchi disk transparency and bathymetric data are applied to determine the extent of the littoral zone in the impoundments and an assessment of the volume and surface area dewatered under normal operating conditions, to determine if at least 75% of the littoral zone remains watered at all times. Assessment of the shoreline littoral environment is necessary to evaluate the impact of Project operations on habitat there to determine if the Project attains Maine's aquatic life criteria, a narrative water quality standard.

9. If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.

The resource management goal is to ensure attainment of Maine Water Quality Standards pursuant to the provisions of the *Water Classification Program*, 38 M.R.S. Sections 464-468 and to certify attainment of such, with any necessary conditions, under Section 401 of the Federal Water Pollution Control Act (a.k.a. Clean Water Act).

10. If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.

Requestor is a resource agency.

11. Describe existing information concerning the subject of the study proposal, and the need for additional information.

The PAD does not present any information regarding maintenance of the littoral habitats associated with the various Penobscot Mills impoundments and the applicant does not propose to conduct habitat assessment studies. The Department requests that Impoundment Habitat Studies be conducted in each of the Project impoundments to demonstrate that the Project impoundments meet habitat and aquatic life criteria under the proposed operating conditions.

12. Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.

Data collected will identify any drawdown effects on the littoral zone habitats in each of the Project impoundments. Information will be used to evaluate whether the project

meets Maine's habitat and aquatic life criteria, and the designated use of habitat for fish and other aquatic life, which will inform the water quality certification process.

- 13. Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.**

The DEP Sampling Protocol for Hydropower Studies (March 2021) was established by Department staff and has been used successfully throughout the State by the DEP and others. A copy of the Department protocol is attached to the PAD comment letter.

- 14. Describe considerations of level of effort and cost, as applicable, and why proposed alternative studies would not be sufficient to meet the stated information needs.**

The Impoundment Aquatic Habitat Study can be completed in one field season, and can be designed as a desktop study utilizing data collected in the Trophic State Study. Costs are considered reasonable given that this study is required for Maine water quality certification and is routinely completed at hydropower projects being relicensed in the State. No alternatives to this study are proposed.

Maine Department of Environmental Protection
Study Request
Ripogenus Hydropower Project (FERC No. 2572)

Downstream Temperature and Dissolved Oxygen Study

1. Describe the goals and objectives of each study proposal and the information to be obtained.

Temperature and dissolved oxygen (DO) are important indicators of water quality to ensure that discharges from the hydropower project are sufficient to maintain the resident biologic community downstream of the Ripogenus dam and downstream of McKay Station. Assessment of temperature and DO data in the downstream reaches will be used to determine if the hydropower project currently¹⁰ meets Maine Water Quality Standards including Class B and Class A DO criteria, respectively.

2. If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.

The resource management goal is to ensure attainment of Maine Water Quality Standards pursuant to the provisions of the *Water Classification Program*, 38 M.R.S. Sections 464-468 and certify attainment of such, with any necessary conditions, under Section 401 of the Federal Water Pollution Control Act (a.k.a. Clean Water Act)

3. If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.

Requestor is a resource agency.

4. Describe existing information concerning the subject of the study proposal, and the need for additional information.

Dissolved oxygen concentrations downstream of the Ripogenus dam must meet Maine water quality criteria for Class B waters and must meet water quality criteria for Class A in waters downstream of the McKay Station. Agency file review indicates temperature and dissolved oxygen data are insufficient to assess current attainment of these criteria. The PAD indicates that a study of this nature is planned for the project; data collection sites must be chosen in coordination with the Department.

5. Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.

Data collected will be used to evaluate project effects on water temperature and DO concentrations in the West Branch of the Penobscot River downstream of the Ripogenus

¹⁰ The Project PAD indicates that water quality in the West Branch of the Penobscot River is good and meets all applicable water quality standards, however such assertions are based on samples collected in 1991, prior to an application for a new FERC license for the Project, and may not be representative of current water quality conditions.

dam. Information will be used to evaluate whether the project meets Maine DO criteria for Class A waters and will inform the water quality certification process.

6. **Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.**

The DEP Sampling Protocol for Hydropower Studies (March 2021) was established by Department staff and has been used successfully throughout the State by the DEP and others. A copy of the Department protocol is attached to the PAD comment letter.

7. **Describe considerations of level of effort and cost, as applicable, and why proposed alternative studies would not be sufficient to meet the stated information needs.**

The DEP Sampling Protocol for Hydropower Studies (March 2021) offers two options for the temperature and DO study that can be completed in one field season.

Temperature and DO samples can be collected one day per week for at least 10 weeks or measured hourly using data sondes placed at designated locations during summer low flow, high water temperature conditions (e.g. July and August). The Department prefers the second method. Costs are considered reasonable given that this study is required for Maine water quality certification and is routinely completed at hydropower projects being relicensed in the State. No alternatives to this study are proposed.

Maine Department of Environmental Protection
Study Request
Penobscot Mills Hydropower Project (FERC No. 2458)

Downstream Temperature and Dissolved Oxygen Study

1. Describe the goals and objectives of each study proposal and the information to be obtained.

Temperature and dissolved oxygen (DO) are important indicators of water quality to ensure that discharges from the hydropower project are sufficient to maintain the resident biologic community downstream of the Millinocket Lake Storage Development dam, the North Twin Development dam, downstream of the Stone dam¹¹, in Millinocket Stream within the tailrace of the Millinocket Development dam, downstream of the Dolby Development dam and downstream of the East Millinocket Development dam. Assessment of temperature and DO data in the downstream reaches will be used to determine if the hydropower project currently¹² meets Maine Water Quality Standards including Class A, Class B and Class C DO criteria, in accordance with classification standards¹³.

2. If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.

The resource management goal is to ensure attainment of Maine Water Quality Standards pursuant to the provisions of the *Water Classification Program*, 38 M.R.S. Sections 464-468 and certify attainment of such, with any necessary conditions, under Section 401 of the Federal Water Pollution Control Act (a.k.a. Clean Water Act)

3. If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.

Requestor is a resource agency.

4. Describe existing information concerning the subject of the study proposal, and the need for additional information.

Dissolved oxygen concentrations in waters downstream of each Project dam must meet Maine water quality criteria as classified in 38 M.R.S. § 467. Agency file review indicates temperature and dissolved oxygen data is insufficient to assess current attainment of these criteria. The PAD indicates that a study of this nature is planned for the project; data collection sites must be chosen in coordination with the Department.

¹¹ In the original channel of the West Branch of the Penobscot River, also referred to as the Back Channel.

¹² The Project PAD indicates that water quality in the West Branch of the Penobscot River is good and meets all applicable water quality standards, however such assertions are based on samples collected in 1991, prior to an application for a new FERC license for the Project and may not be representative of current water quality conditions.

¹³ Classification of each river reach is determined within 38 M.R.S. § 467.

5. **Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.**

Data collected will be used to evaluate project effects on water temperature and DO concentrations in the West Branch of the Penobscot River and in Millinocket Stream downstream of each Penobscot Mills Project dam. Information will be used to evaluate whether the project meets Maine DO criteria for the appropriate classification standard and will inform the water quality certification process.

6. **Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate filed season(s) and duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.**

The DEP Sampling Protocol for Hydropower Studies (March 2021) was established by Department staff and has been used successfully throughout the State by the DEP and others. A copy of the Department protocol is attached to the PAD comment letter.

7. **Describe considerations of level of effort and cost, as applicable, and why proposed alternative studies would not be sufficient to meet the stated information needs.**

The DEP Sampling Protocol for Hydropower Studies (March 2021) offers two options for the temperature and DO study that can be completed in one field season.

Temperature and DO samples can be collected one day per week for at least 10 weeks or measured hourly using data sondes placed at designated locations during summer low flow, high water temperature conditions (e.g. July and August). The Department prefers the second method. Costs are considered reasonable given that this study is required for Maine water quality certification and is routinely completed at hydropower projects being relicensed in the State. No alternatives to this study are proposed.

Maine Department of Environmental Protection
Study Request
Ripogenus Hydropower Project (FERC No. 2572)

Aquatic Habitat Cross-Section Flow Study

1. **Describe the goals and objectives of each study proposal and the information to be obtained.**

Assessment of aquatic habitat downstream of the Ripogenus dam is required to determine whether current in-stream flow releases meet Maine habitat and aquatic life criteria. An aquatic habitat cross-section flow study measures depth, velocity, and wetted width along established transects at various discharges to determine flows where at least 75% of the

stream cross-sectional area has enough water to provide sufficient habitat for fish and other aquatic organisms. Data will be evaluated to determine if the downstream waters provide sufficient quantity of water to maintain riverine aquatic habitat in the bypass and tailrace reaches.

2. If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.

The resource management goal is to ensure attainment of Maine Water Quality Standards pursuant to the provisions of the *Water Classification Program*, 38 M.R.S. Sections 464-468 and to certify attainment of such, with any necessary conditions, under Section 401 of the Federal Water Pollution Control Act (a.k.a. Clean Water Act).

3. If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.

Requestor is a resource agency.

4. Describe existing information concerning the subject of the study proposal, and the need for additional information.

The West Branch of the Penobscot River downstream of the Ripogenus dam must meet Maine habitat and aquatic life criteria. Agency file review indicates data is insufficient in the bypass and tailrace reaches of the Ripogenus Project to assess current attainment of these criteria. The PAD indicates that no water quality studies designed to assess the extent of aquatic habitat are planned for the Project; the Department requests that water quality studies for this project include a study of this nature.

5. Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.

Data collected will be used to evaluate aquatic habitat in the West Branch of the Penobscot River downstream of the Ripogenus dam, in the bypass reach and in the project tailrace. Information will be used to evaluate whether the project meets Maine habitat and aquatic life criteria and will inform the water quality certification process.

6. Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate filed season(s) and duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.

The DEP Sampling Protocol for Hydropower Studies (March 2021) was established by Department staff and has been used successfully throughout the State by the DEP and others. A copy of the Department protocol is attached to the PAD comment letter.

7. Describe considerations of level of effort and cost, as applicable, and why proposed alternative studies would not be sufficient to meet the stated information needs.

A cross-section flow study measures depth, velocity, and wetted width along established transects in the bypass and tailrace reaches at various discharges to determine flows where at least 75% of the stream cross-sectional area has enough water to provide sufficient habitat for fish and other aquatic organisms. This type of study can typically be accomplished in one or two days. Costs are considered reasonable given that this study is required for Maine water quality certification and is routinely completed at hydropower projects being relicensed in the State. No alternatives to this study are proposed.

