STATE OF MAINE
119TH LEGISLATURE
SECOND REGULAR SESSION

Interim Final Report
of the

COMMISSION TO STUDY THE NEEDS AND OPPORTUNITIES ASSOCIATED WITH THE PRODUCTION OF SALMONID SPORT FISH IN MAINE

December, 2000

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Rep. Bruce S. Bryant, co-chair
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Executive Summary

The Commission to Study the Needs and Opportunities Associated with the Production of Salmonid Sport Fish in Maine, hereafter called the "Commission", was created by Resolves of 1999, chapter 82.[1] A copy of that Resolve is attached as Appendix A.

As enacted, Resolves of 1999, chapter 82, created a 13 member Commission to study the salmonid fish culture facilities in Maine. Specifically, the Commission was directed to study the production and distribution capabilities of those facilities, the opportunities and needs for salmonid production in Maine and issues relating to waste discharge licensing of those facilities. The Commission was directed to provide recommendations on how to meet the State's future sport fish production and management needs in the most cost effective manner and to submit those recommendations to the Joint Standing Committee on Inland Fisheries and Wildlife by September 29, 2000.[2] The Commission's reporting date was extended from September 29, 2000 to December 31, 2000 by the Legislative Council.[3] A list of the Commission members is attached as Appendix B.

Work completed to date

The Commission held six meetings between September 28, 1999 and December 5, 2000.[4] During the course of its study, the Commission undertook a comprehensive review of the current condition of the state owned fish hatchery and the current levels and type of fish production at those facilities. In conducting that review, the Commission organized itself into three subcommittees focusing on discharge issues, fish management issues and oversight of the Department of Inland Fisheries and Wildlife's hatchery consultant. Those subcommittees each held several meetings to discuss topics related to their area of inquiry. The Commission and its subcommittee's completed the following substantive tasks:

1). Worked with the Department of Inland Fisheries and Wildlife, the Department of Environmental Protection, private fish hatchery owners and members of the public during the development and final issuance of waste

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[1] Enacted during the 1st Regular Session of the 119th Legislature with an effective date of June 17, 1999. Resolves of 1999, c. 82, is derived from LD 986, Resolve, Establishing a Commission to Study the Feasibility of Reestablishing a Brook Trout and Landlocked Salmon Hatchery in Northern Maine, sponsored by Senator Kieffer of Aroostook.
[2] The reporting deadline of the Commission was extended by the Legislative Council in August of 2000 from September 29, 2000 to December 31, 2000.
[3] This extension was approved by the Legislative Council at its meeting on July 25, 2000.
[4] In Brewer on 9/28/99, in Skowhegan on 10/15/99 and in Augusta on 2/16/00, 3/8/00, 6/19/00 and 12/5/00.

discharge licenses for the nine state-owned fish hatcheries.[5] Obtaining licenses for those hatcheries was a major step that had to be completed before the Commission could undertake its other tasks. The Commission worked with those agencies for over a year to obtain those licenses. Prior to the issuance of these licenses in July, 2000, the hatcheries were operating under licenses last issued in 1983. While the discharge standards set in the recently issued licenses will be the subject of further studies over the next three years, the Commission considers the licensing of those hatcheries a significant step towards a better understanding of the water quality issues associated with the operation of fish hatcheries in the State;[6]

2). Through the work of a consultant working under contract with the Department of Inland Fisheries and Wildlife and under the policy direction of the Commission completed a thorough preliminary strategic fish hatchery planning and engineering study which characterizes and documents the condition of the nine state-owed hatchery facilities and identifies the needs at each facility as well as possible improvements. That consultant also completed a thorough review of the effluent discharge standards contained in the discharge licenses and identified compliance issues and provided guidance to the Commission with respect to what cost effective wastewater treatment options that are available to the State to meet those effluent discharge standards within the three year compliance window; and

3). Began work to determine the future sport fish management needs and to assess how those needs will be met in the most cost effective manner. The Commission will work closely with the Department of Inland Fisheries and Wildlife and the public to assess those needs during the first half of 2001.

Although the Commission feels it has completed a substantial percent of the work outlined in Resolves of 1999, chapter 82, it also believes a substantial amount of work remains to completed. The Commission feels strongly that those efforts must be completed over the next two years if the State is to remain competitive nationally as a destination location for recreational sport fishing. A recent study by the University of Maine, for example, estimates that, in 1996 recreational fishing activities in Maine generated $292.7 million in total economic activity which resulted in $13.5 million in sales taxes and supported 5230 full and part time jobs that paid more than $5.7 million in state income taxes that year.[7] Recreational sport fishing is not only an important part of the outdoor heritage of Maine, is has become an important part of the economy of the State.

[5] Final licenses were issued by DEP on July 25, 2000.

[6] The discharge licenses issued by DEP in July, 2000, provide a 3 year period for the hatcheries to come into compliance with the discharge standards.

[7] Michael Teisl and Kevin J. Boyle. Economic impact of hunting and inland fishing and wildlife-associated recreation in Maine. Rep #479, Maine Agricultural and Forestry Experiment Station, University of Maine, Orono. November 1998.

Maine's nine state-owned hatcheries form the backbone of the sport fishing industry in Maine and are critical to its success in the future. Over the past 40 years, state-owned fish hatcheries have operated for an equivalent of 500 production years and have produced nearly 60 million fish that have been stocked in over 700 lakes and 100 streams statewide. Although the historical trend in the number of fish produced at these facilities has decreased, the total weight of fish produced has increased. In recent years, the state-owed hatcheries have produced more fish, by weight, than at any other time in the state's history.

The nine facilities currently operated by the State were initially constructed between 1857 (Grand Lake Stream) and 1958 (Enfield). In total, these nine hatcheries have been operating for the overall equivalent of 500 production years. The average age of those facilities is 58 years. Many components of those facilities are reaching the end of their useful service life.

Because of the age of these hatcheries, increased demand for more and larger fish and increased costs for environmental compliance, state policy makers are faced with difficult and expensive choices with respect to how to meet the sport fishing needs of the future and maintain a high quality and economically viable recreational sport fishery in the state. To meet those goals, policy makers must set clear fish production and distribution goals and must provide the resources necessary for reliable, efficient and cost effective fish production systems. It is particularly important to note that although recreational fishing activities in Maine generate nearly $300 million in statewide economic benefits, the hatcheries themselves operate on an annual that is directly related to the revenues generated from the sale of resident and nonresident fishing licenses.[8] To the extent that the hatcheries support such a broad based economic benefits to the State, the Commission feels that it is appropriate to consider broader based revenue sources to fund the needed improvements at those facilities.

Findings and recommendations

For those reasons, the Commission makes the following findings and recommendations and offers the following work plan for the next two years:

Finding 1. That legislative policy guidance to the Department of Inland Fisheries and Wildlife is essential over the next two years to establish long term fish production and distribution goals, ensure a high quality and

[8] Although the revenues from fishing licenses are not technically "dedicated" for hatcheries, the General Fund appropriations to the Department of Inland Fisheries and Wildlife have been directly linked to the revenues from license sales since the approval of Article 9, section 22 of the Maine Constitution on November 3, 1992.

economically viable recreational sport fishery in the state and provide for reliable, efficient and cost effective fish production systems.

Recommendation. *Reauthorize the Commission for an additional two years to complete its assigned tasks and to accomplish the following tasks:*

- *Continue to work with the Department of Inland Fisheries and Wildlife and the Commission's consultant in evaluating the effluent characteristics of fish hatcheries, including private fish hatcheries, with the purpose of ensuring that the State fish hatcheries will be able to comply with licensed effluent discharge standards within three years and to obtain information relevant to discussions of discharge license standards for unlicensed private fish hatcheries;*

- *Set statewide production goals for the number, size and species mix of recreational sport fish over a 10 to 20 year planning horizon. Although Commission as a whole has not made a recommendation on production goals and objections, some members of the Commission feel that a reasonable goal would be to increase annual production by 5 million fish in the next 10 years with an additional 3 million fish in the following 5 years; and*

- *Determine how to meet those production goals in the most cost effective manner by evaluating all production options, including investing in cost effective upgrades to existing state owned facilities to produce more fish, closing non-economic state owned facilities, purchasing fish from privately owned hatcheries and building new capacity in other locations. The assessment of other locations will include a statewide search for new locations that meet specific requirements.*

Finding 2. The 119th Legislature appropriated $500,000 to the Department of Inland Fisheries and Wildlife for engineering analysis and assessment of state owned fish hatcheries in Part HHHH-1 of Public Laws of 1999, chapter 731. That work is essential and is underway, but will not be completed before the end of the fiscal year in which the funds were appropriated. Unexpended balances in that appropriation must be allowed to carry forward into Fiscal Year 2002 in order to allow that work to be completed.

- ***Recommendation.*** *Unexpended balances appropriated to the Department of Inland Fisheries and Wildlife under Part HHH-1 of Public Laws of 1999, chapter 731 should be allowed to carry forward into Fiscal Year 2002. Statutory provisions to allow those funds to carry forward are included in legislation attached as Appendix X to be used for the same purposes as they were originally appropriated.*

Work Plan for next 2 years

The Commission has established a work plan to complete the tasks outlined above and to provide a final report to the Second Regular Session of the 120th Legislature no later than October 31, 2002. That work plan would include:

- By July 1, 2001, establish statewide increased production goal for the number, size and species mix of recreational sport fish in Maine for the next 10 to 20 years that includes the equitable distribution of the increased production of fish on a statewide basis;

- By November 1, 2001, complete the detailed engineering evaluation of production and discharge options for fish hatcheries, including some review of effluent licensing of smaller production facilities;

- By July 1, 2002, complete an in depth assessment of all options for meeting fish production goals including investing in cost effective upgrades to existing state owned facilities, closing non-economic state owned facilities, building new capacity in other locations within the state and purchasing fish from privately owned hatcheries. This assessment of possible new locations to determine if those new locations could produce fish more cost effectively than existing facilities; and

- By October 31, 2002, make final recommendations to the Second Regular Session of the 120th Legislature on the production goals for recreational sport fish in Maine and a plan for meeting those production goals in the most cost effective manner.

The Commission will establish subcommittees as necessary to work on these issues or other issues as determined by the Commission.

Background on fish production in Maine

Since the late 19th century, Maine has been actively involved in the management of fisheries in its thousands of lakes, ponds, rivers, and streams. These efforts have focused on the protection of native self-sustaining populations, as well as the establishment and maintenance of other non-native species throughout the state. Large and smallmouth bass, for example, were introduced to the waters throughout the southern half of the state and today represent a major self-sustaining sport fishery. Other species, such as landlocked salmon, brook trout, brown trout, lake trout and splake, are currently raised in State-owned hatcheries and stocked in over 700 waters throughout the state. Species such as bass, pickerel, perch and other "warm water" species are perpetuated by natural reproduction, so no stocking program for these species is considered necessary.

The production of fish from State-owned hatcheries play a vital role in the maintenance of the salmonid angling opportunities that are highly valued by Maine anglers and thousands of others who visit our State to enjoy its outdoor heritage. According to the Maine Department of Inland Fisheries and Wildlife, over 60 percent of the state's landlocked salmon waters have inadequate spawning habitat and are maintained by stocking. For example, only about four natural populations of landlocked salmon existed historically within the state. Now there are over 200 lake salmon fisheries statewide.

The State currently owns and operates fish hatcheries in Gray, Casco, New Gloucester, Palermo, Augusta, Embden, Enfield, Grand Lake Stream, and Phillips. Those nine facilities produced 1.25 million fish in 1999 at nine state-owned fish hatcheries. Table 1 shows the current production levels at each of those facilities by species type.[9] Table 2 shows the 1999 production by size range for each of those species.

Table 1

1999 Fish Production Levels at State-Owned Hatcheries, by Species Type

Facility		Salmon	Brown Trout	Lake Trout	Brook Trout	Splake	Row Total
Casco		35,955	42,980	*	18,426	*	97,361
Dry Mills	1	*	*	*	155,924	*	155,924
Embden		28,068	*	*	145,166	*	173,234
Enfield		23,875	*	23,575	267,945	*	315,395
Governor Hill	2		*	16,218	71,207	71,546	158,971
Grand Lake		44,788	*	*	*	*	44,788
New Gloucester		*	158,557	*	*	*	158,557
Palermo		*	48,690	*	82,321	*	131,011
Phillips	3	*	*	*	16,935	*	16,935
TOTALS		**132,686**	**250,227**	**39,793**	**757,924**	**71,546**	**1,252,176**

Data provided by the Department of Inland Fisheries and Wildlife.

1. Includes 4000 brown trout fry.
2. Includes 52,800 brown trout fry, 8400 lake trout fry and 4300 splake fry.
3. Includes 15,786 brown trout fry.

A tenth facility located at Deblois was closed in the early 1980's for financial reasons and was subsequently placed under a long-term lease to a private aquaculture firm for the production of Atlantic salmon smolts. The current lease expires in the year 2004.

In recent years, greater reliance has been placed in size, health, and genetic makeup of the Department's hatchery stock to maximize survival in the wild. Although the number of fish stocked has been declining over the years, the size

[9] Data provided by the Department of Inland Fisheries and Wildlife.

of fish stocked has been steadily increasing. Table 3 shows the number and weight of fish produced at State-owned hatcheries since 1962. According to that data, the overall average weight of a fish raised in a Maine-owned hatchery has increased by about 300% since 1962. The current average production of 250,000 lbs. of fish represents the greatest weight ever produced by the State.

Table 2

1999 Fish Production Levels at State-Owned Hatcheries, by Size

Size Range	Salmon	Brown Trout	Lake Trout	Brook Trout	Splake	Row Total
Fry	*	*	8,400	72,586	4,300	85,286
2" to 4"	*	51,167	*	71,500	*	122,667
4" to 6"	*	*	*	299,951	*	299,951
6" to 8"	112,213	5,000	30,075	112,714	*	260,002
8" to 10"	11,968	119,130	1,200	126,474	67,246	
10" to 12"	3,650	61,110	*	69,659	*	134,419
12" to 14"	4,355	7,125	*	2,240	*	13,720
14" to 16"	400	6,500	*	942	*	7,842
16" to 18"	*	50	*	959	*	1,009
18" to 20"	100	*	*	674	*	774
20" to 26"	*	145	118	225	*	488
TOTALS	**132,686**	**250,227**	**39,793**	**757,924**	**71,546**	**1,252,176**

Data provided by the Department of Inland Fisheries and Wildlife.

The aging fish production infrastructure

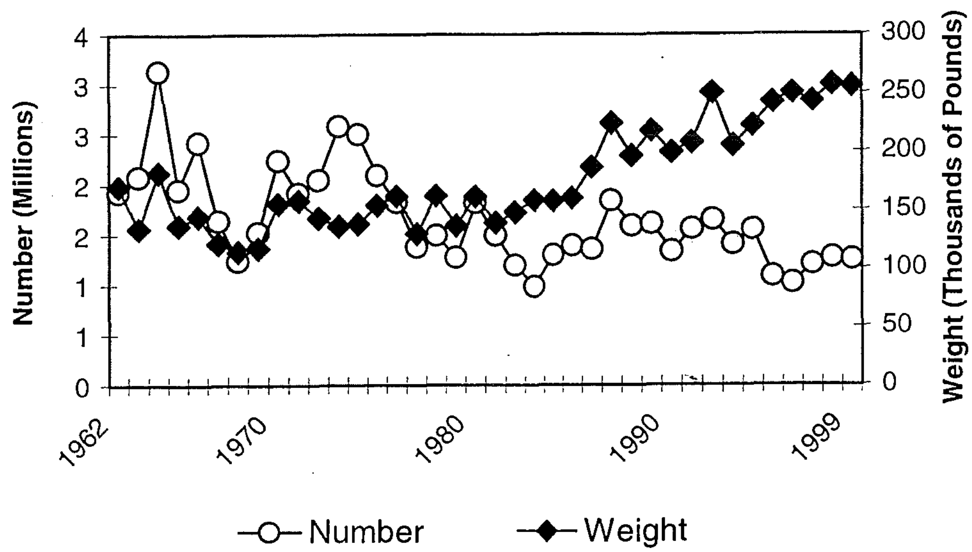
The nine facilities currently operated by the State were initially constructed between 1857 (Grand Lake Stream) and 1958 (Enfield). In total, these nine hatcheries have been operation for the overall equivalent of 500 production years and have an average age of 58 years. According to the Department's consultant, many components of those facilities are reaching the end of their useful service life.[10]

In 1987, the status of these facilities was assessed in a comprehensive manner by the Department of Inland Fisheries and Wildlife, and a plan adopted to address a variety of maintenance needs. Although some of these needs have been addressed since that time, inadequate funds have kept maintenance and enhancement projects at less then desired levels. Raceway renovations were completed at several facilities (Grand Lake Stream, Palermo, Governor Hill, and Dry Mills), and production increased at Dry Mills by increasing water supplies and reclaiming previously unused raceways. Recent renovations to the water supply dam, construction of a new hatchery facility, and development of underground well water supplies have greatly enhanced the operation of the New Gloucester

[10] The Consultant, Fishpro, Inc., visited 7 of the 9 hatcheries in 1999 and 2000. The Executive Summary and overview sections of their subsequent report to the Commission are included as Appendix X. A copy of the complete report is available for review at the Maine State Law Library in the State House in Augusta, Maine.

Table 3

Historical Fish Production at State-owned Hatcheries by Number of Fish and Total Weight



facility. At Governor Hill, new sources of well water have been located that will allow a significant expansion in both brood rearing and fry production, while also allowing for a modest increase in fish for stocking. In addition, voluntary assistance from some or the larger paper companies, through an "Adopt-A-Hatchery" program, is providing technical support and assistance needed to address many ongoing maintenance needs at each facility. All of the nine facilities have been adopted and will be benefiting from significant corporate/employee contributions resulting in major improvements. The Department is also committing significant resources (up to $250,000 annually over the next few years) to support this effort.

During the 1990's, considerable effort was spent on two initiatives to fund improvements at state hatcheries. The first attempt was in 1994 when the Legislature approved a $10 million bond referendum that, if passed by the voters, would have funded improvements and expansions of state fish hatcheries.[11] That referendum failed to receive a majority vote in the general election of November, 1994.[12] A second fish hatchery bond issue for $5 million was contemplated two years later in 1996. At that time, the Department's proposal was to use funds from a bond issue to incorporate new fish rearing

[11] Private and Special Laws of 1993, chapter 90 (LD 1756).

[12] That referendum was supported by 238,092 voters (48.9%) and rejected by 249,142 voters (51.1%).

technology into the existing facilities, expand and protect their water supplies and upgrade effluent treatment facilities to meet new discharge requirements associated with expanded production. That proposal was withdrawn before going before the voters, however, because of the lack of a detailed long-range plan upon which the use of such funds based.

The Commission members agree that the overall goal of the State's fish production systems is to substantially increase the production of more and larger fish for stocking in rivers and lakes statewide. Although some increase in production could be obtained at our existing state-owned facilities for relatively little capital outlay, it is clear that any future expenditure to increase the production at those facilities must be compared to the cost of other options, such as building new facilities or purchasing fish from private hatcheries in operation throughout the State. In addition, those expenditures must be based on a long range plan that allows the State to reach its production goals in the most cost-effective manner. Determining those production goals and developing a plan to reach those goals must, however, wait for the results of further economic and engineering analyses, which the Commission anticipates can be completed over the next 12 months using funds appropriated for that purpose by the 119th Legislature.

Effluent issues at hatchery facilities

On July 25, 2000, the Maine Department of Environmental Protection issued 5-year waste discharge licenses to the nine state-owned fish hatcheries. Those licenses impose monthly and yearly effluent limits on phosphorus, suspended solids and dissolved oxygen, although each of the licenses includes a provision allowing the hatcheries three years to comply with the effluent limits. At the request of the Commission, the Department of Inland Fisheries and Wildlife contracted with Fishpro, Inc., to conduct an effluent study of those hatcheries to determine how the discharge characteristics compared to the effluent limits in the discharge licenses, whether or not compliance was achievable within the 3 year compliance window and, if compliance could not be guaranteed, what effluent treatment options were available to the hatcheries that would allow them to meet their discharge limits when those limits take effect in 2003. That analysis was completed in December of this year and presented to the Commission at its final meeting on December 5, 2000. [13] Licensing these facilities proved to be a major hurdle for the Commission, and required a substantial commitment of time in 1999 and 2000. Now that those licenses have been issued, the Commission will be able to move more rapidly to complete its other tasks.

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[13] The Executive Summary and overview sections of the Fishpro effluent study are included as Appendix X. A copy of the complete report is available for review at the Maine State Law Library in the State House in Augusta, Maine.

The analysis determined that five of the hatcheries are currently in compliance with all the effluent limits in the discharge licenses. Those facilities are Casco, Embden, Grand Lake Stream and New Gloucester. Effluent from three other hatcheries, Dry Mills, Governor Hill and Phillips, do not currently meet the license limits for phosphorus and dissolved oxygen, and are at risk of being in noncompliance with their discharge license in 2003 unless some steps are taken to further treat the effluent from those facilities. The compliance status of the Palermo hatchery is uncertain at this time, due to some technical concerns about how the phosphorus limit included in that facility's license was calculated. All nine hatcheries will likely be unable to meet the discharge limits included in the licenses that apply to effluent concentrations during rearing unit cleanings. This issue, along with the Palermo phosphorus limit, will continue to be discussed with the Department of Environmental Protection over the next year.

As a result of this analysis, the Commission has endorsed recommendations by Fishpro, Inc., and the Department of Inland Fisheries and Wildlife to meet with the Department of Environmental Protection to re-negotiate the discharge licenses to address the Palermo phosphorus limit and the limits applicable to rearing unit cleaning. In addition, the Commission encourages the Department of Inland Fisheries and Wildlife to undertake immediate measures to implement improved solids recovery and management of existing treatment basins at the three hatcheries currently operating above limits established in their discharge permits. Further, the Commission encourages the Department to give a high priority to improvements of solids collection and disposal systems at facilities with solids recovery systems and to evaluate the costs of constructing effluent treatment systems at those hatcheries without solids recovery systems.

APPENDIX A

Membership List

Commission to Study the Needs and Opportunities Associated with the Production of Salmonid Sport Fish in Maine

Rep. Bruce S. Bryant, House Chair
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APPENDIX B

CHAPTER 82

S.P. 332 - L.D. 986

Resolve, Establishing a Commission to Study the Needs and Opportunities Associated with the Production of Salmonid Sport Fish in Maine

Emergency preamble. Whereas, Acts and resolves of the Legislature do not become effective until 90 days after adjournment unless enacted as emergencies; and

Whereas, the salmonid sport fishery in Maine is important to the economy of the State; and

Whereas, the continuation of a healthy salmonid sport fishery requires careful management; and

Whereas, several critical factors necessary for effective management of that fishery must be studied; and

Whereas, in the judgment of the Legislature, these facts create an emergency within the meaning of the Constitution of Maine and require the following legislation as immediately necessary for the preservation of the public peace, health and safety; now, therefore, be it

Sec. 1. Commission established. Resolved: That the Commission to Study the Needs and Opportunities Associated with the Production of Salmonid Sport Fish in Maine, referred to in this resolve as the "commission," is established; and be it further

Sec. 2. Commission membership. Resolved: That the commission consists of the following 13 members:

1. One member of the Joint Standing Committee on Inland Fisheries and Wildlife appointed by the President of the Senate;

2. Two members of the Joint Standing Committee on Inland Fisheries and Wildlife appointed by the Speaker of the House;

3. The Commissioner of Inland Fisheries and Wildlife or the commissioner's designee;

4. The Superintendent of Fish Culture, Department of Inland Fisheries and Wildlife;

5. One member of Trout Unlimited nominated by the president of that organization and appointed by the Governor;

6. Two members of the Inland Fisheries and Wildlife Advisory Council appointed by the Governor;

7. Three individuals representing owners or operators of a private fish hatchery in the State appointed by the Governor;

8. One member of the Sportsman's Alliance of Maine nominated by the president of that organization and appointed by the Governor; and

9. One individual who owns or operates a private aquaculture facility in the State and who is appointed by the Governor; and be it further

Sec. 3. Appointments; meetings. Resolved: That all appointments must be made no later than 30 days following the effective date of this resolve. The appointing authorities must notify the Executive Director of the Legislative Council upon making their appointments. When the appointment of all members is complete, the chairs of the commission shall call and convene the first meeting of the commission no later than August 1, 1999. The first named Senate member is the Senate chair and the first named House member is the House chair; and be it further

Sec. 4. Duties. Resolved: That the commission shall assess and evaluate salmonid fish culture facilities in Maine and associated production and distribution capabilities, opportunities and needs, including waste discharge licensing issues. In addition, the commission shall develop recommendations designed to provide for the production and distribution of fish needed to meet future sport fish management program needs in the most cost effective manner; and be it further

Sec. 5. Staff assistance. Resolved: That the commission shall request staffing assistance from the Legislative Council; and be it further

Sec. 6. Compensation. Resolved: That legislative members are entitled to receive the legislative per diem and reimbursement of necessary expenses for their attendance at authorized meetings of the commission. Public members not otherwise compensated by their employers or other entities whom they represent are entitled to receive reimbursement of necessary expenses for their attendance at authorized meetings of the commission; and be it further

Sec. 7. Report. Resolved: That the commission shall submit its report, together with any necessary implementing legislation, to the Joint Standing Committee on Inland Fisheries and Wildlife no later than September 29, 2000. If the commission requires an extension, it may apply to the Legislative Council, which may grant the extension; and be it further

Sec. 8. Appropriation. Resolved: That the following funds are appropriated from the General Fund to carry out the purposes of this resolve.

	1999-00	**2000-01**
LEGISLATURE		
Commission to Study the Needs and Opportunities Associated with the Production of Salmonid Sport Fish in Maine		
Personal Services	$660	$495
All Other	2,700	2,150
Provides funds for the per diem and expenses of legislative members and expenses for other eligible members of the Commission to Study the Needs and Opportunities Associated with the Production of Salmonid Sport Fish in Maine and to print the required report.		
LEGISLATURE TOTAL	$3,360	$2,645

Emergency clause. In view of the emergency cited in the preamble, this resolve takes effect when approved.

