

WORK PLAN AND COST ESTIMATE
FOR A
PROGRAMMATIC ENVIRONMENTAL IMPACT
STATEMENT FOR SALMON NET-PEN CULTURE
IN WASHINGTON STATE

Prepared for:

Washington Department of Ecology in conjunction with the
Departments of Fisheries, Agriculture and Natural Resources

Prepared by:

Science Applications International Corporation

FINAL REPORT
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STATEMENT FOR SALMON NET-PEN CULTURE
IN WASHINGTON STATE

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1.0 INTRODUCTION

The state intends to develop an Environmental Impact Statement (EIS) for the net-pen culture of salmon in Washington state. The scope of this EIS is to include the net-pen culture of salmon or trout within all marine and estuarine waters of Washington state including Puget Sound, the coastal estuaries, and the lower Columbia River. The EIS would be programmatic (i.e., "nonproject" in SEPA parlance) in that it is intended to address the environmental effects of the industry as a whole rather than any one individual operation. The purposes of this report are: (1) to identify a tentative list of issues which should be addressed; (2) suggest a general approach to the resolution of each issue; and (3) provide a cost estimate and schedule for completion of the programmatic EIS. It is recognized that some changes in the scope of the EIS may result from the public scoping process. However, a deliberate effort was made to solicit input for this report from a number of individuals or groups with interest in the EIS, thus minimizing the likelihood of substantial changes during public scoping.

Two limitations of the programmatic EIS require special note. First, since the EIS will be generic in nature, it will not consider all site-specific conditions which must be evaluated for individual operations. Some potential issues are best dealt with in a generic manner such as potential impacts of the introduction of Atlantic salmon or the environmental effects of antibiotic usage. Other potential impacts are, however, very site-specific such as interference with navigation or conflicts with recreational activities. The EIS should clearly describe the limitations resulting from the programmatic approach, and identify the type of site-specific information which must be evaluated during permit review for individual operations.

Secondly, the EIS should identify the assumptions upon which it is based in terms of a maximum anticipated level of culture (probably expressed in terms of state-wide annual production). As the industry grows and operations become either larger or more numerous, the potential magnitude of environmental impacts can change substantially. The EIS should specify an anticipated intensity of culture, and evaluate the associated impacts. Industry growth beyond this level may require further reevaluation.

As required by SEPA, the EIS must consider reasonable alternatives to the proposed action. It is anticipated that at least two alternatives must be evaluated: (1) no action; and (2) pumped seawater culture (i.e., land-based tanks or raceways). Ocean ranching is not considered as an alternative since it is not legal in Washington state. The alternative analysis should consider economic cost vs. environmental benefit in at least a qualitative fashion.

Issues to be addressed by the EIS and recommended approaches to their resolution are divided into Impacts to the Natural Environment (Section 2.0) and Impacts to the Built Environment (Section 3.0). In some cases potential mitigation measures are discussed if they are anticipated to require substantial effort. This is not meant to imply that these mitigation measures will necessarily be required, nor that these will be the only mitigation measures considered. A level of effort is specified for each task. In most cases this is expressed as the number of technical manhours required to complete the impact evaluation, consider mitigation measures and prepare the draft EIS and associated technical appendices. Labor costs to prepare the final EIS are provided as a single line item in Section 5.0. For those issues which must be addressed by field or laboratory work an estimates of these costs are also provided. The scope of a Management Plan which should be developed as a complementary effort with the EIS is discussed in Section 4.0.

2.0 IMPACTS TO THE NATURAL ENVIRONMENT

2.1 WATER CIRCULATION

Issues

- To what extent do net-pens alter water movement in their vicinity?
- At what distance from a net-pen complex would effects on current velocity or direction be measurable?

Approach

The information provided by Weston (1986) is generally adequate to address the issue of net-pen effects on water circulation. A more detailed discussion of the principles of fluid mechanics could also provide additional insights into the issue. Field measurements could be made around existing net-pen complexes, however intensive study of the subject is probably not justified. The issue has not been one of major concern in the past and the extent of effects are probably too site-specific to permit general application of field data.

Level of Effort

Twenty manhours have been allocated for the minimal information gathering necessary and EIS preparation.

2.2 WATER QUALITY

Issues

- To what extent does fish respiration and the input of organic matter and nutrients associated with net-pen culture alter water quality in the vicinity?
- What are the implications of these water quality effects for facility siting (e.g., size of operation, distance between operations, number of net-pens in a given area)?

Approach

Most of the general information required for the EIS is included either in Weston (1986) or in references cited therein. Some updating may be required

to incorporate data gathered under the interim guideline annual monitoring programs or similar studies conducted elsewhere. Considerable attention has been given to water quality effects of aquaculture in British Columbia, Norway, and Japan and information from these sources should be solicited.

The principal goal of the EIS water quality task should be a re-evaluation and refinement of the interim water quality guidelines. Much work done in specific areas (e.g., Budd Inlet, Sinclair Inlet, Sequim Bay, Dabob Bay) could not be compiled for the interim guidelines, but should be included in the programmatic EIS. Much of this information was developed in connection with the siting of municipal wastewater outfalls, but should be generally applicable to salmon net-pen siting. This effort should be directed towards identifying potential siting limitations or culture intensities achievable in given areas without significant water quality degradation. A high degree of interaction with the phytoplankton task (2.3) is anticipated.

