MARINE SKILL REPORT
SUBMITTED TO THE
UNIVERSITY OF HAWAII
MARINE OPTION PROGRAM

Instructor's Aide of the University
of Hawaii Aquaculture Courses (Fall 1978)

DURATION: July 1, 1978 - December 23, 1978

STUDENT INVESTIGATOR: Debra Shiraishi

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FACULTY ADVISOR:
Ms. Susan Morita, Instructor
University of Hawaii

REPORT DATE: August 30, 1979
ABSTRACT

During the fall semester of 1978, I worked as the instructor's aide for the aquaculture courses at the University of Hawaii. It was my responsibility to assist the instructor in any means, which included researching lecture material, arranging for the use of audio visual equipment, and obtaining necessary supplies. Two of my personal goals were to increase my personal knowledge of aquaculture and to gain insight into the teaching profession. It proved to be a valuable learning experience as the position enabled me to fulfill both of my objectives.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Course Content and Structure</td>
<td>2</td>
</tr>
<tr>
<td>AG 290: Introduction to Aquatic Agriculture</td>
<td></td>
</tr>
<tr>
<td>AG 390: Pond Management</td>
<td></td>
</tr>
<tr>
<td>AG 490: Problems in Aquaculture</td>
<td></td>
</tr>
<tr>
<td>Evaluation of Courses</td>
<td>4</td>
</tr>
<tr>
<td>AG 290: Introduction to Aquatic Agriculture</td>
<td></td>
</tr>
<tr>
<td>AG 390: Pond Management</td>
<td></td>
</tr>
<tr>
<td>AG 490: Problems in Aquaculture</td>
<td></td>
</tr>
<tr>
<td>Instructor's Presentation</td>
<td>7</td>
</tr>
<tr>
<td>Evaluation of Presentation</td>
<td>9</td>
</tr>
<tr>
<td>Personal Responsibilities</td>
<td>10</td>
</tr>
<tr>
<td>Evaluation of Personal Experience</td>
<td>11</td>
</tr>
</tbody>
</table>
INTRODUCTION

In the fall semester of 1978, I had the opportunity to work as the instructor's aide for the new aquaculture courses offered at the University of Hawaii. The three courses were: AG 290 - Introduction to Aquatic Agriculture, AG 390 - Pond Management, and AG 490 - Problems in Aquaculture Production. These courses were funded by the University of Hawaii Sea Grant Program with hopes that after their developmental year, the courses would continue to be offered through the University of Hawaii College of Tropical Agriculture.

The instructor for the courses was Ms. Susan Morita. Ms. Morita holds a B.A. in Animal Science and a M.A. in Agricultural Economics. She will begin work on a Ph.D. in Agricultural Economics in the fall of 1979.

I heard of the need for an instructor's aide for these classes through Mr. John McMahon, the Director of the University of Hawaii Marine Option Program, and immediately looked into it. My personal objectives were as follows: 1) To increase my knowledge of aquaculture, 2) To initiate contacts with the individuals, local agencies, and businesses which are involved in aquaculture, and 3) To gain insight and understanding of the teaching profession. Through the Marine Option Program I was provided with a stipend for the length of the semester.
COURSE CONTENT AND STRUCTURE

I will briefly summarize here the content and structure of each course. Included in this report is a copy of the original course description and syllabus for each course (see Appendix 1).

AG 290 - Intro. to Aquatic Agriculture

This was a two credit, introductory course in the field of aquaculture; the techniques used, species cultured, and economic considerations. The class met once a week for two and a half hours. Registration in this class was open to all students; thirty-eight were enrolled that semester.

The original syllabus was altered considerably as lecture topics were changed and field trips added. There was a wide variety of topics discussed and the course content provided the students with a good overview of aquaculture.

There were four field trips in this class; each scheduled during a different lecture meeting. The visits were to Mike Williamson's engineering laboratory on campus, Aquatic Farms, the Kahuku Seafood Plantation, and the Oceanic Institute.