APPENDIX C

Draft Resolve to Reauthorize the Commission to Study the Needs and Opportunities Associated with the Production of Salmonid Sport Fish in Maine

Emergency preamble. Whereas, Acts and resolves of the Legislature do not become effective until 90 days after adjournment unless enacted as emergencies; and

Whereas, 119th Legislature originally established the Commission to Study the Needs and Opportunities Associated with the Production of Salmonid Sport Fish in Maine in Resolves of 1999, chapter 82, with a reporting date of December, 2000;

Whereas, the 119th also Legislature appropriated $500,000 to be spent over the current biennium for engineering design for the Embden Hatchery and a statewide assessment of all other hatchery facilities;

Whereas, Reauthorization of this Commission for a two year period is essential to complete the original duties assigned to the Commission and to provide on-going Legislative policy guidance on the expenditures of those funds appropriated for engineering design for the Embden Hatchery and a statewide assessment of all other hatchery facilities; and

Whereas, in the judgment of the Legislature, these facts create an emergency within the meaning of the Constitution of Maine and require the following legislation as immediately necessary for the preservation of the public peace, health and safety; now, therefore, be it

Sec. 1. Commission established. Resolved: That the Commission to Study the Needs and Opportunities Associated with the Production of Salmonid Sport Fish in Maine, referred to in this resolve as the "commission," is established; and be it further

Sec. 2. Commission membership; appointed, Ad-hoc and ex officio members. Resolved: The Commission consists of 13 appointed members and one 1 Ad-hoc members as provided below:

1. That, except as otherwise provided in this section, all members appointed pursuant to Resolves of 1999, chapter 82, are reappointed as members of this Commission;

2. The President of the Senate shall appoint one member of the Senate to replace former Senator Leo Kieffer, who was appointed by the President of the Senate during the First Regular Session of the 119th Legislature as the Senate chair of the Commission established by Resolves of 1999, chapter 82. The person appointed to replace former Senator Kieffer shall be the Senate chair of the Commission; and

3. That former Senator Leo Kieffer is appointed as an ad hoc voting member of the Commission; and

4. The Governor shall appoint one person to replace one of the persons appointed by the Governor under Resolves of 1999, chapter 82, section 2, paragraph 6, and one person to replace the person appointed by the Governor under Resolves of 1999, chapter 82, section 2, paragraph 9.

Sec. 3. Duties. Resolved: That the commission shall complete all duties prescribed in Resolves of 1999, chapter 82 and shall provide oversight and policy guidance to the Department of Inland Fisheries and Wildlife with respect to the expenditure of funds appropriated by the 119th Legislature in Public Laws of 1999, chapter 731, Parts A-1 and HHHH-1, for engineering design for the Embden Hatchery and a statewide assessment of all other hatchery facilities. In addition, the Commission shall also:

1. Continue to work with the Department of Inland Fisheries and Wildlife and the department's consultant continue the work of evaluating the effluent characteristics of fish hatcheries, including private fish hatcheries, with the purpose of ensuring that the State fish hatcheries will be able to comply with licensed effluent discharge standards within three years and to obtain information relevant to discussions of discharge license standards for unlicensed private fish hatcheries;

2. Set statewide production goals for the number, size and species mix of recreational sport fish over a 15 to 20 year planning horizon;

3. Determine how to meet those production goals in the most cost effective manner by evaluating all production options, including options for investing in cost effective upgrades to existing state owned facilities to produce more fish, closing non-economic state owned facilities and building new capacity in other locations in Maine and purchasing fish from privately owned hatcheries; and

4. Within existing budgeted resources, undertake any studies or other activities as are necessary to complete the tasks outlined above.

Sec. 4. Staff assistance. Resolved: That the commission shall request staffing assistance from the Legislative Council; and be it further

Sec. 5. Compensation. Resolved: That legislative members and ad-hoc members are entitled to receive the legislative per diem and reimbursement of necessary expenses for their attendance at authorized meetings of the commission that occur on days in which the Legislature is not in Session. Other members not otherwise compensated by their employers or other entities whom they represent are entitled to receive reimbursement of necessary expenses for their attendance at authorized meetings of the commission; and be it further

Sec. 6. Report. Resolved: That the commission shall submit an interim report to the Joint Standing Committee on Inland Fisheries and Wildlife no later than December 1, 2001 and a final report to that same committee no later than October 31, 2002; and be it further

Sec. 7. Unexpended balances carried forward. Unexpended funds appropriated by Public Laws of 1999, chapter 731, Parts A-1 and HHHH-1, to the Department of Inland Fisheries and Wildlife, Fisheries and Hatcheries operation, are carried forward to Fiscal Year 2001-02 and must be used for the purposes originally appropriated. Those funds may not be encumbered for any purpose without prior consultation with the Commission;

Sec. 8. Appropriation. Resolved: That the following funds are appropriated from the General Fund to carry out the purposes of this resolve.

	2000-01	2001-02
LEGISLATURE		
Commission to Study the Needs And Opportunities Associated with the Production of Salmonid Sport Fish in Maine		
Personal Services	$1,200	$1,200
All Other	$1,200	$1,200
Total	**$2,400**	**$2,400**

Provides funds for the per diem and expenses of legislative members and ad-hoc members and expenses for other eligible members of the Commission to Study the Needs and Opportunities Associated with the Production of Salmonid Sport Fish in Maine and to print the required reports. This appropriation includes funds for advertising up to 2 public hearings and printing of the interim and final report.

Emergency clause. In view of the emergency cited in the preamble, this resolve takes effect when approved.

SUMMARY

This Resolve reauthorizes for an additional two years a study commission originally established by the 119th Legislature by Resolves of 1999, chapter 82. The purpose of this Commission is to study the needs and opportunities associated with the production of salmonid sport fish in Maine.

The Resolve reappoints all the members of the Commission originally appointed in 1999, except that it requires the Senate President to appoint a member of the Senate to replace a former Senator and requires the Governor to fill two vacancies among public members appointed by the Governor in 1999. This Resolve appoints the former Senator as an ad-hoc, voting member of this Commission.

The Resolve also carries forward into FY 2001-02 all unexpended balances appropriated to the Department of Inland Fisheries and Wildlife for FY 200-01 for fish hatchery engineering work. The Resolve appropriates a total of $4,800 for authorized per diem and expenses of commission members, advertising costs for up to two public hearings and the printing of an interim and final report.

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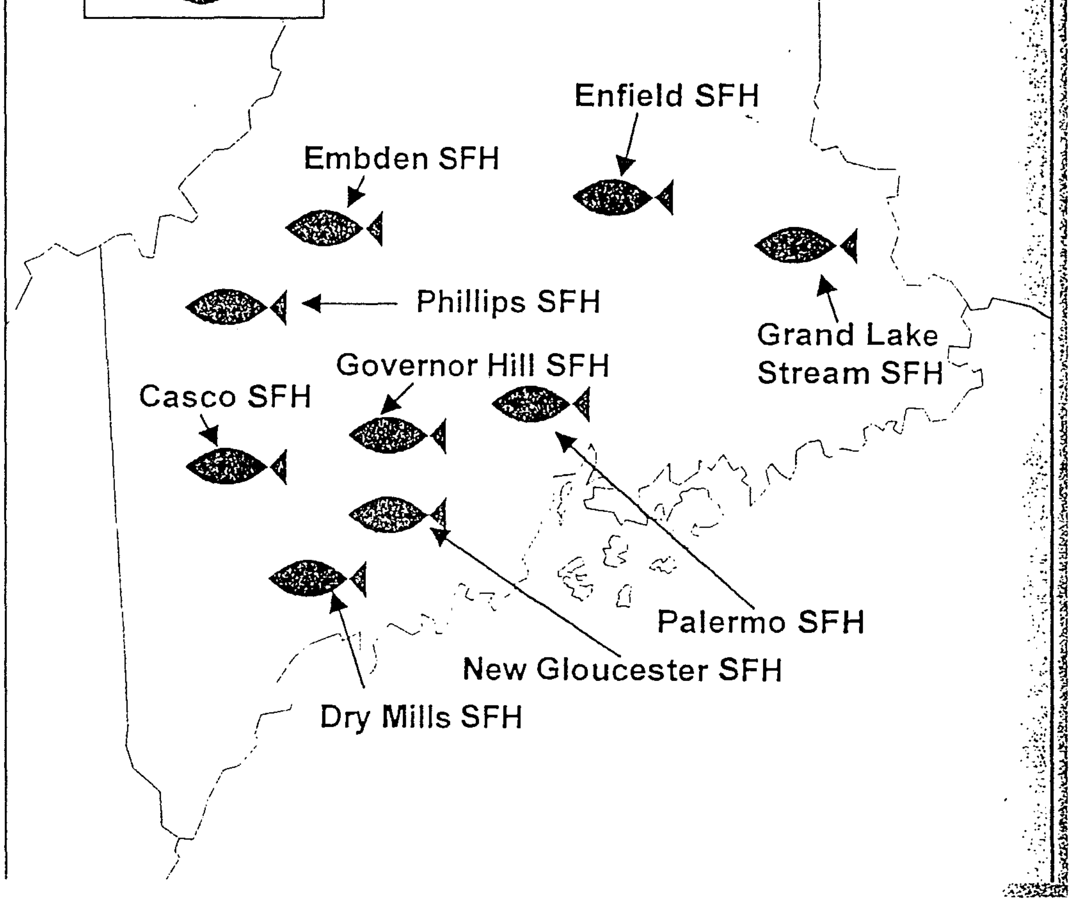
Appendix D

Strategic Fish Hatchery Planning and Engineering Study

November 2000

MAINE



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FISHPRO

I. EXECUTIVE SUMMARY

The Maine Department of Inland Fisheries and Wildlife and the "Commission to Study the Needs and Opportunities Associated with the Production of Salmonid Sport Fish in Maine" requested FishPro/Cochran & Wilken, Inc. to complete an independent review of the work of the Department and to provide recommendations on how to proceed with improvements to the fish hatchery system in Maine.

STRATEGIC PLAN RECOMMENDATIONS

It is the recommendation of this report to provide major capital improvement funds to provide state-of-the-art spawning, incubation, early rearing, and grow-out facilities to optimize existing water supplies, available land and existing staff.

Short-Term Plan

- Assess future statewide fish production needs and hatchery requirements to meet production. This work is ongoing and is essential to determine what hatchery production infrastructure resources are needed to meet production goals. The Department, Fish Hatchery Legislative Commission and the general public must develop a consensus regarding the statewide fish stocking needs in Maine so that fish hatchery production planning can proceed effectively and efficiently. The assessment of current hatchery infrastructure completed to date is an important step in this process that must continue in the future.

- Conduct effluent treatment needs analysis for each facility based upon Maine Department of Environmental Protection (DEP) Waste Discharge Licenses and current/future expanded fish production levels. This study is not complete and specific improvements are needed at three stations (Dry Mills, Governor Hills and Phillips) in order to comply with license limitations. Although all other stations are currently in license compliance, long-term improvements in effluent treatment are suggested as they reflect good resource stewardship and future compliance with DEP discharge standards.

- Conduct a comprehensive facility engineering study at Embden SFH regarding expansion and modernization and proceed with preliminary and final construction documents.

- Secure funding source(s) and legislative approval to proceed with the fish hatchery improvements and modernization program. The Fish Hatchery Legislative Study Commission should seek re-authorization (i.e., extension) from the Legislative Council and continue to work with the Department to oversee, guide and secured funding for the fish hatchery improvements program. The Commission and Department should develop a work plan to implement both the short-term and long-term plans outlined in this strategic planning document.

Long-Term Plan

- Conduct comprehensive engineering studies at the other eight MDIFW fish production facilities to accurately determine facility needs and associated improvements costs. What improvements are specifically needed, why and what will the benefits and costs be are questions that need to be answered.

- Based on the agreed assessment of statewide fish production needs now underway by MDIFW, evaluate production options to meet statewide fish production requirements. This work will involve the Department, Legislative Committee and Consultant Team in the assessment of an array of options to address statewide production requirements including important issues such as cost of production and stocking; existing facility improvements versus new facilities; priority list for improvements implementation; new stocking and production programs to meet management requirements and public needs; and project funding needs and options.

- Develop and implement a Long-Term Fish Hatchery Plan that addresses both short-term and long-term goals. Provide authorization, funding mechanism (both construction and Operation & Maintenance), time-line schedule, and oversight of plan.

- Determine what to do with the Dubois facility now under lease until 2004. If not retained as a MDIFW facility and selling it is an option, provide a mechanism to allow revenue to be used in funding of the hatchery improvements plan.

REPORT SUMMARY

The nine state hatcheries were all originally constructed in the early 1900's. These sites, Casco (1955), Dry Mills (1933), Embden (1957), Enfield (1958), Governor Hill (1923), Grand Lake Stream (1936), New Gloucester (1934), Palermo (1949) and Phillips (1931), have been in operation for a total of over 500 years. The entire fish hatchery production program provides approximately 1.3 million coldwater sportfish annually. The program is characterized by low density rearing providing high quality sportfish for support of the statewide stocking program.

The existing facilities can be broken down into three major fish production functions: water supply, production facilities (i.e., egg incubation, early rearing units, production rearing units), and wastewater treatment facilities. Water supply ranges from a low of 200 gallons per minute (gpm) at the Phillips Broodstock facility, to a high of over 3,500 gpm at Embden, Enfield and Palermo. Five hatcheries are supplied by surface water lakes and four by springs and groundwater systems. Surface supplies are impacted by low winter rearing temperatures and periodic pathogen introduction from existing fish populations in the water supply lakes. The primary advantage of lake water supply is the gravity flow operation.

The most critical component of a fish hatchery is the water; quantity, quality, and temperature. The water supplies at all nine hatcheries are in critical need of protection and improvement to provide adequate, disease-free, properly tempered water throughout the year as the fish culture demands require. An important recommendation of this report is to provide an array of water supply improvements at all nine locations. The improvements include wildfish and debris screening; ultraviolet disinfection; securing high water volumes to meet culture requirements; and improved dissolved gas management including supplemental dissolved oxygen.

The production facilities consist of broodstock holding unit; egg incubation and early rearing facilities; rearing raceways (linear concrete tanks that serially reuse the water for as many as 16 passes); and support facilities including on-site residences, offices, workshops and feed and equipment storage areas.

It should be noted that the Department has developed a strong working relationship with regional paper companies whereby the companies "Adopt-A-Hatchery" and provide materials, labor and equipment and design expertise to help maintain and upgrade the existing hatcheries.

The third major function each facility is the wastewater effluent system. The Department of Environmental Protection (DEP) is issuing new Year 2000 waste discharge licenses to all nine facilities. Effluent discharges from the hatcheries either go into Class A Streams (3) or Class B Streams (6). Three facilities (Grand Lake Stream, Casco, and Enfield) have no existing wastewater treatment systems. The other six facilities have either earthen or concrete solids settling basins. Waste Solids management must be given priority in all nine facilities to ensure compliance with DEP discharge licenses. A detailed study of the impact of the DEP Waste Discharge Licenses on the MDIFW Hatchery System is needed to determine potential production impacts, license compliance and required wastewater treatment improvements, if any.

Due to the age, deterioration and performance of the facility's infrastructure, the threat of decreased water quality and/or quantity, the need for more efficient rearing and production units, and the need to be in compliance with newly issued discharge licenses, it is the recommendation of this report to implement a major statewide renovation and expansion program at the nine state fish hatcheries.

An Implementation Plan has been recommended whereby the Department would concentrate on improvement, renovation and/or expansion at generally one hatchery a year over the next ten years (or more), based on a priority ranking as follows:

1. Embden
2. Grand Lake Stream
3. Palermo
4. Enfield
5. Casco
6. Dry Mills
7. New Gloucester
8. Governor Hill
9. Phillips

Concurrent with the design and construction at Embden, preliminary design would begin for the other eight facilities. Due to the urgency of the wastewater concerns, final design and construction of effluent treatment systems at Dry Mills, Governor Hills and Phillips since the hatcheries currently exceed DEP license limitations. Grand Lake Stream, Casco and Enfield should also be considered since they currently contain no wastewater treatment systems.

The planning and design period will generally require from 9 to 18 months per location, 3 months for the bidding process, and 9 to 18 months for the construction work. All time estimates are sensitive to size and complexity of the improvements. Start of design and planning to completion of construction and start-up will generally be 18 months for smaller ($1 million) projects and up to 36 months for larger ($3 to $4 million) projects.

It is recommended that $3 to $5 million be appropriated for the construction improvement to the Embden Fish Hatchery, and that $18 to $29 million be allocated over the next ten years to address improvements to the other eight facilities. Currently, $500,000 has been appropriated for further planning and design of Embden and preliminary design for the other eight hatcheries. The nature of the major construction work will require engineering plans and specifications, multiple trade contractor construction, start-up and testing. It should be made very clear that the type, size, complexity and system-wide nature of the recommended facility improvements including major renovation and expansion is not Facility Maintenance. The recommended improvements cannot and should not be construed as maintenance. The MDIFW has, in our opinion as aquaculture consultants who have evaluated several hundred sites, done an excellent job in maintaining the present infrastructure.

Strategic Fish Hatchery Planning & Engineering Study

II. Overview

FISHPRO

II. OVERVIEW

INTRODUCTION

The Maine Department of Inland Fisheries and Wildlife has been working with a wide cross-section of interested citizens, legislators, regulators, and commercial aquaculture facility operators for several years within an appointed group called the "Fish Culture Facilities Committee", as well as a recently established Legislative Commission to Study the Needs and Opportunities Associated with the Production of Salmonid Sport Fish in Maine. In January 2000, this group contacted FishPro/Cochran & Wilken, Inc., to provide them a scope-of-work and cost proposal needed to complete an independent review of the work of the Committee and the Department and to provide recommendations (i.e., a Strategic Plan) on how to proceed with improvements and/or expansion to the fish hatchery system in Maine. The plan should address critically needed improvements and the issue of increased fish production consistent with statewide fisheries management goals and objectives.

The Department has completed a self-analysis of their existing nine (9) hatchery/rearing facilities. They have accumulated a great deal of data regarding production, staffing, past capital and maintenance improvements, and tentative proposed repairs and upgrades (See Table II-1, Facility Overview). It was the desire of the Department and the Commission to have an Aquaculture Bioengineering Consulting Firm provide an independent review and comments on the existing conditions and potential improvements of the system.

In early March 2000, Mr. Thomas Johnson, Chief Fisheries Field Biologist, and Mr. Gary Wilken, Chief Civil Engineer for FishPro, were given a brief inspection tour (seven facilities in 2 ½ days) of the hatchery system by Mr. Steve Wilson, Superintendent of Fish Hatcheries for the Department. On March 08, 2000, the FishPro staff made a presentation to the Commission in Augusta regarding the facility assessment and typical comparison to "state-of-the-art" fish hatcheries throughout the nation.

This report is a compilation of the review of all the data provided by the Department and the Commission and the impressions of the facilities that were briefly toured in March. The end result of this report is to provide alternatives and recommendations regarding how to proceed with the development of a Statewide Fish Hatchery Strategic Plan.

WORK TO DATE

The Department has developed an excellent general overview and assessment regarding the hatchery system purpose and goals and brief descriptions of all nine facilities. Rather than ignore this work or restate it, we have chosen to try to incorporate large portions of the existing text and tables and supplement them as necessary to clarify or expand on important items and issues.

Table II-1. Facility Overview

	Casco Information	Dry Mills Information	Embden Information	Enfield Information	Governor Hill Information	Grand Lake Stream Information	New Gloucester	Palermo Information	Phillips Information
Water Supply									
Source	Pleasant Lake / 16" Pipe 2000 gpm (gravity feed)	Spring Water 1200 - 1400 gpm (gravity feed)	Embden Lake / 24" and 16" Lines 3500 gpm (gravity feed0	Cold Stream Pond / 24" and 16" Lir 3500 gpm (gravity feed)	Springs 700 gpm	West Grand Lake / 24" Line / 12" at 2000 gpm (gravity feed)	Spring-fed brook impoundment 1200-2000 gpm (gravity feed)	Sheepscot Lake / 24" and 16" Lines 3500 gpm	Springs / Well 125 - 200 gpm
Potential for Additional Water	Medium (UV reconstruction)	Medium - High (drilled wells)	Medium - High (lake level impacts)	Medium (Lake level impacts)	High (drilled wells, 1400 gpm)	Medium	Low-Medium (drilled wells)	Medium	Low (Drilled Wells)
Temperature Control Capability	Medium (two lake depths / no ml	Low (limited temperature flux)	High (no segregation between lines)	High (segregation between lines)	Low (Limited temperature flux)	Low	Good/Hatchery, Low/Raceways	High (segregation between lines)	Low (Limited Temperature Flux)
Water Quality	High (needs filtration)	High (needs filtration)	High	High	High	Excellent	Good/Hatchery, Mod/Raceways	High	Moderate
Condition of Supply Lines/Age	Medium / 1955	Good / 1980's	Medium / 1950's	Medium / 1950's	Good	Medium / 1960's	Excellent / 1990's	Medium / 1950's	Good
Water Treatment/Age of Equipment	UV / 1979	None	None	UV / Filtration (1976-79)	None	UV / Filtration / 1973	None	None	LHO / 1990's
Impacts on Adjacent Landowners	Low	Low	Low	Low	None	Moderate	Low	Low	None
Other Factors	> UV Capacity / Intake Multilevel Temp.	reduce silt, especially in hatchery				> flow possible with filter replacement			
Waste Discharge									
Type of Receiving Water/Class	Stream / Class B	Stream / Class B	Stream / Class B	Stream / Class A	Stream / Class B	Stream / Class A	Stream/Class B	Stream / Class B	Stream / Class A
Flow of Receiving Water (7Q10)	To be calculated by DEP	To be calculated by DEP	To be calculated by DEP	To be calculated by DEP	To be calculated by DEP	To be calculated by DEP	To be calculated by DEP	To be calculated by DEP	To be calculated by DEP
Flow Form Capacity	2000 gpm	1200 - 1400 gpm	3500 gpm	3500 gpm	700 gpm	2000 gpm	1200-2000 gpm	3500 gpm	125-200 gpm
Dilution Factor	To be calculated by DEP	To be calculated by DEP	To be calculated by DEP	To be calculated by DEP	To be calculated by DEP	To be calculated by DEP	To be calculated by DEP	To be calculated by DEP	To be calculated by DEP
Existing Type of Treatment	None	Settling Basin (700x20x3')	Settling Basin (90x40x4')	none	Settling Basin (700x30x3')	None	Settling Basin (600 x 20)	Settling Basin (100x30x3')	Setting Basin (100x8')Lagoon (100
Rearing Facilities									
Type/Description	32 Concrete Raceways (18,400 ft2)	21 Concrete Raceways (13,000 ft2)	24 Concrete Raceways (13,000 ft2)	36 Concrete Raceways (21,600 ft2)	16 Concrete Raceways (7,500 ft2)	14 Concrete Raceways (11,200 ft2)	Earthen Ponds (13,000 ft2)	31 Concrete Racewasy (18,500 ft2)	8 Concrete Raceways (4,500 ft2)
Condition/Age	Medium / 1955	Good / 1955, 1960, 1980's	Medium / 1950's / 1980's	Medium / 1950's / 1980's	Medium / 1950's, 1980's	Medium / 1960's, 1980's	Medium / 1930's	Medium / 1950's, 1980's	Medium / 1960's
Hatching Facilities									
Type/Description	Aluminum Troughs / gravity feed	Aluminum Troughs / gravity feed	None	Aluminum Troughs / gravity feed	Aluminum Troughs / pump feed	Aluminum Troughs / pump feed	Combi-Tanks, Aluminum Troughs, Pump Feed	None	Aluminum Troughs / Combi-Tanks
Condition/Age	Medium / 1962	Medium / 1930's	N/A	medium 1950's	Medium / 1930's	Medium / 1930's	Combi-Tanks / 1995 Aluminum Tro	N/A	Medium / 1930's, Excellent / 1990's
Other Support Facilities									
Type/Description	Garage / Storage Bldg / Work Shop / Office / 3 Residences	Garage / Storage Bldg / Workshop / Office / 3 Residences	Garage / Storage Bldg / Workshop / Office / 2 Residences	Garage / Storage Bldg / Work Shop / Office 2 Pole Barns, 2 Residences	Garage / Storage Bldg / Workshop / Office 1 / Residence	Garage / Storage Bldg / Work Shop / Office / 2 residences	Garage / Storage Bldg / Workshop Office / 2 Residences	Garage / Storage Bldg Workshop / Office / 2- Residences	Garage/Storage Bldg. Workshop / Office / 1 Residence
Condition/Age	Medium / 1955-1962	Medium / 1930's	Medium / 1950's	Medium / 1950's	Medium / 1930's - 1960's	Medium 1930's-1980's	Medium - Excellent / 1930's, 1995	Medium / 1950's	Medium / 1930's - 1970's
Staffing Level	3 Full Time	4 Full Time	2 Full Time / 1 Seasonal	4 Full Time	3 Full Time	3 Full Time	3 Full Time / 1 Seasonal	2 Full Time / 1 Seasonal	2 Full Time / 1 Seasonal
Planned Production Level	50,000 LLS / 50,000 BNT	175,000 BKT / 20,000 LKT	150,000 BKT / 30,000 LLS	220,000 BKT / 40,000 LLS	60,000 SPK / 30,000 BKT / 40,000 LI	85,000 LLS / 50,000 eggs	135,000 BK,T / 125,000 fry / Brood S	70,000 BKT / 60,000 BK,T	BKT brood stock / eggs to other st.
Net Worth of Facility	Buildings: $865,500 / 8 acres	Buildings: $746,300 / 187 acres	Buildings: $191,600 / 14 acres	Buildings: $715,900 / 18 acres	Buildings: $504,000 / 210 acres	Buildings: $556,200 / 13 acres	Buildings: $1,456,100 / 190 acres	Buildings: $284,800 / 21 acres	Buildings: $171,200 / 65 acres
Annual Operating Cost	Annual Operating Cost: $143,837	Annual Operating Cost: $206,000	Annual Operating Cost: $114,200	Annual Operating Cost: $192,700	Annual Operating Cost: $150,000	Annual Operating Cost: $149,000	Annaul Operating Costs: $153,000	Annual Operating Costs: $136,000	Annual Operating Cost: $110,000
Electric									
Available Electric Power	Three Phase	1 Phase / 3 Phase 1 mile away	2 Phase	3 Phase	2 Phase	1 Phase / 3 Phase available	2 Phase	2 Phase	2 Phase
Electric Costs	$9,736	$3,750	$1,924	$24,700	$6,557	$21,000	$11,364	$2,678	$9,800
Site Conditions									
Available Space for Expansion	Low / would require use of existing space	High	Moderate	Moderate	High	High	High	High	Moderate
Suitable Land for Expansion	Limited	Excellent	Good	Good	Good	Good	Excellent	Good	Good
Surrounding Land Use	Residential	Residential	Forestland		Forestland	Residential	Residential	Forestland	Forestland
Production Capability									
Brook Trout	Overwinter	Year Round	Year Round	Year Round	Year Round	Seasonal	Year Round	Year Round	Year Round
Landlocked Salmon	Year Round	No	Year Round	Year Round	No	Year Round	Limited	Year Round	No
Brown Trout	Year Round	Year Round	Year Round	Year Round	No	No	Year Round	Year Round	No
Lake Trout	Overwinter	Year Round	Seasonal	Year Round	Year Round	Seasonal	None	No	No
Splake	Overwinter	Year Round	Year Round	Year Round	Year Round	Seasonal	Year Round	Year Round	No
Rainbow Trout	Year Round	Year Round	Year Round BN,T	SPK Reg G / 25,000 (SY) BKT, RBT,	No	No SPK	Year Round	Year Round	No
Production Needs	Region A / 15,000 RBT or BKT (SY)	Reg. A 30,000 (SY & FY) BKT	Reg E / 15,000 (SY) BKT or RBT	Excellent (Northern/Eastern)	Increased production of SPK/BKT fry to supply other stations	Could assist with Enfield	Increase fry for rearing stations	Reg B / 60,000 (SY) BKT, BN,T, SPK or RBT	at other stations and private demands
Geographic Location				Good (Sourdnahunk Lake)					
Distribution Needs	Excellent	Excellent	Excellent	Excellent	Excellent (Central)	Excellent (Eastern/Northern)	Excellent	Excellent (Central/Eastern)	Excellent (Central)
Brood Stock Acquisition	Sebago LLS / Excellent / Panther	N/A	N/A	N/A	None	West Grand Lake LLS	BN,T local waters / Excellent	None	Kennebago Lake Strain

One major item that was not readily available and we feel an imperative planning tool was that no to-scale engineering plans of any of the facilities existed either at the hatcheries or in the Augusta Central Office. Through an engineering drawing archive file search by Steve Wilson, FishPro was provided the best available hatchery site plan sheets showing the "original" construction layout. With these drawings and with the use of existing aerial photography, FishPro was able to develop basic site plan sheets for all nine facilities, which located water supply, production buildings, support buildings and residences, roads, and wastewater facilities (if any). These plans have been field reviewed by the fish hatchery staff and are incorporated to this report in Appendix A. While these drawings do not show all piping and other utilities, they are good starting points for future planning; on-site operations; and base documents for future educational brochures and literature. Appendix A also includes series of photographs, which further characterize each facility and illustrate the general condition of the facility infrastructure.