Maine Department of Environmental Protection
Study Request
Penobscot Mills Hydropower Project (FERC No. 2458)

Aquatic Habitat Cross-Section Flow Study

1. Describe the goals and objectives of each study proposal and the information to the obtained.

Assessment of aquatic habitat downstream of the Penobscot Mills dams at Millinocket Lake, North Twin Development, Quakish Lake (Stone dam) and Ferguson Pond (powerhouse tailrace in Millinocket Stream), Dolby Development dam and East Millinocket Development dam is required to determine whether current in-stream flow

releases meet Maine habitat and aquatic life criteria. An aquatic habitat cross-section flow study measures depth, velocity, and wetted width along established transects at various discharges to determine flows where at least 75% of the stream cross-sectional area, measured from bankfull width, has enough water to provide sufficient habitat for fish and other aquatic organisms. Data will be evaluated to determine if the downstream waters provide sufficient quantity of water to maintain riverine aquatic habitat in the bypass and tailrace reaches.

2. If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.

The resource management goal is to ensure attainment of Maine Water Quality Standards pursuant to the provisions of the *Water Classification Program*, 38 M.R.S. Sections 464-468 and to certify attainment of such, with any necessary conditions, under Section 401 of the Federal Water Pollution Control Act (a.k.a. Clean Water Act).

3. If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.

Requestor is a resource agency.

4. Describe existing information concerning the subject of the study proposal, and the need for additional information.

The West Branch of the Penobscot River and Millinocket Stream downstream of each of the Project dams must meet Maine habitat and aquatic life criteria. Agency file review indicates data is insufficient in the bypass and tailrace reaches of the Penobscot Mills Project, including the original channel of the West Branch of the Penobscot River, also referred to as the Back Channel, to assess attainment of these criteria. The PAD indicates that water quality studies are planned for the Project but does not indicate that an aquatic habitat cross-sectional flow study is planned; the Department requests that such studies include a study of this nature.

5. Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.

Data collected will be used to evaluate aquatic habitat in the West Branch of the Penobscot River, including the reach of the river referred to as the Back Channel, as well as in Millinocket Stream, downstream of each of the project dams. Information will be used to evaluate whether the project meets Maine habitat and aquatic life criteria and will inform the water quality certification process.

6. Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate filed season(s) and duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.

The DEP Sampling Protocol for Hydropower Studies (March 2021) was established by Department staff and has been used successfully throughout the State by the DEP and others. A copy of the Department protocol is attached to the PAD comment letter.

7. Describe considerations of level of effort and cost, as applicable, and why proposed alternative studies would not be sufficient to meet the stated information needs.

A cross-section flow study measures depth, velocity, and wetted width along established transects in the bypass and tailrace reaches at various discharges to determine flows where at least 75% of the stream cross-sectional area has enough water to provide sufficient habitat for fish and other aquatic organisms. This type of study can typically be accomplished in one or two days. Costs are considered reasonable given that this study is required for Maine water quality certification and is routinely completed at hydropower projects being relicensed in the State. No alternatives to this study are proposed.

Maine Department of Environmental Protection
Study Request
Ripogenus Hydropower Project (FERC No. 2572)

Benthic Macroinvertebrate Study

1. Describe the goals and objectives of each study proposal and the information to the obtained.

Assessment of the benthic macroinvertebrate community is critical to determine whether current in-stream flow releases affect attainment of Maine habitat and aquatic life criteria for Class B and Class A waters in the West Branch of the Penobscot River below the

Ripogenus dam and downstream of the McKay Station powerhouse. The assessment provides biological data to evaluate potential impacts caused by project operations.

2. If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.

The resource management goal is to ensure attainment of Maine Water Quality Standards pursuant to the provisions of the *Water Classification Program*, 38 M.R.S. Sections 464-468 and certify attainment of such, with any necessary conditions, under Section 401 of the Federal Water Pollution Control Act (a.k.a. Clean Water Act)

3. If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.

Requestor is a resource agency.

4. Describe existing information concerning the subject of the study proposal, and the need for additional information.

The West Branch of the Penobscot River must meet Maine aquatic life criteria in the vicinity of the Ripogenus Project, both in the bypass reach and downstream of the Project powerhouse. Agency file review indicates data is insufficient to evaluate the current aquatic community in the bypass and tailrace reaches downstream of the Ripogenus dam. The PAD indicates that a study of this nature is planned for the project; sample locations must be determined in consultation with the Department.¹⁴

5. Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.

Data collected will be used to evaluate the benthic macroinvertebrate community in the bypass and in the tailrace reach downstream of the Ripogenus dam. Information will be used to evaluate whether the project meets Maine aquatic life criteria and will inform the water quality certification process.

6. Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate filed season(s) and duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.

The DEP Methods for Biological Sampling and Analysis of Maine's Rivers and Streams (April 2014) was established by Department staff and has been used successfully throughout the state by DEP and others since 1983. A copy of the Department manual is attached to the PAD comment letter.

¹⁴ The Project PAD indicates that water quality in the West Branch of the Penobscot River is good and meets all applicable water quality standards, however such assertions are based on dated data and may not be representative of current water quality conditions.

7. Describe considerations of level of effort and cost, as applicable, and why proposed alternative studies would not be sufficient to meet the stated information needs.

Replicate benthic macroinvertebrate sample collectors (rock baskets or cones) are deployed for a 28-day study period in the tailrace reach of the hydropower project during low flow, high temperature conditions. Samples must be collected by a professional aquatic biologist and evaluated by a professional freshwater macroinvertebrate taxonomist. Methods are documented in the DEP manual Methods for Biological Sampling and Analysis of Maine's River and Streams (April 2014). Costs are considered reasonable given that this study is required for Maine water quality certification and is routinely completed at hydropower projects being relicensed in the State. No alternatives to this study are proposed.

Maine Department of Environmental Protection
Study Request
Penobscot Mills Hydropower Project (FERC No. 2458)

Benthic Macroinvertebrate Study

1. Describe the goals and objectives of each study proposal and the information to be obtained.

Assessment of the benthic macroinvertebrate community is critical to determine whether current in-stream flow releases affect attainment of Maine habitat and aquatic life criteria

for Class A, Class B and Class C waters, as applicable, in Millinocket Stream and in the West Branch of the Penobscot River downstream of the Millinocket Lake Storage Development dam, downstream of the North Twin Development dam, downstream of the Stone dam¹⁵, in Millinocket Stream within the tailrace of the Millinocket Development dam, downstream of the Dolby Development dam and downstream of the East Millinocket Development dam. The assessment provides biological data to evaluate potential impacts caused by project operations.

2. If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.

The resource management goal is to ensure attainment of Maine Water Quality Standards pursuant to the provisions of the *Water Classification Program*, 38 M.R.S. Sections 464-468 and certify attainment of such, with any necessary conditions, under Section 401 of the Federal Water Pollution Control Act (a.k.a. Clean Water Act)

3. If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.

Requestor is a resource agency.

4. Describe existing information concerning the subject of the study proposal, and the need for additional information.

Millinocket Stream and the West Branch of the Penobscot River must meet Maine aquatic life criteria downstream of the Project dams (Millinocket Lake Storage Development dam, North Twin Development dam, Millinocket Development dam, Dolby Development dam and East Millinocket Development dam, and in the bypass reach (downstream of the Stone dam, also known as the Back Channel). Agency file review indicates data is insufficient to evaluate the current aquatic community in the bypass and tailrace reaches downstream of the Project dams. The PAD indicates that a study of this nature is planned for the project; sample location must be determined in coordination with the Department.

5. Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.

Data collected will be used to evaluate the benthic macroinvertebrate community in Millinocket Stream and in the West Branch of the Penobscot River downstream of each of the Project dams, including downstream of the Stone Dam in the original channel of the West Branch of the Penobscot River, also known as the Back Channel. Information will be used to evaluate whether the project meets Maine aquatic life criteria and will inform the water quality certification process.

6. Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a

¹⁵ In the original channel of the West Branch of the Penobscot River, also referred to as the Back Channel.

schedule including appropriate filed season(s) and duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.

The DEP Methods for Biological Sampling and Analysis of Maine's Rivers and Streams (April 2014) was established by Department staff and has been used successfully throughout the state by DEP and others since 1983. A copy of the Department manual is attached to the PAD comment letter.

7. Describe considerations of level of effort and cost, as applicable, and why proposed alternative studies would not be sufficient to meet the stated information needs.

Replicate benthic macroinvertebrate sample collectors (rock baskets or cones) are deployed for a 28-day study period in the tailrace reach of the hydropower project during low flow, high temperature conditions. Samples must be collected by a professional aquatic biologist and evaluated by a professional freshwater macroinvertebrate taxonomist. Methods are documented in the DEP manual Methods for Biological Sampling and Analysis of Maine's River and Streams (April 2014). Costs are considered reasonable given that this study is required for Maine water quality certification and is routinely completed at hydropower projects being relicensed in the State. No alternatives to this study are proposed.

LAKES, PONDS, AND IMPOUNDMENTS

Applicability

This impoundment sampling protocol shall apply to existing hydropower impoundments regardless of their waterbody classification, where existing data are insufficient (in terms of density or quality) to determine water quality.

Trophic State Study

Overview & Sampling Stations

Each basin or station shall be sampled at the deepest location twice each month, at approximately 2-week intervals for at least five consecutive months during one open-water season. Sampling will consist of obtaining physical measurements as well as water samples. Water samples will be obtained using an integrated core sampler that is 10-meters long, and, when water is of adequate depth, a grab device. During August, additional water samples will be obtained. Sampling personnel must be certified for this sampling protocol annually, prior to data collection by DEP's Division of Environmental Assessment, Lake Assessment Section staff. If sampling is inadequate or certification is bypassed, a second open water season of data may be required. Additional sampling may be required due to the hydraulic or physical characteristics of a given waterbody or to the presence of significant water quality problems. Refer to Table 1 for an overview of parameters, frequency, sampling methods and detection/reporting limits.

