Appendix A

MAINE TALU IMPLEMENTATION CASE HISTORY[1]

I. Establish conceptual foundation

Since the early 1970s, prior to adoption of the CWA, Maine water quality law has had a tiered structure, based on a gradient of water quality conditions. An early articulation of the conceptual basis for a tiered approach to establishing aquatic life uses was made by John Cairns and others in a U.S. EPA-sponsored symposium on the biological integrity objective of the Clean Water Act (Ballentine and Guarraia 1977), with further elaboration in Cairns et al. (1993) and Karr and Chu (2000). The underlying basis depicts biological condition declining across a gradient of stressors.

Maine's goal-based management classes range from Class AA, the highest water quality standard and greatest restrictions on human activity, to Class C (and formerly Class D, discontinued), the lowest quality standard with more flexible allowances for human activities (MDEP 2004 305b report). Maine's current water quality classification law for rivers and streams establishes four tiers of aquatic life use (ALU) that represent the upper end of a gradient of biological condition that occurs in the State (State of Maine 1985, Courtemanch et al. 1989, Courtemanch 1995). Conditions worse than this upper end (i.e., worse than Class AA/A, B, or C) are deemed unacceptable. Numeric biocriteria are based on assessment of benthic macroinvertebrates (State of Maine 2003, Davies et al. unpublished manuscript). Assessment of algal assemblages also occurs in most waterbodies but numeric criteria have not yet been developed. Maine relies on the response of benthic macroinvertebrates to human influences for several reasons:

- Diverse life history strategies and a wide range of pollution tolerance;
- Relatively long-lived (+/- 1 year) compared to algae and bacteria;
- Limited mobility diminishes stressor avoidance behavior and emigration;
- The indigenous fish assemblage in Maine is not very diverse and information is limited to just a few species.

Biologists in Maine and elsewhere have long observed clear-cut differences in community structure and composition of benthic macroinvertebrate samples that are collected from waters across a continuum of increasing stressors. The conceptual foundation of the Maine Department of Environmental Protection (MDEP) Biological Monitoring Program (and resulting biocriteria) was framed by three factors: 1) the first-hand observations of such biological response patterns, 2) published empirical and theoretical work in aquatic stress ecology, and 3) Maine's pre-existing water management context. The first two factors are discussed in sequence in this section. The water management context is discussed in the next section, II. *Merge Scientific & Policy Foundations*.

Empirical Observations of Maine Biologists

Differences in resident biological assemblages are evident even to the untrained eye when there are substantial differences in water quality (Figure A-1). This can be illustrated with a very simple example based on a gradient of increasing enrichment. In the initial years of biological assessment in Maine, biologists observed that minimally disturbed sampling locations tended to support many invertebrate taxa (high diversity), but at low to moderate density. In contrast, streams receiving well-treated or well-diluted domestic effluents exhibited higher organism densities, though the types of organisms were similar.

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[1] Appendix A was written by Susan Davies, Maine Department of Environmental Protection.

Streams receiving heavy loadings of sewage or nutrient-laden industrial effluents showed obvious differences in taxa and numbers from that expected in minimally disturbed streams. Streams receiving toxic amounts of chlorine or industrial waste showed much lower densities and many more hardy types of organisms than would be expected in undisturbed areas.

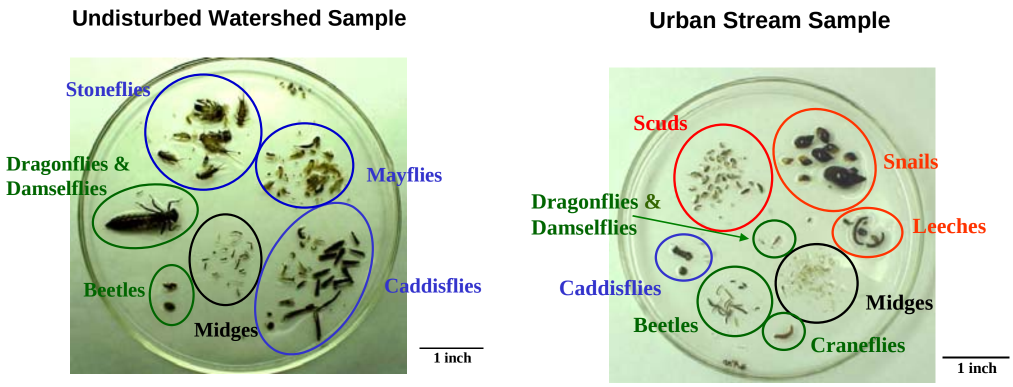

FIGURE A-1. Differences in numbers and types of organisms that are associated with different levels of disturbance can be evident even to the untrained eye.

Published Empirical and Theoretical Work in Aquatic Stress Ecology

The very obvious differences in biological responses for Maine streams, described above, are consistent with published conceptual models and empirical findings of stress ecology. The subsidy-stress gradient model of Reibesell (1974), and further developed by Odum et al. (1979) and Odum (1985), provided Maine DEP biologists with a theoretical model of expected patterns of biological change that was consistent with their own empirical observations (Figure A-2a and A-2b). Development of numeric biocriteria proceeded from this underlying ecological paradigm with the goal to statistically characterize the observed biological condition groups to determine aquatic life use class attainment.