HATCHERY SITE ANALYSIS

According to the Departmental records, the existing nine hatcheries were originally sited and developed as hatcheries generally in the first half of the 1900's. Specifically:

- Casco (1955)
- Dry Mills (1933)
- Embden (1957)
- Enfield (1958)
- Governor Hill (1923)
- Grand Lake Stream (1875/1936)
- New Gloucester (1934)
- Palermo (1949)
- Phillips (1931)

Rationale for locating hatcheries 50 to 70 years ago is still valid today. Ideally, a hatchery will be located downstream of an abundant, high-quality water supply. Gravity flow transmission from water source to discharge eliminates or reduces the need for pumping. Geographic location relative to where fish will be transported for release or broodstock sources is important as well. Five stations (Casco, Embden, Enfield, Grand Lake Stream and Palermo) use surface (lake) water supplies. Four facilities (Dry Mills, Governor Hill, New Gloucester and Phillips) use groundwater spring or well water supplies.

Generally, all of these hatcheries meet the above criteria and have been functioning successfully as hatcheries for a total of <u>over 500 years</u>! However, all facility infrastructure is now 40 to 80 years old and many components are reaching the end of their useful service life. The average age of the nine hatcheries is over 58 years. The system has served the citizens and the anglers of the State of Maine well. They serve as a living "memorial" to the fish culturists, administrators, engineers and construction crews who first developed each site as well as the dedicated hatchery staff that have operated, maintained and improved these facilities throughout the decades to the present.

The overall impression of the seven hatcheries toured was that the facilities were generally well maintained and that the staff was knowledgeable and dedicated. A series of photographs taken of the Phillips State Fish Hatchery and Grand Lake Stream State Fish Hatchery by the mangers along with telephone conversations provided helpful characterization of the two stations not visited during the brief tour. Despite the age, the deteriorating condition of some facility components, the less than optimum treatment of water supplies and the often non-existent wastewater treatment facilities, the end product (salmonid sport fish) being delivered to the public was high quality and economically produced. Table II-2 provides a comparison of the MDIFW Hatchery System to other state fish hatchery systems (T. Engerling, TPWD, 2000).

In order to analyze each hatchery site, we reviewed existing USGS 7.5 Minute Quadrangle Maps, Delorme Maps, and aerial photographs. We obtained the aerials from the USGS National Aerial Photography Program (NAPP). These photos are reflown at least every five years. Since they are high altitude (20,000 feet) flights, they are not ideal for to-scale enlargement. However, since this is the only source available, 1"=200' photos were developed to assist us in overall site analysis. These photographs are included in Appendix A, along with engineering site plans that were developed for this report. The most current photos available had the following flight dates:

Casco:	04/29/98	Grand Lake Stream:	05/28/97
Dry Mills:	04/29/98	New Gloucester:	04/29/98
Embden:	05/07/96	Palermo:	04/27/97
Enfield:	04/07/97	Phillips:	06/03/97
Governor Hill:	05/07/96		

The timing of taking aerial photographs is critical. They must be taken when leafy vegetation is off and when snow cover is gone (or minimal). This leaves a very short window of time when this work can be done. A recommendation of this report will be that low altitude aerial photos be flown that can be converted to topographic (one foot contour) plans for further study and design documents.

Since all the hatcheries are gravity flow, linear (serial reuse) raceway design the actual production components of the systems are very compact. This "compacted" concept generally resulted in fairly small tracts or parcels of properties associated with the State-owned facility. According to records provided by the Department, the approximate acreage of each hatchery is as follows:

Casco	8	Grand Lake Stream	13
Dry Mills	187*	New Gloucester	190*
Embden	14	Palermo	21
Enfield	18	Phillips	65
Governor Hill	210*		

* The acreage associated with these facilities includes some steep valleys and/or wetland/ bog areas that are not suitable for hatchery production unit construction.

WATER SUPPLIES

Water supplies at existing facilities are adequate to support existing and modestly expanded levels of production. Lake water facilities have existing supplies of from 2,000 to over 4,000

Table II-2 State Fish Hatchery Comparative Summary

State	Number of Facilities	Production Acres	Number of Raceways	Full-time Emplyees	Part-time Employees	Production	Operating Costs
Alabama	3	105.0	16	17	0	4,000,000	$715,000
Arkansas	5	480.0		40	12	15,357,383	$1,479,400
Colorado	17	92.5	306	81	10	59,252,015	$2,270,263
Florida	2	70.5	24	12	2	3,365,000	$570,000
Georgia	10	150.4	0			37,262,146	$2,341,100
Illinois	3	68.5	53	27	15	67,000,000	$1,455,000
Indiana	8	95.0	10	26	17	25,000,000	$464,175
Iowa	5	39.2	74	19	13		$1,950,290
Kansas	4	125.0	24	16	13	52,655,123	$873,925
Kentucky	2	180.0	36	25	6	6,000,000	$574,500
Louisiana	5	116.0	16	15	3	5,000,000	$310,000
Maryland	11	29.0	36	22	6	13,835,000	$1,500,000
Mississippi	3	80.0	0	9	3	2,000,000	$575,000
Missouri	11	107.0	171	69	20	18,956,714	$992,848
Nebraska	5	164.1	65	22	2	9,700,000	$408,178
North Carolina	6	83.0	100	26	2	2,000,000	$549,000
Oklahoma	4	185.0		23	6	30,000,000	$560,000
South Carolina	7	76.0	0	22	6	8,360,359	$643,884
Tennessee	9	90.3		30	5	5,260,890	$500,781
Texas	5	307.0	26	56	0	30,000,000	$782,921
Virginia	9	63.0	1.4 acres	38	29	6,300,000	$907,414
Washington [1]	90		14	312		221,689,601	$9,801,718
Average	**6.4**	**128.9**	**56.3**	**29.8**	**8.5**	**20,065,232**	**$972,556**
Maine	**9**	**0**	**206**	**26**	**4**	**1,370,000**	**$1,354,737**

1 - Not included in average

Source - Texas Wildlife & Parks Division (1999), FishPro gpm. The two lake water facilities with the lowest supply of 2,000 gpm (Casco and Grand Lake Stream) are limited by the size and configuration of the water supply lines and UV equipment, and not the supply of lake water. Enfield, Embden, and Palermo have water supplies of from 3,500 to over 4,000 gpm; however, these facilities are at maximum capacities **due to lake draw down limitations (lake data is needed to document requirements & impacts under different facility water use regimes).** The potential exists to significantly expand production at these facilities with existing water supplies using new round tank technology. None of these facilities are, however, considered suitable for extremely large scale increases in production (an increase in production of over 300,000 fish greater than 6 inches). Governor Hill is a spring fed facility with a capacity of 700 gpm, however, over 400 gpm of well water has been located and is available for development. Dry Mills is a spring fed facility with up to 1,400 gpm, however it is also located on an aquifer and additional underground water is also likely available. New Gloucester is on an impounded spring fed brook with a capacity of up to 2,000 gpm, however low flow periods can affect production. One 150 gpm well has been developed at this facility to supply the new hatchery, and a second well estimated to produce up to 40 gpm is also available for development. Water temperature within individual raceway lines can be regulated at Palermo, while mixing at Embden occurs above the head box and precludes differential temperature control. At Casco and Enfield temperature mixing occurs above the UV systems and water temperatures cannot be adjusted in the individual raceway lines. Water supplies at Palermo and Embden are not UV treated. Grand Lake Stream has no means to adjust water temperature. A deep water line would need to be installed to accomplish this.

PRODUCTION FACILITIES

All hatcheries but Embden and Palermo have incubation, hatching and early rearing facilities. Phillips was upgraded in 1990 and a new hatchery building was constructed at New Gloucester in 1995. All the other hatching facilities are 20 to 70 years old. Constant temperature and disease-free groundwater supplies are very important resources at Dry Mills, Governor Hill, New Gloucester and Phillips. Cold winter lake water temperatures adversely impacts rearing cycles (especially early rearing) at Casco, Enfield and Grand Lake Stream.

New Gloucester is the only facility with earthen pond rearing raceways. The other 8 hatcheries all have concrete raceways (serial reuse – up to 16 passes). The hatcheries with the number of raceways, their raceway capacity (in square feet of surface area) and the decade of original construction(s) is as follows:

Hatchery	Number of Raceways	Raceway Capacity	Raceway Volume	Decade of Construction
Casco	32	18,400 SF	24,472 CF	1950
Dry Mills	21	13,000 SF	17,290 CF	1950, 1960, 1980
Embden	24	13,000 SF	17,290 CF	1950, 1980
Enfield	36	21,600 SF	28,728 CF	1950, 1980
Governor Hill	16	7,500 SF	9,975 CF	1950, 1980
Grand Lake Stream	14	11,200 SF	14,896 CF	1960, 1980
New Gloucester	22*	13,000 SF	17,290 CF	1930
Palermo	31	18,500 SF	24,605 CF	1950, 1980
Phillips	8	4,500 SF	5,985 CF	1960

*Earthen Ponds

Each facility (except New Gloucester and one series at Embden) has permanent covers over their production units. Concrete deterioration and spalling, and leaking wastewater cleanout valves are the most common recurring problems observed.

All facilities have garage/storage/workshop/office buildings, as a minimum. On-site residences for on-call staff vary from one to three houses per site. New roofs, windows, siding, and electric have been installed at most facilities, with plans for the remainder to be completed in the next few years.

WASTEWATER TREATMENT

Existing wastewater treatment facilities consist of concrete solids clarifiers at Embden and Palermo and earthen settling basins at Dry Mills, Governor Hill, New Gloucester and Phillips. Treatment is non-existent at Casco, Enfield, and Grand Lake Stream. The discharge licenses developed by the Department of Environmental Protection (DEP) may require that all facilities upgrade their solids collection and handling systems prior to discharge.

All hatcheries discharge into either Class A Streams (3) or Class B Streams (6). The following list provides current peak discharge and type of wastewater treatment discharge:

Hatchery	Peak Discharge	Wastewater Treatment System
Casco	2,000 gpm	None
Dry Mills	1,400 gpm	20'x700' earthen channel
Embden	3,500 gpm	40'x90' concrete tank
Enfield	3,500 gpm	None
Governor Hill	700 gpm	30'x700' earthen channel
Grand Lake Stream	2,000 gpm	None
New Gloucester	2,000 gpm	20'x600' earthen channel
Palermo	3,500 gpm	30'x100' concrete tank
Phillips	200 gpm	8'x100' earthen channel and 25'x100' setting lagoon

There are basically two types of discharges from each hatchery. The largest quantity of discharge is overflow water. After passing through 6 to 16 serial raceway rearing units, it overtops the last unit and usually flows directly to the receiving stream. The second type of discharge, production unit cleaning waste, is discharged manually on a regular basis when workers clean each individual rearing unit. The concentrated waste (uneaten food and feces) is discharged from the unit solids settling chamber (quiescence zone) for a period of 5 to 10 minutes per unit.

This concentrated waste ideally should be directed to an off-line clarifier or settling basin, which will settle and remove accumulated solids by simple gravity settling. Microscreening and/or filtering of low concentrations overflow wastewater can be completed to meet DEP discharge limits, if required.

WATERSHED/ECO-SYSTEM ANALYSIS

Fish hatcheries by their very nature are designed to utilize and enhance the natural resource. A full-scale comprehensive statewide fish hatchery engineering analysis should include an investigation on the existing and potential impacts the fish hatchery has on the surrounding watershed/eco-system and conversely the impacts that other developments or degrading activity may have on the hatchery.

The following is a very brief analysis for each hatchery location. This analysis can be expanded as appropriate during the next phase of the study/ development plan.

1.) **Casco Fish Hatchery**

Water Source:	Pleasant Lake – 2,000 gpm maximum.
Wastewater Treatment:	None
Discharge:	To Class B Waters – Mill Brook to Crooked River to Sebago Lake.
Surrounding Land Use:	Residential

2.) **Dry Mills Fish Hatchery**

Water Source:	Multiple Springs – 1,400 gpm maximum
Wastewater Treatment:	20' x 700' settling basin
Discharge:	To Class B Waters – Hatchery Brook to Mill Brook to Libby Brook to Collyer Brook to Royal River
Surrounding Land Use:	Game Farm on east, major new residential development at Crystal Lake along State Route 26. The West Spring is only 1,000 feet from highway/ development.

3.) **Embden Fish Hatchery**

Water Source:	Embden Lake – 3,500 gpm maximum
Wastewater Treatment:	40' x 90' settling basin
Discharge:	To Class B Waters – Mill Stream to Carrabassett River to Kennebec River.
Surrounding Land Use:	Domestic sewage lagoon located upstream to NW.

4.) **Enfield Fish Hatchery**

Water Source:	Cold Stream Pond – 3,500 gpm maximum
Wastewater Treatment:	None
Discharge:	To Class A Waters – Cold Stream through wetlands to Passadumkeag River to Pennobscot River
Surrounding Land Use:	Residential

5.) **Governor Hill Fish Hatchery**

Water Source:	Two major springs – 700 gpm maximum. Two new groundwater wells – 450 gpm maximum.
Wastewater Treatment:	30' x 700' settling basin
Discharge:	To Class B Waters – Spring Brook to Tanning Brook to Bond Brook to Kennebec River
Surrounding Land Use:	Forestland. Upstream developments at Sanford Road (multiple gravel pits and new residential areas at Summer Haven.)

6.) **Grand Lake Stream Fish Hatchery**

Water Source:	West Grand Lake – 2,000 gpm maximum
Wastewater Treatment:	None
Discharge:	To Class A Waters – Grand Lake Stream to Big Lake to St. Croix River.
Surrounding Land Use:	Totally surrounded by residential.

7.) **New Gloucester Fish Hatchery**

Water Source:	Spring-fed brook impoundment – 2,000 gpm maximum
Wastewater Treatment:	20' x 60' settling basin
Discharge:	To Class B Waters – Eddy Brook to Libby Brook to Collyer Brook to Royal River
Surrounding Land Use:	Residential. Maine Turnpike is 1,000 feet west upstream of the hatchery. Sand pit located 6,000' NW.

8.) **Palermo Fish Hatchery**

Water Source:	Sheepscot Lake – 3,500 gpm maximum
Wastewater Treatment:	30' x 100' settling basin
Discharge:	To Class B Waters – Sheepscot River through Long Pond to Sheepscot River.
Surrounding Land Use:	Forestland. Little other development.

9.) **Phillips Fish Hatchery**

Water Source:	Springs and Groundwater Well – 200 gpm maximum
Wastewater Treatment:	8' x 100' settling basin and 25' x 100' lagoon
Discharge:	To Class A Waters – Toothaker Pond to Sandy River to Kennebec River.
Surrounding Land Use:	Forestland. Little other development.

The purpose of the more in-depth analysis will be to correlate surface water withdrawal impacts, groundwater (springs and wells) withdrawal impacts; other water withdrawals within the watershed; upstream encroachments that will have negative impacts to water quality and quantity; how to optimize wastewater treatment effectiveness; impacts on downstreams Class A and Class B waters.

FUTURE DATA AND STUDIES

In order to develop a comprehensive understanding of the existing condition impacts and future potential for each hatchery additional data should be obtained. The following is a partial list of issues that need to be reviewed in the next level of the Statewide Study:

1. Water Quality/ Quantity/Temperature Profiles: Need to understand the existing water quality parameters and monthly temperature maximum/minimum as well as potential for modifications to enhance and optimize the quality/quantity/temperature to the needs of each hatchery. Part of this data has been completed during the **Fish Hatchery Effluent Study**; however, many data gaps still exist.

2. Wastewater Characteristics: Additional monitoring and water quality analysis for overflow and cleaning wastewater that is currently being discharged to and from any settling basins and/or directly to the receiving stream is needed. This data is a component of the new Discharge License as issued by DEP. Some additional data is also needed to fill in certain gaps in understanding existing effluent treatment system performance.

3. Confirmation of Existing Conditions: As discussed previously we have developed existing site plans based on old drawings, air photos, and site photographs. Each hatchery staff has completed their review, confirmation, and revision of the site plans and these have been included in the existing condition documentation. These plans along with proposed new aerial photography, topography (See Item #5 below) will serve as the basis of all future planning, maintenance, and design and construction drawings.

4. Hydrogeologic Investigations: Due to the need for constant temperature for incubation and rearing and in order to reduce the need to filter and sterilize surface/spring water supplies it appears that additional utilization of ground water as supplemental supply is logical. A statewide analysis for possible groundwater sources should be conducted either by a State Agency that is involved in this type of investigation and permitting; or by a private hydrogeology consultant as part of the Statewide Study is recommended.

5. Aerial Photography/Topographic Mapping: As discussed in other sections, it is recommended that all nine hatchery sites be flown for to-scale aerial photographs. Survey ground control at each hatchery will provide for future topographic plotting of the contours if beneficial to the planning/ design process. As needed, to confirm critical elevations (head box inverts, supply and discharge pipe elevations, etc.) minimal on-site survey work will also be beneficial.

   This work could be included as part of the Statewide Study, or could be executed as a separate contract with an Aerial Survey Company. At a minimum all sites should be flown and ground control completed. Topographic mapping could be authorized and plotted later as the need was determined. Cost to complete all photo, ground control and topographic mapping is estimated to be $70,000 to $90,000.

ADOPT-A-HATCHERY

The Department has a very innovative and successful program whereby regional paper companies provide materials, labor, and design expertise to upgrade existing hatcheries.

It is recommended that this work continue and the Statewide Study include a section for each facility for projects and proposed schedule for future "adopt" projects.

Strategic Fish Hatchery Planning & Engineering Study

III. Current Program

FISHPRO

III. CURRENT PROGRAM

PREFACE

Since the late 19th century, the Department has been actively involved in the management of fisheries on the State's thousands of lakes, ponds, rivers, and streams. These programs have focused on the protection of native self-sustaining populations, as well as the establishment and maintenance of other non-native species throughout the state. Large and smallmouth bass were introduced to the waters throughout the southern half of the state and today represents a major self-sustaining sport fishery. Species such as landlocked salmon, brook trout, brown trout, and a variety of other species are currently maintained by stocking in over 700 waters throughout the state. The greatest amount of recreational interest is directed toward eight (8) species: landlocked Atlantic salmon, brook trout, lake trout, brown trout, largemouth bass, smallmouth bass, chain pickerel, and white perch. Bass, pickerel, perch and other "warmwater" species in Maine are perpetuated by natural reproduction, so no stocking program for these prolific species is considered necessary.

IMPORTANCE OF FISH CULTURE

The annual production of fish from Department fish culture stations play a vital role in the maintenance of salmonid angling opportunities that are highly valued by Maine anglers, as well as thousands of visitors who come to Maine annually to enjoy the State's outdoor heritage. Many of Maine's salmon and trout fisheries would not exist without the help of artificial propagation. Over 60 percent of the state's landlocked salmon waters have inadequate spawning habitat and are maintained by stocking. For example, only about four natural populations of landlocked salmon existed historically within the state. Now there are over 200 lake salmon fisheries statewide. Currently, over 1 million salmon and trout over 6 inches in length and up to 400,000 fry are stocked in over 700 lakes and over 100 streams each year. In recent years, greater reliance has been placed in the size, health, and genetic makeup of the Department's hatchery stock to maximize survival in the wild. Although the number of fish stocked has been declining over the years, the size of fish stocked has been steadily increasing. In 1996, the Department stocked out nearly 250,000 lbs of fish that represents the greatest weight ever produced by this agency (Table 1.). Despite a heavy reliance on stocking to maintain salmonid fisheries and keep up with demand, the Department of Inland Fisheries and Wildlife places priority on preserving wild (self-sustaining) populations where possible.

ECONOMIC VALUE OF SPORT FISHERIES

The economic impact of Maine's inland sport fishery has been studied by Kevin Boyle, a resource economist from the University of Maine's Department of Agriculture and Resource Economics. Based upon the results of a survey of fishermen in 1989, Boyle estimated the economic impact of Maine's inland sport fishery to be at least $160 million per year. Of that, at least $40 million was generated by nonresidents. Hatchery fish currently provide 49 percent of the principle salmonid fishery in Maine lakes and ponds, and are crucial to maintaining the economic benefits derived from these resources.

FISH CULTURE FACILITIES

The Department operates nine (9) fish culture facilities located in Gray, Casco, New Gloucester, Palermo, Augusta, Embden, Enfield, Grand Lake Stream, and Phillips. A tenth facility located at Deblois was closed in the early 1980s due to budgetary short falls. This facility was subsequently placed under a long-term lease to a private aquaculture firm for the production of Atlantic salmon smolts. The current lease expires in the year 2004. The nine facilities currently operated by the Department were built in the late 1930s and the 1940s with the newest production facility constructed at Enfield in 1959. Each facility represents a distinct operation as far as geographical location, production capabilities, water supply, physical plant, fish husbandry, operation particularities, waste discharge capacity, and related matters. Some are fed by lake water, while others receive their water supplies from springs, and underground wells. All are relatively simple gravity feed systems that are quite economical to operate with a relatively low level of environmental impact. The culture program is characterized by relatively low density rearing (kg/cubic meter) and low loadings (kg/lpm). The use of "open" lake water supplies with the potential to periodically introduce fish disease is one primary reason for the use of low density rearing. Modern water supply treatment technologies recommended in this report can achieve higher density rearing but do have a significant capital cost for both construction and operation.

FISH CULTURE OPERATIONS

The operation of these facilities involves: (1) close coordination with the Department's fisheries biologists regarding the number, size, species, and strains of fish needed for future fisheries management programs, (2) the capture of wild fish for eggs, and the development, management, and care of brood stock, (3) the care and hatching of eggs, (4) the husbandry of a number of species and associated strains of coldwater fish, each having specific environmental and care requirements, from egg sac stage through the large fish retained for brood stock, and (5) the distribution of fish to waters throughout the state by large hatchery trucks, small tank trucks, airplane, ATV, and backpack as appropriate.

Production schedules are planned several years in advance to ensure the number and size of a particular species/strain are available to meet the Department's fisheries management needs. Exactly what species are produced by a particular facility are governed but the need for specific species/strain and size of fish, the suitability of a facility for specific species, and the geographic need for specific species. This requires a very close working relationship between the fish culture staff and fish management staff.

Fish are raised for the purpose of stocking into the wild; and health, condition, and behavior factors are vital to the success of this program. To this end, eggs to establish brood stocks are acquired in the wild or maintained, and their off spring raised at relatively low densities in controlled environments. Changes to fish culture practices are steadily increasing growth rates, and resulting in a much larger fish at the time of stocking then occurred only a few years ago. These fish are stocked by the fish culture and fish management staff using a variety of methods. The stocking of many waters includes the boating of fish to various sections of the water body to spread the fish out and reduce depredation. Seven hundred lakes, ponds, rivers, and streams are stocked annually, many of which receive multiple stockings. The stocking of fish by hatchery personnel alone requires nearly 500 workdays each year, and over 65,000 vehicle miles.

CURRENT AND FUTURE PRODUCTION REQUIREMENTS

Department goals over the next 10 years are to maintain production of landlocked salmon and lake trout, while increasing production of brook, brown trout, rainbow trout, splake, and whitefish. This would increase production of fish greater than 6 inches from 1 to 1.4 million fish annually. During the Year 2000, MDIFW Fisheries Management biologists will be completing a statewide assessment of stocking needs by species (i.e., Species Management Plans). These plans involve input via public hearings to determine "future" stocking requirements on a statewide level. This revised statewide stocking needs assessment is <u>essential</u> to the fish hatchery planning process. Specific production program facility infrastructure requirements cannot be effectively completed without knowing the species, numbers and sizes of fish to be produced.

FACILITIES ENHANCEMENTS

In 1987, the status of these facilities was assessed in a comprehensive manner, and a plan adopted to address a variety of maintenance needs. Although some of these needs have been addressed since that time, inadequate funds have kept maintenance and enhancement projects at less then desired levels. Raceway renovations were completed at several facilities (Grand Lake Stream, Palermo, Governor Hill, and Dry Mills), and production increased at Dry Mills by increasing water supplies and reclaiming previously unused raceways. Recent renovations to the water supply dam, construction of a new hatchery facility, and development of underground well water supplies have greatly enhanced the operation of the New Gloucester facility. At Governor Hill, new sources of well water have been located that will allow a significant expansion in both brood rearing and fry production, while also allowing for a modest increase in fish for stocking. In addition, voluntary assistance from major paper companies through an "Adopt-A-Hatchery" program is providing technical support and assistance needed to address many ongoing maintenance needs at each facility. All of the nine facilities have been adopted and will be benefiting from significant corporate / employee contributions resulting in major improvements. The Department is also committing significant resources (up to $250,000 annually over the next few years) to support this effort.