Level of Effort

The collection of the numerous relevant studies from Washington marine waters and the development of siting guidelines is anticipated to require a substantial effort. It is estimated that 200 manhours will be required for this task.

2.3 PHYTOPLANKTON

Issues

- Will nutrient inputs associated with net-pen culture initiate or sustain phytoplankton blooms?
- What limitations on project size or siting are necessary to minimize potential phytoplankton impacts?

Approach

Little additional literature review is required for this task. Available information on the phytoplankton effects of net-pen culture is extremely limited, and largely summarized in Weston (1986). The Japanese have devoted a great deal of attention to the subject in recent years, and some inquiries of these investigators may be worthwhile.

The primary emphasis of this task should be a modeling approach that addresses the fates of added nutrients. Metro's studies on phytoplankton productivity in the vicinity of municipal wastewater outfalls may provide valuable parallels. Key questions which must be addressed include the extent to which nutrients are converted into phytoplankton biomass and the time-scale of this conversion. The effects on phytoplankton productivity will be both site-specific and time-specific. The EIS, however, should develop a generalized approach to determining phytoplankton effects which can then be applied to individual net-pen sites. The EIS should give particular attention to reevaluation of the interim water quality guidelines which are intended to minimize the potential for phytoplankton effects. The approach used in the guidelines should be reassessed and modified as required.

The discussion of phytoplankton impacts of net-pen culture should include an assessment of possible impacts on paralytic shellfish poisoning (PSP). This issue is of particular concern because of public health implications and, therefore, any potential link between net-pen culture and the frequency and severity of PSP outbreaks should be given careful consideration. The EIS should review the current state of knowledge on the causative factors for PSP in light of the water chemistry changes attributable to net-pen culture.

Level of Effort

Approximately 150 manhours will be required to adequately address the effects of net-pen culture on phytoplankton productivity.

2.4 SEDIMENTATION

Issues

- To what extent (horizontal and vertical) will fecal material and unused food accumulate on the bottom beneath the net-pens?
- Can the extent of this accumulation be predicted prior to site development?
- What is the time-scale of this accumulation, both its appearance after the initiation of culture and recovery after culture cessation?

Approach

It is recommended that this task be addressed almost entirely through field surveys at existing net-pen facilities followed by the development of empirical models. There are three principal goals of these surveys. The first goal is to determine the extent of correlation between visible solids accumulation and alterations in sediment chemistry and biology. Secondly, empirical relationships should be established between the extent of solids accumulation and the variables of operation size, duration of culture, water depth and current velocity to provide the basis for evaluations of potential culture sites. Finally, the data collected through this effort should permit a reevaluation and refinement of the depth/current interim guidelines.

Fifteen facilities in Washington and British Columbia should be surveyed for this effort. The survey protocol at each site should closely follow the annual benthic monitoring survey as described in the interim guidelines. This survey would include diver transects, sediment chemistry sampling, and benthic infauna sampling. At some deeper sites it may be necessary to replace diver observations with either photographic techniques or more intensive sampling with a grab or box corer. It will also be necessary to measure current velocity and direction at various points in the water column.

Potential Mitigation Measures

The EIS should consider siting requirements as a means to minimize sediment accumulation. A number of existing or potential mitigation measures may be available including feed/feces collection devices, periodic sediment removal, devices which disperse feed and feces over a broad area, and polyculture techniques. Periodic rotation of culture sites is another potential mitigation measure. The potential use of these techniques in Washington State has not been explored nor has their economic feasibility. These techniques should be given careful consideration through the programmatic EIS.

Level of effort

Field costs other than labor are anticipated to be approximately \$13,000. Estimated analytical costs, excluding macrofauna analysis (discussed below), are \$14,000. It is estimated that 640 manhours will be required for the field

surveys, subsequent data interpretation and analysis of mitigation measures. The majority of these manhours (430) are field time which will also be used to support field studies conducted for other tasks (i.e., macrofauna, pathogens, antibiotics).

2.5 MACROFAUNA

Issues

- What changes in species composition and abundance occur in the benthic macroinvertebrate community occur as a result of net-pen culture?
- How much bottom area is typically affected?
- How rapidly does the benthic community recovery following cessation of culture?

Approach

Weston (1986) can be utilized to provide background information and a summary of existing information. Additional field data from existing net-pen facilities will, however, be required as described in Section 2.4. Benthic infauna samples should be collected concurrently with the diver surveys and sediment chemistry sampling. Taxonomy should be at the species level, and the data should be used to establish both the extent of areas which may lack macrofauna (as has been reported under some pens) and the extent of areas in which the benthic community differs from the unaffected community. Duration of culture should be given consideration in choosing the sampling sites in order to provide information on rates of community change and recovery.

Level of Effort

Macrofaunal sampling and identification is anticipated to cost \$34,000 assuming a total of 225 samples. Data interpretation and EIS preparation will require about 140 manhours.

2.6 FISH AND MEGAFUNA

Issues

- Do net-pen activities, water quality changes or sediment accumulation affect the species composition and abundance of wild fish or megafaunal communities?