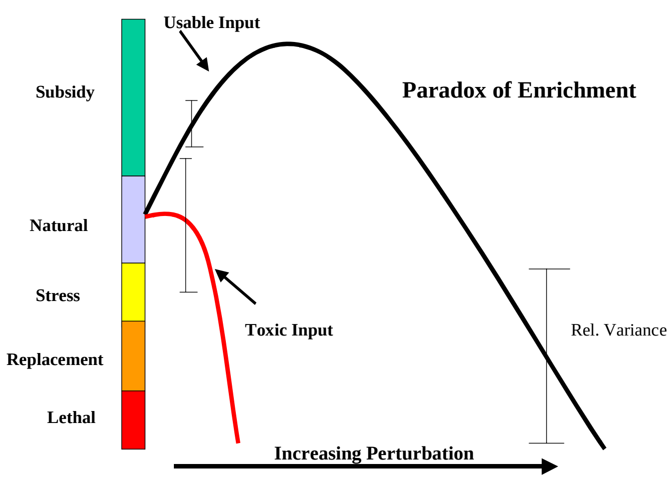

FIGURE A-2a. Subsidy-stress gradient: The ecological theory basis for Maine's aquatic life use descriptions (Odum et al. 1979). Some disturbances have an enriching or subsidizing effect on biological assemblages because they provide more than normal usable resources (nutrients, organic matter, etc.). Inputs in excess of what can be processed by the resident community have a detrimental effect (increased biochemical oxygen demand, accumulation of unusable resources, etc.) and lead to negative community response. Toxic or poisonous inputs have an immediate detrimental effect.

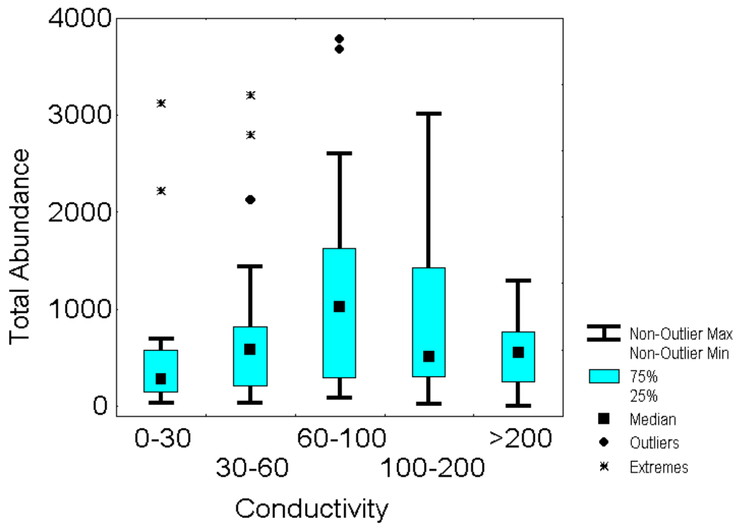

FIGURE A-2b. Empirically observed subsidy-stress gradient in Maine streams, documented by changes in benthic macroinvertebrate density. Low levels of conductivity are an indicator of slight enrichment while high levels are often associated with toxic contamination.

Stress ecology recognizes biological changes in response to increasing levels of stressors (i.e., gradients of environmental quality) as distinct from those that occur in responses to natural gradients, such as elevation, climate, alkalinity, stream size, and geographic location. While natural and ecoregional gradients can and do influence biological expectations in important ways, biological responses from the high to the low end of generalized stressor gradients in Maine streams tend to be far more obvious (Davies et al. 1999, Davies et al. unpublished manuscript). Odum's model supported our observation that structurally distinct biological groups exist across a gradient of water quality. Identifying predictable, characteristic differences among those biological condition groups could serve as the underlying conceptual basis for development of tiered aquatic life uses. Four biological condition groups would also fit well with the State's four-tiered standards for dissolved oxygen, bacteria, and habitat described in the existing water quality classification law.

II. Merge scientific and policy foundations

The narrative aquatic life use statements in Maine's TALUs describe conditions ranging from "as naturally occurs" (Class AA and Class A- the highest ALU designations) to "maintenance of structure and function" (Class C- the lowest ALU designation allowed in Maine) (Table A-1). The subsidy-stress gradient model helped guide the development of the ecologically-based definitions in the law. These specific definitions establish the biological characteristics that are required for attainment of each ALU classification (Table A-2).

TABLE A-1. Maine's narrative aquatic life and habitat standards for rivers and streams (M.R.S.A Title 38 Article 4-A § 464-465).