Table 1. Summary of parameters, frequency, sampling methods and detection/reporting limits for hydropower impoundment sampling.			
Parameter	Frequency	Sampling Method	Detection/Reporting Limits
Secchi disk transparency	2x/month	disk and water scope	0.1 meter
Temperature	2x/month	electronic meter (profile)	0.1 °C
Dissolved oxygen	2x/month	electronic meter (profile)	0.2 mg/l
Trichromatic Chlorophyll-a (uncorrected)	2x/month	core tube	0.001 mg/L
Water Chemistry	2x/month; additional samples in August	core tube or grab device	See Table 2 below

Physical measurements

Physical measurements will include the determination of water transparency using a Secchi disk and water scope following the Maine Lake Assessment SOP for *Secchi Disk Transparency* (DEPLW0947R2). In addition, profiles for temperature and dissolved oxygen will be taken from the water surface to the bottom of the impoundment. Readings will be obtained, recorded, and submitted on DEP lake monitoring forms. Readings will be obtained in 1-meter increments from the surface to 15 meters in depth, then in 2 meter increments from 15 meters to 25 meters, and every 5 meters in water deeper than 25 meters; if between 15 and 25 meters, a rapid change in temperature or oxygen is discovered, readings will be taken at 1 meter intervals until they stabilize. Refer to the Maine Lake Assessment SOP for obtaining Dissolved Oxygen/Temperature Profiles using electronic meters for additional details (DEPLW0941R2). If a multiparameter device is used that can also measure pH and specific conductance, these data may be substituted for lab data, providing that calibration and quality control check records are maintained and submitted with the data.

Epilimnetic core samples

The depth to which an integrated epilimnetic sample will be obtained using a core tube will be determined according to the Maine Lake Assessment SOP for *Epilimnetic Core Sample Collection* (DEPLW0946R2). Water samples collected through the season will be analyzed for uncorrected chlorophyll-a by the trichromatic method, total phosphorus, color, pH and alkalinity. Water samples collected in August will be additionally analyzed for nitrate, TKN, DOC, iron, calcium, magnesium, total and dissolved aluminum, sodium, potassium, silica, specific conductance, chloride, and sulfate. Refer to Table 2 for specific requirements; obtain bottles and preservatives from the analytical lab. In impoundments that do not thermally stratify (no change in temperature greater than or equal to 1°C per meter below a depth of 2 meters from the water surface), the core sample will be collected to 1 meter above the bottom, unless dissolved oxygen is less than or equal to 2 ppm, in which case the sample should be collected to the meter above that depth.

During warmer times of the year, if the lake is deep enough to stratify, examine the dissolved oxygen / temperature profile to determine the depth of the true seasonal epilimnion using the 1°C change over 1 meter of depth rule below a depth of 2 meters. Be aware that within the true or seasonal epilimnion, a shallow, secondary ephemeral (temporary) epilimnion can form in the top few meters of water as a result of a few calm, warm days. Take the core sample to 1-meter below the bottom of the true epilimnion so as to include neutrally-buoyant algal growth at the epi/metalimnion interface. Elevated dissolved oxygen lower in the profile may indicate need to extend the core deeper to capture the algae responsible for the oxygen spike. Because Chlorophyll

samples are generally obtained from the core sample, never incorporate any water having 2 ppm of oxygen or less into the sample.

Grab samples

During late summer (mid to late August depending on latitude and weather conditions), in stratified lakes, grab samples will be obtained using a Kemmerer, Van Dorn or similar device, according to the Maine Lake Assessment SOP for the *Collection of Grab (discrete) Samples* (DEPLW0949R2). The grab samples will be analyzed for total phosphorus, color, pH, alkalinity, TKN, DOC, iron, calcium, magnesium, total and dissolved aluminum, sodium, potassium, silica, specific conductance, chloride, and sulfate. Refer to Table 2 for additional details.

If the lake does not stratify, no grab samples are needed. Otherwise, the number of grab samples taken is determined by the depth and thermal stratification pattern in the lake. In lakes deep enough to thermally stratify into 3 layers, grabs will be obtained from the metalimnion and hypolimnion. The metalimnetic sample will be taken 1 meter below the depth to which the integrated epilimnetic core sample was taken, and the hypolimnetic sample will be taken a meter above the bottom of the impoundment. In lakes that only stratify thermally into 2 layers, only one grab depth is necessary; in this case the grab sample will be obtained a meter above the bottom of the impoundment.

Table 2. Summary of water sampling parameters, reporting levels, frequency, and sample types limits for hydropower impoundment sampling.

Parameter	Reporting Level	2x per month	August	Sample types
Trichromatic Chlorophyll a (uncorrected)	0.001 mg/L	X	X	core
Total phosphorus	0.001 mg/L	X	X	core & grab(s)
Nitrate	0.01 mg/L	X	X	core & grab(s)
TKN	0.01 mg/L	X	X	core & grab(s)
Color	5.0 SPU	X	X	core & grab(s)
DOC	1.0 mg/L	X	X	core & grab(s)
pH	0.1 pH units	X	X	core & grab(s)
Total alkalinity	1.0 mg/L	X	X	core & grab(s)
Total iron	0.05 mg/L		X	core & grab(s)
Total & dissolved aluminum	0.002 mg/L		X	core & grab(s)
Total calcium	0.05 mg/L		X	core & grab(s)
Total magnesium	0.05 mg/L		X	core & grab(s)
Total sodium	0.05 mg/L		X	core & grab(s)
Total potassium	0.05 mg/L		X	core & grab(s)
Total silica	0.05 mg/L		X	core & grab(s)
Specific conductance	2 μ S/cm		X	core & grab(s)
Chloride	0.5 mg/L		X	core & grab(s)
Sulfate	1 mg/L		X	core & grab(s)

Habitat Study

For lakes, ponds, and riverine impoundments, determination of attainment of the designated use ‘habitat for fish and other aquatic life’ will be determined as follows. Using a depth of twice the mean summer Secchi disk transparency, determined from the Trophic State Study or historic DEP data, as the bottom of the littoral zone, the volume and surface area dewatered by the drawdown will be calculated to determine if at least 75% of the littoral zone remains watered at all times. Alternatively, studies of fish and other aquatic life communities, including freshwater mussels, may be conducted to demonstrate that the project maintains ‘structure and function of the resident biological community’ despite a drawdown that results in less than 75% of the littoral zone remaining watered at all times.

Fishing (Mercury Contamination) Study

To ensure that the project does not contribute to the Statewide Fish Consumption Advisory due to mercury, projects with excessive drawdowns (generally >10 feet) may be required to analyze sport fish from the project waterbody and one or more reference waters for mercury. Contact DEP for specific requirements for each project.

RIVERS AND STREAMS

Temperature and Dissolved Oxygen Study

Applicability

This rivers and streams sampling protocol shall apply to tailwater areas that are not impoundments where existing data are insufficient to determine existing and future water quality.

Sampling Stations

Sampling shall occur in the tailwater downstream from the turbine/gate outlet or dam at a location representative of downstream flow as agreed by DEP on a case by case basis. Initially, measurements of temperature and dissolved oxygen should be made along a transect across the stream at the first, second and third quarter points across the width. If there is no violation of dissolved oxygen criteria and no significant (<0.4 mg/l) difference in concentrations among the quarter points, subsequent measurements may be made at the location shown to be representative of the main flow. Otherwise, measurements should be made at the location of the lowest concentration and the location of the main flow. Sampling should also occur in any bypassed segment of the river created by the project. Additional sampling stations may be required in the upstream or downstream areas where significant point or nonpoint sources exist or where slow moving or deep water occurs. The number and spacing of any additional stations will be determined by DEP on a case-by-case basis.

Parameters

Temperature and dissolved oxygen shall be sampled at mid-depth in rivers less than 2 m deep or in a profile of 1-meter increments of depth in rivers greater than 2 m deep. In rivers where it is already known that attainment of required statutory dissolved oxygen criteria is questionable, sampling for additional parameters (e.g. BOD, nitrogen, phosphorus) may be necessary.

Frequency and Timing

Sampling should be conducted during the summer low flow high temperature period, with the ideal conditions being the 7Q10 flow (the 7-day average low flow with a 10-year recurrence interval) combined with daily average water temperatures exceeding 24 °C. Measurements of temperature and dissolved oxygen shall be made every hour with a data sonde in remote unattended mode continuously during July and August, unless high flows well above seasonal median flows occur.

Alternatively, with concurrence by DEP, sampling could be undertaken one day per week for a minimum of ten weeks throughout the summer low flow, high temperature period. Each discrete grab sampling event for temperature and dissolved oxygen would consist of a minimum of two daily runs, the first of which should occur before 7 AM and the second of which should occur after 2 PM. Sampling results will not be considered complete unless a minimum of 5 sampling days meets the following conditions: The product of the water temperature (°C) and the flow duration (the percentage of the time a given flow is statistically exceeded) at the time of sampling exceeds 1500. For cycling hydropower projects, in addition to twice daily monitoring, continuous monitoring may be required at some locations for a duration equivalent to the period of one cycle of the storage and the release of flow.

For either method, a summer in which low flows and high temperatures are not experienced may result in additional sampling requirements for the next summer. Low flow conditions may occur naturally, as an unregulated river or may be artificially induced, as in the case of upstream flow regulation or flows downstream from a cycling or peaking power project or in the case of a bypassed segment which receives flow only by spillage, leakage or specific releases.

Available Data

The use of data already available is encouraged provided that adequate QA/QC procedures have been followed. Old data may not be acceptable for considerations of meeting minimum sampling requirements but could still provide useful information. Acceptance/rejection of data will be determined on a case by case basis, but generally data more than 10 years old may be rejected.

Habitat and Aquatic Life Studies

For rivers and streams, determination of attainment of the designated use ‘habitat for fish and other aquatic life’ and “structure and function of the resident biological community” will be determined as follows. A Cross-Section Flow Study is required that measures width and depth at various flows to determine the flow at which at least 75% of the bank full cross-sectional area of the river or stream is continuously watered. At least three cross-sections representative of the river or stream must be measured. Alternately, a combination of ambient measurements in one cross-section, flow data from existing flow gages, and/or modelling may be approved by DEP.

In addition, to determine if the project ‘attains the aquatic life criteria, i.e. ‘maintains the structure and function of the resident biological community’, biological monitoring of the benthic macroinvertebrate community must be conducted following DEP’s standard protocol in Methods for Biological Sampling and Analysis of Maine’s Rivers and Streams, DEP LW0387-B2002.