Approach

Little information on this subject is available in the literature beyond some studies in freshwater environments and surveys of shellfish culture areas in Spain. Therefore, additional field work is recommended because of the significance of fish and megafauna effects to both commercial and recreational fishing interests. The necessary data will, in part, be provided by annual monitoring surveys done by culture operators under the interim guidelines; however, more intensive surveys should be done through the programmatic EIS. First, the diver surveys described under the sedimentation task (Section 2.4) should include transects made for the purpose of estimating fish and megafauna abundances. Qualitative estimates (e.g., "rare," abundant, etc.) should be made for all fish and megafauna observed with particular emphasis on those species important in commercial or recreational fisheries. Similar transects should also be run in reference areas to provide comparative data.

Secondly, a program of intensive, seasonal, quantitative sampling is recommended at one or two net-pen sites and comparable reference areas. If permitted by timing constraints, it would be preferable to conduct these surveys both before and after net-pen installation. The effect of net-pen operation on fish species composition and abundance should be determined through diver surveys, hydroacoustics, stationary gill nets and/or trawls. Collection of concurrent samples for fish size and stomach contents may also be advisable.

Level of Effort

Field costs associated with the diver-surveys have been included in the sedimentation task (2.4) and are not duplicated here. An additional \$13,000 should be included for field and analytical activities associated with the seasonal, quantitative surveys. Labor for the field surveys, data interpretation, and EIS preparation are estimated to require 330 manhours.

2.7 INTRODUCTION OF ATLANTIC SALMON

Issues

- In the event of escape from net-pens, will Atlantic salmon be able to establish self-sustaining populations in Washington?
- Can Atlantic salmon interbreed with any of the native salmon or trout species?
- Will Atlantic salmon displace native salmon stocks?

Approach

Much of the available information has been summarized in Lindbergh (unpub.). The programmatic EIS should, however, collect additional information through three avenues. First, the technical literature should be reviewed to identify work that may have been done since Lindbergh's review. Secondly, fisheries management agencies should be contacted. Several deliberate, unsuccessful attempts have been made to introduce Atlantic salmon in the Pacific Northwest. Those persons involved in these efforts should be contacted to determine the reasons for failure, if known. Finally, interviews should be conducted with fish geneticists, behaviorists and ecologists to obtain information on the probable consequences of Atlantic salmon introduction. The best professional judgement of recognized authorities should be solicited regarding the probability of interbreeding, competitive interactions and habitat requirements.

Potential Mitigation Measures

If culturists could raise sterilized fish, there would be no potential for interbreeding with native fish or the establishment of a self-sustaining population. The relative growth and survival rates of sterilized fish in net-pen systems is currently being evaluated. The status of these efforts and potential application to Puget Sound should be reviewed in the EIS.

Level of Effort

Completion of the literature review and interviews will require approximately 90 manhours.

2.8 INTRODUCTION OF PESTS, PARASITES AND PATHOGENS

Issues

- What are the risks and consequences of accidental introduction of pests, parasites or pathogens along with the importation or transplantation of salmon for culture?

Approach

General information on the subject of accidental importation of organisms can be found in numerous reviews on the subject and can readily be incorporated in the EIS. The principal objective of this task should be to provide a review of all federal and state requirements pertinent to the importation and transplantation of salmon or their reproductive products. The state regulations are currently in review, and members of the review group may be able to provide additional insights on the subject. A thorough assessment of risks would also require the identification of present or probable sources of salmon cultured in Washington state. A probable frequency of importations required to support the anticipated intensity of net-pen culture in the state should also be determined.

Level of Effort

Approximately 40 manhours will be required for completion of this task.

2.9 PATHOGENS

Issues

- Will net-pen culture foster the growth of bacteria pathogenic to fish, shellfish or humans?
- Will shellfish in the vicinity of a net-pen operation accumulate these bacteria, resulting in disease in the shellfish themselves or providing a route for human infection?

Approach

Some of the available information has already been summarized in Weston (1986), but this effort can be supplemented through additional literature review. The results of recent studies should also be incorporated (e.g., current

work in British Columbia on coliform and staphylococcal bacteria in the vicinity of net-pens). It is anticipated that interviews with scientific authorities will comprise a significant portion of this effort because there are very little published data on the subject.

Excluding the accidental introduction of non-native pathogens, there are no documented cases of disease transmission from cultured to wild fish. The potential for such transmission, however, should be addressed specifically for those diseases common in Puget Sound net-pen culture. A list of such diseases can readily be compiled. Data should be assembled on causative agents, environmental factors contributing to infection, susceptibility of native species and mechanisms for disease transmission.

Existing culture operations throughout the world provide potential parallels to Puget Sound in evaluating the potential for both the proliferation of shellfish pathogens and consequent human health risks. In several countries net-pen culture is conducted in close proximity to shellfish culture. Fisheries officials of these countries should be contacted to determine if there is any evidence that net-pen culture has adversely affected the health of the shellfish or their marketability.

Because of the paucity of data on microbial populations around net-pens, additional field work in Puget Sound is recommended through the programmatic EIS. An intensive survey at a single existing net-pen complex is recommended to determine both the presence of pathogenic bacteria and their abundance relative to areas unaffected by net-pen culture. Samples of sediment, water and/or biota should be collected at varying distances from the net-pen site, and cultured for pathogenic bacteria of concern. These bacteria should include both pathogenic bacteria already present in the marine system but potentially enhanced by net-pen operations (e.g., Vibrio), and those microorganisms which could be introduced through the feed (e.g., Staphylococcus).