CLASS	MANAGEMENT	BIOLOGICAL STANDARD
AA*	High quality water for recreation and ecological interests. No discharges or impoundments permitted.	Habitat shall be characterized as natural and free flowing. Aquatic life shall be as naturally occurs.
A	High quality water with limited human interference. Discharges limited to non-contact process water or highly treated wastewater of quality equal to or better than the receiving water. Impoundments allowed.	Habitat shall be characterized as natural. Aquatic life shall be as naturally occurs
B	Good quality water. Discharge of well-treated effluent with ample dilution permitted. Impoundments allowed.	Habitat shall be characterized as unimpaired. Discharges shall not cause adverse impacts to aquatic life. Receiving water shall be of sufficient quality to support all aquatic species indigenous to the receiving water without detrimental changes in the resident biological community.
C	Acceptable water quality. Maintains the interim goals of the Federal Water Quality Act (fishable/swimmable). Discharge of well-treated effluent permitted. Impoundments allowed.	Habitat for fish and other 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 water and maintain the structure and function of the resident biological community.
Impound-ments	Riverine impoundments not classified as Great Ponds and managed for hydropower generation	Support all species of fish indigenous to those waters and maintain the structure and function of the resident biological community.

*The narrative aquatic life standard is the same for Class AA and Class A.

TABLE A-2. Definitions of terms used in Maine's water classification law.

1. **Aquatic life** any plants or animals that live at least part of their life cycle in fresh water.
2. **As naturally occurs** conditions with essentially the same physical, chemical and biological characteristics as found in situations with similar habitats, free of measurable effects of human activity.
3. **Community function** mechanisms of uptake storage and transfer of life-sustaining materials available to a biological community, which determine the efficiency of use and the amount of export of the materials from the community.
4. **Community structure** the organization of a biological community based on numbers of individuals within different taxonomic groups and the proportion each taxonomic group represents of the total community.
5. **Indigenous** supported in a reach of water or known to have been supported according to historical records compiled by State and Federal agencies or published in scientific literature.
6. **Natural** living in or as if in, a state of nature not measurably affected by human activity.
7. **Resident biological community** aquatic life expected to exist in a habitat, which is free from the influence of the discharge of any pollutant. This shall be established by accepted biomonitoring techniques.
8. **Unimpaired** without a diminished capacity to support aquatic life.
9. **Without detrimental changes in the resident biological community** no significant loss of species or excessive dominance by any species or group of species attributable to human activity.

Consistency with other applicable WQ criteria

As shown in Figure A-3, MDEP designed the narrative ALUs to be parallel to the tiered dissolved oxygen and bacteria standards. This was done because Department biologists recognized that differences in allowed human activities and water quality criteria of the different classes (AA, A, B, C) would inevitably yield different expectations for aquatic community response. For example, it is unreasonable to expect the same biological assemblages to thrive in both Class AA waters (dissolved oxygen: "as naturally occurs"- >7 ppm for Maine; dams and discharges prohibited) and Class C waters (minimum dissolved oxygen 5 ppm; dams, industrial and municipal discharges allowed).

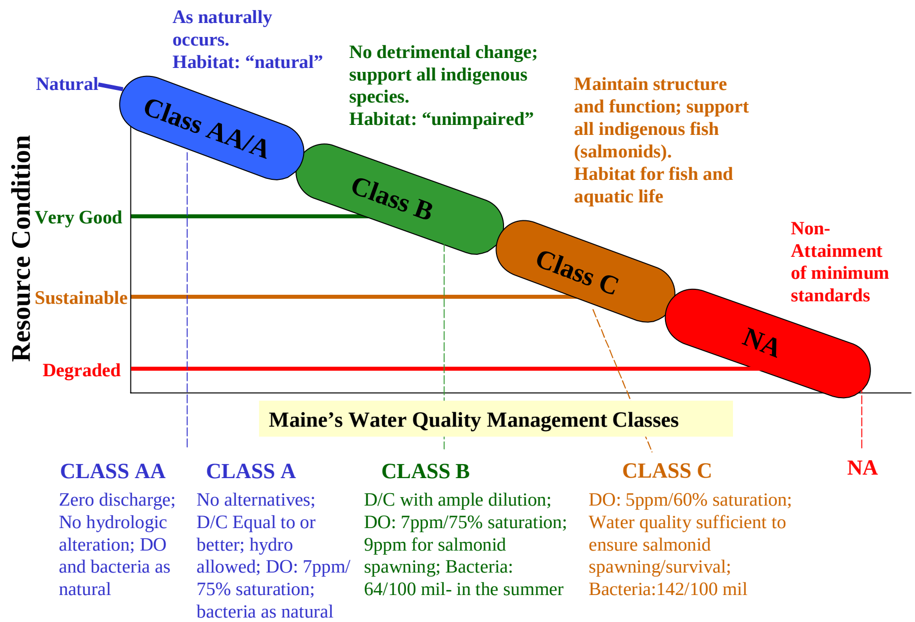

FIGURE A-3. Relation between Maine TALUs and other water quality standards and criteria.

The final language of the narrative aquatic life uses was the result of extensive negotiations between MDEP biologists and stakeholder biologists, under the purview of a legislative subcommittee. Lawyers on both sides weighed in regularly to ensure the fairness and legality of the statute. MDEP biologists drafted the narrative standards and definitions with careful attention to retaining a sound foundation in ecological theory. Furthermore, careful attention was given to how each biological attribute could be quantified (and thus assessed for attainment), with credible and widely accepted biological metrics (Table A-3).

TABLE A-3. Maine tiered uses based on measurable ecological values.