RENOVATIONS AND IMPROVEMENTS

Since 1993, considerable effort has been focused on the passage of a general fund bond issue to finance a major upgrade of these facilities including system improvements and expansion (where appropriate). Funds from a bond issue would be used to incorporate new fish rearing technology, expand and protect water supplies, and meet new effluent discharge requirements associated with expanded production. The most recent effort was aborted because of the need for a detailed long-range plan upon which passage of a bond issue could be based.

The Fish Culture Facilities Committee was established by the Commissioner in the spring of 1996 to develop recommendations regarding the future development / maintenance of the Department's fish culture facilities. The recommendations were to provide the basis for defining future development/maintenance projects carried out with Department funds and support from the "Adopt-A-Hatchery" program. In addition, it was to provide the basis to support a search for additional funding to enhance the Department's fish culture operations based on an assessment of alternatives associated with accomplishing the Department's fish culture goals. The work of this committee was never completed, as waste discharge license requirements were never determined by the DEP. Discharge Licenses have been issued (July 25, 2000) and their impact to the MDIFW Hatchery System has been assessed in the Fish Hatchery Effluent Study (see report November, 2000). In 1999, the legislature created a task force to study the needs and opportunities associated with the production of salmonid sport fishing in Maine. The Fish Hatchery Legislative Study Commission was provided the information compiled by the previous committee and, in cooperation with the Department, contracted for this study. The purpose of this study is to review facility characteristics, problems and potential maintenance/improvement needs or expansion potential; evaluate preliminary assessments by the Department regarding maintenance needs and enhancement opportunities; and to develop generalized conceptual improvements drawings, improvements priority list, global cost estimates, and implementation schedules. This Strategic Plan will help to guide the planning, design and construction process in the future.

DEPARTMENT GOALS AND OBJECTIVES (1997)

1) Upgrade fish culture capabilities with a specific objective of increasing production capabilities of fish greater than 6 inches in length from 1 to 1.4 million per year. Production needs are being evaluated statewide in the Year 2000. Revised species, numbers and sizes will determine statewide production requirements.

2) Maximize hatchery fish survival in the wild.

3) Maximize program efficiency and effectiveness.

FISH CULTURE FACILITIES COMMITTEE (1996)

The committee was asked to develop recommendations that:

- Support the accomplishment of the production goals.
- Assure desired level of fish condition and health, as well as desired behavioral traits.
- Improve operational efficiencies.

- Minimize capital expenditures.

- Allow for the efficient and effective distribution of fish statewide.

To carry out its charge the committee selected the following course of action:

- Compile and review information regarding a variety of variables involved in assessing fish culture facilities.

- Visit as many facilities as possible to assess first hand: (1) the physical configuration and operation of the facilities; (2) maintenance needs and expansion opportunities; (3) existing and potential production capabilities and any related matters.

- Assess existing and potential water supplies at each facility.

- Assess the impact of pending wastewater discharge licensing requirements on existing and expanded levels of production at each facility.

- Identify and assess potential renovations and improvements to each facility.

- Identify preferred options.

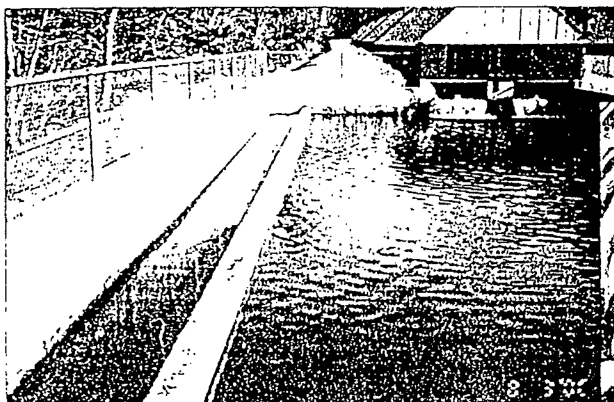
LEGISLATIVE COMMISSION TO STUDY THE NEEDS AND OPPORTUNITIES ASSOCIATED WITH PRODUCTION OF SALMONID SPORT FISH IN MAINE (1999)

On June 17, 1999, the Governor approved a Legislative Resolution (S.P. 332-L.D. 986) to establish a 13 member Commission to assess and evaluate salmonid fish culture facilities in Maine and associated needs, including waste discharge licensing issues. In addition, the Commission is to develop recommendations designed to provide for the production and distribution of fish needed to meet future sport fish management program needs in the most cost-effective manner. The Commission is to submit its report, together with any necessary implementing legislation, to the Joint Standing Committee on Inland Fisheries and Wildlife no later than September 29, 2000.

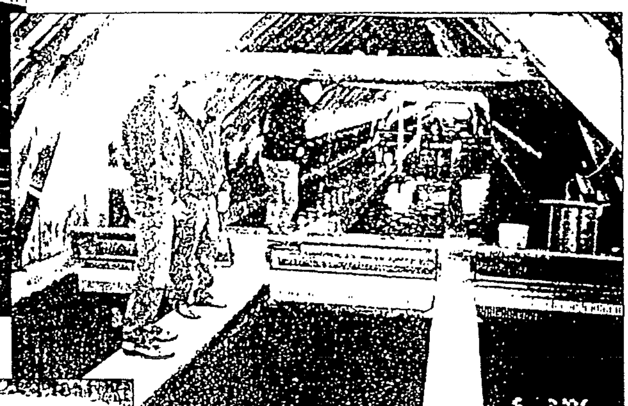
Appendix E

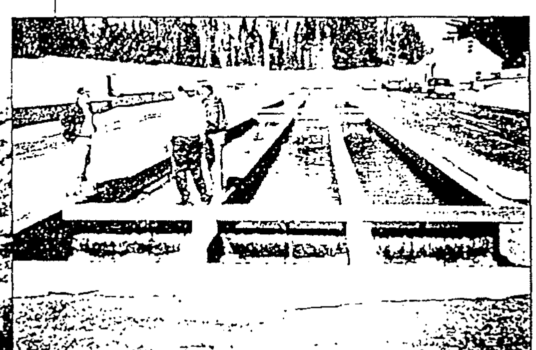
Maine Department of Inland Fisheries & Wildlife

Fish Hatchery Effluent Study



November 2000





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I. Introduction

FISHPRO

I. INTRODUCTION

Preface

Recreational fishing in the United States has grown to become the second most popular recreational activity in the country, second only to swimming. According to a 1996 National Survey conducted by the U.S. Department of the Interior, Fish and Wildlife Service, and the U.S. Department of Commerce, Bureau of the Census, 32.5 million U.S. residents 16 years of age and older engaged in fishing activities throughout the country. In all, $24.2 billion was spent on freshwater fishing for equipment and trips during 1996. Of the 32.5 million, 356 thousand residents and nonresidents enjoyed fishing activities throughout the State of Maine. Those fishing the state averaged 14.2 days per angler and over 5.1 million total fishing days.

The popularity of recreational fishing has increased the demand for goods and services by an estimated 37 percent nationwide between 1991 and 1996. In Maine alone, anglers spent approximately $349 million on fishing related items that included $144 million on trip related expenditures, $180 million on equipment, and $40 million in other expenses such as magazines, club memberships and tours. These expenditures translated to over 8,600 Maine jobs in 1996.

With the obvious fishing pressure and economic support that freshwater fishing has, the need for fisheries management is greater than ever. Therefore, it is very important to protect, manage, and enhance the fisheries resources throughout Maine. Management programs utilize fish stocked from Maine Department of Inland Fisheries and Wildlife (MDIFW) operated fish hatcheries as one of several essential tools to provide statewide fisheries resource management. For over one hundred years, Game and Fish Agencies have successfully integrated fish stocking requirements with the operation of public fish hatcheries.

The MDIFW mission focuses on the protection and enhancement of the state's inland fisheries and wildlife, while at the same time providing for the wise use of these resources. The Department is dedicated to assuring that these highly valued resources are available for the use and enjoyment of future generations. MDIFW operates nine coldwater fish hatchery facilities throughout the state, which support the state fisheries management program including (see Figure I-1):

- Casco State Fish Hatchery
- Dry Mills State Fish Hatchery
- Embden State Fish Hatchery
- Enfield State Fish Hatchery
- Governor Hill State Fish Hatchery
- Grand Lake Stream State Fish Hatchery
- New Gloucester State Fish Hatchery
- Palermo State Fish Hatchery

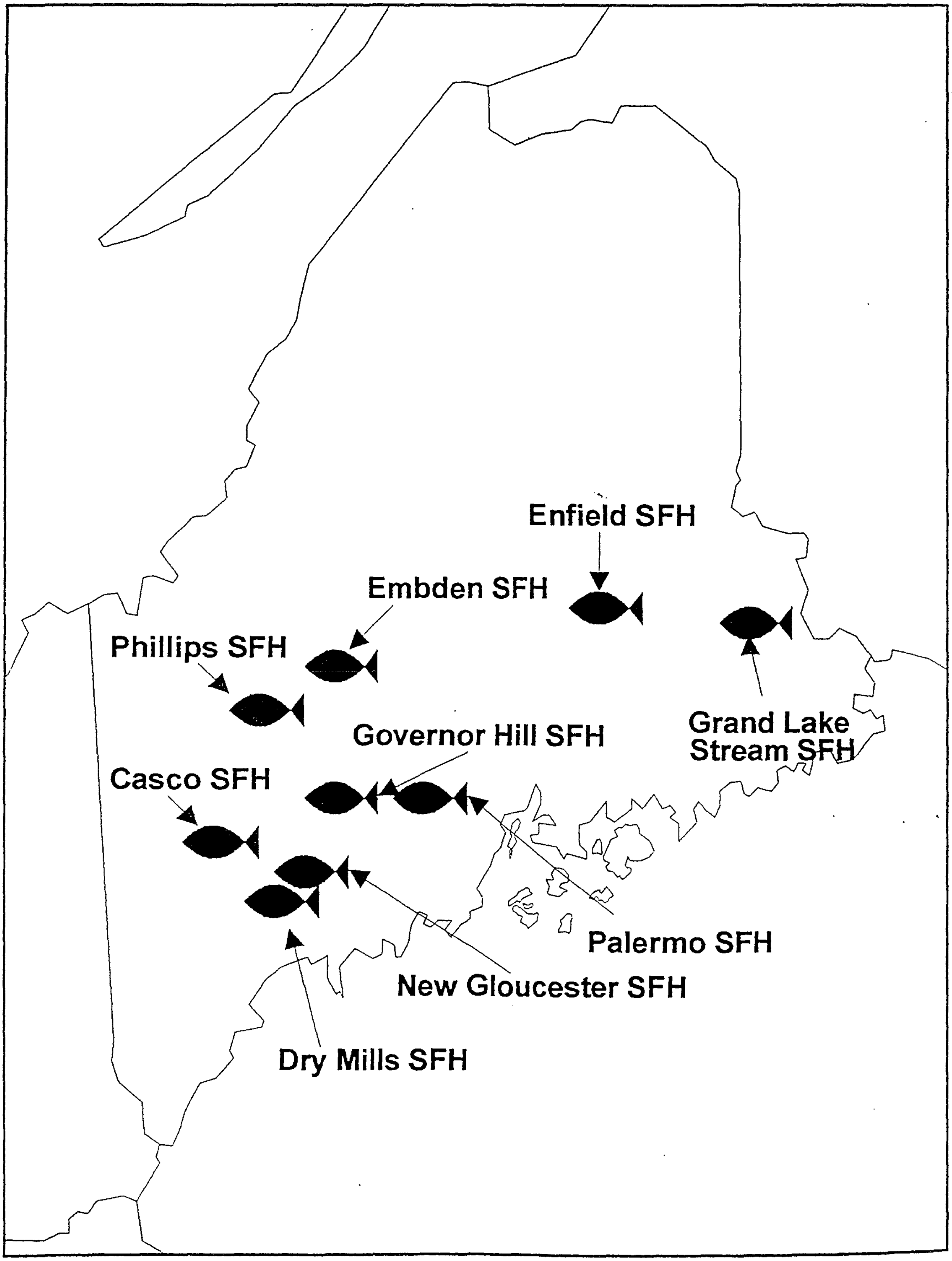

Figure I-1: State Fish Hatchery Locations

- Phillips State Fish Hatchery

The major objectives of these facilities are to produce the requested amount of fish species to support fisheries management activities statewide. Species produced by these facilities include landlocked salmon, brown trout, brook trout, lake trout, and splake.

Project Description

The Maine Department of Environmental Protection issued revised Waste Discharge Licenses for each hatchery on July 25, 2000. The effluent criteria and monitoring requirements have become more stringent compared to the previous Waste Discharge Licenses. The new Waste Discharge Licenses may have impacts to the current as well as future production programs at the hatcheries. Therefore, a hatchery effluent study was proposed to specifically address the licenses and their implications for all nine Maine Department of Inland Fisheries and Wildlife hatcheries.

The purpose of the effluent study is to review the Waste Discharge Licenses compared to historical and current effluent data to determine whether compliance is achievable. If compliance cannot be guaranteed, several possible wastewater system improvement options will be evaluated for all nine hatcheries including: traditional municipal/industrial wastewater treatment technologies such as clarifiers and sludge handling; lagoon treatment; microscreening/ microstraining; and constructed wetlands. Then, from these alternatives, the most efficient and cost effective aquaculture wastewater treatment solution will be selected. Implementation of the wastewater treatment solutions will allow the MDIFW to meet their current and future wastewater treatment goals.

Project Authorization and Scope

This study has been developed under a consultant services contract made on August 14, 2000 by and between the Maine Department of Inland Fisheries and Wildlife and FishPro/Cochran and Wilken, Inc., 5201 South Sixth Street Road, Springfield, Illinois, 62703, 217/585-8333. The project scope, as specified in the contract, is outlined below.

Task 1 **Review MDIFW Hatchery Effluent Data**

Compile data (1995, 1996, 1997, 1999 and new 2000 data as available) into EXCEL database with graphics for all nine facilities.

Task 2 **Review DRAFT DEP Discharge Licenses for each Facility**

This task will identify the permitted discharge locations on hatchery site plans. Piping implications for cleaning (WW) and non-cleaning (OW) wastewater flows will be investigated. The proposed DRAFT DEP Discharge licenses will be reviewed and implications for both current and future production will be determined. Monitoring requirements will be reviewed. Comments and possible improvements will be outlined for MDIFW sampling procedures. Monitoring and sampling costs will be addressed. This work will include coordination with DEP to discuss best management practices (BMP) criteria and determination of discharge standards.

Task 3 **Analyze DEP License Effluent Standards**

During this task we will review and evaluate the DEP Licenses and compare them to the fish biomodels at each of the nine fish hatcheries. It will be determined whether the licenses are both reasonable and achievable.

Task 4 **Effluent Treatment Engineering Analysis**

During this task we will provide preliminary effluent treatment engineering analysis for each of the nine hatcheries. Level and type of treatment will be determined for each facility.

Task 5 **Cost of Operations and Cost Efficiency Analysis**

During the completion of this task cost estimates will be provided. Estimates of probable costs will be generated using unit quantities, unit costs and estimated construction costs for each station. Data from our experience as aquaculture facility designers will be used to estimate costs.

Task 6 **Future Production Recommendations**

During this task we propose to provide recommendations regarding MDIFW fish production increases at each facility with respect to the DEP licenses and probable treatment requirements. Issues to be reviewed include treatment approaches and percent removals, low phosphorus diets, improved food conversion, station operation, and facility expansion.

Task 7 **Report Preparation, Review Coordination and Presentation of Recommendations**

This task involves our proposed work effort in preparing and coordinating the report study and its various submittals with the MDGIF. Report will be submitted at the 65% 95% and 100% completion levels. The report shall include the following:

- Report work products organized in written documentation of the condition of the existing hatchery system
- Narrative outlining potential wastewater treatment solutions

- Existing and conceptual site development drawings (CAD format)
- Cost estimates (engineering design, construction & operation)

Task 8 **Presentation of Recommendations**

Upon completion of the study, we suggest a presentation of the study findings and recommendations to the Legislative Committee and MDIFW staff may be useful to answer questions and discuss implementation of the recommended wastewater treatment improvements.

Acknowledgments

The following individuals have been involved in the development and review of this report entitled, **Fish Hatchery Effluent Study**. Their cooperation and assistance is gratefully acknowledged.

Maine Department of Inland Fisheries and Wildlife	
Mr. Steve Wilson	Superintendent of Fish Hatcheries
Mr. Bruce Winslow	Fish Culture Supervisor, Casco SFH
Mr. John Veader	Fish Culture Supervisor, Dry Mills SFH
Mr. Eugene Arsenault	Fish Culture Supervisor, Embden SFH
VACANT	Fish Culture Supervisor, Enfield SFH
Mr. David Rayner	Fish Culture Supervisor, Governor Hill SFH
Mr. Chris Marsanskis	Fish Culture Supervisor, Grand Lake Stream SFH
Ms. Marlene Whittier	Fish Culture Supervisor, New Gloucester SFH
Mr. Michael Boyer	Fish Culture Supervisor, Palermo SFH
Mr. Christopher Short	Fish Culture Supervisor, Phillips SFH

FishPro Consulting Engineers & Scientists	
Mr. Tom Johnson	Fisheries Biologist
Mr. Matt Cochran	Fisheries Biologist
Mr. Gary Wilken	Civil Engineer
Mr. Richard Dirks	Civil Engineer
Ms. Terra McParland	Environmental Engineer

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U.S. Department of Agriculture, National Resources Conservation Service

U.S. Department of Agriculture, National Resources Conservation Service

U.S. Department of Commerce, National Climatic Data Center

U.S. Department of Commerce, Bureau of the Census

Fish Hatchery Effluent Study

Maine Department of Inland Fisheries & Wildlife

II. Executive Summary and Recommendations

FISHPRO

II. RECOMMENDATIONS

This study has analyzed the DEP Discharge Licenses (issued July 25,2000) for the nine Maine Department of Inland Fisheries and Wildlife and implications of these licenses upon the existing and future fish production programs of the MDIFW Hatchery System. Included in this study's analysis was the review of historical and current effluent sampling data, current and potential fish production data, and potential effluent treatment options and costs.

Table II-1 summarizes the analysis of the current fish production programs at the nine MDIFW fish production facilities and the regulatory implications of the DEP Discharge Licenses.

As shown in Table II-1, facilities in compliance with their Discharge Licenses are Casco, Embden, Enfield, Grand Lake Stream, New Gloucester and Palermo (if the DEP annual phosphorus discharge limit of 95 Kg/year is adopted (see Palermo Section XI of this report). Facilities not in compliance with their Discharge Licenses are Dry Mills, Governor Hill and Phillips.

Based upon the findings of this study the following actions are recommended:

1. MDIFW, DEP and the Consultant Team should meet to discuss the effluent monitoring data collected to date. We suggest that automated composite sampling be used to provide more representative effluent characterization at reduced cost and labor. Re-negotiation of all nine Discharge License Wastewater parameter concentrations during rearing unit cleaning should be completed as these criteria are not achievable or realistic (in our opinion). The cooperative approach between DEP and MDIFW regarding the issue of regulation of hatchery effluents should continue in the future. Continued effluent monitoring, improved MDIFW management and operation of existing solids collection systems and sludge disposal should be completed.

2. Stations **not in compliance** with their Discharge License (Dry Mills, Governor Hill and Phillips) should take immediate measures to implement improved solids recovery and management with existing treatment basins. Discuss non-compliance with DEP and resolve options. Removal of existing solids and possible installation of solids retention baffles should undertaken. A decrease in fish biomass and feeding may be required if solids management efforts fail to meet permit requirements.

3. The improvement of solids collection and disposal systems at all facilities should be given a high priority as components of the major capital improvements to the MDIFW Hatchery System outlined in the Strategic Plan are completed. Findings for effluent treatment improvements reflect good environmental resource stewardship. Stations without solids recovery (Casco, Enfield, Grand Lake Stream) should plan for construction of effluent treatment systems during capital improvements to these facilities.

4. Administrative and legislative support including long-term funding for improvements to the MDIFW Hatchery System must be provided. The major capital improvements to these facilities outlined in the ***Strategic Plan*** and this ***Fish Hatchery Effluent Study*** are not facility maintenance. The facility improvements are major capital construction projects that will require planning, engineering, qualified contractor-construction and start-up training. Without support and funding, MDIFW cannot implement the recommended improvements.

POTENTIAL PRODUCTION INCREASES AND DEP DISCHARGE LICENSE COMPLIANCE.

Table II-2 provides a summary of two theoretical examples of fish production expansion above the current IFW production level (a 25% and 50% increase) and the predicted effluent treatment implications of production expansion. Please note we are not recommending production expansion at all nine facilities – this exercise only defines the impact of theoretical increased production on the current DEP Discharge licenses. Note that facilities with high production expansion potential (Embden, Enfield, Casco, Grand Lake Stream, and possibly Palermo) have the capability to allow production expansion and remain in compliance with their DEP Discharge License effluent requirements. The benefit of solids recovery and effluent treatment is reflected in the table as the percent (%) of the annual DEP permitted level. The costs of effluent treatment options are discussed in the following section.

EFFLUENT TREATMENT COST ESTIMATES

Cost estimates for six levels of effluent treatment (**Options A, B, C, D, E, and F** (see Section III for details) have been prepared (Table II-3). These **Options** vary in complexity from composite sampling and discharge flow measurement to full flow high technology solids removal, recovery, and disposal. The costs vary depending upon the Option selected and the sizing required to meet the facility effluent treatment flow rate.

Costs of the effluent treatment options vary from $45,000 to $1,585,000 depending on the level of treatment complexity and flow rate treated.

All nine stations should consider installation of composite wastewater samplers and flow measurement (Option A). Stations without solids recovery (Casco, Enfield, Grand Lake Stream) should consider Option B or Option C as minimal solids recovery systems.

If Dry Mills, Governor Hill and Phillips cannot come into Discharge License compliance by enhanced management and operation their present earthen solid recovery basins, then Option B or Option C will most likely be required as minimal systems.

Palermo will likely require improvements to the existing clarifier and separation of cleaning flows from overflow water to meet the phosphorus limits in the DEP Discharge License (as a minimum) and may require Option D or F to meet strict phosphorus criteria. MDIFW should continue to work closely with DEP in regard to implementation of

Table II-1 Comparison of IFW Facility Current Production WW Mass Kg/Yr, DEP Discharge License Requirements.

Note: Kg /Yr Wastewater MASS Values are calculated values based on Current Production and do not reflect any recovery or removal by the present wastewater Systems.

Note: [ ] indicates values that exceed DEP Discharge License Requirements ie., NOT in Compliance.

Station	WW Parameter	Yearly	DEP Lic.	Kg / Year DEP	Percent	DEP License Compliance	Compliance Options & Comments
Casco	calc.Mass (kg)	Total	per Month	License	of Lic.	YES	
	Total Phos	77.1	8.8	105.9	73%		Solids Recovery Recommended
	TSS	4,520.1	663.1	7,957.6	58%		Prod. Expansion with more water
	BOD	5,239.5	663.1	7,957.6	66%		

Station	WW Parameter	Yearly	DEP Lic.	Kg / Year DEP	Percent	DEP License Compliance	Compliance Options & Comments
Dry Mills	calc.Mass (kg)	Total	per Month	License	of Lic.	NO	Improve Solids Ditch Mgt.
	Total Phos	78.3	6.1	73.0	108%		Adjust Production / Feeding
	TSS	4,723.5	397.9	4,774.6	99%		More Water
	BOD	5,358.0	397.9	4,774.6	112%		

Station	WW Parameter	Yearly	DEP Lic.	Kg / Year DEP	Percent	DEP License Compliance	Compliance Options & Comments
Embden	calc.Mass (kg)	Total	per Month	License	of Lic.	YES	Production Expansion
	Total Phos	57.5	16.4	197.1	29%		Improve Clarifier-Add Storage
	TSS	3,453.8	1,094.2	13,130.0	26%		
	BOD	3,910.3	1,094.2	13,130.0	30%		

Station	WW Parameter	Yearly	DEP Lic.	Kg / Year DEP	Percent	DEP License Compliance	Compliance Options & Comments
Enfield	calc.Mass (kg)	Total	per Month	License	of Lic.	YES	Solids Recovery Recommended
	Total Phos	106.3	34.4	412.5	26%		
	TSS	6,408.2	1,104.1	13,249.4	48%		
	BOD	7,262.6	1,104.1	13,249.4	55%		

Station	WW Parameter	Yearly	DEP Lic.	Kg / Year DEP	Percent	DEP License Compliance	Compliance Options & Comments
Governor Hill	calc.Mass (kg)	Total	per Month	License	of Lic.	NO	Improve Solids Ditch Mgt.
	Total Phos	44.0	3.3	40.2	110%		Adjust Production / Feeding
	TSS	2,641.3	232.1	2,785.2	95%		More Water
	BOD	2,994.0	232.1	2,785.2	107%		

Station	WW Parameter	Yearly	DEP Lic.	Kg / Year DEP	Percent	DEP License Compliance	Compliance Options & Comments
Grand Lake Stream	calc.Mass (kg)	Total	per Month	License	of Lic.	YES	Prod Expansion
	Total Phos	32.0	17.0	208.1	15%		
	TSS	1,922.3	663.1	7,957.6	24%		
	BOD	2,178.3	663.1	7,957.6	27%		

Station	WW Parameter	Yearly	DEP Lic.	Kg / Year DEP	Percent	DEP License Compliance	Compliance Options & Comments
New Gloucester	calc.Mass (kg)	Total	per Month	License	of Lic.	YES AT PERMIT	Improve Solids Ditch Mgt.
	Total Phos	90.8	7.6	90.8	100%		Replace Outdoor Units &
	TSS	5,447.1	712.9	8,554.4	64%		add WW Treatment System
	BOD	6,170.3	712.9	8,554.4	72%		

Station	WW Parameter	Yearly	DEP Lic.	Kg / Year DEP	Percent	DEP License Compliance	Compliance Options & Comments
Palermo	calc.Mass (kg)	Total	per Month	License	of Lic.	YES	Improve Clarifier-Add Storage
	Total Phos	52.9	7.9	55.0	95%		> DEP Phos Limit
	TSS	5,295.4	928.4	11,140.6	48%		
	BOD	6,114.7	928.4	11,140.6	55%		

Station	WW Parameter	Yearly	DEP Lic.	Kg / Year DEP	Percent	DEP License Compliance	Compliance Options & Comments
Phillips	calc.Mass (kg)	Total	per Month	License	of Lic.	NO	More Water
	Total Phos	12.3	0.9	11.0	117%		Reduce Biomass & Feeding
	TSS	768.8	66.3	795.8	97%		Improve Solids Ditch Mgt.
	BOD	871.3	66.3	795.8	109%		

Table II-2 Comparison of IFW Facility Current Production WW Mass Kg/Yr, DEP Discharge License Requirements, Potential Prod. Expansion, and WW Treatment Benefits Kg/Yr.