A copy can be found at www.maine.gov/dep/water/monitoring/biomonitoring/material.html



Methods for Biological Sampling and Analysis of Maine's Rivers and Streams

Susan P. Davies
Leonidas Tsomides



DEP LW0387-C2014
Revised April, 2014

**MAINE DEPARTMENT OF ENVIRONMENTAL
PROTECTION**

METHODS

FOR

BIOLOGICAL SAMPLING AND ANALYSIS OF

MAINE'S RIVERS AND STREAMS

Susan P. Davies

Leonidas Tsomides

Maine Department of Environmental Protection
Bureau of Land and Water Quality
Division of Environmental Assessment
Augusta, Maine 04333
January, 1987

Revised April, 2014

Printed under Account #: 010 06A 1327 102

Cover Design: Thomas J. Danielson

Photo Credit: *Paragnetina immarginata* by Eric D. Fleek, North Carolina Division of Water Quality

CONTENTS

FOREWORD	iv
I - GENERAL METHODS FOR RIVER AND STREAM AQUATIC LIFE CLASSIFICATION ATTAINMENT EVALUATION	1
1. Qualifications of Sampling Personnel	1
2. Apparatus, Equipment, Supplies, Instruments	2
(1) Sampling devices	2
(2) Sieves, sieve buckets, nets	3
(3) Optical equipment	3
3. Sampling Season, Sampler Exposure Period, Placement and Retrieval	3
(1) Sampling season	3
(2) Exposure period	3
(3) Sampler placement	4
(4) Sampler retrieval	4
4. Site Selection Criteria	5
(1) Site attributes	5
(2) Precautions	5
(3) Matching reference and effluent impacted sites	6
(4) Factors to be considered in site selection below point sources	6
5. Sample Size	6
6. Physical Habitat Evaluation	7
II - LABORATORY METHODS	7
1. Qualifications of Laboratory Personnel	7
2. Sample Preservation, Sorting	7
3. Sample Labeling	8
4. Sample Log Book	8
5. Subsampling	8
(1) Methods	8
(2) Precautions	9
(3) Chironomidae subsampling	9
6. Sample Taxonomy	10
(1) Taxonomic resolution	10
(2) Identification of Chironomidae	10
(3) Quality control	11
III - ANALYTICAL METHODS	11
1. Minimum Provisions	12
2. Aquatic Life Statistical Decision Models	12
(1) Linear discriminant models	12
(2) Application of professional judgment	13
(3) Classification attainment evaluation of waters subjected to flow regulation	13
(4) Adjustments of a decision	14

(5) Sampling procedures do not conform	15
APPENDICES	
Appendix A Field Data Sheet	17
Appendix B Instructions for Macroinvertebrate Sorters	18
Appendix C-1 Methods for the Calculation of Indices and Measures of Community Structure Used in the Linear Discriminant Models	19
Appendix C-2 Indicator Taxa: Class A	24
Appendix C-3 Family Functional Groups	25
Appendix D Aquatic Life Standards for the State of Maine	27
Appendix E Process of Calculating Model Variables and Association Values Using Linear Discriminant Models	28
Appendix F Process for Determining Attainment Class Using Association Values	29
References	30

FOREWORD

This manual describes the field, laboratory and data preparation methods required by the Maine Department of Environmental Protection to collect and analyze benthic macroinvertebrate samples for the River and Stream Biological Monitoring Program. The biological classification of Maine's inland waters was authorized by the Maine State Legislature with the passage of Public Law 1985 Chapter 698 - The Classification System for Maine Waters. This law states that it is the State's objective "to restore and maintain the chemical, physical and biological integrity" of its waters, and establishes a water quality classification system to enable the State to manage its waters so as to protect their quality. The classification system further establishes minimum standards for each class, which are based on designated uses, and related characteristics of those uses, for each class of water.

Each water quality class contains standards that, among other things, describe the minimum condition of the aquatic life necessary to attain that class. The Maine Department of Environmental Protection (the Department) has developed numeric criteria in support of the narrative aquatic life standards in the Water Quality Classification Law. The Department has collected a large, standardized database consisting of benthic macroinvertebrate samples from above and below all significant licensed discharges in the State, from areas impacted by non-point sources, as well as from relatively unperturbed areas. These sampling locations were chosen to represent the range of water quality conditions in the State. This information has been used to develop numeric criteria which are specific to the natural biotic community potential of the State of Maine (see Davies et al., 1995 and 1999 for a description of the development and application of numeric criteria) and is established in DEP regulation Chapter 579 : Classification Attainment Evaluation Using Biological Criteria for Rivers and Streams.

Standardization of data collection and analytical methods is fundamental to the consistent, unbiased and scientifically sound evaluation of aquatic life impacts. This manual sets forth the standardized practices and procedures used by the Department to acquire or accept benthic macroinvertebrate data for use in regulation, assessment or program development.

Biological Monitoring Unit
Division of Environmental Assessment
Bureau of Land and Water Quality
Maine Department of Environmental Protection
Augusta, Maine 04333
207-287-3901

I GENERAL METHODS FOR RIVER AND STREAM AQUATIC LIFE CLASSIFICATION ATTAINMENT EVALUATION

Each water quality class is defined by standards that describe the minimum condition of the aquatic community necessary to attain that class. The benthic macroinvertebrate community is used as an indicator community of the general state of the aquatic life in flowing waters for the purpose of assessment of classification attainment. Standardized sampling techniques and sample analysis are required for assessment of biological attainment of stream water quality classification. This manual presents the standard practices and procedures that have been adopted by the Department to acquire benthic macroinvertebrate data for purposes of aquatic life classification attainment evaluation.

Purpose:

To determine the water quality class attained by a particular river or stream reach in terms of the aquatic life standards set forth in 38 MRSA Sec. 465 (The Classification System for Maine Waters).

Requirements:

All samples of aquatic life that are collected for purposes of classification attainment evaluation, whether collected by the Department or by any party required to make collections by the Department, must be collected, processed and identified in conformance with the standardized methods outlined in this manual. Selection of appropriate sampling sites and micro-habitat to sample, as well as procedures for quantitative analysis of the sample must conform to methods set forth in this manual. Data submitted by any party required to make collections by the Department must be accompanied by a Quality Assurance Plan, approved by the Commissioner.

1. Qualifications of Sampling Personnel

Biological sampling must be performed by a professional aquatic biologist or by qualified personnel under the supervision of a professional aquatic biologist. The professional aquatic biologist must have, as a minimum, a Bachelor of Science degree in biological sciences with aquatic entomology, invertebrate zoology, fisheries or closely related specialization, and greater than 6 months experience working with macroinvertebrate sampling methods and taxonomy. (See also Qualifications of Laboratory Personnel, Sec. II-1.)

2. Apparatus, Equipment, Supplies, Instruments

(1) Sampling devices

a) Rock-filled wire basket introduced substrate

Use: flowing wadeable, eroded, mineral-based bottom rivers and streams.

Description: cylindrical plastic coated or chrome wire, baskets with at least 1.5 cm spaces between wires, a hinged opening, and secure closure (Klemm, D.J. et al, 1990).

Substrate material: clean, washed, bank-run cobble, graded to uniform diameter range of 3.8 to 7.6 cm (1.5 to 3 inches) in size (#2 roofing stone).

Baskets must be filled to 7.25 +/- 0.5 kg (16 lbs +/-1 lb) of substrate material.

b) Rock-filled mesh bag introduced substrate

Use: small flowing streams, too shallow for rock baskets to be fully submerged.

Description: mesh bags of sufficient size to hold 7.25 +/- 0.5 kg of cobble substrate as described above, with at least 2.54 cm aperture mesh, and secure closures.

c) Closing introduced substrate cone

Use: deep, non-wadeable rivers having sufficient flow to have an eroded, mineral based bottom.

Description: cone shaped wire, or plastic coated wire basket filled with substrate material and closed by means of an inverted, weighted funnel (Courtemanch, 1984).

Substrate material: (see above Rock-filled wire basket substrate material).

(2) Sieves, sieve buckets, nets

Samples are concentrated on sieves having a mesh size between 500 - 600 microns (USA Standard Testing Sieve ASTM-E-11 Specification size No. 30 or No. 35).

(3) Optical equipment

- a) Binocular microscope: Magnification range from 10x or less to 30x or greater.
- b) Compound microscope: Magnification range from 10x to at least 400x; 100x with oil immersion lens is advisable.

3. Sampling Season, Sampler Exposure Period, Placement and Retrieval

(1) Sampling season

The standard sampling season upon which all macroinvertebrate classification criteria are based is the late summer, low flow period (July 1 to September 30). All baseline data for the biological classification program has been collected during this time period. This period often presents conditions of maximal stress to the biological community due to decreased dilution of pollutional material and increased stream water temperatures. Furthermore, because the composition of the benthic macroinvertebrate community changes with season, due to natural life history features, this period defines a standardized seasonal community.

As noted, the Department's linear discriminant models define biological classification criteria derived from a macroinvertebrate community defined by the specific sampling methods and index season under which they were collected. Samples collected at other times of year may yield valuable water quality related information, however classification attainment may not be assigned solely on the basis of results of the linear discriminant models for these non-standard samples.

(2) Exposure period

Standard methods require that substrate samplers be exposed in the water body for a period of 28 days +/- four days within the above-specified sampling season. However, extended exposure periods may be necessary to allow for adequate colonization in the case of assessments of low velocity or impounded habitats. If such conditions exist a 56 days +/- four days exposure period may be used.

(3) Sampler placement
Rock Baskets/Bags

The actual sampler location should be approached so as to avoid any disturbance in, or upstream of, the sampled site. Position baskets in locations of similar habitat characteristics. Orient baskets with the long axis parallel to stream flow. Provide for relocation of baskets by flagging trees in the vicinity and/or by drawing a diagram with appropriate landmarks indicated.

Cones

Cone samplers should be marked with individual marker buoys (milk jugs or other suitable float) leaving about 5 extra feet of line to allow for water level changes and to provide for easy retrieval. They should be placed on the substrate with a minimum of disturbance, in an apex-up position, and located in the approximate middle fifty percent of the channel. (Note however, care should be taken not to create an obstruction to boat traffic.) In areas subject to vandalism, or in rivers having extensive macrophyte beds, it may be necessary to attach the sampler lines to a common anchor and thence to one unobtrusive surface float. Retrieval funnels will not properly close when lines are fouled with drifting macrophytes.