Narrative Standard		Ecological Value		Quantifiable Measures
CLASS A *natural*	→	Taxonomic and Numeric Equality; Presence of Indicator Taxa	→	Similarity, Richness, Abundance, Diversity; EPT, Indicator Taxa, Biotic Index
CLASS B *unimpaired, maintain indigenous taxa*	→	Retention of taxa and numbers; Absence of hyperdominance; Presence of sensitive taxa	→	Community loss; Richness; Abundance; Diversity; Equitability; Evenness; EPT; Indicator Taxa, Biotic Index
CLASS C *maintain structure*	→	Resistance, Redundancy; Resilience; Balanced Distribution	→	Richness; Diversity; Equitability; Evenness
and function	→	Energy exchange; Resource assimilation; Reproduction	→	Trophic groups; Richness; Abundance; Community loss; Fecundity; Colonization rate

How do Maine's tiered aquatic life uses relate to the Biological Condition Gradient?

Maine's aquatic life standards specify different levels (tiers) of water quality necessary to maintain designated aquatic life uses. These standards correspond to the tiers of the Biological Condition Gradient in Figure A-4.

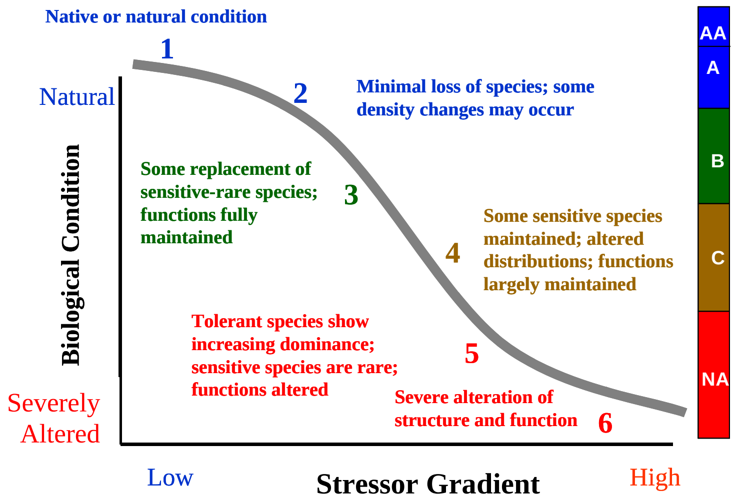

FIGURE A-4. Maine TALUs in relation to the BCG tiers.

Class AA and Class A have the same narrative aquatic life uses requiring that aquatic life be "as naturally occurs." This phrase is defined in the statute as "conditions with essentially the same physical, chemical, and biological characteristics as found in situations with similar habitats, free of measurable effects of human activity." The stated goal condition for Class AA/A thus conforms to Tier 1 or high Tier 2 conditions on the BCG.

Samples attaining MDEP Class A numeric criteria cover a range of conditions, some of which are fully consistent with BCG Tier 1 but some of which would have to be interpreted as BCG Tier 2. Examples of the latter are mildly enriched locations showing higher abundance of organisms (than "natural" for Maine) and increased algal biomass, and Class A locations that are influenced by dams.

Class B aquatic life standards require that there be "no adverse impacts" and that water quality be "sufficient to support all indigenous aquatic species without detrimental changes in the resident biological community." This phrase is defined as "no significant loss of species or excessive dominance by any species or group of species attributable to human activity." This wording was carefully chosen to allow for commonly observed increases in measures of biomass, density, and richness that occur in response to mild enrichment (as depicted by Odum's "subsidy hump" in Figure A-2a and A-2b) but to prohibit negative biological changes, such as notable loss of indigenous taxa. Thus the expectation for Class B is that sensitive taxa should be well represented with community structure comparable to Class A.

Samples attaining MDEP Class B numeric criteria cover a range of conditions, some of which are fully consistent with BCG Tier 2 but some of which would have to be interpreted as BCG Tier 3 because of the degree of structural change or the failure to collect Sensitive-Rare taxa. Dams, well-managed landscape changes, and well-treated point sources are allowed in Class B waters. These changes may result in detectable signals such as absence of migratory taxa, increased algal biomass, higher total abundance of organisms, and increased abundance of sensitive-ubiquitous taxa (i.e., higher relative abundance of some mayflies and some filter feeders; higher abundance of Perlid stoneflies) resulting in a community structure more consistent with Tier 3.

<u>Class C</u> aquatic life standards require that structure and function of the resident biological community be maintained. Numeric biocriteria in Maine document that waterbody segments meeting Class C dissolved oxygen and bacteria standards, but not attaining Class B standards, show obvious differences in biological assemblages. In terms of benthic macroinvertebrates, differences can be generally described as lower numbers and richness of cold-water obligate taxa and those taxa that have high dissolved oxygen requirements (e.g., gill-breathing mayflies and stoneflies), higher densities of filter-feeding organisms, and increased densities of some types of chironomid midges and other facultative or tolerant groups.