Note: Kg /Yr Wastewater MASS Values are calculated values based on Current Production and do not reflect any recovery or removal by the present WW Systems.

Note: [ ] indicates values that exceed DEP Discharge License Requirements ie., NOT in Compliance.

Station	WW Parameter calc.Mass (kg)	Yearly Total	DEP Lic per Month	Kg / Year DEP License	Percent of Lic.	Production 125 % > Yearly Kg Mass	After Solids Recovery Yearly Kg Mass	After Solids WW Recovery Percent of Lic.	After Solids Rec. & Microscreen Yearly Kg Mass	After Full WW Treatment Percent of Lic.	Production 150 % > Yearly Kg Mass	150 % > After Solids Recovery Yearly Kg Mass	After Solids WW Recovery Percent of Lic.	After Solids Rec. & Microscreen Yearly Kg Mass	After Full WW Treatment Percent of Lic.
Cosco	Total Phos	77.1	8.8	105.9	73%	96.3	48.2	45	28.9	27	115.6	72	68	43	41
	TSS	4,633.1	663.1	7,957.6	58%	5,778.9	2,889.5	36	1,733.7	22	6934.7	4,334	54	2,601	33
	BOD	5,239.5	663.1	7,957.6	66%	6,549.4	3,274.7	41	1,964.8	25	7859.3	4,912	62	2,947	37
Embden	Total Phos	57.5	16.4	197.1	29%	71.9	35.0	18	21.6	11	86.3	54	27	32	16
	TSS	3,153.0	1,094.2	13,130.0	24%	4,316.2	2,158.1	16	1,294.9	10	5179.4	3,237	25	1,942	15
	BOD	3,913.3	1,094.2	13,130.0	30%	4,891.7	2,445.8	19	1,467.5	11	5870.0	3,669	28	2,201	17
Governor Hill	Total Phos	44.0	3.3	40.2	110%	55.0	27.5	69	16.5	41	66.0	41	103	25	62
	TSS	2,641.8	232.1	2,785.2	95%	3,302.3	1,651.1	59	990.7	36	3962.7	2,477	89	1,486	53
	BOD	2,994.0	232.1	2,785.2	107%	3,742.6	1,871.3	67	1,122.8	40	4491.1	2,807	101	1,684	60
Palermo	Total Phos	89.9	7.9	95.0	95%	112.4	56.2	59	33.7	35	134.9	84	89	51	53
	TSS	5,395.4	928.4	11,140.8	48%	6,744.2	3,372.1	30	2,023.3	18	8093.0	5,058	45	3,035	27
	BOD	6,114.7	928.4	11,140.8	55%	7,643.4	3,821.7	34	2,293.0	21	9172.1	5,733	51	3,440	31
Phipps	Total Phos	12.8	0.9	11.0	117%	16.0	8.0	73	4.8	44	19.2	12	110	7	66
	TSS	768.8	66.3	795.8	97%	961.0	480.5	60	288.3	36	1153.2	721	91	432	54
	BOD	871.3	66.3	795.8	109%	1,089.1	544.6	68	326.7	41	1306.9	817	103	490	62
Dry Mills	Total Phos	78.8	6.1	73.0	108%	98.5	49.3	67	29.6	40	118.2	74	101	44	61
	TSS	4,728.5	397.9	4,774.6	99%	5,910.6	2,955.3	62	1,773.2	37	7092.8	4,433	93	2,660	56
	BOD	5,359.0	397.9	4,774.6	112%	6,698.7	3,349.4	70	2,009.6	42	8038.5	5,024	105	3,014	63
Enfield	Total Phos	106.8	34.4	412.5	26%	133.5	66.8	16	40.1	10	160.2	100	24	60	15
	TSS	6,408.2	1,104.1	13,249.4	48%	8,010.3	4,005.1	30	2,403.1	18	9612.3	6,008	45	3,605	27
	BOD	7,262.6	1,104.1	13,249.4	55%	9,078.3	4,539.1	34	2,723.5	21	10893.9	6,809	51	4,085	31
Grand Lake Stream	Total Phos	32.0	17.3	208.1	15%	40.0	20.0	10	12.0	6	48.1	30	14	18	9
	TSS	1,922.3	663.1	7,957.6	24%	2,402.8	1,201.4	15	720.8	9	2883.4	1,802	23	1,081	14
	BOD	2,178.6	663.1	7,957.6	27%	2,723.2	1,361.6	17	817.0	10	3267.8	2,042	26	1,225	15
New Gloucester	Total Phos	90.8	7.6	90.8	100%	113.5	56.7	63	34.0	38	136.2	85	94	51	56
	TSS	5,447.1	712.9	8,554.4	64%	6,808.9	3,404.4	40	2,042.6	24	8170.6	5,107	60	3,064	36
	BOD	6,173.3	712.9	8,554.4	72%	7,716.7	3,858.3	45	2,315.0	27	9260.0	5,787	68	3,472	41

Table II-3 Cost Estimate Summary for Effluent Treatment Options A,B,C,D,E,and F) at MDIFW Fish Hatcheries.

		Summary Cost Estimate					
Dwg ID #	ITEM	Option A	Option B	Option C	Option D	Option E	Option F
	CASCO						
1	General Site	$12 500	$12 500	$50 000	$60 000	$50 000	$60 000
2	Site Piping	$0	$0	$110 000	$110 000	$110 000	$110 000
3	Drum Microscreen	$0	$0	$0	$179 000	$0	$179 000
4	Clarifier	$0	$0	$225 000	$225 000	$345 500	$345 500
5	Sludge Storage	$0	$25 000	$150 000	$150 000	$150 000	$150 000
6	Monitoring System	$25 000	$25 000	$25 000	$25 000	$25 000	$25 000
7	Raceway Improvements	$0	$118 800	$118 800	$118 800	$9 600	$9 600
	Estimating Contingency	$7 500	$36 260	$137 760	$173 560	$140 220	$176 020
	Design and Construction Contingencies	NA	NA	$205 640	$260 340	$210 330	$264 030
	TOTAL	$45,000	$217,560	$1,033,200	$1,301,700	$1,051,650	$1,320,150
8	Sludge Trucks with Land Application	$100 000	$100 000	$100 000	$100 000	$100 000	$100 000
	DRY MILLS						
1	General Site	$12 500	$12 500	$50 000	$50 000	$50 000	$50 000
2	Site Piping	$0	$0	$94 000	$94 000	$54 000	$54 000
3	Drum Microscreen	$0	$0	$0	$131 000	$0	$131 000
4	Clarifier	$0	$0	$225 000	$225 000	$346 500	$346 500
5	Sludge Storage	$0	$25 000	$150 000	$150 000	$150 000	$150 000
6	Monitoring System	$25 000	$25 000	$25 000	$25 000	$25 000	$25 000
7	Raceway Improvements	$0	$118 800	$118 800	$118 800	$9 600	$9 600
	Estimating Contingency	$7 500	$36 260	$132,560	$158 760	$135 0[illegible]	$151 220
	Design and Construction Contingencies	NA	NA	$198 840	$238 140	$202 5[illegible]	$241 830
	TOTAL	$45,000	$217,560	$994,200	$1,190,700	$1,012,650	$1,209,150
8	Sludge Trucks with Land Application	$100 000	$100 000	$100 000	$100 000	$100 000	$100 000
	EMBDEN						
1	General Site	$12,500	$12 500	$60 000	$50 000	$50 000	$60 000
2	Site Piping	$0	$0	$54 000	$84 000	$84 000	$54 000
3	Drum Microscreen	$0	$0	$0	$225 000	$0	$225 000
4	Clarifier (Modifications, No Removal)	$0	$0	$20 000	$20 000	$20 000	$20 000
5	Sludge Storage	$0	$25 000	$128 000	$128 000	$128 000	$128 000
6	Monitoring System	$25 000	$25 000	$25 000	$25 000	$25 000	$25 000
7	Raceway Improvements	$0	$118 800	$118 800	$118 800	$9 600	$9 600
	Estimating Contingency	$7 500	$36 260	$67,160	$132 160	$65 320	$110 320
	Design and Construction Contingencies	NA	NA	$100 740	$198 240	$97 980	$165 480
	TOTAL	$45,000	$217,560	$653,700	$991,200	$489,900	$827 400
8	Sludge Trucks with Land Application	$100 000	$100 000	$100 000	$100 000	$100 000	$100 000
	ENFIELD						
1	General Site	$12 500	$12 500	$60 000	$60 000	$60 000	$60 000
2	Site Piping	$0	$0	$190 000	$190 000	$190 000	$190 000
3	Drum Microscreen	$0	$0	$0	$225 000	$0	$225 000
4	Clarifier	$0	$0	$225 000	$225 000	$381 000	$381 000
5	Sludge Storage	$0	$25 000	$150 000	$150 000	$150 000	$150 000
6	Monitoring System	$25 000	$25 000	$25 000	$25 000	$25 000	$25 000
7	Raceway Improvements	$0	$118 800	$118 800	$118 800	$9 600	$9 600
	Estimating Contingency	$7 500	$36 260	$153 760	$198 760	$163 120	$208 120
	Design and Construction Contingencies	NA	NA	$230 640	$298 140	$244 680	$312 180
	TOTAL	$45,000	$217,560	$1,153,200	$1,490,700	$1,223,400	$1,560,900
8	Sludge Trucks with Land Application	$100 000	$100 000	$100,000	$100 000	$100 000	$100 000
	GOVERNOR HILL						
1	General Site	$12 500	$12 500	$60,000	$60 000	$60 000	$60 000
2	Site Piping	$0	$0	$84,000	$84 000	$84 000	$84 000
3	Drum Microscreen	$0	$0	$0	$131 000	$0	$131 000
4	Clarifier	$0	$0	$225 000	$225 000	$346 500	$346 500
5	Sludge Storage	$0	$25 000	$128 000	$128 000	$128 000	$128 000
6	Monitoring System	$25 000	$25 000	$25 000	$25 000	$25 000	$25 000
7	Raceway Improvements	$0	$118 800	$118 800	$118 800	$9 600	$9 600
	Estimating Contingency	$7 500	$36 260	$128 160	$154 360	$130 620	$156 820
	Design and Construction Contingencies	NA	NA	$192,240	$231,540	$195 930	$235 230
	TOTAL	$45,000	$217,560	$961,200	$1,157,700	$979,650	$1,176,150
8	Sludge Trucks with Land Application	$100 000	$100,000	$100 000	$100 000	$100 000	$100 000

		Summary Cost Estimate					
Dwg ID #	ITEM	Option A	Option B	Option C	Option D	Option E	Option F
	GRAND LAKE STREAM						
1	General Site	$12 500	$12,500	$60 000	$60 000	$60 000	$60 000
2	Site Piping	$0	$0	$156 000	$156 000	$156 000	$156 000
3	Drum Microscreen	$0	$0	$0	$175 000	$0	$175 000
4	Clarifier	$0	$0	$225 000	$225 000	$345 500	$345 500
5	Sludge Storage	$0	$25 000	$108 000	$108 000	$108 000	$108 000
6	Monitoring System	$25 000	$25 000	$25 000	$25 000	$25 000	$25 000
7	Raceway Improvements	$0	$118 800	$118 800	$118 800	$9 600	$9 600
	Estimating Contingency	$7 500	$36 260	$136 560	$174,360	$141 020	$176 820
	Design and Construction Contingencies	NA	NA	$207 840	$261,540	$211,530	$265 230
	TOTAL	$45,000	$217,560	$1,039,200	$1,307,700	$1,057,650	$1,326,150
8	Sludge Trucks with Land Application	$100 000	$100 000	$100 000	$100 000	$100 000	$100 000
	NEW GLOUCESTER						
1	General Site	$12 500	$12,500	$60 000	$60 000	$60 000	$60,000
2	Site Piping	$0	$0	$228 000	$228 000	$228 000	$228 000
3	Drum Microscreen	$0	$0	$0	$179 000	$0	$179 000
4	Clarifier	$0	$0	$225 000	$225 000	$346 500	$346 500
5	Sludge Storage	$0	$25 000	$150 000	$150 000	$150 000	$150 000
6	Monitoring System	$25 000	$25 000	$25 000	$25 000	$25,000	$25 000
7	Raceway Improvements	$0	$118 800	$118 800	$118 800	$9 600	$9 600
	Estimating Contingency	$7 500	$36,260	$161 360	$197,160	$163 820	$199 620
	Design and Construction Contingencies	NA	NA	$242 040	$295 740	$245 730	$299 430
	TOTAL	$45,000	$217,560	$1,210,200	$1,478,700	$1,228,850	$1,497,150
8	Sludge Trucks with Land Application	$100 000	$100 000	$100 000	$100 000	$100 000	$100 000
	PALERMO						
1	General Site	$12 500	$12 500	$60 000	$60 000	$60 000	$60 000
2	Site Piping	$0	$0	$126 000	$126 000	$126 000	$126 000
3	Drum Microscreen	$0	$0	$0	$225 000	$0	$225,000
4	Clarifier (New Clarifier & Modifications to Existing)	$0	$0	$350 000	$350 000	$471 500	$466 500
5	Sludge Storage	$0	$25 000	$126 000	$128 000	$128 000	$128 000
6	Monitoring System	$25 000	$25 000	$25 000	$25 000	$25 000	$25 000
7	Raceway Improvements	$0	$118 600	$118 800	$118 800	$9 600	$9 600
	Estimating Contingency	$7 500	$36 260	$161 560	$206 560	$164 020	$168 020
	Design and Construction Contingencies	NA	NA	$242 340	$309 840	$246 030	$282 030
	TOTAL	$45,000	$217,560	$1,211,700	$1,549,200	$1,230,150	$1,410,150
8	Sludge Trucks with Land Application	$100 000	$100 000	$100 000	$100 000	$100 000	$100 000
	PHILLIPS						
1	General Site	$12 500	$12 500	$50 000	$60 000	$50 000	$60 000
2	Site Piping	$0	$0	$126 000	$126 000	$126 000	$126 000
3	Drum Microscreen	$0	$0	$0	$131 000	$0	$131 000
4	Clarifier	$0	$0	$225 000	$225 000	$277 500	$277 500
5	Sludge Storage	$0	$25 000	$108 000	$108 000	$108 000	$108 000
6	Monitoring System	$25 000	$25 000	$25 000	$25,000	$25 000	$25 000
7	Raceway Improvements	$0	$118 800	$118 800	$118 800	$9 600	$9 600
	Estimating Contingency	$7 500	$36,260	$132 560	$158,760	$121,220	$147 420
	Design and Construction Contingencies	NA	NA	$198 840	$238,140	$181,830	$221,130
	TOTAL	$45,000	$217,560	$994,200	$1,190,700	$909,150	$1,105,650
6	Sludge Trucks with Land Application	$100 000	$100 000	$100,000	$100 000	$100 000	$100 000

improved effluent treatment components within the MDIFW Hatchery System to insure that long-term Discharge License compliance and environmental protection is achieved. Embden (the high priority facility for production expansion) should integrate effluent treatment improvements into the proposed rearing expansion including clarifier improvements to create laminar flow, sludge storage and sludge transfer / land application as needed. Note that the purchase of sludge transfer trucks with complete vacuum / pressure capability for solids cleaning/transfer and land application is also recommended. Using private sector contractual sludge hauling is another (more expensive) option.

Fish Hatchery Effluent Study

Maine Department of Inland Fisheries & Wildlife

III. General Overview

FISHPRO

III. GENERAL OVERVIEW

Discharge License Discussion

History of Licensing

A brief summary of the waste discharge licensing (NPDES) process to the present date is described below:

- 1971 – All MDIFW hatcheries were licensed via U.S. Army Corps of Engineers and the FWPCA (prior to USEPA). Monitoring of all effluents was established.
- 1977 – Maine DEP took over the NPDES permitting program from USEPA, new licenses with new numbers were issued.
- 1978 – March 8, DEP issued licenses for all hatcheries, expiration date March 8, 1983 (see example copy of Palermo SFH discharge license in Appendix B).
- 1979 – MDIFW requested renewal of licenses.
- 1983 – May 11, DEP issued new licenses and decided that monitoring would not be required until new licenses were issued (see example copy of Palermo SFH discharge license in Appendix B).
- 1986 – Maine Legislature directed DEP to reclassify all Maine waters. Discharges from all facilities occurring and in existence prior to January 1, 1986 were grandfathered.
- 1988 –All licenses expired but were continued until relicensing was established (did not occur until July 2000)
- 1995 – Hatchery Task Force was established by the 117th Maine Legislature to look into fish hatchery licenses.
- 1996 – January 17, DEP sent letter to DIFW stating that hatcheries are not required to monitor until new licenses are issued and that, "hatchery effluents are not a problem."
- 1996 – January 23, DEP issued a memo with proposed Best Practicable Technology (BPT) limits, Water Quality-Based Limits and the elimination of the fish pathogens on fish hatchery discharge licenses.
- 1999 – July 7, DEP issued a letter to DIFW eliminating BPT for hatchery discharges and described the Biomonitoring Program.
- 2000 – June 5, DEP issued DRAFT Discharge Licenses.
- 2000 – July 21, DEP issued Discharge Licenses for all hatcheries with expiration dates in July 21, 2005.

The Discharge Licenses, as issued on July 21, 2000 for each hatchery, are the subject of this report (see Appendix B for an example copy of the current Casco SFH waste discharge license). Effluent monitoring locations, sampling requirements, and effluent permitted limits are discussed within each individual hatchery section (see Casco SFH – Section IV, Dry Mills SFH – Section V, Embden SFH – Section VI, Enfield SFH – Section VII, Governor Hill SFH – Section VIII, Grand Lake Stream SFH – Section IX, New Gloucester – Section X, Palermo SFH – Section XI, and Phillips SFH – Section XII).

Current Waste Discharge Licenses

According to the Maine Department of Environmental Protection (DEP), conditions of the hatcheries' licenses require that the effluent limitations prescribed for discharge require application of Best Practicable Treatment (BPT), are consistent with the Clean Water Act, and ensures that the receiving waters attain the State water quality standards as defined in Maine's Surface Water Classification System. The United States Environmental Protection Agency (EPA) has not adopted national effluent guidelines for fish hatcheries yet. Therefore, Maine DEP has based the effluent limitations on Best Professional Judgment (BPJ).

DEP considers the new license limitations as strict or stricter as those considered achievable in past licenses. However, current data will illustrate that the limits may not be achievable during raceway cleaning (see individual hatchery discussions). DEP used five sets of effluent monitoring data from each hatchery (55 data points from 1996) to determine effluent limitations. Acknowledging the unreliability of such few data points, DEP has included a license reopener clause in the event that the limits, as developed by BPJ, are too restrictive or not restrictive enough. In either case, the effluent limits or monitoring frequencies can be adjusted based on new data to better reflect the hatchery's discharge. DEP feels that the MDIFW hatcheries, as presently operated, should be able to meet these discharge limits. Again, Year 2000 discharge monitoring data will indicate that the discharge limits appear to be too stringent during the cleaning operations. DEP plans to develop BPT criteria for the hatcheries based on collection of more hatchery wastewater data. A cooperative monitoring program of hatchery effluents is being completed between DEP and MDIFW to provide data needed to set reasonable discharge limits.

Each permit consists of the main license portion, which generally summarizes the wastewater quantities, receiving water conditions, and describes how the effluent limitations were determined. The receiving water conditions within the license include the following:

- Receiving stream class
- Whether the effluent tributaries discharge eventually into lakes
- If the drainage area upstream of the hatchery is less than ten square miles
- If the receiving stream may require future Total Daily Maximum Limits (TDML)
- If the downstream tributaries are currently attaining classification standards
- Whether the hatchery discharge is causing classification standards non-attainment

All these items were used to determine final effluent limitations and which Special Conditions were applicable for each facility

The Special Conditions portion of the license specifically outlines the effluent limitations and monitoring requirements (see Sections IV-XII for discussion of individual hatcheries). Also included in the Special Conditions is narrative discussion on pathogen control, therapeutic agents, sanitizing agents, show pool or clarifier cleaning, narrative effluent limitations (i.e., visual effluent criteria), reopener clause, biomonitoring, effluent limitation compliance schedule, practical alternatives study and reporting requirements. Each facility's discharge license contains most of the same Special Conditions; differences are outlined in Table III-1.

Table III-1. Discharge License Comparison Matrix

	Casco SFH	Dry Mills SFH	Embden SFH	Enfield SFH	Governor Hill SFH
Permit Number	W002038-5Q-A-R	W002031-5Q-A-R	W002029-5Q-A-R	W002032-5Q-A-R	W002034-5Q-A-R
Receiving Water Conditions					
Receiving Stream	Mile Stream	Hatchery Brook	Mill Stream	Cold Stream	Spring Brook
Receiving Stream Class	Class B	Class B	Class B	Class A	Class B
Drainage < 10 mi^2 ?	yes	yes	no	no	yes
Trib to Lake Disch. & Tot. Yrly. P Lim.	yes	no	no	no	no
Potential TDML ?	no	yes	no	no	no
Hatchery Causing Non-Attainment ?	no	aquatic life stds.	no	DO	DO
Special Conditions					
Settling Pond Cleaning	20% full	20% full	20% full	-	20% full
Biomonitoring Required ?	yes	no	yes	yes	yes
Practical Alternatives Study Req'd?	yes	yes	no	yes	yes

	Grand Lake Stm SFH	New Gloucester	Palermo SFH	Phillips SFH
Permit Number	W002037-5Q-A-R	W002030-5Q-A-R	W002035-5Q-A-R	W002036-5Q-A-R
Receiving Water Conditions				
Receiving Stream	Grand Lake Stream	Eddy Brook	Sheepscot River	Meadow Brook
Receiving Stream Class	Class A	Class B	Class B	Class A
Drainage < 10 mi^2 ?	no	yes	no	yes
Trib to Lake Disch. & Tot. Yrly. P Lim.	yes	no	yes	no
Potential TDML ?	no	yes	no	no
Hatchery Causing Non-Attainment ?	no	aquatic life stds	no	no
Special Conditions				
Settling Pond Cleaning	-	20% full	20% full	20% full
Biomonitoring Required ?	yes	no	no	yes
Practical Alternatives Study Req'd?	yes	yes	no	yes

If the receiving stream was Class A or if the drainage area was less than ten square miles, a practical alternatives study is required within six months of the effective date of the license. If the discharge entered a tributary that eventually feeds a lake (Classification GPA), a yearly phosphorus limit was imposed. If the hatchery was determined to be the factor in non-attainment of class water quality criteria for aquatic life standards, a future TMDL may be required for the portion of the stream. Biomonitoring requirements were imposed for all but Dry Mills, New Gloucester and Palermo.

Each license also contains Attachment A which describes and outlines the Receiving Water Study, July 1 through September 30, 2000 for each hatchery. According to DEP, the Receiving Water Study will help to better quantify the characteristics of the hatchery effluent, the effectiveness of the various stages of treatment, and to determine effects on water quality. The receiving stream (upstream and downstream of the hatchery) will be monitored in the morning for temperature (temp) and dissolved oxygen (DO) and in the afternoon for temperature, DO, biochemical oxygen demand (BOD), total phosphorus (TP), and total suspended solids (TSS). The period of monitoring (July, August, and September) corresponds with historical hatchery effluent monitoring and represents periods of peak hatchery biomass and feeding.

Items of Concern

Upon careful review of the licenses, the following points were outlined as areas of concern either in the determination of effluent limitations, special conditions, monitoring requirements or future hatchery expansion implications. If the item concerns more than one hatchery, the items are listed below. Items related to specific hatcheries only are listed within that hatchery's discussion Section.

1. Effluent Limitations. DEP used only 55 data points taken in only 2-1/2 months in 1996 as a basis for effluent limit determination. According to hatchery personnel, the 1996 samples were not taken during raceway cleaning so, most likely, the license effluent limits for during cleaning are too low. Also, narrative within the license describing effluent limitations determination states, "The IFW hatcheries, as presently operated, should be able to meet these discharge limits." As discussed above, the current operations during raceway cleaning, may not meet these limits. The BOD and TSS limits of 2 mg/l are very low and cannot be guaranteed to be met at all times even with best available technology (BAT, i.e., clarifier, microscreens, filter beds) according to manufacturer's recommendations. Also, it should be noted that if the licenses are reopened, it may be difficult to obtain public support for less stringent effluent limitations.

2. Special Condition A, Effluent Limitations and Monitoring Schedule. The licenses require reporting pounds of fish and BOD, TP and TSS in lb./100 lb. fish. This is a very unusual requirement. No other hatchery NPDES permits within the U.S. that we are aware of requires pounds of fish in the permit at all. This requirement has implications for potential fish production increases in the future. Contact with DEP indicates that this requirement is based on USEPA's guideline for hatcheries. DEP placed this requirement in case the USEPA requires it in the future. Fish species, size and a variety of environmental factors influence the amount of feed fed per biomass of fish (as discussed in this report). The validity of the USEPA method is questionable.

3. Special Condition A, Effluent Limitations and Monitoring Schedule. The licenses require reporting BOD, TSS and TP only in concentrations (mg/l). In only a few cases is the mass of phosphorus limited. Most states also include mass limitations for BOD, TSS and TP so that if the instantaneous concentrations were too high, it could be compared with the overall mass of parameter entering the receiving water. Usually, the instantaneous reading in concentration provides a false picture that the effluent stream contains higher levels of parameters. This is only occurring for that moment in time. Throughout the day or even within the same hour, the concentrations in the discharge may be much lower. Automated composite sampling helps eliminate grab sample bias and it is recommended in this study as a method to improve hatchery effluent sampling.

4. Special Condition A, Effluent Limitations and Monitoring Schedule. Note 3. What are "Department approved methods" for flow measurement? Many outfalls are usually culvert-type piping. Contact with DEP suggests that the hatchery has leeway on this measurement based on the site conditions. Flow could be based on pipe sizes, inflow measurements, weir measurements, or other such methods.