(4) Sampler retrieval

Rock Baskets/ Bags

Baskets are approached from downstream. Excessive accumulations of macrophytes, algae or debris clinging to the outside of the basket should be carefully removed, taking care to avoid jarring the basket itself. An aquatic net or drift net (mesh size 500 - 600 microns) is positioned against the substrate immediately downstream of the basket which is then quickly lifted into the net. The contents of the basket and all net washings are emptied into a sieve bucket (500 - 600 microns); the basket wires are carefully cleaned first, then rocks are hand washed and inspected and returned to the basket. All sieve bucket contents are placed in sample jars. A small amount of stream water and 95% ethyl alcohol is added to yield an approximately 70% solution of alcohol. Especially dense samples should be re-preserved in the laboratory, with fresh 70% ethyl alcohol. Rock baskets should be thoroughly cleaned and allowed to desiccate prior to re-use.

Cones

Cone samplers should be retrieved with the boat anchored directly upstream of the samplers. Once the float is retrieved and removed, the line should be held as vertically as possible while the weighted funnel is released down the line to enclose the cone. Cone and funnel should be retrieved quickly and smoothly from the bottom, and released directly into a sieve bucket or tub. Field processing should then proceed as described above for rock baskets.

4. Site Selection Criteria

Classification criteria apply to a strictly defined sample of the benthic macroinvertebrate community. Habitat type from which the community is obtained is a significant determinant of the make-up of the target community. Benthic macroinvertebrate communities of flowing streams and rivers having a hard, eroded substrate comprise the majority of samples in the baseline data set. This habitat is characteristic of the majority of the river and stream waters of the State. Exceptions to these conditions may require special consideration and the exercise of professional judgment. (Note: See Section III-2. (3) "Classification attainment evaluation of waters subjected to flow regulation" page 13, for procedures relating to the assessment of regulated flow sites.) While it is useful to obtain both an upstream and downstream sample to evaluate the effect of a pollution source, classification attainment evaluation does not require data from a matched reference site in order to arrive at a determination of aquatic life class. Analytical methods for classification attainment evaluation are described in Section III.

(1) Site attributes

- a) The area selected should be generally representative of the habitat of the stream reach as a whole;
- b) Where there is alternating riffle/pool habitat, the riffle/run is the habitat of choice;
- c) A location should be selected where there is a high degree of certainty that the rock basket samples will remain fully submerged even if the water level drops significantly.

(2) Precautions

- a) Avoid atypical influences such as bridges, entering culverts, channelized areas such as road crossings, culverts, or obstructions to flow;
- b) Avoid bank effects: samplers should be located in the middle 50% of the bank to bank width, or in an area with a flow regime typical of the overall character of the stream segment;
- c) Avoid slackwater areas and eddies immediately upstream or downstream of large rocks or debris.

(3) Matching reference and effluent impacted sites

If possible both stream reaches should be viewed prior to selection of sampling sites. Efforts should be made to sample habitats which are comparable in the following characteristics:

- a) Water velocity;
- b) Substrate composition (i.e., size ranges and proportions of particles making up the substrate);
- c) Canopy coverage;
- d) Depth;
- e) Other upstream influences except the pollution source in question (for example, use caution when one site is just below a lake outfall and the other is not).

(4) Factors to be considered in site selection below point sources

The area of initial dilution of an effluent should be determined by visual observation of the plume pattern; by observations of biotic effects attributable to the plume, if evident (periphyton growth, die-off patterns); and by transects of specific conductance measurements from the outfall, in a downstream direction. The site selected should be in an area where reasonable opportunity for mixing of the effluent has occurred. If a mixing zone has been defined in a license, sampling should occur immediately downstream of it. In cases where the effluent plume channels down one bank for great distances (>1 km), or where localized effluent impact is expected to be severe for a distance beyond the zone of initial dilution, it is advisable to have a sampling site upstream of the source, one or more in the plume, and at least two farther downstream. One downstream site should be located at the point of presumed bank to bank mixing and subsequent sites should be located to assess the extent of impact downstream.

5. Sample Size

The biological community is evaluated on the basis of benthic macroinvertebrates obtained from at least three samplers which yield an average of at least 50 organisms per sampler. Matched upstream and downstream sites must be sampled using identical methods and level of effort, preferably by the same personnel.

Subsampling may be performed on samples if the mean number of organisms in a sampler exceeds 500 and subsampling will yield at least 100 organisms per rock/cone sampler. All samplers in a site should be treated consistently. Subsampling methods are described in Section II-5. Note: Subsampling will

reduce sample richness by an indeterminate amount. This may affect the outcome of linear discriminant analysis. See Section III-2. (2).

6. Physical Habitat Evaluation

A field data sheet (Appendix A) is to be completed at the time of sampler placement. This form records site specific information concerning natural variables that may affect community structure. Items addressed include exact site location (latitude and longitude, narrative description of the mapped location and/or a topographic map with site indicated); substrate composition; canopy coverage; land use and terrain characteristics; water velocity, temperature, dates of exposure and investigator name. The form is to be completed by observation as well as instrument measurement of water velocity, specific conductance, dissolved oxygen, global positioning device, temperature, etc.

II **LABORATORY METHODS**

1. Qualifications of Laboratory Personnel

Sample processing and taxonomy in the laboratory must be performed or supervised by a professional freshwater macroinvertebrate taxonomist who is certified by the Society of Freshwater Science in the identification of eastern US taxa. Certification must include Genus level categories, such as Ephemeroptera, Plecoptera and Trichoptera (EPT), General Arthropods and Chironomidae taxa. Taxonomic data will not be accepted without verification that the supervising laboratory taxonomist has been certified in relevant categories.

2. Sample Preservation, Sorting

All sample material collected in the field, as described in Section I, is preserved in 70% ethyl alcohol. Samples are stored in airtight containers until sorted. Sorting of macroinvertebrates from detritus and debris should follow methods described in Appendix B. One out of every ten samples is evaluated by a biologist for sorting completeness.

After sorting, recommended storage for macroinvertebrates is in 70% ethyl alcohol with 5% glycerin, in vials sealed with tightly fitting rubber stoppers.

3. Sample Labeling

All samples are labeled in the field immediately upon collection. The label must include the following information:

- Date of sample retrieval
- Waterbody
- Town or target discharge
- Whether above or below the discharge (if applicable)
- Replicate number

4. Sample Log Book

In the laboratory, the samples from each sampled site are to be assigned a sample log number, written on all items generated by the sample (e.g., sample vials, slides, records, count sheets, etc.). Log numbers are sequentially recorded in a master log book. The log book shall also contain site identification, date of placement and retrieval, investigator name, sampler type and any comments regarding sampler retrieval or data quality.

5. Subsampling

(1) Methods

If it is determined that a sample should be subsampled (see criteria in Section I-5 Sample Size) methods of Wrona et al, (1982) are followed. These are summarized below:

- a) Fit a plastic or glass Imhoff-type settling cone with an aquarium air stone sealed in the bottom and connected to a compressed air supply.
- b) Place the sorted macroinvertebrate sample in the cone and fill the apparatus with water to a total volume of one liter.
- c) Agitate gently for 2 to 5 minutes with the air stone.
- d) Remove 25% of the sample in 5 aliquots with a wide-mouth 50 ml dipper and combine into one sample vial. The dipper should be submerged and withdrawn over a five second interval.
- e) Ascertain whether or not the required 100 organisms have been obtained in the subsample.
- f) Indicate clearly on the sample label and on the data sheet the fraction of the sample that the subsample represents.

(2) Precautions

- a) Especially large or dense organisms such as crayfish, molluscs or caddisflies with stone cases, which do not suspend randomly in the sample, should not be included in the subsample. They should be counted separately.
- b) When removing aliquots, the subsampler should be careful to avoid biased capture of organisms in the cone. Avoid watching the cone as the dipper is withdrawn.

This method has been tested by the Department and has been found to randomly distribute the sample. The five separate counts conform to a Poisson series and thus can be combined into one sample (Elliott, 1979).

(3) Chironomidae subsampling

A subsampling plan for Chironomidae shall be approved by the Department. A Department recommended subsampling plan follows the following criteria:

- a) For samples having less than 100 midges, all midges will be identified to genus/species level.
- b) For samples having 100 to 199 midges, a subsample of one half (0.5) will be removed by randomly selecting the specimens to be identified and identified to genus/species level. Remaining unsampled midges will be examined for unusual or rare specimens, which will be removed and identified to genus/species level separate from the subsample of the sample.
- c) For samples having 200 to 499 midges, a subsample of one quarter (0.25) will be removed by randomly selecting the specimens to be identified and identified to genus/species level. Remaining unsampled midges will be examined for unusual or rare specimens, which will be removed and identified to genus/species level separate from the subsample of the sample.
- d) For samples having 500 or more midges, midges will be grouped by genus for those for which it is possible to confidently identify them to genus level without mounting. For remaining midges not grouped by genus, a subsample of 100 specimens will be randomly selected and identified to genus/species level. Remaining unsampled midges will be examined for unusual or rare specimens, which will be removed and identified to genus/species level separate from the subsample of the sample.

- e) Reporting of the subsample of the sample will be as follows. Numbers reported on the Excel spreadsheet will be converted to reflect the sample total. Any round-off errors between the subsample total and the sample total will be equalized by adding or deducting the difference from the most numerous taxon. If unusual or rare specimens are removed from the sample following the subsample removal, the conversion of the subsample total to a “partial” sample total will be based on the sample total minus the number of unusual or rare specimens. Following this procedure, the number of unusual or rare specimens will be added to the “partial” sample total to bring it back to the sample total.

6. Sample Taxonomy

All taxonomic data submitted to the Department must be accompanied by the name(s) of the individual(s) actually performing the identifications. A list of taxonomic references used, and a reference collection of organisms must also be submitted (see below).

(1) Taxonomic resolution

Macroinvertebrate organisms are identified to genus in all cases where possible. If generic keys are not available or taxonomic expertise is lacking for a taxon it should be identified to the lowest level possible. Identification of organisms to species is highly recommended whenever possible. Although quantitative analysis of benthic macroinvertebrate samples by the Department is based on counts adjusted to the generic level of resolution, species designations are recorded in the Department database and can contribute to the final stage of data analysis, Professional Judgment Evaluation of the model outcome. This is especially important for Class Insecta. Taxonomists submitting data for use by the Department must use current taxonomic references.