Samples attaining MDEP Class C numeric criteria cover a range of biological conditions, most of which are fully consistent with BCG Tier 3 and/or Tier 4. About 10% of samples that attain MDEP Class C numeric criteria would have to be interpreted as BCG Tier 5 because of the degree of structural change or very low numbers of Sensitive taxa (e.g., the mean abundance of Ephemeroptera in sites attaining Class C numeric criteria is 86 individuals per sampler but about 10% have less than 10 mayflies). Attainment of Class C numeric criteria usually indicates that other community structure attributes are present (e.g., evenness of distributions, richness and/or diversity of the assemblage of taxa of intermediate tolerance). Hyper-dominance of filter-feeders, complete absence of expected sensitive insect taxa (especially stoneflies and mayflies), and high proportions of tolerant taxa signal assemblages that fail to meet Class C water quality standards. These conditions represent BCG Tiers 5 and 6.

III. Establish technical program

How does Maine DEP collect biological data?
The MDEP's Biological Monitoring Program began standardized sampling of river and stream macroinvertebrates in 1983 (less rigorously standardized biological assessments had begun at least 10 years before). Experience gained on the Penobscot River (Davies 1987, Rabeni et al. 1988) had demonstrated the practical usefulness and reliability of rock-filled basket artificial substrates (Klemm et al. 1990). Maine has adapted the basic design of these devices to enable sampling of waterbody depths ranging from as little as 5 cm (using rock-filled mesh bags; Davies et al. 1999) to about 10 meters in large riverine impoundments (using boat-retrievable cones; Courtemanch 1984, Davies and Tsomides 2002, http://www.state.me.us/dep/blwq/docmonitoring/biological/biorep2000.htm). The success of these devices has enabled the MDEP to apply comparable field and analytical methods to nearly all rivers and streams of significant regulatory interest (Davies and Tsomides 2002), greatly simplifying the development and application of river and stream biocriteria. Further, the physiography of Maine is quite homogeneous with roughly 85% of the State falling within just two relatively similar ecoregions (Omernik 1987). For this reason stratification by ecoregion was not the critical concern that it is for States in some other regions of the country (Davies et al. unpublished manuscript).[2]

In 1999, Maine began an algal monitoring program to strengthen the interpretation of ecological condition by providing information from a second biological assemblage. Maine's fish assemblage is naturally depauperate, limiting its suitability as a candidate for bioassessment. The algal monitoring program will assist the Department in the development of river and stream nutrient criteria. The Department also has a companion biomonitoring program to assess wetland biological condition.

Database development
By the late summer of 2004, the Department had established about 800 monitoring stations in all major watersheds throughout the State (Figure A-5). Data from macroinvertebrate samples are stored in an Oracle© database and all stations are geo-referenced in the Department's geographic information system

[2]Maine's southern ecoregion is very small but recent data suggest that some improvement in accuracy of class prediction could result from better accounting for ecoregional differences there.

(ArcInfo©). Data collected in accordance with Maine's biocriteria protocol are analyzed using statistical models that estimate to which of the four water quality classes a sample belongs. Findings of the Biological Monitoring Program are used to document existing conditions, identify problems, set water management goals, assess the progress of water resource management measures, and trigger needed remedial actions.

Sampling methods
Samples of benthic macroinvertebrates are collected from flowing streams in rock bags (or baskets or cones). At least three substrate samplers are exposed in the waterbody for 28 days during the late summer, low flow period (July 1 to September 30). The MDEP usually conducts sampling, but others may also perform monitoring to determine attainment of classification if done according to a quality assurance plan.

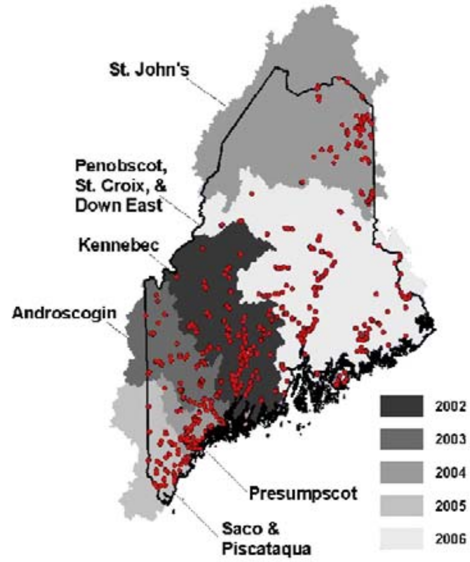

FIGURE A-5. Macroinvertebrate sampling stations in Maine.

Laboratory methods
Samples are retrieved, sorted, and stored for identification by a professional freshwater macroinvertebrate taxonomist. Organisms are identified to species whenever possible or otherwise to the lowest taxonomic level possible.

Analytical methods
If a sample satisfies the minimum data requirements (total mean abundance of at least 50 individuals, generic richness of at least 15 taxa for 3 replicate samplers), data are entered into the MDEP's computer software for further analysis through the numeric criteria statistical model. The model is able to take large amounts of information generated from a biological sample, describe which variables appear to be most significant in the classification decisions, and provide a mathematical summary that integrates the information. The model produces probability scores from 0 to 1 that indicate the likelihood that a sample attains each water quality class.