Level of Effort

The cost of the microbiological field studies will be dependent upon the number of bacterial groups of concern, number of samples, frequency of sampling, concurrent physical/chemical data required, etc. It is estimated

that about \$16,000 will be required for microbial and chemical analytical work. Field costs have been included with the sedimentation task assuming both the sedimentation and pathogen tasks can be done concurrently. An additional 290 manhours will be required.

2.10 GENETIC EFFECTS

Issues

- In the event of escape of cultured fish which are native to Washington state (e.g., cultured coho salmon), would interbreeding with wild stock adversely affect the native gene pools?

Approach

Interbreeding of Atlantic and Pacific salmon was considered separately in Section 2.7. This section addresses the potential for interbreeding among cultured and wild populations of fish native to Washington. Despite decades of deliberate transplantation of salmon stocks for fisheries enhancement, there is very little information on the genetic consequences of these activities. The programmatic EIS should assemble the information available, and interview fisheries management agency staff and other scientific authorities (e.g., fish geneticists) with expertise in this subject. The EIS should also identify the sources of coho salmon stocks currently used in Puget Sound net-pen culture to obtain estimates of genetic differences between cultured and wild stocks. It may also be helpful if the EIS could review the extent of past and current transplantations for fisheries enhancement purposes in order to put these practices into perspective with the potential escape of fish from net-pens.

Potential Mitigation Measures

The culture of sterilized fish would be a potential mitigation measure. This possibility was discussed in Section 2.7.

Level of Effort

Only 80 manhours would be required to address this issue because of the very limited data available.

2.11 CHEMICAL USAGE

Issues

- What chemicals are likely to be used in salmon net-pen culture and what are the environmental risks associated with this usage?
- Do indigenous biota in the vicinity of a net-pen operation accumulate antibiotic residues in their tissues?
- How long do antibiotics persist in the vicinity of net-pen operations (water, sediment and biota) following their use for disease treatment?
- Do antibiotics provided in the feed to cultured fish have any effect on microbial populations beyond the confines of the net-pen and what are the extent and duration of these effects?
- Does antibiotic use encourage the growth of antibiotic-resistant strains of marine bacteria?

Approach

The Food and Drug Administration (FDA) has registered or approved 24 disinfectants, therapeutants, anesthetics, or water treatment chemicals for use in food fish culture. The majority of these are used in freshwater culture (e.g., ponds or hatcheries) and would have no application in marine net-pen culture. The EIS effort, however, should include interviews with growers to determine the range of chemicals of present or potential use. The environmental risks associated with this usage should be reviewed by reference to the available literature. Since antibiotics are the only chemicals now known to be in general use, and because these substances have been of particular concern in past permit reviews, significant effort should be spent in the EIS to evaluate the environmental consequences of antibiotic use.

Information should be compiled on the environmental fate of those antibiotics licensed by the FDA for use on food fish (i.e., oxytetracycline, sulfamerazine and Romet 30). Information required includes water solubility, persistence, degradation products and bioaccumulation potential. Both the FDA and drug manufacturers should be contacted for information on these subjects.

Information on the stimulation of antibiotic resistance in marine bacteria is also required. Some data are available from fish farms, although it is

anticipated that the EIS will have to rely, in large part, on data collected near sewage outfalls or other discharges carrying antibiotics.

It is known from past reviews (Weston, 1986) that the information available on the environmental effects of antibiotic usage in fish culture is extremely limited. Field studies in the vicinity of a net-pen complex in Puget Sound, therefore, are highly recommended. These studies should include measurements of antibiotic concentrations in sediment, water and/or biota at various distances from the pens. Antibiotic resistance (both total microbial community and individual species of concern) should be measured concurrently with the chemical sampling. Samples should be taken prior to antibiotic treatment, during treatment and periodically for at least one month after treatment.

Potential Mitigation Measures

Some countries (e.g., Norway) permit antibiotic use in salmon culture only by prescription. The adoption of this practice in Washington could be considered if mitigation measures were required. The aquaculture industry is also experimenting with vaccination as a technique to minimize the need for antibiotic usage. This technique also represents a mitigation measure which should be considered.

Level of Effort

Analytical work for the field studies is expected to cost approximately \$15,000. Approximately 240 manhours will be required to address the antibiotic issue as outlined above.

2.12 MARINE MAMMALS

Issues

- What are the types and frequencies of interactions between marine mammals and net-pen operations?
- What effect do sub-lethal predator control measures have on marine mammal behavior and physiology?

Approach

Interviews with knowledgeable authorities (e.g., NOAA, WDG) should be conducted to identify species of concern and the range of potential interactions. Interviews with net-pen operators both in Puget Sound and British Columbia are also recommended to determine the type and frequency of interactions with marine mammals, predator control measures employed and the effectiveness of these measures. Siting conditions should be identified which may affect the frequency of interactions (e.g., proximity to haul-out areas).

Information should be compiled on the effect of predator control measures currently or potentially used in Washington state on mammal behavior and physiology. It is anticipated that, while little information will be available, the data which do exist should be readily available from appropriate state and federal agencies.

Level of Effort

It is estimated that 120 manhours will be required to address this potential impact in the EIS.

2.13 BIRDS

Issues

- What are the types and frequencies of interactions between birds and net-pen operations?
- To what extent does net-pen culture displace avian habitat?