5. Special Condition, Effluent Limitation Compliance Schedule. Compliance within three years. As discussed above, it should be noted to DEP that compliance within discharge limitations appear to not meet the present criteria during cleaning. Also, it will most likely take longer than three years to construct additional treatment for a state funded project depending on legislative funding, design, review, etc. MDIFW could request an extension pending review of actual data. Contact with DEP suggests that a schedule of compliance could be amended to the license.

6. Special Condition, Reopener Clause. It was determined after contact with DEP that either DEP or MDIFW can reopen the license if either feels that the criteria are too stringent. If fish production increases in the future, the license can be reopened as well. MDIFW will need to request a modification in the permit if hatcheries are renovated, modified or if fish production changes significantly.

7. All Permits, Special Condition H, Biomonitoring. The licensee (MDIFW) is required to conduct a biomonitoring test during 2000 or 2001 downstream of the hatchery outfall. We suggest that MDIFW conduct biomonitoring tests both upstream and downstream of the outfall to ensure that baseline data and downstream data are sampled, measured and tested the same. Background water supply quality should also be established by sampling. DEP indicates that biomonitoring has been performed by DEP for Dry Mills, New Gloucester, and Palermo in 1999 and Casco, Embden and Phillips in 2000. Reports will not be available until May 2001.

8. Listed Permits, Special Condition A, Effluent Limitations and Monitoring Schedule. Dry Mills 001A, Governor Hill 002A, New Gloucester 001A, Phillips 001A. Note 1 says, "Monitoring for the parameters for outfall _____ is suspended until notified by the DEP to resume monitoring for the parameters." According to DEP, this monitoring is suspended based upon direct request from MDIFW. MDIFW argued that if the limit could be met when cleaning, the limit should be met when not cleaning so monitoring wouldn't be necessary. It is suggested that MDIFW request this note to all sites in order to reduce overall monitoring and testing costs.

9. Casco, Dry Mills, Enfield, Governor Hill, Grand Lake Stream, New Gloucester, and Phillips, Special Conditions, Practical Alternative Study. Discharge is only allowed until "practical alternatives exist." The question was raised about what kinds of alternatives are acceptable except to stop discharge completely or discharge into another stream? The new stream would most likely be in the same watershed so the situation would not be solved. Contact with DEP suggests piping to a larger stream, crop or spray irrigation, etc. Additional treatment does not count as an alternative. Another question is if the discharge is meeting license requirements, does the alternatives study need to still be

undertaken? DEP says the study is required by law. MDIFW needs to follow-up with DEP and determine exact requirements for this study and whether it is essential.

10. Casco, Dry Mills, Embden, Governor Hill, New Gloucester, Palermo, and Phillips, Special Conditions, Settling (or Show Pool) Cleaning. The requirement outlines cleaning after 20% filled capacity or a certain date (whichever occurs first). MDIFW needs to change operations to incorporate this requirement as defined in the permit.

11. Dry Mills and New Gloucester, Fact No. 4, Receiving Water Conditions. A TDML may be required in the future. Contact with DEP suggests that this determination will be avoided if possible. If required, a time frame could not currently be provided by DEP.

12. Special Conditions, Sanitizing Agents. Footbath wastes. A question was raised about what would be acceptable disposal for footbath wastes. DEP indicates that it depends on the chemical, but ground or gravel driveway disposal may be an option.

13. Cleaning flows and overflow water. Cleaning flows cannot be easily measured since overflow water is also occurring at the same time. Also, cleaning samples may include overflow water in the sample. DEP was asked that if a composite sampler was used, could the cleaning/no cleaning requirements be combined into only one effluent outfall requirement? For example, combine 001A and 001B into one effluent monitoring point, 001? Then the phosphorus would not need to be added together (outfall 002) since it would be accounted for in the new combined 001. DEP suggested that the current method can provide data that would help design treatment since times of non-compliance could be better determined. MDIFW will need to document cleaning flows based on cleaning durations. MDIFW might consider modifying the licenses to allow automatic composite sampling to reduce overall monitoring and sampling costs. Composite sampling will also more accurately reflect concentrations of BOD, TSS and TP that the effluent stream will actually receive since cleaning and overflow wastewaters are combined.

14. Enfield, Grand Lake Stream. Influent (i.e., lake water supply debris) Filter Backwash measurements. The effluent limit appears to be too low to meet. Backwash flows are usually very concentrated. Actual data will need to verify or refute the limit.

15. Composite Sampling. The cleaning effluent monitoring requirements request four composite samples taken during an eight-hour duration. Cleaning may occur for less time. Also, DEP suggested that composite sampling might need to be taken at different outfalls for those sites that maintain more than one raceway outlet to the stream. Or another option would be to sample one outlet per month, switching outlets every month.

16. Is the detection level of each parameter as reported by the laboratory important? MDIFW has been receiving "not detected" results at the level of standard. It seems that the standards chosen for TSS and BOD are 2 mg/l which is also the detection limit of the laboratory results. This indicates that the license limitations may be too low for accurate monitoring.

By-Product Modeling Discussion

By-Product Overview

The chemical changes in the water used in a fish hatchery are primarily the result of fish metabolism. One exception is the case-by-case use of therapeutic chemicals or sanitizing chemicals for disease control, which will be discussed later in this report. The magnitude of fish metabolism depends upon the amount (biomass) of the fish and the amount of food utilized by the fish. Therefore, the water quality impacts (i.e., effluent by-products) are in direct proportion to the amount of fish fed. The following levels of by-products generation (kg) per quantity of food fed (kg) have been determined (1972 – Willoughleys, Larsen and Bowen):

Fish Metabolic By-Product Conversion	
Ammonia (Total Ammonia Nitrogen)	0.032 kg/kg feed metabolized
C-BOD	0.340 kg/kg feed metabolized
Nitrate	0.087 kg/kg feed metabolized
Dissolved Oxygen Consumption	0.250 kg/kg feed metabolized
Total Phosphorus *(Varies slightly by the amount of Phosphorus in the feed)*	0.005 kg/kg feed metabolized
Total Suspended Solids	0.300 kg/kg feed metabolized

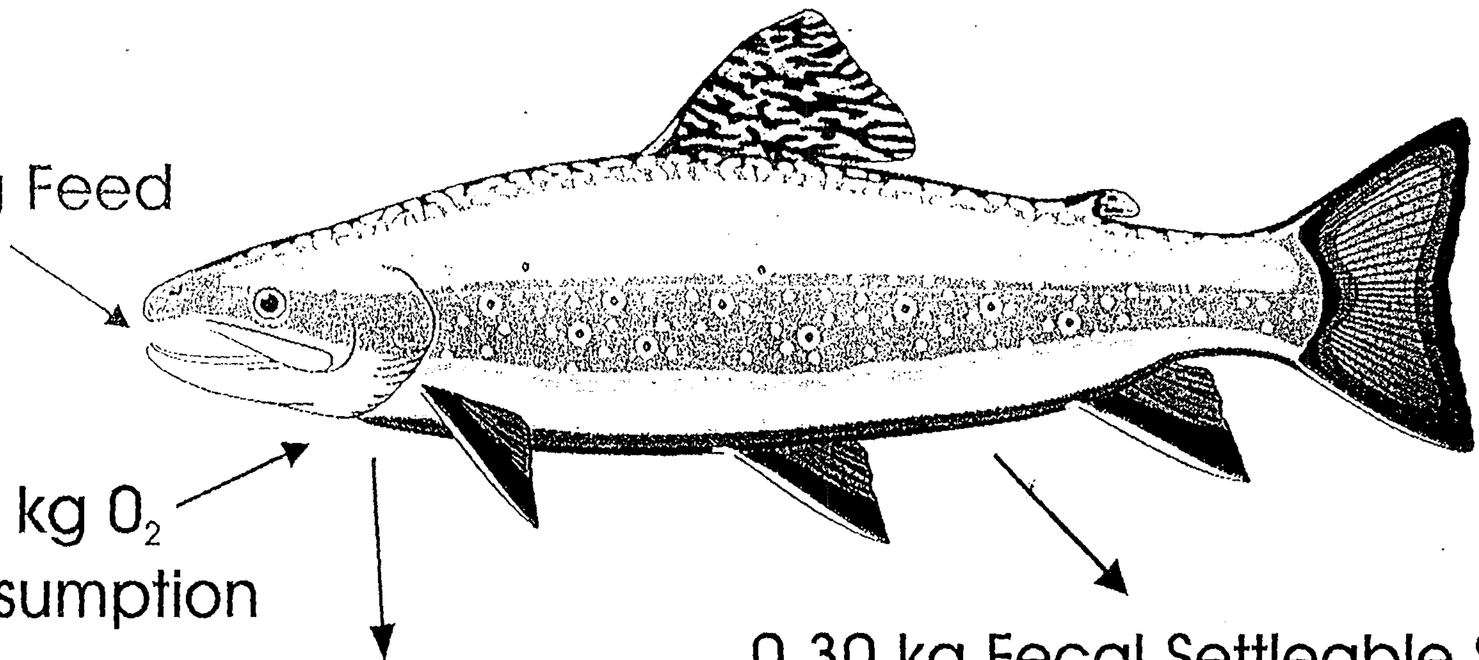
These feeding by-product generation values have been confirmed by many research studies that include coldwater fishes (trout and salmon), cool water fishes (pikes, perch, true bass) and warm water fishes (sunfishes, catfishes, and many tropical species).

In July 2000, DEP issued new Waste Discharge Licenses to the nine MDIFW operated sportfish production hatcheries. Each facility's new discharge license (discussed in detail in Sections IV-XII) specifically defines discharge limitations and monitoring requirements. Effluent characteristics (parameters) regulated and monitored by the licenses include biomass of fish, wastewater flow, biochemical oxygen demand (BOD), Total Phosphorus (TP), and Total Suspended Solids (TSS). Temperature and pH are regulated to maintain natural fluctuations within the receiving waters. During development of effluent limitations, DEP reviewed five sets (55 data points) of effluent monitoring data collected from the nine MDIFW facilities during the months of July, August, and September 1996. Effluent limitations in the newly issued discharge licenses are as stringent or more stringent then the preceding (1983) licenses. This report has analyzed the previously collected effluent data, new discharge license requirements data and the discharge license monitoring data for July, August, and September 2000 and compared them to the 1999 feed metabolism by-product generation for each MDIFW facility.

By-Product Modeling

Each MDIFW facility maintains detailed records for each lot (i.e., species group) of fish produced throughout the year. Production Data is recorded on three different data forms: a monthly egg incubation/fry history monitor, monthly broodstock monitor and a monthly fish

FISH METABOLIC REQUIREMENTS AND BY-PRODUCTS



production report. (See examples in Appendix F). The MDIFW data reports accurately track fish numbers, biomass, feed type and amounts, feed conversion, growth, water temperature, dissolved oxygen, water flow rates and a variety of calculated indices to monitor fish production. Using the 1999 MDIFW individual lot records for each facility, the consultant team prepared EXCEL workbooks to summarize the monthly water flows, biomass, fish feeding, fish weight gain, feed conversion and other production statistics for the 1999 production year at each facility.

Using the known mass (kilograms) of food fed each month and monthly water flows, the theoretical calculated mass (in kg/month) and concentrations (in mg/l) for each facility were generated. We believe the data accurately reflects MDIFW facility feed type, feeding levels, food conversion, water flows and calculated by-product mass. Graphical plots have been prepared for each facility that present the 1999 production year parameter by-product calculated mass and concentrations alongside the actual 1996 data and Year 2000 measured data (in mg/l) concentrations. Due to the fact that concentration data has been used to develop the new DEP discharge license for MDIFW facilities, we believe that comparison to the food-calculated parameter mass and concentrations is necessary to determine validity and accuracy of the methods used.

Fish Rearing Units and Cleaning

In general, the following discussion outlines fish rearing units, feeding operations, rearing unit cleaning and effluent treatment systems at the MDIFW facilities.

Hatchery Buildings (Egg Incubation and Early Rearing)

The MDIFW facilities at Casco, Dry Mills, Governor Hill, Grand Lake Steam, New Gloucester, and Phillips have hatchery buildings where egg incubation hatching as well as feed training and early rearing are conducted. Hatchery building operation involves relatively low flows (<500 gpm or 1,800 lpm) and very low feeding mass because fish are small and learning to feed on artificial diets. Trough feeding is completely both by automatic feedings and hand feedings. Trough cleaning is accomplished by siphoning or draining feed material to the building floor drains.

Raceway Feeding and Cleaning

Linear concrete raceways with serial (i.e., multiple pass) water use are the principal rearing units used within the MDIFW fish hatchery system. Concrete raceways are approximately 100 feet long and range from 4 to 8 feet in width. Water depth is about 16" (1.33 ft.). Fish are fed mostly by hand, with some use of demand and belt feeders. Only the New Gloucester facility uses raceways which are earthen channels with concrete stoplog control structures. Earthen raceways are difficult to clean and are considered poor fish rearing units by today's standards.

Water is serially reused through the raceway bank until the final unit. Water from the final unit overflows into the effluent pipeline where it eventually reaches the receiving water. This form of hatchery wastewater is termed overflow water (OW) and generally matches the influent flowrate.

DEP currently requires monitoring this wastewater stream separately from the cleaning wastewater (as described below).

The cleaning operation for concrete raceways is completed by a combination of partial draining and broom sweeping of solids. Each raceway is equipped with a drain, drain plug and narrow quiescent zone, (QZ, 18" wide x width of the raceway). The MDIFW quiescent zones do not meet the typical recommended length, which is at least the width of the raceway. The raceway cleaning operation is begun from the upstream (top) of the raceway series, moving downstream. The drain plug is removed and the floor brooming operation is begun moving from the top of the raceway to the drain area. The cleaning effluent (WW) volume has been approximated to be 75% of the raceway volume and lasts about ten minutes. After brooming, the drain plug is replaced and the unit fills to its normal operating water surface and again, begins to overflow to the downstream unit.

Cleaning effluent (WW) is drained to a solids clarifier (at Embden, Palermo), earthen solids collection basin (at Dry Mills, New Gloucester, Governor Hill, and Phillips), or directly to the receiving stream (at Casco, Embden, Enfield, Grand Lake Stream). Overflow from the clarifiers or earthen collection basin eventually reach the receiving stream. Rearing unit cleaning frequency varies depending upon time of year and feed amounts. Units are cleaned once every two weeks in the winter period and as frequent as every other day in the peak of the summer growing season.

Effluent Treatment Discussion

Wastewater Treatment Alternatives

There are three major types of unit processes utilized for the reduction of parameters during wastewater treatment: physical, chemical, and biological. In physical units such as screening, mixing, sedimentation and filtration, removal or treatment occurs via physical operations. Conversely, in chemical units such as precipitation and disinfection, parameter removal is brought about by the addition of chemicals or by chemical reactions. Similarly, in biological units, reduction of parameters occurs due to the metabolism of biological organisms such as those present in activated sludge or nitrifying bacteria colonies. These three unit processes are used to remove a variety of components from both water supply and wastewater. Usually the processes are used in conjunction with one other in a series as a complete treatment regime. For example, most municipal wastewater treatment facilities utilize, among other processes, screening, settling, activated sludge, and disinfection processes for parameter reduction to permitted discharge levels.

As mentioned previously, the main components of concern in hatchery wastewater are solids, nitrogen, phosphorus and to a lesser extent, biochemical oxygen demand. Overall wastewater treatment can be accomplished by utilizing various unit processes as outlined below. Each unit process will be discussed as it relates as a possible wastewater treatment option for Maine hatcheries. The main factors used for choosing treatment units for this hatchery will be removal performance and ease of maintenance, and to a lesser extent, low operational and construction cost. Since the main purpose of the facility is rearing fish, wastewater treatment should not be a major staff burden. Only those units that meet these criteria will be discussed in detail. Options pertaining to both wastewater treatment and solids disposal will be outlined. Preliminary costs associated with only the recommended or feasible unit processes will be presented in Section XIII.

Vacuuming from Quiescent Zones

Solids may be removed from raceway floor and solids collection chambers by direct vacuuming systems. Commercial pool vacuum systems, with screened pickup wands to avoid fish entrainment, are used by some hatcheries. While the vacuum cleaning process is effective, it is labor intensive. Final solids recovery may be accomplished directly in the vacuum tank or a separate solids collection vessel (a trailer mounted unit or a fixed chamber). Another type of vacuuming equipment utilizes the vacuum created in sludge application tanks. Either trailer or self-contained truck units are available. These systems incorporate the solids collection vacuuming, storage and land application components in a single unit which makes them an attractive solution. Examples of vacuuming systems are provided in Appendix D.

Another alternative for removing solid material from rearing units is to use a gravity or pumped piping collection system. The solids from the collection chamber would be transferred to the next stage of wastewater treatment (such as a clarifier or microscreen). A pumped system will require power.

Treatment Lagoon

Lagoons, or wastewater stabilization ponds, are one of the simplest biological treatment processes available. Microorganisms metabolize the organic content of the wastewater to produce cell growth and end products of carbon dioxide and water. Therefore, the organic concentration (i.e., BOD) of the wastewater is reduced. Lagoons may be used alone or in conjunction with other treatment processes. Lagoons are usually employed downstream of clarifiers to provide secondary effluent settling and aerobic treatment. Currently, clarifiers and lagoons are the most common method employed for aquaculture wastewater treatment. The three principle types of lagoons are: aerobic, facultative, and aerated (Corbitt, 1990).

In aerobic ponds, the only oxygen available to the microorganisms is that available from algae photosynthesis and from surface reaeration. Therefore, most ponds are very shallow (0.5 to 1.5 feet) with a detention time ranging from 5 to 20 days. Most aerobic ponds are used to reduce the soluble BOD from the wastewater. A facultative lagoon, also referred to as an oxidation pond, is characterized by an aerobic surface zone with a gradient to an anaerobic bottom zone. Oxygen is again supplied via algal photosynthesis and surface reaeration. The aerobic microorganisms stabilize organic wastes and by-products generated from the anaerobic processes in the lower layer. The depth of this type of pond is generally deeper (3 to 8 feet) but requires a longer detention time (30 to 180 days). In turn, the area requirements of this type of treatment are very large. By adding oxygen from either mechanical aeration or diffused aeration, the aerated pond requires less land and provides greater flexibility for variable waste loads and climate changes. The depth of this type of pond ranges from 6 to 20 feet with a detention time of 5-20 days. In general, the longer the detention time, the better the removal efficiency.

A disadvantage to lagoon treatment is that the suspended solids are not consistently removed from the wastewater. Also, algae concentrations formed within the pond add to the total effluent TSS level. Therefore, some type of settling or filtration facility must usually follow pond treatment. Hatchery wastewater does not usually contain high concentrations of BOD so this form of treatment may not be effective. Large size requirements are due to the relatively large effluent flows and the required detention times. Therefore, space allocations of these units mostly preclude their suitability at the current sites. Leaching of nutrients from solids collected in lagoons may be a problem in some systems since solids removal from the lagoon is not normally done at regular intervals such as in the case with the clarifier.

Settling Clarifier

Clarifiers are used to facilitate the settling of suspended particles from the wastewater column through gravitational settling. When a liquid containing solids in suspension is placed in a relatively quiescent state, the solids with specific gravity higher than the liquid will tend to settle. A clarifier may be also referred to as a settling or sedimentation basin, or a settling or sedimentation tank. This process is one of the most common processes used in wastewater treatment. Settling may occur either as a preliminary treatment step or as the principle treatment process. Currently, clarifiers and lagoons are the most common method employed for aquaculture wastewater treatment. Winter sludge storage and land application equipment are normally components of clarifier systems.

Typically, parameter removal within a traditional clarifier ranges from 50% to 70% for suspended solids and 25% to 40% for BOD (Metcalf and Eddy, 1979) with modern equipment manufacturers estimating from 80% to 90% removal efficiencies for enhanced clarifiers. Many factors influence removal efficiencies including settling characteristics of the wastewater, detention time, surface loading rates, and influent conditions. In general, clarifiers are designed to provide from 1.5 to 3 hours of detention for the wastewater to provide ample time for the solids to settle. Proper surface loading rates (i.e., 500 to 2,000 gal per day per square foot of surface area) are also instrumental in clarifier design. This term is also called surface overflow rate (SOR). Two or more clarifiers could be installed so one unit can remain on-line during maintenance and repair work. Care should be taken when designing the clarifier's inlet (even distribution of flow), settling zone (ability to provide quiescent conditions), sludge zone (sufficient sludge storage for thickening) and outlet (minimize effluent velocities).

Most facilities utilize mechanically cleaned clarifiers of standardized circular or rectangular shape. The sludge is generally moved to a sump or a hopper and stored until it is periodically pumped to a solids drying unit or storage unit. Wastewater can enter circular tanks either centrally or peripherally (i.e., along the rim). In circular units, an arm carrying scraper plows or blades revolves around a central shaft pushing the sludge to a central well (see Appendix D for product literature). Some clarifiers utilize a suction arm rather than scraper blade for removal of lighter sludges. Wastewater enters the inlet end only of a rectangular unit. Rectangular tanks utilize a series of blades or flights attached to an endless chain, which pushes the sludge to a hopper at one end. The mechanical sludge handling system will require the most maintenance for this type of treatment unit. If the clarifier inflow is supplied by gravity flow, the only operational costs will be associated with the sludge collection, pumping and eventual solids handling.

In some cases, chemical polymers can be added to aid in reducing settling time requirements by generating a sticky floc of solids which settles easier. However, there are operating costs associated with chemical addition and mixing. In other cases, tubes or plate settling units can be added to increase settling potential. The plastic or metal plates are placed at a 30° to 60° angle so when wastewater flows upward through the plates, solids settle along the inclined walls and drop to the bottom of the clarifier. However, additional cleaning and algae control are required with most plates or tubes. In general, clarification alone is not adequate to reduce TSS to strict effluent standards.

A settling test of the effluent solids would be required to more accurately determine the exact sizing (i.e., diameter, depth and inflow design). This treatment option is usually used in conjunction with some other form of treatment such as filtration (see paragraph below). It is usually used to remove high solids loadings from the wastewater prior to a higher level of serial treatment to reduce the size and costs of downstream treatment.

Gravity Filtration System

In the past, filtration has generally been utilized during water treatment. However, in recent years and in order to meet more stringent effluent requirements, the process has been used for achieving residual suspended solids removal during wastewater treatment as well. Filtration occurs when a liquid passes through a granular media bed and suspended particles are retained upon the media. The particulates are primarily removed by entrapment (straining, interception, inertial impact, sedimentation and other hydro-dynamic forces) and adhesion (chemical bonding, Van der Waals forces, electrostatic forces or mutual adsorption) forces. Filtration processes allow particles smaller than the media diameter to be removed.

The media may consist of sand, gravel, anthracite, garnet or a combination of the above. The influent flow scheme can be upflow, downflow or biflow through the media and can enter the filter via gravity or pressure. Pressure filters are generally used at smaller plants due to space constraints but require higher maintenance and operational expertise. Polymers can be added in small doses to aid in particulate removal. The main purpose of the chemical is to alter the polarity of either the media or the parameter; not to form a floc which would readily clog the filter. In all types of units, filtration continues until a predetermined delta pressure (20 to 25 psi), a maximum turbidity (1 to 5 ppm) or preset time is achieved. At that time, a backwash sequence (15 to 25 gpm/SF) occurs in which the direction of flow is reversed and the media bed is fluidized to remove the trapped particles. The backwash water should be sent either to a clarifier or other treatment process for removal since it will contain high levels of suspended solids. System instrumentation and indicator controls are required for overall operational control. Air scour mechanisms can be added to help clean the bed more effectively.

The filter is generally sized using the peak plant flowrate as design criteria. The number of units should be kept to a minimum to reduce piping and construction costs but sufficient to assure that backwash flowrates do not become too large and that redundancy is available during service. A typical gravity bed filtration unit is composed of underdrains, support gravel, media (of varying depths) and backwash piping. Filtration is a relatively simple mechanical process for eliminating suspended solids from wastewater. However, there are many types of manufactured systems that can be chosen ranging from simple to very complex at a similar range of costs. The pumped backwash system will require operational and maintenance costs. Operational problems such as turbidity breakthrough, mudball formation, crack development and loss of filter media do occur but can generally be controlled with maintenance. Sometimes algal growth on the media is a problem. An optional PVC, domed cover could be added to help reduce algal growth on the surface if necessary.

Gravity operated bed filters with moving backwash hoods are popular since the filtration unit always stays on-line (see Appendix D for product literature). In addition, backwash water volume requirements and overall headlosses are reduced compared to other types of filters. These filters are capable of removing sub-micron-sized particles including unicellular algae.

Sizing is based upon a loading rate of 2.5 gallons per minute per square foot of filter. The width of the unit described above with the backwash hood is fixed at 16 feet. This option is best used for final, polishing solids removal and performs best when preceded with some form of settling (i.e., clarifier or settling lagoon).

Other various types of filtration equipment can be used to essentially extract solids from the wastewater. Bag filters can be used to remove solids. Due to the volume of generated fish waste solids, bag filters must be sufficiently sized to avoid rapid plugging which drives up the cost of these systems. Frequent changing of filtration bags is time consuming and energy intensive so these types of filtration are not typically used for solids recovery in aquaculture applications. However, a correctly configured trailer mounted bag filter and pump with filtration bags sized to permit rapid removal of the bulk material (normally in the range of 10 to 60 microns in size) may be a viable method. See Appendix D for examples of typical filtration equipment.

Microscreen

A screen is a device with uniform openings that is used to retain solids found in wastewater. A screening unit may consist of parallel bars, rods or wires, grating, wire mesh or perforated plate with openings of any shape and size. Microscreening (i.e., fine screening) can been used instead of primary solids settling or to remove the residual suspended solids from wastewater. Microscreens for solids removal have a mesh size that ranges from 10 to 100 microns with 40-micron mesh typically being used for solids reduction. These units have also been used at fish hatcheries for larvae and fish escapement control and raw water screening but have a much larger mesh size (200 to 500 micron openings) compared to those used for particulate removal. Rotating screens are a fine screening device used for pretreatment or polishing treatment for particulate removal. Particulates are removed from the microscreen surface by high-pressure backwashing. Although solids are effectively removed from the wastewater stream, solids must still be collected from the backwashing operation and disposed. The backwash water should be sent either to a clarifier or other treatment process since it will contain high levels of suspended solids.