IV. Develop and validate quantitative thresholds

How does Maine quantify the tiered aquatic life uses so that attainment can be assessed?
In the late 1980's, the MDEP quantified the narrative aquatic life goals for each water quality class by developing a probability-based statistical model to serve as numeric biocriteria (Courtemanch et al. 1989, Courtemanch 1995, Davies et al. unpublished manuscript). The model uses 31 biological variables, many of which were specifically chosen because of their utility in measuring some important ecological attribute in the narrative standard. The model quantifies and standardizes the expert judgment of biologists and it now serves as an expert system for decision-making (*See Case Examples 3-3 and 3-6*).

To develop the model, biologists used agreed-upon decision rules and a Delphi technique (Bakus et al. 1982) to assign an aquatic life attainment classification (A, B, C, or non-attainment) to 144 samples of benthic macroinvertebrate data, based on conformity of the sampled community to one of the 3 narrative aquatic life standards in Maine's statute, or to a fourth category representing non-attainment of minimum State standards (Shelton and Blocksom 2004, Davies et al. unpublished manuscript). The samples evaluated represented 300 distinct taxonomic units and 70,000 organisms collected from rivers, streams, and riverine impoundments. Those data and their classification assignments were used as the baseline for construction of the expert system, in the form of a linear discriminant model, to evaluate future macroinvertebrate samples for water quality classification attainment. The original model was used from 1992 through 1999 when the model was recalibrated with an additional 229 (for a total of 373) sampling events. The recalibration resulted in relatively minor changes to the structure of the original model, involving simplification of the structure of two of the sub-models, the elimination of two poorly performing variables, and changes in model coefficients to account for the new data.

How has Maine established reference conditions?
Maine has taken a conceptually different approach to establishing baseline reference conditions from which to develop numeric biological criteria. Because we determined that detection of four distinct biological condition groups, characterized by differences in specified ecological attributes, was our management goal, it was also our goal for statistical analysis. We desired to develop numeric criteria that would enable us to assign sites to one of those four condition groups (A, B, C, non-attainment). Therefore, our task for characterizing reference conditions was to conceptually and then statistically define those four groups. Thus in a sense, initially by expert judgment and then by multivariate analysis, we created a Class A reference condition (deemed to be close to natural), a Class B reference condition, a Class C reference condition, and non-attainment reference conditions. Use of biological information to establish a minimally disturbed reference has been criticized due to the dangers of a too circular process. We have tested our biology-based a priori assignment of sites to Class A using more traditionally identified reference locations (i.e., based on high percent natural landcover) and found good correspondence with the biologically-defined Class A sites.

Adoption of the Numeric Biocriteria Rule
On April 17, 2003 the Maine Board of Environmental Protection adopted numeric freshwater biocriteria in rule. The biocriteria rule describes the process that the MDEP uses to make decisions about attainment of aquatic life uses in rivers and streams. The rule describes protocols for biological sampling of benthic macroinvertebrates, laboratory analyses, modeling analysis of laboratory data, and selective use of expert judgment. Adoption of this rule quantitatively interprets Maine's existing narrative 'aquatic life' standards for each riverine water quality classification.

V. Application in water quality management

How does the MDEP decide which waterbodies and locations to monitor?
For purposes of biological monitoring, the MDEP divided the State into five major river basins, which are sampled on a 5-year rotational schedule (Figure A-6): Androscoggin, Kennebec and Mid-Coast, Penobscot, St. Croix and North Coastal Rivers, Piscataqua, Saco and Southern Coast, St. John and Presumpscot. The decision to monitor specific locations on a waterbody can be based on a variety of factors such as:

- prior knowledge of human activities that could have a detrimental effect on a waterbody: sampling seeks to detect actual impacts on biological communities;
- knowledge of future potential threats to a waterbody: sampling can be done to collect baseline data before, for example, development occurs or a discharge is licensed; follow-up sampling can determine the effect, if any, on the biological community by said development or discharge;
- requirement/desire to monitor the effects of remediation activities or water quality management changes;
- desire to expand coverage of the monitoring program and to more fully document natural variability.

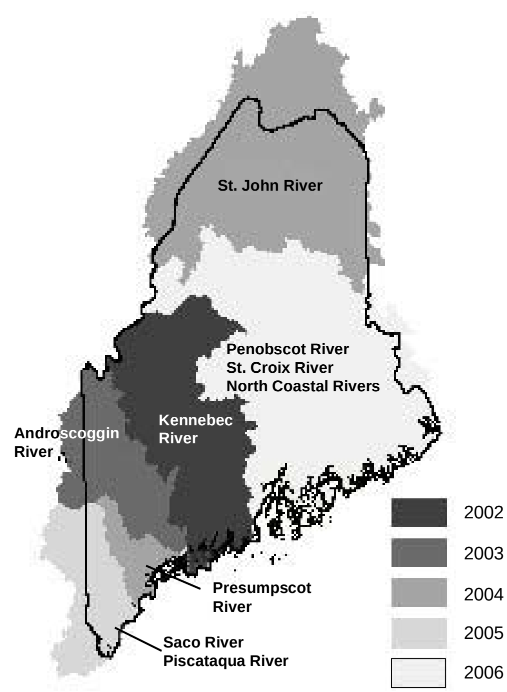

FIGURE A-6. Maine five-year rotating basin sampling schedule.