Approach

Interviews should be conducted with knowledgeable authorities (e.g., USFWS, WDG, Audobon Society) to identify species of concern and the range of potential interactions. Particular attention should be given to potential impacts on endangered, threatened or sensitive species. Habitat loss is an issue of concern, thus, the interviews should attempt to determine the severity of this effect.

Interviews with net-pen operators both in Puget Sound and British Columbia are also recommended to determine the type and frequency of interactions with birds, predator control measures employed and the effectiveness of these measures. Siting conditions should be identified which may affect the frequency of interactions (e.g., proximity to seabird nesting areas).

Level of Effort

It is estimated that 100 manhours will be required to address this potential impact in the EIS.

2.14 ANTIFOULING AGENTS

Issues

- How toxic are the available antifouling chemicals to non-target organisms?
- If held in treated net-pens, do cultured fish accumulate antifoulants or their degradation products?

Approach

Present indications are that most existing salmon culturists in Puget Sound either use no antifouling chemicals or only treat the perimeter predator exclusion net. This observation should be verified by interviews with all growers in the Sound. The EIS should determine the extent of antifoulant use, the chemicals used, the method of treatment and the frequency of treatment.

The antifoulants of greatest concern are the organotin compounds. The available information on the environmental fate and biological effects of these compounds is growing rapidly, and the EIS should summarize the current state of knowledge. Similar information should be compiled for other compounds in current use or of probable use in Puget Sound.

Level of Effort

A total of 120 manhours is estimated to be necessary to complete this task.

2.15 AIR QUALITY

Issues

- Will net-pen culture result in any deterioration of air quality?

Approach

The issue of odors is addressed separately in Section 3.4. The only other potential effect on air quality would be emissions associated with boat usage. The effects are believed to be trivial but should the issue should be noted in the EIS.

Level of Effort

Five manhours have been allocated for this task because of the minimal effort required.

3.0 IMPACTS TO THE BUILT ENVIRONMENT

3.1 HUMAN HEALTH

Issues

- If net-pen culture is found to enhance the growth of bacteria pathogenic to humans (Section 2.9), what are the potential risks to human health?
- If antibiotic usage at net-pens is found to foster the growth of antibiotic-resistant bacteria strains (Section 2.11), what are the potential human health implications?
- What human health risks are associated with the consumption of fish containing organotin residues from the antifouling agents?
- What human health risks are associated with the consumption of antibiotic-tainted food (either by the ingestion of wild fish and shellfish incidentally exposed to the drugs or by ingestion of cultured salmon retaining antibiotic residues)?

Approach

The scope of the human health issues will be extremely dependent upon the results of the antibiotic and pathogenic bacteria field surveys described in Sections 2.9 and 2.11 (i.e., if no pathogenic bacteria are found, the first issue above becomes a moot point). It should be noted that all of the above potential effects are extremely speculative. There has been no past evidence of human health threats associated with net-pen culture, although our knowledge of both marine systems and human physiology is inadequate to entirely dismiss the issues. It is very unlikely that the EIS will be able to provide any resolution. For at least the first three issues listed above, there is little or no published information. The EIS will have to rely largely on the professional judgement of authorities in pertinent fields. An interview approach to data gathering is therefore recommended.

The only issue listed above for which there may be some published data is the health risks associated with the ingestion of antibiotic-tainted food. Antibiotics are extensively used in agriculture (e.g., beef, pork and poultry), thus it is anticipated that the FDA will have given the issue considerable

attention. As part of this issue the EIS should summarize available information on the adequacy of the holding period required prior to marketing of salmon treated with antibiotics (e.g., 21 days for oxytetracycline).

Level of Effort

An estimated 110 manhours will be required for the task.

3.2 NOISE

Issues

- What sources of noise are associated with net-pen culture and would the noise levels exceed state standards?

Approach

The principal sources of noise associated with net-pen culture are boat usage and potentially pumps or generators. These sources should be discussed and noise levels qualitatively evaluated. Some information on pump or generator noise levels may be available from the manufacturer. If noise levels are considered sufficient to justify further evaluation, it would be possible to measure noise levels at varying distances from selected facilities and compare these levels to state standards.

Level of Effort

Twenty manhours will be required for this task.

3.3 LIGHT AND GLARE

Issues

- What types of lighting are associated with net-pen facilities?

Approach

The U.S. Coast Guard has requirements for lighting of floating structures in order to protect navigation. Those requirements pertinent to net-pens should be reviewed by the EIS. Several net-pen operations should also be visited to

determine the types of lighting and the typical hours of operation of these lights.

Level of Effort

Thirty manhours will be required for this task.

3.4 ODORS

Issues

- Are there objectionable odors associated with net-pen culture (e.g. from anaerobic sediments or the drying of nets)?

Approach

This issue should be addressed through visits to existing net-pens and interviews with facility employees and local residents.

Level of Effort

Twenty manhours will be required for this task.

3.5 AESTHETICS

Issues

- What is the general appearance of a net-pen operation and to what extent is this appearance dependent upon variables such as distance from and height of the viewer, the surrounding environment, and color of the facility?

Approach

In general, this subject is adequately covered by EDAW (1986) although some reformatting will be required for the EIS. The EIS, however, should give further attention to density of operations and cumulative visual impact.

Potential Mitigation Measures

The EIS should examine ways to minimize the aesthetic impacts of net-pen culture. To some extent this was done by the EDAW report although further

assessment is necessary of operation size and separation as potential mitigation measures.