One type of rotating screen, a drum screen (See Appendix D for Product Literature), involves the use of a variable low-speed (up to 4 rev/min) screen partially submerged in the effluent stream. Drum filters operate under gravity conditions with less headloss than disc screens. The filtering fabric contains openings from 10 to 100 microns (u) that are fitted on the drum periphery. The wastewater enters the open end of the drum and flows outward through the rotating screening cloth or visa versa. These units are normally used in concrete basins or self-contained metal tanks to which raceway solids are sent via a wastewater solids transmission pipeline. The collected solids are backwashed by high-pressure jets into a trough located within the drum at its highest point. Backwashing can be continuous or intermittent. The fabric should be a corrosion resistant, sturdy material such as polyester, 316 stainless steel or titanium (for saltwater applications). Like other mechanical systems, these units require electrical energy, pumping, drive motors and a reasonable level of maintenance.

The second type of rotating screen, a disc screen, employs stainless or alloy wire cloth with a typical openings ranging from 10 to 100 micron (u) mounted on a rigid circular frame. The unit rotates on a shaft in a channel perpendicular to the direction of flow. Like the drum screen, the lower half is submerged so that solids impinge on the surface of the screen and are lifted in the rotation cycle above the level of flow where they can be continuously removed by water spray. Multiple disc screen units can be used to increase screening area and removal efficiencies and are being used in various wastewater applications (see Appendix D for Product Literature). Multiple discs can use a "graded" incrementally decreasing mesh size to improve performance. Mesh size of 40 microns is suggested for TSS reduction in this application based on a manufacturer's review of MDIFW data.

Problems encountered with these systems include incomplete solids removals and inability to handle solids fluctuations when loaded too heavily (i.e., blinding). Unlike filtration, submicron size particles or unicellular algae cannot be removed by microscreening alone. Less frequent flushing and reducing drum rotation can alleviate these concerns. However, the removal capacity will be reduced. These types of screening devices have been used successfully at other fish hatchery operations for both influent water treatment (debris and wild fish removal) and water reuse treatment.

Constructed Wetland System

Wetlands are areas of land which are periodically inundated at a frequency and depth sufficient to support the growth of vegetation adapted to life in saturated soil conditions (WEF, 1990). The high cost of conventional wastewater treatment systems has led scientists and engineers to search for innovative and natural treatment alternatives. Since discharge into existing, natural wetlands is mostly prohibited (effluent must meet minimum of secondary treatment quality), constructed wetlands have developed as a viable treatment option. Compared to natural wetlands systems, constructed wetlands can be built with a greater degree of control such as site selection, sizing flexibility, hydraulic pathways and retention time (Moshiri, 1993). In general, constructed wetlands have been designed to treat primary and secondary municipal wastewaters as well as waters from a variety of other sources such as stormwater, landfill leachate, industrial and agricultural wastewaters and acid-mine drainage (Kadlec and Knight, 1996).

Among many other attractive attributes, three functions of wetlands especially useful for wastewater treatment include: physical entrapment of pollutants through sorption in the surface soils and organic material; utilization and transformation of elements by microorganisms; and low energy and low maintenance requirements to attain consistent treatment levels (USEPA, 1988). The three main designations of constructed wetlands are Aquatic Plant Systems, Free Water Surface System, and Subsurface Flow System.

Aquatic Plant Systems are shallow ponds with floating or submerged aquatic plants, mainly water hyacinth and duckweed. Retention rates vary from 15 (hyacinths) to 30 days (duckweed) for nutrient uptake (main process) and sedimentation to occur. Most aquatic plant systems require periodic harvesting for maintenance purposes. In general, the presence of plants provides a higher quality effluent for equivalent or shorter detention times compared to treatment lagoons (discussed in the beginning of this Section). Typical hydraulic loadings should range from 0.8 to 5.9 inches per day (2 to 15 cm/d). Since the systems rely only on one or a few species, they are susceptible to catastrophic events. Plant metabolism and growth is affected by seasonal changes even in temperate climates. When plant cover is lost, treatment effectiveness may be seriously impaired for weeks or months as new plants are established. The second potential problem with these systems results from harvesting biomass for nutrient removal and growth maintenance. These plants are typically 95% water when harvested so drying and residual disposal are a concern.

Free Water Surface (FWS) or Surface Flow (SF) wetlands consist of shallow basins or channels with vegetation planted on soil or other suitable substrate. The wastewater flows over the surface at relatively shallow depths. Some systems are lined with clay or synthetic liner for leakage control while others act to recharge the groundwater. The shallow water depth, low flow velocity and plant stalks act to support solids settling. The main advantages of this system compared to the SSF system are lower installation cost and simpler hydraulics.

Subsurface Flow (SSF) wetlands also consist of shallow basins or channels with vegetation planted on gravel, sand or other media. The wastewater flows horizontally (or in some cases vertically) through the media with no surface flow. Most of these systems are lined in clay or with a synthetic liner. The system is built with a slight slope between to the inlet and outlet to facilitate proper flow. The main potential advantage of a SSF system compared to FWS systems is greater cold tolerance, minimization of vector and odor problems, and possibly greater assimilation capability per unit of land area. However, greater capital and operational investment may be necessary.

Suspended solids removal occurs in the first few meters beyond the inlet due to the quiescent conditions and shallow water depth. Proper influent diffusion and dispersion is necessary to distribute the solids loading. Some of the most common plants species used in constructed wetlands include cattails (*Typha* spp.), bulrushes (*Scirpus* spp.) and common reed (*Phragmites* communis). Many factors affect the removal efficiencies within wetlands so care should be taken during design to meet as many of the following criteria as possible. A typical design contains distribution systems, berms, beds, liners, outlet structures, and plants. The length to width ratio of a wetlands should range from 1:1 to 4:1. Removal efficiencies increase with larger aspect ratios but at an added cost of construction. The wetlands should be compartmentalized into cells arranged either in parallel or series. The hydraulic residence time (HRT) is the average amount of time a molecule of water resides within the wetlands' confines. The HRT is calculated based on flow, area and depth of the wetlands. The optimal HRT varies for different wastewater constituents. The hydraulic loading rate (HLR) is the wastewater loading on a volume per area basis (in/d or cm/d). It should range from 1.0 to 2.0 in/d (2.5 to 5.0 cm/d) for FWS and 2.4 to 3.1 in/d (6 to 8 cm/day) for SSF. The normal wetland depth should be less than 3.3 feet (1.0 meter) for FWS and from 2.0 to 3.0 feet (60 to 90 cm) for SSF.

Effective wetland performance is affected on proper constituent and hydraulic loading. Optimally, the average effluent BOD concentration can range from 3 to 5 mg/l with 50 to 90% removal rates. TSS removals have been found to be similar to BOD with 80 to 90% removal efficiencies. However, it is important to maintain shaded conditions at the effluent to reduce algal growth and potential elevated TSS levels. Compared to conventional treatment techniques, overall operation and maintenance (O&M) requirements of wetlands systems are reduced. The most common difficulties associated with wetlands systems have been related to organic or hydraulic overloading. Flow and influent/effluent water quality should be monitored to assess the effectiveness of the system to allow for possible modifications as required.

Possible constraints to the use of constructed wetlands for treatment include: geographical limitations of plant species or the chance that an introduced species will become a nuisance or local agricultural competitor; size of wetlands treatment ranges from four to ten times compared to conventional treatment techniques; plant harvesting is difficult due to high plant moisture content and wetland configuration; and wetlands may provide a breeding ground for disease producing organisms or insects and may produce odors (USEPA, 1988).

The aquatic plant system and a surface flow wetland system will not fit on any of the sites due to the large size requirements. The wetland could be employed downstream of a clarifier to provide secondary or polishing treatment prior to discharge into the receiving stream. It is not usually recommended to use constructed wetlands alone as a method of solids removal since coldwater hatcheries can generate enough waste solids to create the potential for clogging. While this treatment choice is very effective as a final polishing step, the size requirements are too large and effluent quality cannot be guaranteed for stringent effluent requirements.

Municipal Treatment

If the hatcheries cannot meet effluent criteria, final treatment design and cost analysis would have to compare treatment construction to municipal treatment. If adequate municipal treatment capacity were available, this option would need to be evaluated on a site-by-site basis.

Some issues to consider would be that the Department may be required to pay all system capital improvement and annual maintenance costs needed to provide for effluent treatment at the agreed upon volumes as an up-front cost. The transmission of effluent to the City treatment system would most likely need to be paid for by the Department. Present capacity of City sewers and lift stations may not be adequate to handle the expected volumes. Transmission would most likely require a hatchery effluent pumping system and an adequately sized force main to pump effluent from the hatchery to a City treatment plant. Hatchery effluent treatment costs could be estimated based on a preliminary cost assumption of $6.00/1,000 gallons treated. Using the 2,500 gpm average flow rate for a facility, the cost per day for effluent would be $6,957 or $2.5 million per year. The treatment of hatchery effluent using the City system does not appear to be feasible. This form of treatment is very costly and will have high operational costs compared to other treatment options. However, if no other form treatment is viable, this alternative would have to be investigated further.

Water Reuse Options

The primary advantage of water reuse is the reduction of dependence upon raw lake, river or groundwater water for total hatchery operations. This is especially important during low water supply conditions (i.e., drought). A secondary benefit is the theoretical reduction of effluent nutrient loading to the receiving water since reuse provides a method to recirculate treated water back to the hatchery complex. Most of the nutrients are removed during the effluent treatment process but must be handled and disposed as discussed in this report. The effluent parameters mass produced in a reuse system are identical to a flow-thru system. Reuse options are not recommended for MDIFW facilities as a method to reduce or eliminate effluent treatment requirements.

Solids Handling and Disposal

Except for lagoon and wetlands treatment, all the outlined wastewater treatment options require some sort of solids handling and eventual disposal. At the present time, the hatchery collects as much of the solids material as possible in the quiescent zones of the raceways. However, not all the solid material moves to the collection area, so manual sweeping of raceway with lowered water level is a part of normal raceway cleaning operations. Flow baffles and the swimming activity of fish help to move solids to the solids collection area. In a few of the Maine hatcheries, the accumulated solids are sent to a clarifier or settling in-stream area for removal. The sludge material does not contain hazardous or detrimental components and is quite safe for land application as a fertilizer.

In wastewater treatment, the problem of sludge disposal is a very complex problem due to the nature of the material. The sludge generated from typical wastewater treatment devices is in the form of a semi-liquid state which contains only about 1 to 10 percent solids. The volume and costs related to disposal are significant. The clarifier, filtration backwash, screen backwash and lagoon sludge needs to be collected, conveyed to a dewatering device or storage unit so that it can be ultimately disposed. It is generally recommended that solids be continuously collected and removed from the wastewater system to avoid long-term leaching of nutrients to receiving waters. Each solids handling option has benefits and detriments in terms of performance, labor requirements, construction cost and operating cost. Ease of use, low manpower requirements, low costs and overall compatibility with fish culture operations are important criteria used to determine the suitability of solids handling systems.

After solids have been accumulated in one location and concentrated as much as possible, final disposal is required. The method of residual disposal is dependent on sludge characteristics, local conditions and government regulations. Final disposal generally involves some type of application to land and usually requires sludge to be transported away from the site. Depending on the volume of sludge and the distance to the disposal site, transportation costs can be quite significant. On-site sludge storage during inclement and winter months is also important to consider. The following solids (sludge) disposal options will also depend on the treatment methods chosen prior to this stage (i.e., clarification, wetlands, lagoon, etc.).

Landfill

The application of sludge at a sanitary landfill receiving refuse or at a dedicated landfill is the most widely practiced technique for domestic and industrial sludge disposal. However, hatcheries located in rural areas require transportation considerations and associated costs. Other landfill type applications include a sludge dedicated trench fill or area fill method. In each case, the sludge is buried and covered with soil. Provisions are required to divert surface drainage and sometimes a liner is required for groundwater protection. Both of these alternatives require large land areas dedicated for disposal.

Land Application

Applying aquaculture sludge to the land is a popular residual disposal method because of the relatively simple operating requirements and low operating costs if suitable land is nearby. Also, since it contains considerable quantities of organic matter and essential plant nutrients, sludge is an excellent soil conditioner and fertilizer for agricultural lands and for reclaiming disturbed lands. Aquaculture sludge is free from heavy metals and toxic materials and is frequently used by farmers as fertilizer. Liquid, dewatered, or dried sludge may be applied to the land using tank truck, spray irrigation, subsurface injection or ridge and furrow spreading. (See Appendix D)

A common method of liquid sludge application is direct spreading by tank trucks with capacities ranging from 1,000 to 2,000 gallons (3.8 to 7.6 m3). Sludge is spread from a manifold on the rear of the truck or tank as it is driven across the field. Application rates can be controlled either by valving on the manifold or by varying the speed of the truck. The principle advantages of a tank-truck system are low capital investment and ease of operation. The system is also flexible in that a variety of application sites can be served such as pastures, farmland, golf courses or athletic fields. Disadvantages include wet-weather problems and the high operating cost of the sludge haul. Tank trucks are not able to enter sites when the ground is soft. Consequently, storage or wet-weather alternatives must be available. Odors and nuisance vectors can be a problem associated with this method.

A second sludge application method is to apply the liquid sludge to the land by either fixed or portable sprinkler systems that have been designed to handle solids without clogging. The benefits of spraying include reduced operating labor, less land preparation, and use on a variety of plants. Operator attention is required to use wet portable systems, but fixed units can be highly automated. Sprinklers can operate satisfactorily on land too rough or wet for tank trucks or injection equipment and can be used throughout the growing season. Disadvantages include power costs of high-pressure pumps, contact of sludge with all parts of the crop, possible foliage damage to sensitive crops, nuisance odors and vectors and the potential for aerosol pollution. Using buffer zones, low-pressure sprinkling and operational control (avoid sprinkling on windy days) will help to alleviate some of these concerns.

A third form of sludge application involves injection. Two forms of sludge injection can be performed. The first method includes cutting a furrow, delivering sludge into the furrow and covering the sludge, all in one operation. The second choice is where the sludge is injected beneath the surface without turning over the soil. Sludge can also be trenched or plowed into the soil. The advantage of injection is the immediate mixing of sludge and soil, odor and vector problems are eliminated and surface runoff is controlled. The main disadvantage of injection is that application can only be made prior to the growing season or on noncultivated land. A tank truck or trailer is required so wet-weather operation is limited due to accessibility.

The forth sludge application option is ridge and furrow sludge application which is generally the same operation as ridge and furrow crop irrigation. Sludge flows in furrows between row crops, irrigating and fertilizing the soil. Advantages include the simplicity of the equipment involved and flexibility of use at existing sites. A disadvantage of this method is the settling of solids at the head of the furrows and the need for well-prepared sites with proper gradients. Ponding of sludge in the furrows, which can result in odors, is also likely.

Soil characteristics, climate, and topography all determine the feasibility of using a particular area to receive sludge applications. Favorable soils have high infiltration and percolation rates, provide high water and nutrient holding capability, possess good drainability and aeration and have a neutral or alkaline pH. Sludge loading rates are generally limited by nitrogen concentrations and long-term use of a selected site may be limited by trace-element contents. Therefore, sludge component analysis is required prior to any land application operation.

Application of sludge in the liquid state is attractive because of its simplicity. Dewatering processes are not required and inexpensive liquid-transfer systems can be used. Application of dewatered sludge to the land is similar to the application of semisolid animal manure. This is an important advantage of dewatered sludge because private farmers can handle application on their lands with their own equipment. (Metcalf and Eddy, 1979). This system will operate with existing manpower and raceway cleaning protocols now in use. Sludge handling may require MDIFW to purchase land application equipment (see Appendix D) if local farmers or municipal plants will not remove clarifier sludge under contract with MDIFW. A vacuum/pressure tank truck with land application accessories could be used for direct raceway vacuuming, but this is a labor-intensive method that may exceed MDIFW staffing abilities.

Sludge Storage

If the sludge is land applied, the hatcheries must allow for off-line storage during inclement weather and winter months. As discussed previously, the sludge needs to be removed frequently from the clarifier or settling area in order to reduce nutrient leaching. An off-line storage tank or basin will provide storage of the sludge until weather conditions allow for land application. An earthen basin will require truck access and labor for sludge removal. The basin should be lined in order to eliminate opportunities for nutrients to leach into the groundwater. A concrete or metal (bolted glass-fused to steel or stainless steel) can also be used to store the sludge. Collected sludge can be sent to a sludge holding tank with optional aeration capabilities. Aeration will reduce anaerobic conditions and possible odors. The tanks could be covered to reduce odor and freezing potential. The tank could be equipped with an easy to operate land application equipment loading system (either MDIFW or local farmers). The tank will provide sufficient winter storage (approximately six months) to meet MDIFW requirements per site.

Sludge Dewatering

After drying, the volume of sludge is reduced and easier to handle after dewatering. Dried sludge is a stable, less odorous material that is easier to store and handle than liquid slurry sludge. The available dewatering devices include: vacuum filters, centrifuges, filter presses, horizontal belt filters, drying beds and drying lagoons. Only the last two, non-mechanical processes will be discussed regarding hatchery implementation. In general, air drying processes are less complex, easier to operate, and require less operational energy than do mechanical dewatering systems. However, they require larger land area and more labor (primarily for sludge cake removal).

Sand beds are the oldest and most frequently used sludge dewatering technique used in the United States (EPA, 1987) for small and moderate sized facilities. A sand filter bed relies on percolation and natural evaporation for dewatering sludges. Sludge is placed on a sand bed underlain with gravel and open jointed drainage tiles in 8 to 12 inch (20.3 to 30.5 cm) layers and allowed to dry (see Appendix D). Open drying beds are used where adequate land area is available and sufficiently isolated to avoid complaints caused by occasional odors. Covered beds can be used where it is necessary to dewater solids throughout the year regardless of weather. Under ideal conditions, the moisture content of the sludge is generally about 60% (40% solids) after about 15 days. After drying, the sludge is typically removed manually with shovels or a front end loader. Some sort of truck running boards must be added if trucks are driven on the bed. The collected underdrain water should be sent back to the treatment process since it will contain somewhat high solids concentrations. Some sand will generally be lost during cleaning operations so replacement is a constant maintenance requirement. The general advantages of this system include: low capital cost (excluding land), low operational labor and skill requirement, low energy, low maintenance and material cost, little or no chemicals required, and high dewatering potential. The major disadvantages relate to weather conditions (rain or freezing), large area requirements, high labor requirement for sludge removal, media must be replaced periodically, may be aesthetically unpleasing and may produce odors. However, hatchery wastewater sludge is not as offensive as municipal sludge. Disposal of bed material is often more difficult than direct land application of liquid sludge.

A second type of drying system is a modified drying bed utilizes a wedgewire screen in place of the sand as the medium (see Appendix D). The properties of wedgewire screen were described in the screening portion of this Section. The screen panel is composed of high density polyurethane or stainless steel. Each unit contains a built in underdrain for continuous dewatering. Molded structural elements allow the panels to support small front-end loaders for sludge removal. Interlocking panels allow for ease of installation and replacement. The circulation of air both above and below the sludge layer speeds drying. While the capital cost of this type of bed is somewhat larger, the smaller size requirements make this process more comparable to a sand filter bed. This technology avoids the periodic media replacement required for sand bed systems. However, polymer is usually added to aid in dewatering. At an additional cost, tiltable units are available for easier sludge cake removal which can be used to slide the solids directly into a semi-tractor trailer.

A third sludge drying system is the reed bed drying bed which utilizes a modified sand drying bed with dense vegetation growth to obtain dewatering. Usually reeds (Phragmites) are utilized but rushes or cattails can also be used. The plant roots act to absorb the sludge's water which is then evapotranspired to the atmosphere. Also, the stem and root penetration allows for constant drainage throughout the system. Finally, the microorganisms attached to plants and roots act to stabilize the sludge. The rootstock is planted on one foot (30.5 cm) centers and the bed is flooded for several weeks to encourage plant development. The freeboard above the sand is at least 3.3 feet (1 meter) to provide for long-term sludge storage. Sludge at about 3 to 4 percent solids is applied to the bed in four-inch (10.2 cm) layers (less than a typical drying bed). A new layer can be applied about every ten to twenty days without removing the dried sludge. Annual vegetation harvest is recommended which can be burned, composted or otherwise disposed of. Multiple beds are required. In a proposed ten-year cycle, twelve beds would be required to allow for one out of service and one for emergencies. When a bed is to be cleaned, sludge application stops in early spring, vegetation is harvested in early fall and the sludge cake and sand is removed by early winter. A new sand layer is installed and vegetation needs to be replanted. The total bed area required is similar if not slightly larger than a conventional sand bed system. The main advantage of the reed system is the infrequent sludge harvesting. While vegetation harvesting is still required, the overall volume of vegetation and sludge cake in a ten-year cycle is less than the conventional system. The creation of attractive reed habitat for wildlife is an added advantage of this type of system. This system seems best suited for smaller wastewater treatment facilities.

Treatment Design Parameters

Flow

In order to evaluate different wastewater treatment techniques, it is important to know the quantity (i.e., flow) of wastewater that will need to be treated. As discussed above, coldwater hatcheries generate two forms of wastewater: overflow wastewater (OW) and cleaning wastewater (WW). Overflow wastewater is water that is serially reused within the raceways, and gravity flows down the raceway bank to the next unit until the end is reached. Flow enters and leaves the raceway bank at a constant rate. Raceway cleaning occurs from about once per week to every other day. Cleaning flows generally consist of higher concentrations of by-products (i.e., BOD, TSS, nitrogen and phosphorus). In a few cases, the incoming water supply is treated prior to use with a rotary drum screen. The drum screen removes solids from the influent source and the screened solid material is backwashed from the screen to form an additional type of hatchery wastewater (BW).

MDIFW measured hatchery flows from each facility in 1995 for each month. These values were used as estimates of overflow wastewater. Cleaning flows were based on calculating the volume of water expected to be released from the raceways during the cleaning process (conservatively about 75%) and dividing by the estimated duration of cleaning. Overflow and backwash wastewater is generated twenty-four hours per day. Cleaning operations generally last from four to eight hours and were conservatively estimated for eight hours per day. Within the daily operation, the hatchery experiences daily peaks and ebbs of flow so daily averages are generally used for preliminary effluent treatment sizing purposes.

Hatchery Effluent Characteristics

Hatchery wastewater generally contains uneaten fish food, fish feces and urine and added chemicals. Most hatchery effluents are monitored for BOD, TSS and/or nitrogen and/or phosphorus. In order to determine the size of various treatment options, the second preliminary design requirement is determination of the concentration of potential parameters (i.e., BOD_5, TSS, nitrogen and phosphorus) in the wastewater. As suggested by DEP, MDIFW has been monitoring the hatchery discharge and most recently, the receiving streams. Historical and current data per facility is presented in the By-Product Analysis portion for each individual hatchery (Sections IV-XII). This data is compared with the quantities of expected quantities of by-products as determined from the by-products model.

Effluent Treatment Criteria Options

As mentioned above, the first two criteria necessary for sizing treatment units were related to the effluent flow and effluent water quality. The final criteria necessary for evaluation includes determining final effluent limits to impose on the treatment system. Schwartz and Boyd (1995) averaged effluent concentration limits recommended by the U.S. Environmental Protection Agency and individual State Agencies as follows: TSS, 30 mg/l; BOD5, 30 mg/l; Total Ammonia, 1.77 mg/l; nitrate-nitrogen, 16.9 mg/l; nitrite-nitrogen, 0.83 mg/l and total phosphorus, 0.17 mg/l. The new Maine DEP waste discharge licenses are much lower than the national average at 2 mg/l for TSS and BOD and total phosphorus ranging from 0.011-0.063 mg/l. Individual effluent limitations and monitoring requirements are detailed in the Waste Discharge License portion of each hatchery Section (see Sections IV-XII). In general, the final treatment design will be based upon trying to meet the Waste Discharge Licenses as issued by the Maine DEP.

Wastewater Transmission

Due to the construction cost and continuing operation and maintenance costs, the preferred method of effluent transmission through the treatment system alternatives is via gravity flow. The topography of the land and property boundaries will dictate whether complete gravity flow is obtainable. However, higher excavation costs and potential floodplain and flooding issues may result from gravity operation. Sometimes additional development is not allowed in floodplain areas. There are components of all of the effluent treatment system alternatives that must be protected from flooding including: pump motors, control electronics and instrumentation as well as the selected treatment system components themselves. Therefore, the gravity flow based treatment system must be protected by some type of flood protection system. It should be noted that some portions of the treatment system might require pumping such as microscreen backwashing and transmission of clarifier sludge to the sludge holding. Alternate wastewater handling may need to be considered during flood stage since water may not be able to discharge into the receiving stream.

If hatchery boundaries, floodplain development or flood protection is not viable, relocation of the treatment equipment to upstream of the final discharge location would be required. Subsequently, wastewater pumping would be required at great operational cost. Using a theoretical example of one submersible solids handling pump, rated at 2,500 gpm with 25 horsepower motors, pumping costs would be as follows:

25 hp x 0.746 kW/hp x 1.25 (80% efficient motor) x $0.10/kWh x 24 hr/day = or about $55.95/day/pump.

Using two lift station pumps as an estimated average, yearly pumping costs would approach $41,000 plus annual maintenance. It is our recommendation to avoid effluent pumping due to the high construction and reoccurring annual operation and maintenance costs. It also appears that gravity flow wastewater effluent transfer can be used at all nine MDIFW facilities.

General Recommended Treatment Options

As discussed above, many forms of wastewater treatment and solids disposal exist at an equal number of ranges of capital costs, operational costs, maintenance requirements and ease of operation. Many of the treatment alternatives are land intensive, such as lagoons, wetlands, and sludge drying beds so they are not feasible at the current Maine hatcheries. Municipal treatment is not an option at the existing sites either. Final polishing media filtration would only be recommended if all other less expensive treatment options fail to meet effluent compliance. Water reuse does not eliminate the need for wastewater treatment and also includes additional disinfection and biofiltration requirements to allow for production reuse. Therefore, several options have been chosen for further consideration by the hatcheries: effluent flow reduction via flow baffles and quiescent zone improvements, vacuum cleaning, clarifiers, microscreening, sludge storage and land application of solids. Again, many alternatives are available within these chosen options at a wide variety of costs and varying potential for effluent compliance.

As mentioned previously, the new hatchery discharge license limitations in concentrations measurements are most likely too low to be met during cleaning. It appears, according to data analysis, that the overflow wastewater will usually fall within the effluent limits. Based on similar hatchery wastewater treatment studies in Pennsylvania and Michigan (Big Springs, PA and Platte River, MI), linear raceways generally allow approximately half of the metabolized by-products (i.e., mainly BOD, TSS, phosphorus and nitrogen) to escape through the overflow wastewater. However, the concentrations are much lower and more difficult to remove than those formed during unit cleaning due to the higher flow of water. Therefore, the treatment of the cleaning wastewater alone needs to be considered first. In cases where parameters are limited by mass per month or year, it may be necessary to also consider solids removal in overflow water as well, since treatment of only cleaning wastewater will remove about 37% to 50% of the total mass of all by-products.