How are tiered aquatic life uses designated in Maine?

The quality of Maine's waters is described in terms of physical, chemical and biological characteristics associated with the State's water classification program. As established in Maine statute (38 MRSA Sections 464-470), the classification program consists of designated uses (e.g. drinking water supply, recreation in and on the water, habitat for fish and other aquatic life), criteria (e.g. bacteria, dissolved oxygen and aquatic life), and characteristics (e.g. natural, free flowing) that specify levels of water quality necessary to maintain the designated uses. All State waters have a classification assignment (Rivers and streams: AA, A, B, C; Lakes: GPA; Marine and estuarine: SA, SB, SC). Tiered narrative aquatic life uses specific to wetlands are currently under consideration by MDEP and a supporting wetland biomonitoring program is in place.

The classification system in Maine is goal-based in that assignment of a given waterbody to a use class (AA, A, B or C) may not necessarily reflect its current conditions. Rather, it establishes the level of quality the State has deemed the waterbody must achieve. Maine's classification system is also more risk based than quality based. Water quality differences among the various classes are not large, however, the different levels of restrictions put on human activities associated with each class establishes the level of risks that water quality could be degraded resulting in increased threats to designated use attainment. Rivers and streams are assigned to a tiered aquatic life use goal (Table A-1: AA and A -"*as naturally occurs,*" B- "*no detrimental change,*" C- "*maintain structure and function and water quality sufficient to support salmonids*") that represents the best fit after considering:

- The current condition in terms of dissolved oxygen, bacteria, and aquatic life (Figure A-3) and
- The highest attainable goal condition (taking into account ecological and socioeconomic factors).

The State water quality assessment provided in Maine's 305b report gives the status of attainment of the water resource goals established in the classification program. Thus, some waters may be listed as impaired even though they have relatively good water quality (Table A-4), e.g., a Class A river may be listed because it does not fully attain the standards of that class but may be of sufficiently good quality to attain Class B or C, and the Clean Water Act interim goal. The classification program is reviewed every three years (Triennial Review) by the Department and the Board of Environmental Protection (Board). The Board may, after opportunity for public review and hearing, make recommendations to the Legislature for changes in water quality standards or reclassification of selected waters. The most recent revisions to the classification program were completed in 2002-2003 when the Legislature authorized classification upgrades to 75 river, stream and coastal segments totaling over 800 miles of waters (Figure A-7).

TABLE A-4. Examples of how numeric biocriteria results determine whether or not a waterbody attains designated aquatic life uses in Maine.

Legislative Class	Monitoring Result	Attains Class?	Next Step
A	A	Yes	--
C	B	Yes	--
A	B	No	TMDL
B	NA	No	TMDL

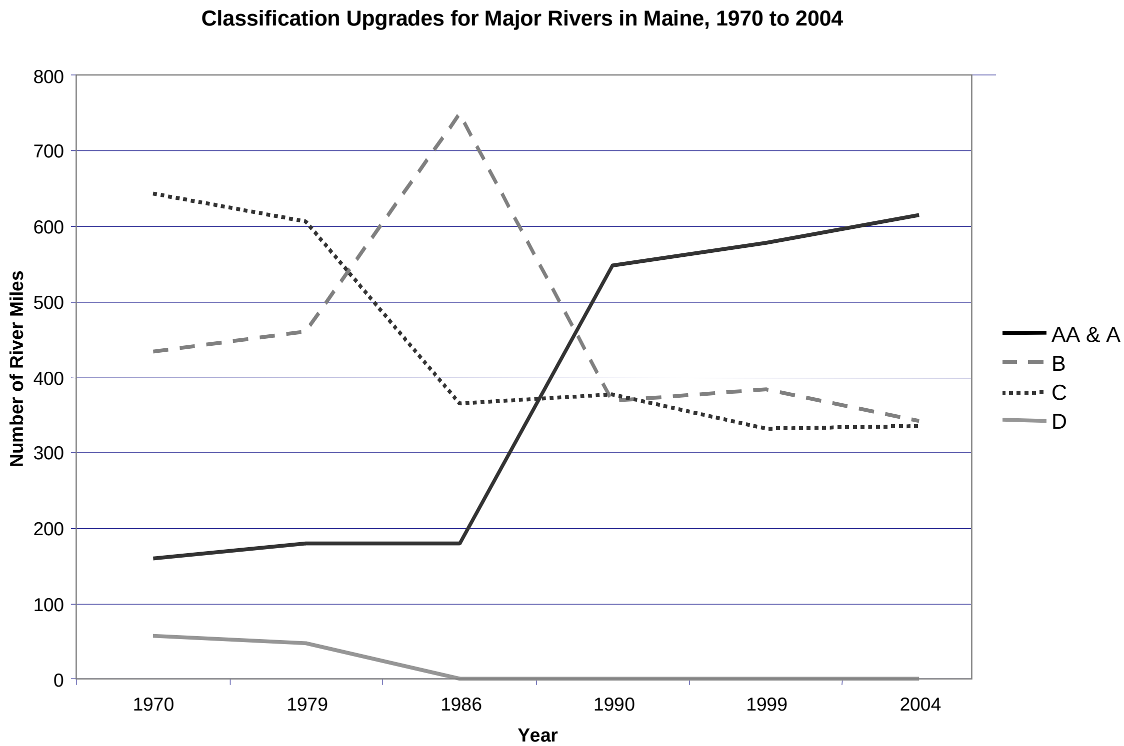

FIGURE A-7. Increased designation of Class AA and Class A uses on major Maine rivers (as shown by river miles) between 1970 and 2004, as a result of water quality improvements and public support for the Class AA/A goal in the Triennial Review Process.