Level of Effort

Approximately 80 manhours will be required to supplement the existing information and complete the aesthetics task.

3.6 NAVIGATION

Issues

- To what extent will net-pen operations present a hazard to navigation or interfere with normal navigation routes?

Approach

The EIS effort should include consultation with state and federal agencies (e.g., Parks and Recreation, Coast Guard) and private organizations (e.g., sailing clubs) having interests in potential conflicts between net-pen facilities and navigation. The EIS should specifically review Coast Guard requirements pertinent to net-pen operations (e.g., siting, lighting, bouys, etc.). A discussion should also be included of the physical structures typically surrounding net-pen facilities (e.g., mooring lines, log booms, etc.) and the extent of potential interference with navigation. The EIS, however, will only be able to address the issue in general terms. The extent to which net-pens will interfere with navigation will be entirely site-specific and the EIS can only identify this as an issue which must be considered with each operation.

Level of Effort

A review of Coast Guard requirements and a general discussion of the issue is anticipated to require 50 manhours.

3.7 RECREATION

Issues

- What conflicts would be anticipated between net-pen culture and recreational water uses such as fishing, swimming, diving, and navigation?

Approach

The review of net-pen effects on fish and megafauna (Section 2.6) will be valuable in assessing impacts on recreational fisheries. The review of pathogenic bacteria impacts (Section 2.9) will have some bearing on recreational swimming and diving. Most recreational issues are too site-specific for resolution by the programmatic EIS, but the EIS can identify the potential conflicts. This effort should include consultation with the state Parks and Recreation Commission and sportsmen's groups. Maps may be available through WDF indicating major recreational fishing areas and thus areas of potential conflict. The EIS should include a discussion of the physical size of typical operations so as to indicate the amount of area that may become unavailable to recreational fishing.

Level of Effort

An estimated 40 manhours will be required for this task.

3.8 RELATIONSHIPS TO OTHER LAND AND WATER USES

Issues

- What existing or potential land and water uses would be displaced by net-pen culture?

Approach

The development of an area for net-pen culture would preclude other land and water uses in the vicinity. For example, the area would become unsuitable for the siting of an industrial outfall for which toxicants would be a concern. Depending on the extent of sediment accumulation, the operation may reduce the bottom area available for shellfish harvesting. There are a multitude of potential conflicts which must be considered in siting an aquaculture facility. The EIS should identify the range of potential conflicts in order to provide decision-makers the information necessary to evaluate the potential water use trade-offs. The EIS should also identify ways to minimize these conflicts such as by site selection or operational practices.

Level of Effort

This task will require approximately 20 manhours.

3.9 REAL ESTATE

Issues

- What effect will net-pen culture operations have on resale values of properties in the vicinity?

Approach

Despite much speculation as to potential positive and negative effects of net-pen culture on property resale values, there has been no in-depth evaluation of the issue. Island County has conducted a cursory examination of assessed vs. sale values of properties in the vicinity of mussel raft and longline culture (A. Dold, Island County Planning Dept., pers. comm.). This study, however, was of very limited scope and there were no conclusions drawn which would be of general applicability in the programmatic EIS.

A case study approach is recommended to resolve the issue. This approach would involve a detailed analysis of several existing net-pen sites by a real estate appraisal firm. The effect of net-pen culture on property values may depend on many factors such as the extent of previous waterfront development (e.g., pristine vs. commercial areas) and geomorphology (e.g., high bank vs. low bank sites). It is, therefore, imperative that a number of sites encompassing a diversity of siting possibilities be evaluated. It is preferred that the analyses be conducted at existing sites in Puget Sound, although British Columbia net-pen operations may be evaluated if adequate sites can not be found locally.

At the selected sites, the properties of concern are those which either have a view of the aquaculture facility or may in some other way be affected by net-pen operations (e.g., boat or vehicle traffic). The effect of net-pen operations on the resale values of these properties could be addressed in either of two ways. The first approach is a comparison of sale values of these properties before net-pen development with sale values after the

net-pens were in place. Regional trends in market values would also have to be considered to reduce confounding variables. An alternative approach would be to compare the sale values of potentially affected properties over a given period of time with the sale values of properties along an unaffected but otherwise comparable shoreline.

Level of Effort

The cost for the analysis would depend on the number of sites evaluated. Based on discussions with real estate appraisal firms, it is estimated that it would cost approximately \$25,000 assuming three or four sites will be evaluated.

3.10 ECONOMICS

Issues

- What will be the direct and indirect contributions of net-pen culture to the state and local economies?

Approach

There has never been a quantitative evaluation of the economic contributions of net-pen culture. While this topic is probably not required to be in an EIS under SEPA regulations, it is an option and one which is highly recommended. Potential water use conflicts often are resolved through a cost/benefit evaluation, yet the data do not presently exist to conduct such an evaluation for net-pen culture. This task of the EIS should determine such factors as the number of jobs provided by a net-pen operation, the salaries of the employees, costs of feed and other supplies, equipment costs, typical sources of equipment and supplies (local, intrastate, etc.), and business provided to local seafood processors and transporters. The EIS should determine such factors both at a local level for a single operation and state-wide given the anticipated extent of growth of the industry.

Level of Effort

The economic analysis is anticipated to require 140 manhours.