(2) Identification of Chironomidae

Specimens of chironomid midges are identified from slide mounts of the cleared head capsule and body parts. Euparal or Berlese mounting medium is recommended for preparation of slides. CMCP-9 is recommended for the preparation of permanent slide mounts of reference material, for voucher specimens or for permanent collections. These slides should be prepared under a fume hood. Instructions for preparation and slide mounting may be found in Wiederholm, (1983). In samples in which a given taxon is represented by a large number of individuals, the identification to genus may be made from slide mounts of a sufficient proportion of the individuals to give a high degree of certainty that they are all the same (10-50% depending on

the distinctiveness of the taxon visible under binocular microscope). A subsampling plan for Chironomidae is described in Section II-5. Each permanent slide mount is to be fully labeled or coded in a manner which positively associates the slide with the sample from which it originated.

(3) Quality control

All organisms and records from any sampling event intended to serve regulatory purposes must be preserved for a period of at least ten years. In the course of identifying taxa collected as part of the Department's biological monitoring program, or in other collection activities, a special reference collection of separate taxa is established. This collection allows subsequent identifications of the same taxon to be confirmed and thus serves to standardize taxonomy for the program.

Each contracted taxonomist, working for the Department or working for anyone submitting data to the Department, will be required to submit a reference collection of taxa identified, as well as a list of the taxonomic references used in the identifications. Organism identifications will be checked against the Department's collection by a Department taxonomist.

III ANALYTICAL METHODS

In general, it is the responsibility of the Department, or its agents, to conduct sampling for the purpose of making decisions on the attainment of water quality classification. Under certain conditions, sampling may be required of applicants for waste discharge licenses, or applicants requiring Section 401 Water Quality Certification. Sampling may be performed by corporations, businesses, organizations or individuals who can demonstrate their qualifications and ability to carry out the Department's sampling and analytical protocol, described in this manual. Such monitoring will be conducted according to a quality assurance plan provided to the Department and approved by the Commissioner.

Classification attainment evaluation is established in DEP regulation Chapter 579: Classification Attainment Evaluation Using Biological Criteria for Rivers and Streams. Davies et al, 1995 details the conceptual and technical basis for the State's application of linear discriminant analysis to assess attainment of aquatic life standards. A synopsis of Chapter 579 follows in this section.

1. Minimum Provisions

Properly collected and analyzed samples that fail to achieve the following criteria are unsuitable for further analysis through the numeric criteria statistical models:

- Total Mean Abundance must be at least 50 individuals (average per basket/bag/cone);
- Generic Richness for three replicate basket/bag/cone samplers must be at least 15.

Samples not attaining these criteria shall be evaluated by Professional Judgment. A determination will be made whether the affected community requires re-sampling or whether the community demonstrates non-attainment of minimum provisions of the aquatic life standards.

2. Aquatic Life Statistical Decision Models

The four statistical decision models consist of linear discriminant functions developed to use quantitative ecological attributes of the macroinvertebrate community (Appendix C-1) to determine the strength of the association of a test community to any of the water quality classes (Appendix D). The coefficients or weights are calculated using a linear optimization algorithm to minimize the distance, in multivariate space, between sites within a class, and to maximize the distance between sites between classes.

(1) Linear discriminant models

The discriminant function has the form:

$$Z = C + W_1X_1 + W_2X_2 + \dots W_nX_n$$

Where: Z = discriminant score
 C = constant
 W_i = the coefficients or weights
 X_i = the predictor variable values

Association values are computed, using variable values from a test sample, for each classification using one four-way model and three two-way models. The four-way model uses nine variables pertinent to the evaluation of all classes and provides four initial probabilities that a given site attains one of three classes (A, B, or C), or is in non-attainment (NA) of the minimum criteria for any class. These probabilities have a possible range from 0.0 to 1.0, and are used, after transformation, as variables in each of the three subsequent final decision models. The final decision models (the three, two-way models)

are designed to distinguish between a given class and any higher classes as one group and any lower classes as the other group (i.e., Classes A+B+C vs. NA; Classes A+B vs. Class C+NA; Class A vs. Classes B+C+NA). The equations for the final decision models use the predictor variables relevant to the class being tested (Appendix E). The process of determining attainment class using association values is outlined in Appendix F.

(2) Application of professional judgment

Where there is documented evidence of conditions which could result in uncharacteristic findings, allowances may be made to account for those situations by adjusting the classification attainment decision through use of professional judgment as provided in DEP regulation Chapter 579: Classification Attainment Evaluation Using Biological Criteria for Rivers and Streams. The Department may make adjustments to the classification attainment decision based on analytical, biological, and habitat information or may require that additional monitoring of affected waters be conducted prior to issuing a classification attainment decision.

Professional Judgment may be utilized when conditions are found that are atypical to the derivation of the linear discriminant model. Factors that may allow adjustments to the model outcome include but are not limited to:

- a) Habitat factors
 - Lake outlets
 - Impounded waters
 - Substrate characteristics
 - Tidal waters
- b) Sampling factors
 - Disturbed samples
 - Unusual taxa assemblages
 - Human error in sampling
- c) Analytical factors
 - Subsample vs. whole sample analysis
 - Human error in processing

(3) Classification attainment evaluation of waters subjected to flow regulation

The Maine State Legislature, in 38 MRSA Article 4-A Sec. 464 (9)-(10), *The Water Classification Program*, acknowledges that changes to aquatic life and habitat occur as the result of the impoundment of riverine waters and has modified the standards of waters so affected. The habitat and aquatic life criteria of riverine impounded waters of Class A, Class B or Class C are

deemed to be met if the impoundment attains the standards of Class C (e.g., maintenance of structure and function of the resident biological community). Impoundments managed as Great Ponds must also attain Class C aquatic life standards. If the actual water quality attains any more stringent characteristic or criterion than the Class C standards dictate, then the waterbody must be managed so as to protect those higher characteristics. Class C standards also apply to the *downstream* waters below certain specified riverine impoundments on the Kennebec River and the Saco River (Wyman Dam, Moosehead East Outlet Dam, West Buxton Dam and Skelton Dam) that are classified as A or B. All other waters subjected to flow regulation are managed according to standards of the water quality classification assigned by the Legislature.

(4) Adjustments of a decision

It is the responsibility of the Department to decide if adjustments of a decision should occur. The following adjustments may be made to correct for these conditions:

a) Resample

The Department may require that additional monitoring of the test community be done before a determination of class attainment can be made, based on documented evidence of specific sampling factors that may have influenced the results.

b) Raise the finding

- i. The Department may raise the classification attainment outcome predicted by the model from non-attainment of any class to indeterminate or to attainment of Class C, based on documented evidence of specific conditions, as defined above.
- ii. The Department may raise the classification attainment outcome predicted by the model from attainment in one class to attainment in the next higher class, based on documented evidence of specific conditions, as defined above.

c) Lower the finding

The Department may decide to lower the classification attainment finding, on the basis of documented, substantive evidence that the narrative aquatic life criteria for the assigned class are not met.

- d) Determination of non-attainment: minimum provisions not met
Samples having any of the ecological attributes not attaining the minimum provisions, and where there is no evidence of conditions which could result in uncharacteristic findings, as defined above, must be determined to be in non-attainment of the minimum provisions of the aquatic life criteria for any class.
- e) Determination of attainment: minimum provisions not met
Where there is evidence of factors that could result in minimum provisions not being met, professional judgment may be used to make a professional finding of attainment of the aquatic life criteria for any class. Such decisions will be provisional until appropriate resampling is carried out.

(5) Sampling procedures do not conform

For classification attainment evaluation of test communities that do not conform to criteria provided in Section I General Methods, or Section III-1, Minimum Provisions, of this manual, and are therefore not suitable to be run through the linear discriminant models, the Department may make an assessment of classification attainment or aquatic life impact in accordance with the following procedures:

- a) Approved assessment plan
A quantitative sampling and data analysis plan must be developed in accordance with methods established in the scientific literature on water pollution biology, and shall be approved by the department.
- b) Determination of sampling methods
Sampling methods are determined on a site-specific basis, based on habitat conditions of the sampling site, and the season sampled:
 - i. Soft-bottomed substrates shall, whenever ecologically appropriate and practical, be sampled by core or dredge of known dimension or volume.
 - ii. The preferred method for sampling hard-bottomed substrates shall be the rock basket/cone/bag as described in Section I-2.
 - iii. Other methods may be used where ecologically appropriate and practical.

- c) Classification attainment decisions
Classification attainment decisions may be based on a determination of the degree to which the sampled site conforms to the narrative aquatic life classification criteria provided in 38 MRSA Section 465 and found in Appendix D. The decision is based on established principles of water pollution biology and must be fully documented.
- d) Site-specific impact decisions
Site-specific impact decisions may rely on established methods of analysis of comparative data between a test community and an approved reference community.
- e) Determination of detrimental impact
A determination of detrimental impact to aquatic life of a test community without an approved reference community may be made if it can be documented, based on established methods of the interpretation of macroinvertebrate data, and based on established principles of water pollution biology, that the community fails to demonstrate the ecological attributes of its designated class as defined by the narrative aquatic life standards in the water quality classification law.