What is the management perspective for TALU designations in Maine?

Class AA waterbodies, as compared to Class A, have significantly greater restrictions on allowed activities. For example, no discharge of wastewater and no dams are allowed in Class AA waterbodies. Class A waters carry a higher risk of degradation because discharges are allowed, though the risk is small because they must be of "equal to or better" water quality than the receiving water. Dams are also allowed. Obstructions to flow, whether man-made or natural can alter assemblage structure from free-flowing conditions (Poff et al. 1997, Davies et al. 1999). The definition in water quality standards for the term "natural" sought to limit the effects of altered flows to no greater than what could be expected from a "natural" obstruction to flow (e.g., a natural hydrological control or a beaver dam). Thus to accommodate dams in Class A, "*natural*" is defined as "occurring in, *or as if in*, a state of nature not measurably affected by human activities." Assemblages that are characteristic of the waters above and below beaver dams <u>or</u> low-head, run-of-river, man-made dams are deemed to pass this standard. Most dams in Class A provide for passage of anadromous fish.

Class B was originally applied as the default ALU for unmonitored waters though current use designations are nearly equal in stream miles for Class A and Class B, both of which far exceed Class C miles when all rivers and streams in the State are considered (Figure A-8). From the management perspective, a Class B designation often applies to waterbody segments exposed to well-treated or well-diluted domestic discharges or to areas subjected to landscape alterations that result in moderate increases in the nutrient and organic matter load.

Class C narrative aquatic life standards prohibit any activities that result in the loss of structure and function of the resident biological community. "Community structure" is defined as "the organization of a biological community based on numbers of individuals within different taxonomic groups and the proportion each taxonomic group represents of the total community," while community function is defined as "mechanisms of uptake storage and transfer of life-sustaining materials available to a biological community which determine the efficiency of use and the amount of export of the materials from the community." This management class is applied to waterbodies that may be impounded, altered by landscape changes, or that receive industrial wastewater.

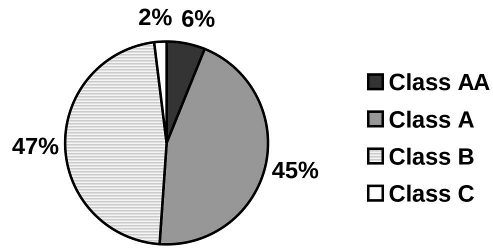

FIGURE A-8. Percent of linear miles of all rivers and streams in each of Maine's designated use classes (year 2000).

What process was used to bring the Maine TALU biocriteria rule through adoption?

The MDEP Biological Monitoring Program completed provisional numeric biocriteria in 1990. Those numeric thresholds were the basis for extensive regulatory and non-regulatory Department decisions between 1990 and 2003, e.g., issuance or denial of 401 water quality certificates and recommendations for flow management changes, 303d and 305b listings, prioritization of at-risk waterbodies, and problem identification. In April 2003, the State formally adopted tiered numeric biocriteria rules that were the result of the analysis of 15 years of biological data and the experience gained through 20 years of regulatory decision-making based on numeric biocriteria (Table A-5). Remarkably, the biocriteria rule was one of the most complicated and important, but least contested water quality rules that the Maine Department of Environmental Protection has adopted in the last 15 years. Stakeholders from all sides had become convinced of the merits of the approach.

TABLE A-5. Chronology of Maine's biocriteria development.

1983	The MDEP Biological Monitoring Program began a standardized program of sampling stream invertebrate communities.
1986	The revised Water Classification Program, which defined tiered narrative standards for aquatic life, became law.
1989	MDEP staff and University of Maine statistical ecologist, Dr. Frank Drummond embarked on the development of numeric criteria to support the narrative standards of the law.
1990	A technical advisory committee of stakeholder scientists was convened to provide peer review and oversight of the biocriteria development process. Over the course of approximately 2 ½ years, MDEP staff, Dr. Drummond, and the committee developed a statistical model based on expert judgment and linear discriminant analysis to address the scientific goals, as well as the policy and regulatory goals of the new biocriteria program.
1991-1993	Public informational workshops on the process were held in March 1991, September 1993, and December 1993.
1999	The original statistical model was recalibrated to take advantage of the expanded dataset available at that time.
2002	During a formal stakeholder review process, meetings were held in March and April and comments were solicited from representatives of the hydropower and paper industry, environmental advocacy groups, other State agency biologists (e.g., fish and wildlife), university scientists, and private consultants.
2002	A workshop on the rule and its background was held in early October for the Maine Board of Environmental Protection.
2003	The Board of Environmental Protection adopted the rule on April 3 and it was subsequently adopted by the Maine State Legislature.