The current Best Available Treatment (BAT) technology for treatment of aquaculture wastewater generally includes clarification (i.e., solids settling) or microscreening. In some cases, this is followed by lagoon or media filtration treatment. Some form of solids handling and final disposal always needs to be considered. Additional polishing treatment could be provided but at a very high cost. Higher levels of treatment costs are exponentially proportional to increased treatment but the actual removal is minimal. For instance, it may cost the same to bring a wastewater BOD from 100 to 10 mg/l and from 10 mg/l to 5 mg/l. Even with final polishing filtration and millions of dollars in capital and operational expense, the cleaning effluent level may contain up to 5 mg/l of BOD and TSS. It appears that no treatment option can guarantee compliance to the strict cleaning effluent concentration limitations imposed by DEP. Equipment has not been developed to economically meet such stringent criteria, even for municipalities. In fact, laboratory detection limits for BOD and TSS are at the license levels (2 mg/l). As mentioned previously, most effluent limits are closer to the level of 10 to 30 mg/l. In the Maine hatcheries, one of the main goals is to meet effluent criteria. It might be in the best interest of MDIFW to work closely with DEP to get the current discharge licenses modified to more reasonable limits for cleaning concentrations and overall mass reductions. With that said, the one of the purposes of this report was to help MDIFW determine ways to manage the currently generated wastewater using the most economical methods.

The recommended treatment choices were divided into several options, Options A through F. The BAT technology would include improved rearing unit solids collection and transfer, clarification of cleaning wastewater, microscreening of overflow water and collecting the solids in a storage tank. However, this option requires a high level of capital expense with no guarantee of meeting the cleaning effluent limits. Therefore, several lower cost and lower technological options have been provided for MDIFW to consider for comparison purposes.

Option A (see Figure III-1) includes only addition of an automatic composite sampler and flow measurement device to measure and sample both cleaning and overflow wastewater streams together. This will provide a more accurate measurement of the wastewater composition that the receiving water will actually receive. In the best case, this data will assist DEP assessment of the hatchery effluent that the hatchery is in compliance with the current licenses and that no additional treatment is required. Or it might help to illustrate that the current limits are too low and that DEP's models are not representative of actual hatchery wastewater.

Treatment costs increase as flows increase. Option B (see Figure III-2) includes methods for the hatchery to implement that will improve raceway solids transfer to quiescent zones (i.e., make the units self-cleaning) and limit the amount of flow that accompanies cleaning operations. Flow baffles added to the raceways help to move accumulated solids downstream to the quiescent zones so only quiescent zone brushing is required. Baffles require spacing approximately equal to the raceway width. Mounting could be accomplished using simple stainless steel toggle bolts and stainless steel wall inserts. A removable wingwall device can be used during cleaning of the QZ to limit the amount of water that enters the drain during quiescent zone cleaning/draining. Finally, the quiescent zones (QZ) are currently undersized and do not act to provide a settling and holding area for solids. The recommended minimum size for a QZ is for the length to be equal to the width of the raceway. These improvements will help to size treatment for the cleaning wastewater to approximately half of the current operation. Since clarification and sludge storage at each site is expensive, Option B includes a vacuum cleaning method that will allow trucks to drive up to the raceway, vacuum out the QZ and take the solids to a centrally located sludge storage tank during inclement weather and winter. The decanting water from the sludge storage tank will require one clarifier. The sludge storage tank will need to be sized to hold about six months of estimated sludge from all the sites. This option includes purchase of four to five solids vacuuming truck/tanks (one truck for two to three sites) that can either dispose of the sludge immediately through land application or discharge the sludge to storage. The hatcheries will need to share the sludge trucks and manage cleaning operations, accordingly.

Option C (see Figure III-3) includes the cleaning flow reduction recommendations from Option B. In addition, a clarifier and sludge storage tank is proposed at each site. The clarifier will be sized smaller (almost half) due to lower flows compared to Option E (below). This option includes piping modifications to collect all cleaning wastewater and conveying it to the clarifier. The proposed clarifier is a circular unit with an automatic sludge removal scraper and/or suction arm. The sludge is pumped to the sludge storage tank, which will include a decanting, telescoping valve to remove clarified water from the tank. The off-line aerated sludge storage tank will be sized to provide up to six months of sludge storage. This system will improve clarifier solids settling efficiency since regular periodic transfer of sludge to storage will be provided. The loading of sludge land application trucks will be considerably easier than trying to remove the sludge from the clarifier alone. MDFIW will need to decide if it will contract sludge removal from the sludge storage tank commercially or purchase land application trucks similar to Option B. Again, hatcheries can share trucks to help reduce overall capital expenses. Finally, it should be noted that a less complex rectangular clarifier similar to the existing systems at Embden or Palermo could be installed at less cost. However, this type of unit will require sludge removal and additional labor costs and will not perform as efficiently as the proposed circular type.

Option D (see Figure III-4) includes all of Option C with the addition of microscreening the entire overflow wastewater. The proposed microscreen (40 microns) will be a partially submersed drum unit sized to handle current hatchery maximum influent flows. The system will be enclosed in a building to provide all-season operation and security. Effluent particles smaller than the drum filter mesh cannot be removed by microscreening and 50% removal efficiency is assumed for this type of low solids concentration removal. In this option, the overflow water from the clarifier will be directed to the microscreen as an additional blanket of treatment. Due to the different size hatcheries with varying influent flows, the hatcheries have been grouped to utilize three different size microscreens. Embden, Enfield and Palermo will require the highest flow models (3,500-4,000 gpm), Casco, Grand Lake Stream and New Gloucester the medium flow models (2,000 gpm) and Dry Mills, Governor Hill and Phillips the lowest flow models (1,000-1,500 gpm).

Option E (see Figure III-5) is the same as Option C except for sizing the clarifier for the current cleaning flows without flow raceway cleaning reduction measures. Sludge storage sizing remains the same since sludge generation is tied into the mass of fish food as opposed to flowrates.

Option F (see Figure III-6) represents the BAT technology with full cleaning flow clarification, overflow microscreening and sludge storage. Microscreening sizing is the same as that outlined in Option D since overflow rates have not change between options.

A comparative summary table provides probable estimates of cost for these different options, Table III-1. These options allow MDIFW to determine which level of treatment best matches their operational regimes and budgets. In general, Option B costs less but requires more manpower for sludge collection, hauling and disposal. During a single day's cleaning operations, the truck may have to haul up to 50,000 gallons or 16 trips (~3,000 gal truck) of sludge either to the holding tank or to direct land application. Options B and C require management operational

Figure III-1. Wastewater Treatment Option A - Composite Sampling

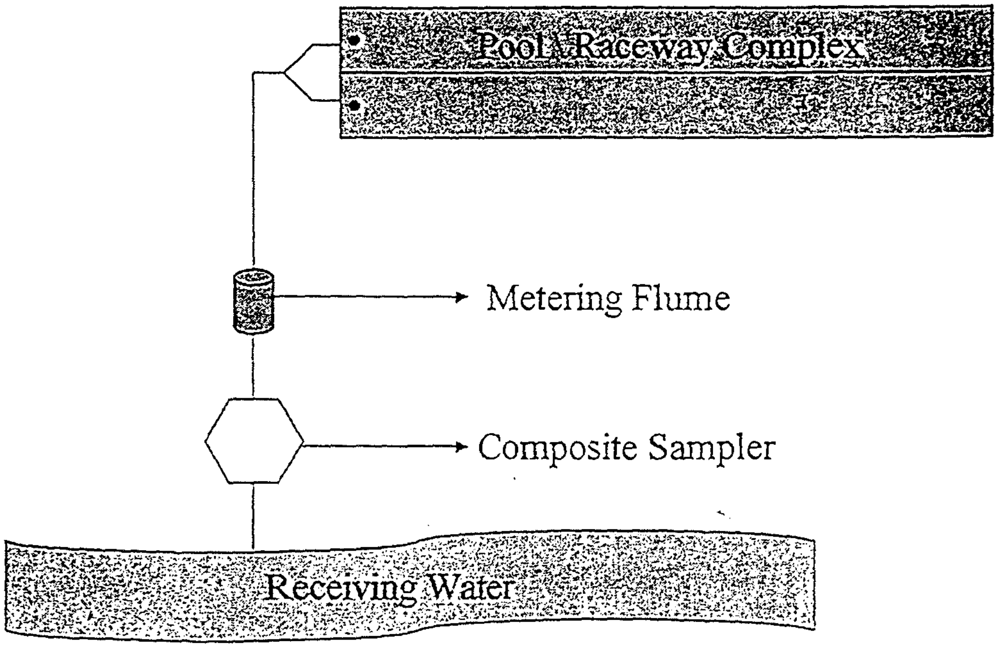


Figure III-2. Wastewater Treatment Option B - Central Maine Storage

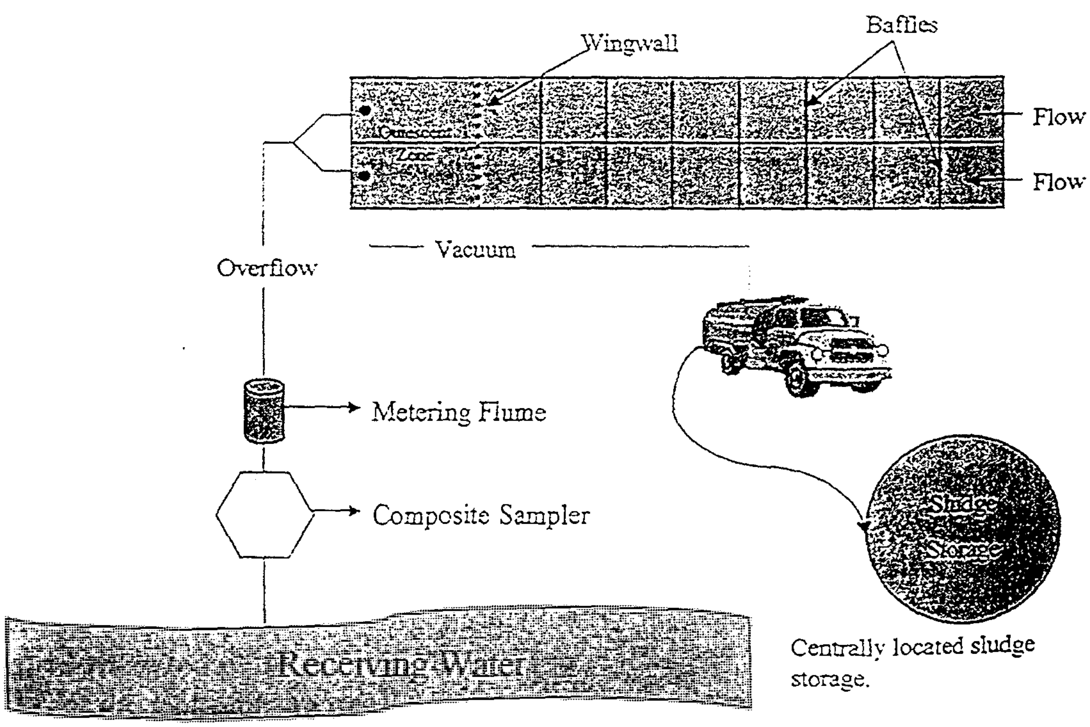


Figure III-3. Wastewater Treatment Option C - Onsite Storage (Reduced flow)

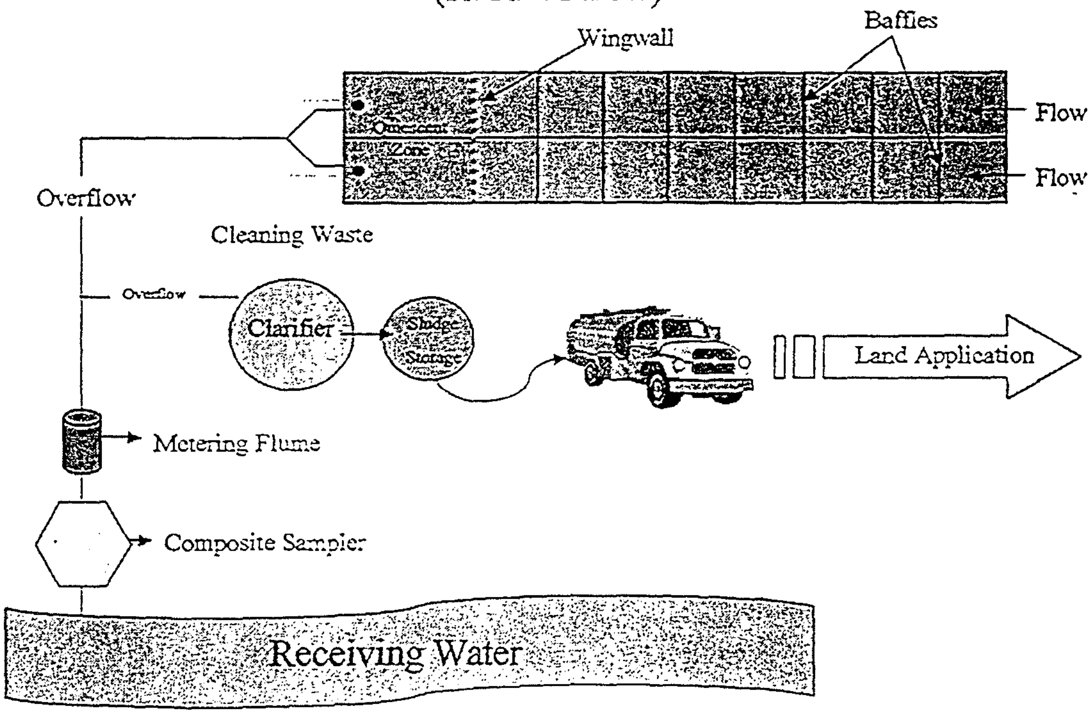


Figure III-4. Wastewater Treatment Option D - Onsite Storage & Screen (Reduced Flow)

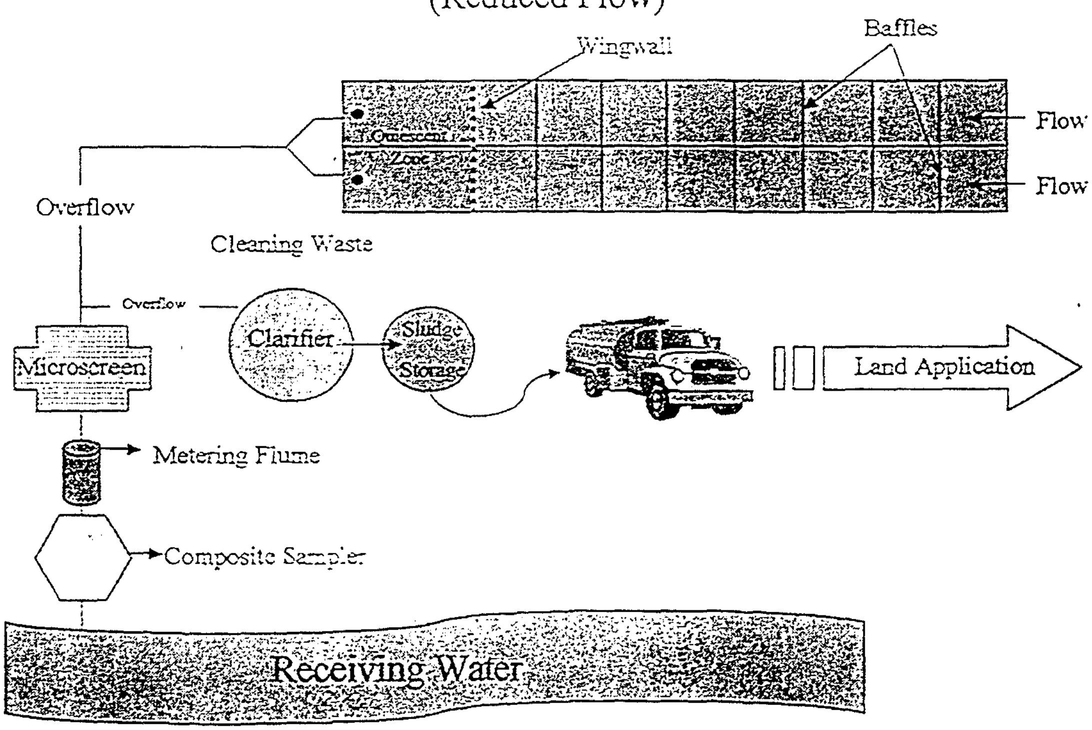


Figure III-5. Wastewater Treatment Option E - Onsite Storage & Screen (Full Flow)

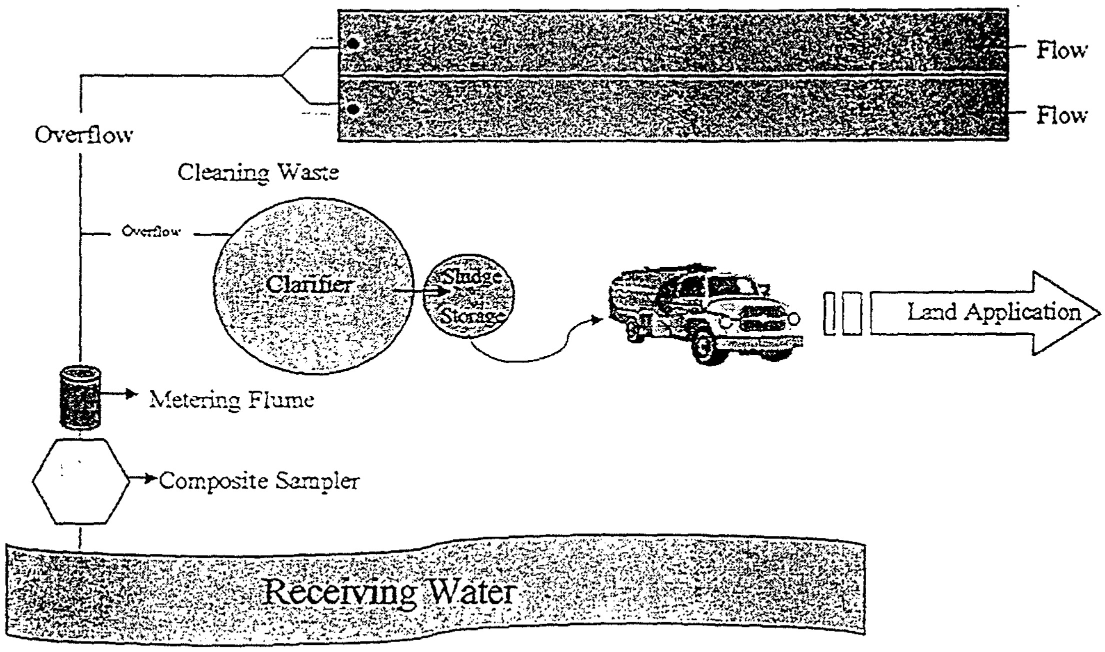
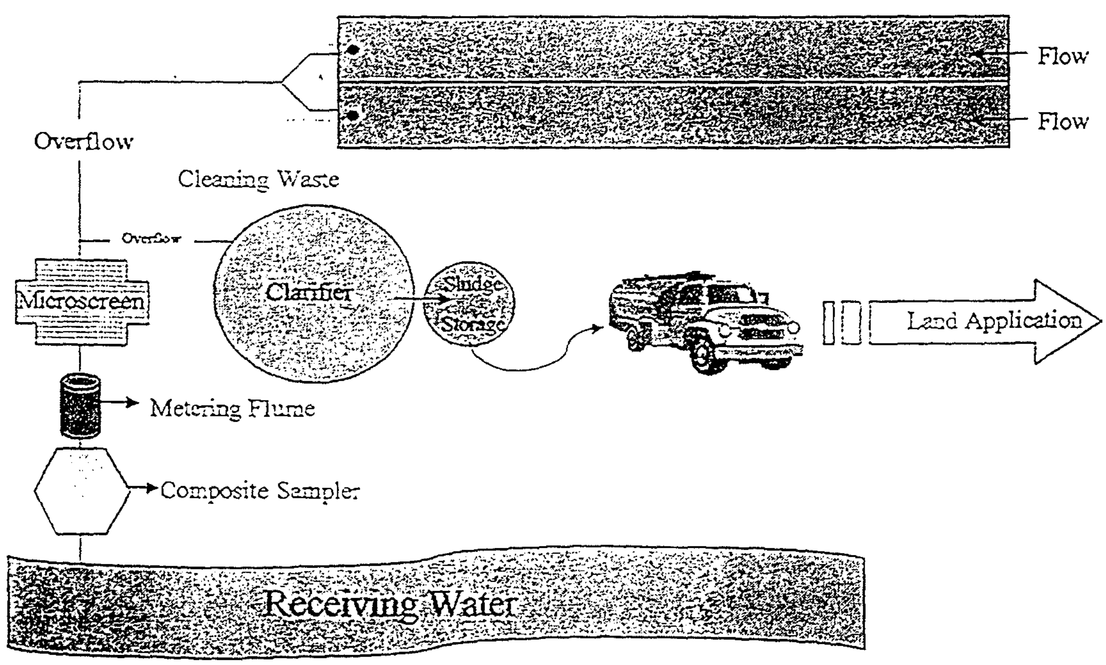
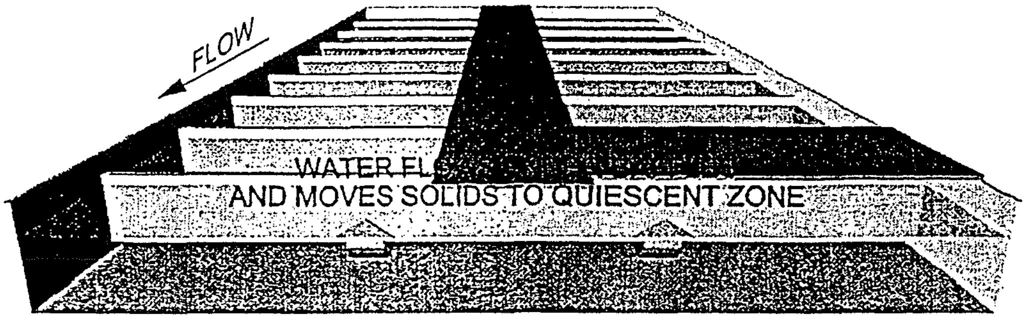
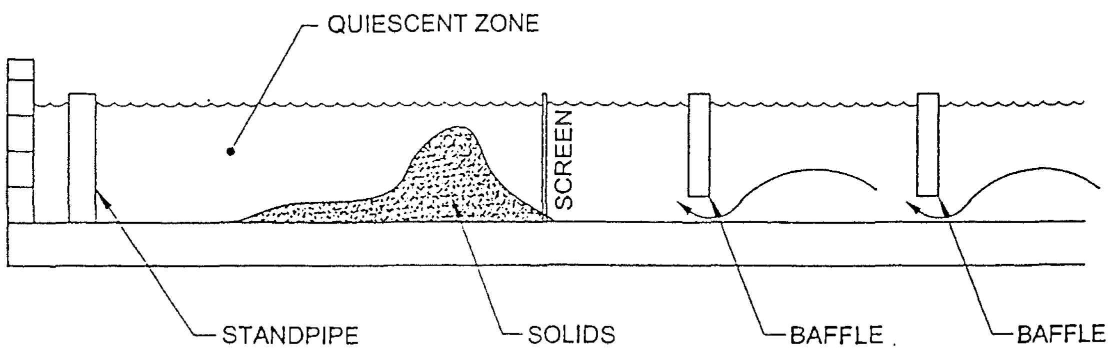


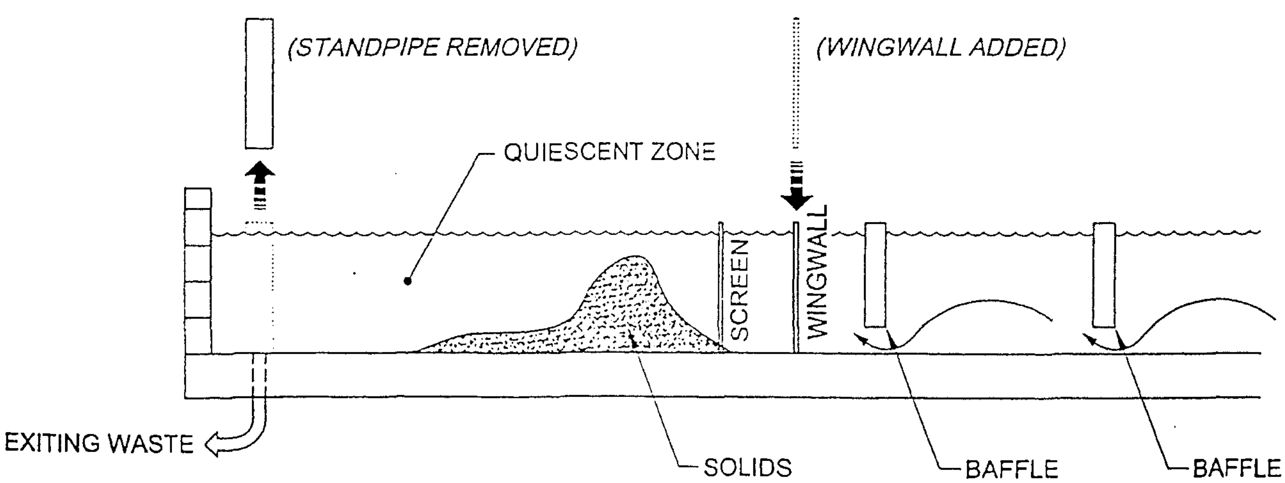
Figure III-6. Wastewater Treatment Option F - Onsite Storage & Screen (Full Flow)



BAFFLE EXAMPLE







changes during cleaning which may or may not be conducive to each hatchery's overall fish production or management philosophy (i.e., quiescent zone reduces overall production space slightly, flow baffles are not accepted by all hatchery personnel, etc.). Similar to no-till agriculture, not brooming is a departure from usual procedure. We suggest a pilot set of baffles be installed and tested by the staff to determine performance and compatibility with the production programs. All Michigan DNR hatcheries producing coldwater species use baffles in indoor and outdoor raceway operations. Another option is the change to circular rearing units with self-cleaning solids drains but this requires major capital construction outlays and still requires solids capture and handling treatment. Options E and F are high-cost treatment alternatives, which might not be justified until composite data indicates otherwise.