3.11 SECONDARY IMPACTS

Issues

- In the event of continued expansion of the net-pen industry, what secondary impacts could be expected in the growth of support services?

Approach

Growth of the salmon net-pen culture industry will require concomittant growth in other industries such as fishing and agriculture (to supply raw materials for pelletized feed), feed manufacturing, hatcheries, seafood processing, and seafood wholesaling and distribution. The EIS should examine the current capacity of these industries and the growth which might be required to meet demands of the net-pen culture industry. This entire analysis should be predicated on the level of anticipated culture in Washington as defined in Section 1.0.

Level of Effort

This task will require about 100 manhours.

3.12 COMMERCIAL FISHING

Issues

- What physical conflicts would be anticipated between net-pen culture and the commercial fishing industry in Washington state?
- What is the potential for economic conflict (i.e., marketplace competition) between net-pen cultured fish and wild-caught Pacific salmon?

Approach

The physical presence of a net-pen facility could potentially conflict with commercial fishing activity. Given the typical size of a net-pen operation (and associated structures such as log booms) and a probable density of operations in a given area, the EIS should address the likely extent of conflict. WDF should be consulted in order to identify areas of major fishing activity and, thus, areas of potentially severe conflict. The results of the fish and

megafauna task (Section 2.6) should also be incorporated to indicate probable effects of culture on fish distribution and abundance.

Some concern has been expressed that net-pen grown salmon will displace wild-caught salmon in the marketplace. Others maintain that there would be no direct competition because of the greater cost of pen-reared fish, and that cultured fish would be marketable only when wild-caught fish are unavailable. Consideration of this issue may not be mandatory under SEPA, but it is highly recommended that it be addressed in the programmatic EIS. The assessment must rely primarily on a market analysis conducted by interviews with salmon growers, commercial fishermen, and particularly seafood wholesalers. The analysis should address questions such as the relative cost of cultured and wild fish, any anticipated major changes in cost in the future, the seasons of availability for cultured and wild fish, the intended markets of the net-pen growers, and market acceptance of cultured fish as a substitute for wild-caught fish. In performing this analysis it should be recognized that potential competition between wild-caught salmon and pen-reared salmon from other countries (e.g., Norway, Scotland, Canada) is not the issue of concern. If there is competition from these sources, it will occur regardless of the status of net-pen culture in this state. The EIS is to address only the consequences of continued industry growth of the net-pen industry in Washington state.

Level of Effort

The commercial fishing task will require approximately 150 manhours.

3.13 MISCELLANEOUS ISSUES

The EIS must also address the effects of net-pen culture on demands for utilities, schools, public services, transportation, etc. None of these issues are anticipated to require a major effort and a total of 20 manhours has been allocated to complete all these tasks.

4.0 MANAGEMENT PLAN

The Management Plan for salmon net-pen culture in Washington state is an essential complementary effort to the programmatic EIS. The EIS will identify the potential environmental effects of net-pen culture. The Management Plan, however, will build on this information to establish the conditions and procedures under which culture will be allowed, and outline the institutional framework for management of the industry. It is recommended that development of the Management Plan be initiated during the later stages of the EIS process and be distributed concurrently with the EIS.

The Management Plan should include at least five principal elements:

- Identification of the federal, state and local agencies having management responsibilities pertaining to net-pen culture and a discussion of their relative roles;
- A discussion of the permits required for development and operation of a net-pen facility;
- The regulatory pathway an applicant should follow for permit submission and review;
- The information that will be required of each applicant with regards to site characteristics, operational plans, and site-specific data needs required to supplement the programmatic EIS;
- Policies for site selection, culture operation and monitoring programs. This should include a revision of the interim guidelines in light of the additional data gathered during the EIS process.

5.0 COST ESTIMATE AND SCHEDULE

An estimate of costs required to complete the programmatic EIS and management plan are provided in Table 1. Manhour allocations for each task have been converted to a dollar value assuming a cost of \$40.00 per manhour. This is only intended to be a general estimate of hourly costs since the actual values will depend on the level of expertise required for the specific task as well as whether the work is performed by the state or through a contract mechanism. It is assumed that the state will retain overall EIS management and 0.75 FTE has been allocated for this task.

A schedule of activities is provided in Figure 1. The schedule assumes a start date of June 1 and a 12-month period of performance. There is some flexibility to the date of project initiation, however, it is critical that much of the field work (particularly the antibiotic and pathogen tasks) be completed during the summer months. The schedule assumes that the public scoping process has been completed prior to June 1.