Appendix A



Maine DEP Biological Monitoring Unit Stream Macroinvertebrate Field Data Sheet



Log Number _____	Directions _____	Type of Sample _____
Station Number _____	_____	Date Deployed _____
Waterbody _____	_____	Number Deployed _____
River Basin _____	Lat-Long Coordinates (WGS84, meters) _____	Date Retrieved _____
Municipality _____	Latitude _____	Number Retrieved _____
Stream Order _____	Longitude _____	Agency/Collector(s) _____

1. Land Use (500 m radius upstream) ☐ Urban ☐ Upland conifer ☐ Cultivated ☐ Swamp hardwood ☐ Pasture ☐ Swamp conifer ☐ Upland hardwood ☐ Marsh	2. Terrain (500 m radius upstream) ☐ Flat ☐ Rolling ☐ Hilly ☐ Mountains	3. Canopy Cover (upstream view) ☐ Dense (75-100% shaded) ☐ Partly open (25-75% shaded) ☐ Open (0-25% shaded) (% daily direct sun) _____
---	--	---

4. Physical Characteristics of Bottom (estimate % of each component over 12 m stretch of site; total = 100%)			
[] Bedrock	[] Rubble (3" – 10")	[] Sand (<1/8")	
[] Boulders (<10")	[] Gravel (1/8" – 3")	[] Silt-clay-muck	[] Detritus

5. Habitat Characteristics (immediate area)	
Time _____ AM PM Width (m) _____ Depth (cm) _____ Flow (cm/s) _____ Diss. O ₂ (ppm) _____ Temp (°C) _____ pH _____ SPC (µS/cm) _____ TDS (ppm) _____	Time _____ AM PM Width (m) _____ Depth (cm) _____ Flow (cm/s) _____ Diss. O ₂ (ppm) _____ Temp (°C) _____ pH _____ SPC (µS/cm) _____ TDS (ppm) _____

Temperature Probe # _____ ☐ deployed ☐ retrieved
6. Observations (describe) Fish _____ Algae _____ Macrophytes _____ Habitat quality _____ Dams/impoundments _____ Discharges _____ Nonpoint stressors _____

7. Water Samples ☐ Standard ☐ Metals ☐ Pesticides Lab Number _____
8. Photographs

9. Landmarks of Sampler Placement (illustrate or describe landmarks to be used for relocation)

Appendix B

Instructions for Macroinvertebrate Sorters

1. Pick the sample **in small portions** (1-2 TBS of material) at a time.
2. Pick all organisms you can see. If in doubt it's usually best to include it.
3. Some types of samples can be easily floated by adding a saturated solution of Epsom salt or sugar to the water. Maintain the saturated solution for the lab by adding enough salt or sugar to water to maintain a thick layer of crystals on the bottom of the storage jar. Use the supernatant solution for picking. Large numbers of organisms can be removed with a sieve spoon from the water surface. After the floaters have been removed, proceed to pick the rest of the sample as usual. A significant portion of the sample will not float and must be picked out with forceps.
4. The sample can be considered done when a careful 45 second search, after swirling the sample, yields no further organisms.
5. The samples are picked in water but should not remain unpreserved for more than 8 hours. Be certain that the final sample vial is preserved with 70% alcohol and 5% glycerin solution when done.
6. Return the detrital material to the original sample jar and preserve with 70% alcohol.
7. Write on the sample jar label "Picked X1 (your initials)".
8. Include in the vial of organisms a slip of index card label in hard pencil (No. 2) including **all information appearing on the original jar label**:

Log Number

River

Date - month/day/year

Location (Town or industry name)

whether above or below

Basket or Cone number

Vial number if more than 1 vial is needed per basket

ex. Log 621 Sandy R. 9/5/97
Below Farmington (disturbed)
Basket 2 vial #1 of 2

9. Complete all samples from one log number before beginning a new log number.
10. Keep a record of samples picked including log number

Basket number
Your name

Time spent per basket
Date

Appendix C-1

Methods for the Calculation of Indices and Measures of Community Structure Used in the Linear Discriminant Models

Variable
Number

1 Total Mean Abundance

Count all individuals in all replicate samples from one site and divide by the number of replicates to yield mean number of individuals per sample.

2 Generic Richness

Count the number of different genera found in all replicates from one site.

Counting rules for Generic Richness:

- a) All population counts at the species level will be aggregated to the generic level.
- b) A family level identification which includes no more than one taxon identified to the generic level is counted as a separate taxon in generic richness counts.
- c) A family level identification with more than one taxon identified to generic level is not counted towards generic richness. Counts are to be divided proportionately among the genera that are present.
- d) Higher level taxonomic identifications (Phylum, Class, Order) are not counted toward generic richness unless they are the only representative.
- e) Pupae are ignored in all calculations.

3 Plecoptera Mean Abundance

Count all individuals from the order Plecoptera in all replicate samplers from one site and divide by the number of replicates to yield mean number of Plecopteran individuals per sampler.

4 **Ephemeroptera Mean Abundance**

Count all individuals from the order Ephemeroptera in all replicate samplers from one site and divide by the number of replicates to yield mean number of Ephemeropteran individuals per sampler.

5 **Shannon-Wiener Generic Diversity (Shannon and Weaver, 1963)**

After adjusting all counts to genus following counting rules in Variable 2:

$$\bar{d} = \frac{c}{N} (N \log_{10} N - \sum n_i \log_{10} n_i)$$

where: $\bar{d}$ = Shannon-Wiener Diversity
c = 3.321928 (converts base 10 log to base 2)
N = Total abundance of individuals
 n_i = Total abundance of individuals in the i^{th} taxon

6 **Hilsenhoff Biotic Index (Hilsenhoff, 1987)**

$$\text{HBI} = \sum \frac{n_i a_i}{N}$$

where: HBI = Hilsenhoff Biotic Index
 n_i = number of individuals in the i^{th} taxon
 a_i = tolerance value assigned to that taxon
N = total number of individuals in sample with tolerance values.

7 **Relative Chironomidae Abundance**

Calculate the mean number of individuals of the family Chironomidae, following counting rules in Variable 4, and divide by total mean abundance (Variable 1).

8 **Relative Diptera Richness**

Count the number of different genera from the Order Diptera, following counting rules in Variable 2, and divide by generic richness (Variable 2).

9 ***Hydropsyche* Mean Abundance**

Count all individuals from the genus *Hydropsyche* in all replicate samplers from one site, and divide by the number of replicates to yield mean number of *Hydropsyche* individuals per sampler.

- 10 **Probability (A + B + C) from First Stage Model**
- Sum of probabilities for Classes A, B, and C from First Stage Model.
- 11 ***Cheumatopsyche* Mean Abundance**
- Count all individuals from the genus *Cheumatopsyche* in all replicate samplers from one site and divide by the number of replicates to yield mean number of *Cheumatopsyche* individuals per sampler.
- 12 **EPT - Diptera Richness Ratio**
- EPT Generic Richness (Variable 19) divided by the number of genera from the order Diptera, following counting rules in Variable 2. If the number of genera of Diptera in the sample is 0, a value of 1 is assigned to the denominator.
- 13 **Relative Oligochaeta Abundance**
- Calculate the mean number of individuals from the Order Oligochaeta, following counting rules in Variable 4, and divide by total mean abundance (Variable 1).
- 14 **Probability (A + B) from First Stage Model**
- Sum of probabilities for Classes A and B from First Stage Model.
- 15 **Perlidae Mean Abundance (Family Functional Group)**
- Count all individuals from the family Perlidae (Appendix C-3) in all replicate samplers from one site and divide by the number of replicates to yield mean number of Perlidae per sampler.
- 16 **Tanypodinae Mean Abundance (Family Functional Group)**
- Count all individuals from the subfamily Tanypodinae (Appendix C-3) in all replicate samplers from one site and divide by the number of replicates to yield mean number of Tanypodinae per sampler.
- 17 **Chironomini Mean Abundance (Family Functional Group)**
- Count all individuals from the tribe Chironomini (Appendix C-3) in all replicate samplers from one site and divide by the number of replicates to yield mean number of Chironomini per sampler.

- 18 **Relative Ephemeroptera Abundance**
- Variable 4 divided by Variable 1.
- 19 **EPT Generic Richness**
- Count the number of different genera from the Order Ephemeroptera (E), Plecoptera (P), and Trichoptera (T) in all replicate samplers, according to counting rules in Variable 2, generic richness.
- 20 **Variable Reserved**
- 21 **Sum of Mean Abundances of: *Dicrotendipes*, *Micropsectra*, *Parachironomus* and *Helobdella***
- Sum the abundance of the 4 genera and divide by the number of replicates (as performed in Variable 4).
- 22 **Probability of Class A from First Stage Model**
- Probability of Class A from First Stage Model.
- 23 **Relative Plecoptera Richness**
- Count number of genera of Order Plecoptera, following counting rules in Variable 2, and divide by generic richness (Variable 2).
- 24 **Variable Reserved**
- 25 **Sum of Mean Abundances of *Cheumatopsyche*, *Cricotopus*, *Tanytarsus* and *Ablabesmyia***
- Sum the number of individuals in each genus in all replicate samplers and divide by the number of replicates (as performed in Variable 4).
- 26 **Sum of Mean Abundances of *Acroneuria* and *Stenonema***
- Sum the number of individuals in each genus in all replicate samplers and divide by the number of replicates (as performed in Variable 4).
- 27 **Variable Reserved**

28 **Ratio of EP Generic Richness**

Count the number of different genera from the order Ephemeroptera (E), and Plecoptera (P) in all replicate samplers, following counting rules in Variable 2, and divide by 14 (maximum expected for Class A).

29 **Variable Reserved**

30 **Ratio of Class A Indicator Taxa**

Count the number of Class A indicator taxa as listed in Appendix C-2 that are present in the community and divide by 7 (total possible number).

Appendix C-2

Indicator Taxa: Class A

Brachycentrus (Trichoptera: Brachycentridae)

Serratella (Ephemeroptera: Ephemerellidae)

Leucrocuta (Ephemeroptera: Heptageniidae)

Glossosoma (Trichoptera: Glossosomatidae)

Paragnetina (Plecoptera: Perlidae)

Eurylophella (Ephemeroptera: Ephemerellidae)

Psilotreta (Trichoptera: Odontoceridae)

Appendix C-3

Family Functional Groups

PLECOPTERA

Perlidae

Acroneuria

Attaneuria

Beloneuria

Eccoptura

Perlesta

Perlinella

Neoperla

Paragnetina

Agnetina

CHIRONOMIDAE

Tanypodinae

Ablabesmyia

Clinotanypus

Coelotanypus

Conchapelopia

Djalmabatista

Guttipelopia

Hudsonimyia

Labrundinia

Larsia

Meropelopia

Natarsia

Nilotanypus

Paramerina

Pentaneura

Procladius

Psectrotanypus

Rheopelopia

Tanypus

Telopelopia

Thienemannimyia

Trissopelopia

Zavrelimyia

Appendix C-3

Family Functional Group (continued)

Chironomini

Pseudochironomus

Axarus

Chironomus

Cladopelma

Cryptochironomus

Cryptotendipes

Demicryptochironomus

Dicrotendipes

Einfeldia

Endochironomus

Glyptotendipes

Goeldichironomus

Harnischia

Kiefferulus

Lauterborniella

Microchironomus

Microtendipes

Nilothauma

Pagastiella

Parachironomus

Paracladopelma

Paralauterborniella

Paratendipes

Phaenopsectra

Polypedilum

Robackia

Stelechomyia

Stenochironomus

Stictochironomus

Tribelos

Xenochironomus

Appendix D

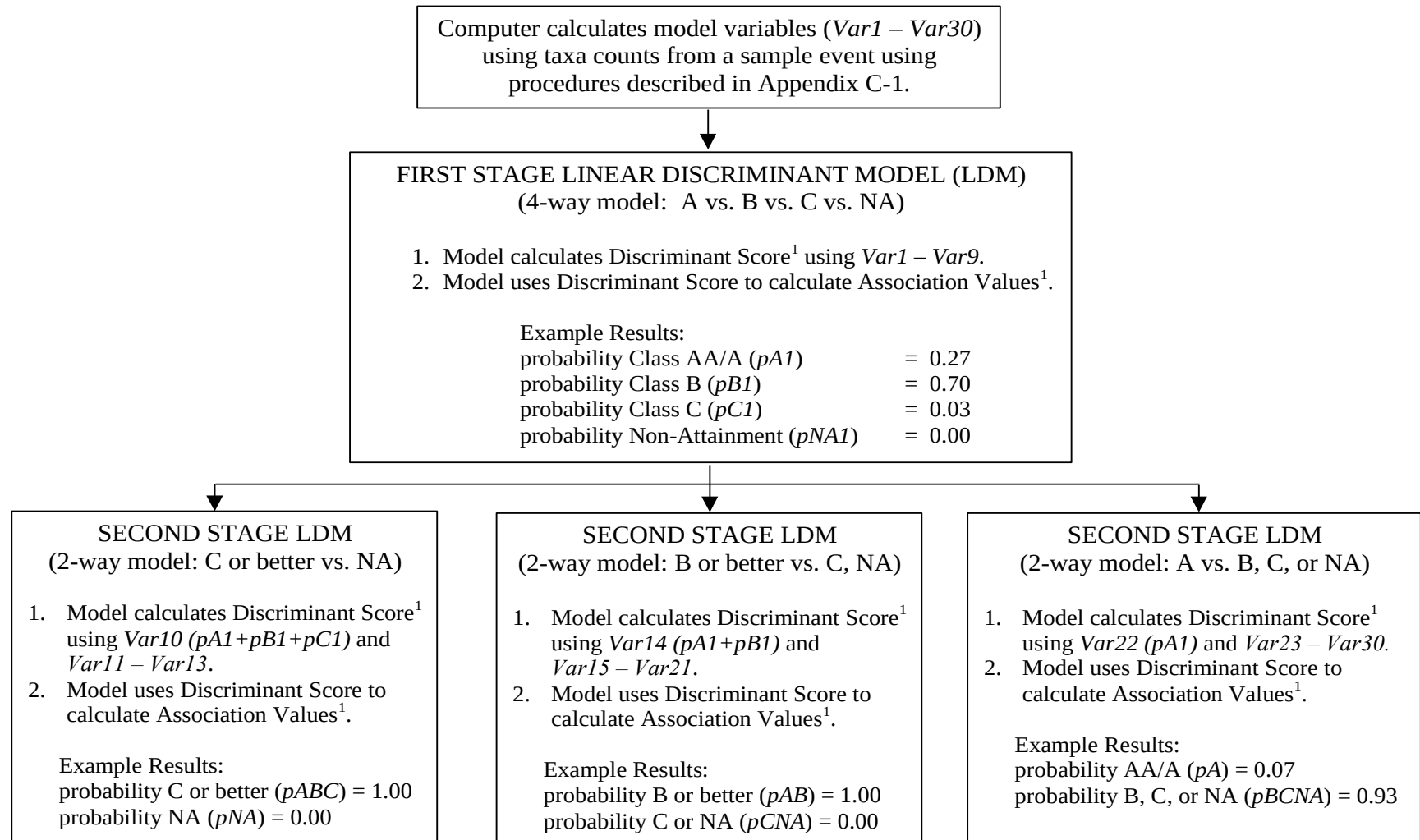
MRSA 38, 4-A Sec 464-465

Aquatic Life Standards for the State of Maine

<u>Classification</u>	<u>Biological Standards</u>
AA	No direct discharge of pollutants; aquatic life shall be as naturally occurs.
A	Natural habitat for aquatic life; aquatic life shall be as naturally occurs.
B	Unimpaired habitat for aquatic life; discharges shall not cause adverse impact to aquatic life in that the receiving waters shall be of sufficient quality to support all aquatic species indigenous to the receiving water without detrimental changes in the resident biological community.
C	Habitat for aquatic life; discharges may cause some changes to aquatic life, provided that the receiving waters shall be of sufficient quality to support all species of fish indigenous to the receiving waters and maintain the structure and function of the resident biological community.

Appendix E

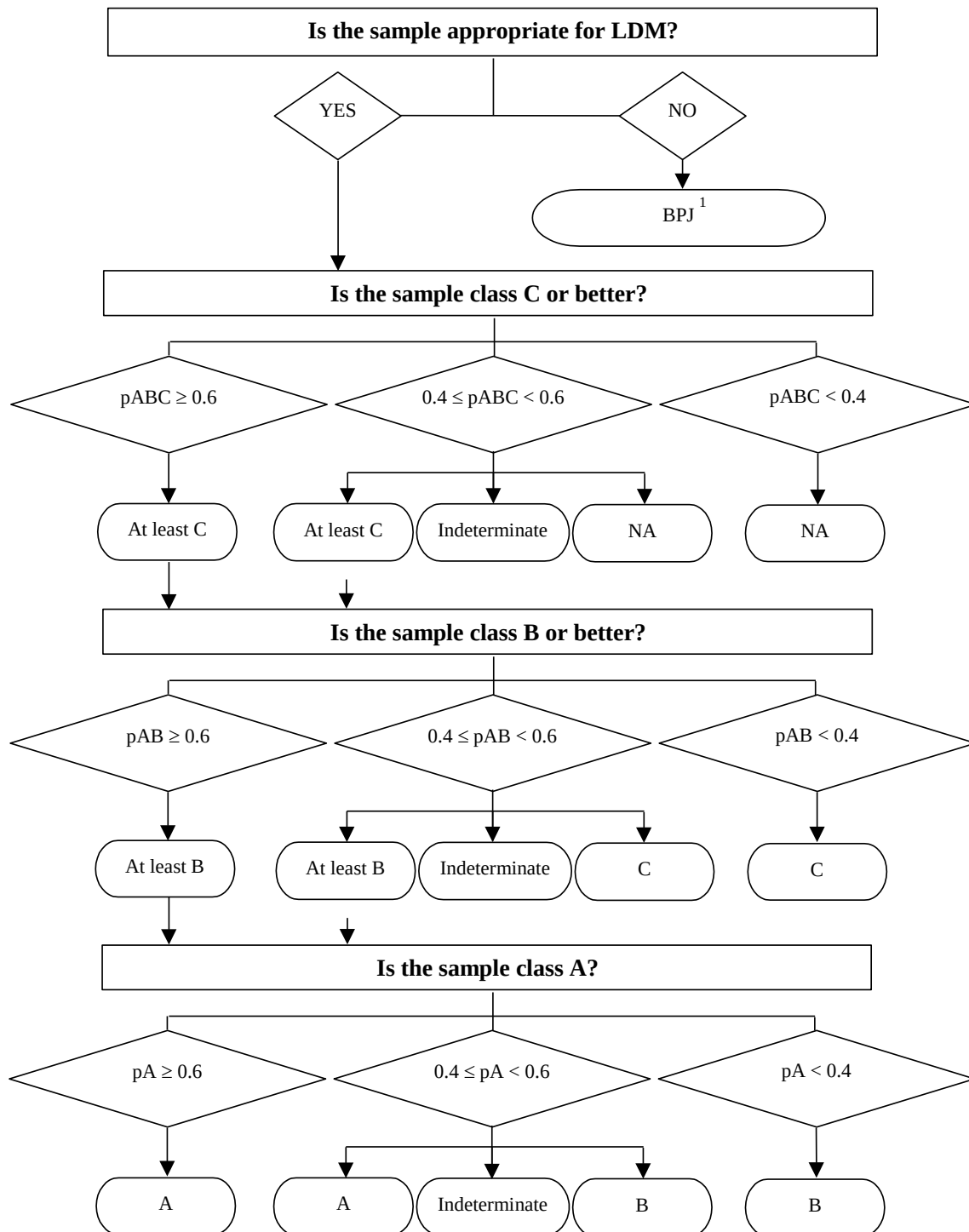
Process of Calculating Model Variables and Association Values Using Linear Discriminant Models



¹ Discriminant Score and Association Values are defined in Section III-2.(1).

Appendix F

Process for Determining Attainment Class Using Association Values



¹ Best Professional Judgment (BPJ) is defined in Section III-2. (2), (4), and (5)

Chart by Thomas J. Danielson

References

- Courtemanch, D.L. 1984. A closing artificial substrate device for sampling benthic macroinvertebrates in deep rivers. *Freshwater Invert. Biol.* 3(3):143-146.
- Davies, S.P., L. Tsomides, D.L. Courtemanch and F. Drummond. 1995. 2nd Ed. Maine biological monitoring and biocriteria development program. DEP-LW108 Maine Dept. Environ. Protect., Augusta, Maine. pp 61.
- Davies, S.P., L. Tsomides, J. DiFranco and D. Courtemanch. 1999. Biomonitoring retrospective: fifteen year summary for Maine rivers and streams. DEPLW1999-26. Maine Department of Environmental Protection, Augusta, Maine. pp 190.
- Elliot, J.M. 1977. Some methods for the statistical analysis of samples of benthic macroinvertebrates. *Freshwater Biological Assoc. Sci. Publ.* No. 25. pp 160.
- Hilsenhoff, W.L. 1987. An improved biotic index of organic stream pollution. *The Great Lakes Entomol.* 20(1): 31-39.
- Klemm, D.J., P.A. Lewis, F. Fulk and J.M. Lazorchak. 1990. Macroinvertebrate field and laboratory methods for evaluating the biological integrity of surface water. EPA/600/4-90/030, U.S Environmental Protection Agency, Cincinnati, OH. pp 256.

Shannon, C.E. and W. Weaver. 1963. The mathematical theory of communication. University of Ill. Press, Urbana, IL.

Wiederholm, T. 1983. Chironomidae of the Holarctic region. Entomologica Scandinavica, Suppl. No.19. pp 457.

Wrona, F.J., J.M. Culp and R.W. Davies, 1982. Macroinvertebrate subsampling: a simplified apparatus and approach. Can. J. Fish. Aq. Sci. 39: 1051-1054.