Table 1
COST ESTIMATE

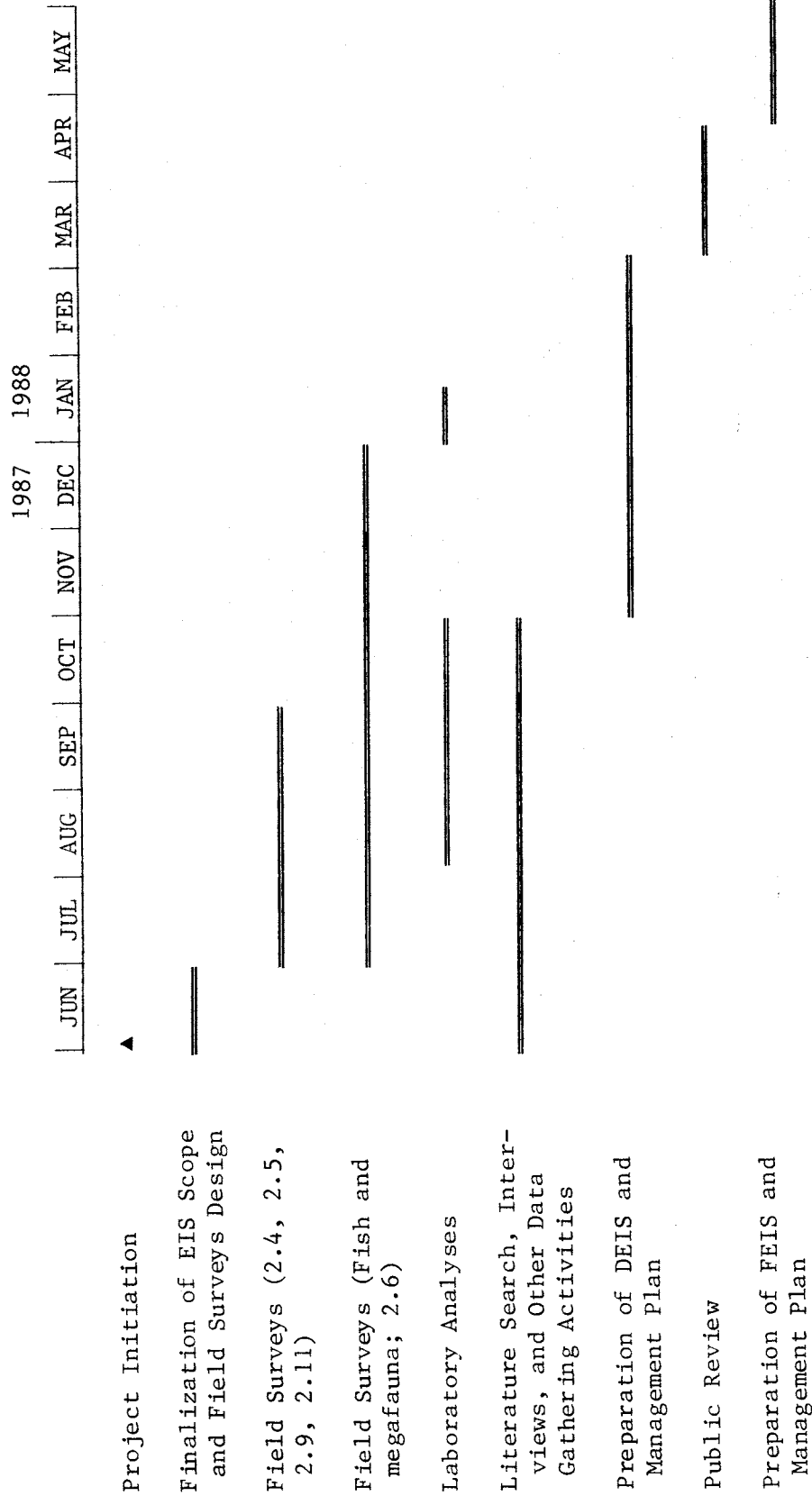
<u>LABOR</u>	<u>Manhours</u>	<u>Cost</u>
EIS Management (0.75 FTE)	1,560	\$ 42,000
Impacts to the Natural Environment		
Water circulation	20	800
Water quality	200	8,000
Phytoplankton	150	6,000
Sedimentation	640	25,600
Macrofauna	140	5,600
Fish and megafauna	330	13,000
Introduction of Atlantic salmon	90	3,600
Introduction of pests, parasites & pathogens	40	1,600
Pathogens	290	11,600
Genetic effects	80	3,200
Chemical usage	250	10,000
Marine mammals	120	4,800
Birds	100	4,000
Antifouling agents	120	4,800
Air quality	5	200
Impacts to the Built Environment		
Human health	110	4,400
Noise	20	800
Light and glare	30	1,200
Odors	20	800
Aesthetics	80	3,200
Navigation	50	2,000
Recreation	40	1,600
Relationships to other water uses	20	800
Real estate	---	25,000
Economics	140	5,600
Secondary impacts	100	4,000
Commercial fishing	150	6,000
Miscellaneous issues	20	800
Alternatives Analysis	100	4,000
Meetings and Briefings	200	8,000
Preparation of FEIS	300	12,000
Clerical support (\$20/hour)	<u>300</u>	<u>6,000</u>
TOTAL LABOR:	5,885	\$231,000

OTHER COSTS

Field and Analytical Costs	
Sedimentation	\$ 27,000
Macrofauna	34,000
Fish and megafauna	13,000
Pathogens	16,000
Antibiotics	15,000
Computer Costs (data analysis & literature search)	2,000
Travel	1,600
Photocopying and EIS Publication	8,000
Miscellaneous Other Costs	<u>3,000</u>
TOTAL OTHER COSTS:	\$119,600
TOTAL EIS COST:	\$350,600
MANAGEMENT PLAN:	30,000
TOTAL ESTIMATED COSTS:	<u>\$380,600</u>

Figure 1

SCHEDULE FOR PROGRAMMATIC EIS AND MANAGEMENT PLAN



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Weston, D.P. 1986. The Environmental Effects of Floating Mariculture in Puget Sound. Prepared by the University of Washington for the Washington Department of Fisheries and Ecology.