The textbook used in this course was Bardach, et al; Aquaculture: The Farming and Husbandry of Freshwater and Marine Organisms; Wiley - Interscience; 1972.
A number of aquaculture related films were shown in this course in order to supplement the lectures.

Grading in this course was based upon a mid-term, a final, and three "pop" quizzes.

**AG 390: Pond Management**

This was a three credit course which focused upon the pond culture of prawns. The lectures looked into topics such as: harvesting techniques, pond construction, and water quality. The field work portion of the course enabled students to gain practical hands-on experience through working at the prawn pond which is located at the Pearl City Facility of the College of Tropical Agriculture. The pond was approximately half an acre in size, three to four feet deep, and squarish in shape. Prior to registration in the course, the instructor's consent was required; eighteen students enrolled that semester. The class met for an hour of lecture once a week and every Saturday morning.

At the Saturday morning work sessions any necessary maintenance work was done (i.e.; mowing, fixing pipelines, and weed control).

In addition, once every two weeks, each student was expected to drive down to the pond, between the hours of 11:00 p.m. - 3:00 a.m., in order to run the water pump and feed the prawns.
Only a couple of films were shown in this course. One field trip was made to the Hanohano's prawn ponds in Punaluu.

The textbook used was by Marcel Huet; *The Textbook of Fish Culture*; Fishing News Ltd.; 1975.

Grading was based on forty percent—Saturday attendance, thirty percent on the mid-term, and thirty percent on the final.

**AG 490: Problems in Aquaculture Production**

This course discussed the specific problems which aquaculturists encounter. It was held on a seminar format with guest speakers invited to speak on various aspects of aquaculture. For example, Mr. Ed Scura of Aquatic Farms discussed institutional constraints, Mr. William Madden of Oceanic Institute explained aspect of spawning, and Mr. Robert Ota of Bank of Hawaii discussed financing.

Grading was based largely upon a required research paper which was orally presented to the class late in the semester.

**EVALUATION OF COURSES**

In this section of the report I would like to give a personal evaluation of each course in regards to the content and structure. I will also include some of my personal opinions on improvements which could be made.
AG 290: Introduction to Aquatic Agriculture

The wide range of topics which were introduced in this course presented the students with a broad overview of the field of aquaculture. Students were exposed to topics such as: the species being commercially cultured, different methods of culture, and problems in production. In my personal communication with a number of the students, I found that the field trips and films were regarded as strong points of the course. Through the field trips the students received a first-hand look at some of the commercial operations here in Hawaii.

The book Aquaculture: The Farming and Husbandry of Freshwater and Marine Organisms is an excellent resource book, but in my personal opinion there must be a greater amount of preparational work if it is to be used as a course textbook. This book contains a wealth of species specific information. An instructor must, therefore, be certain to emphasize the basic theoretical concepts which are underlying, otherwise, the available information is likely to become a mere mass of irrelevant and undistinguishable facts, figures, and information to many of the students.

AG 390: Pond Management

The textbook used in this course, "The Textbook of Fish Culture," was an excellent book and highly appropriate for the course. It was well organized, well photographed, and stressed the concepts in aquaculture. The textbook covered both extensive and intensive methods of fish culture around the world.
In my opinion, safety needed to be stressed more at the Saturday work days. For example, many of the students wore slippers while working, there were gas cans without caps being stored in a closet, and water on the floor of the pump house.

It is also my opinion that the Saturday morning work sessions were not properly utilized to provide the students with an educational experience. A typical morning involved the chore of either weeding, mowing, or fixing leaks in the pipeline. These may have been necessary chores, however, the students were not learning new skills.

The discharge water of the pond was used to irrigate a small corn patch as a model of an aquaculture/agriculture system. However, the preparation and maintenance of the corn field was time consuming and the group's work hours were increasingly diverted into the raising of corn. I think a better alternative would have been to work in conjunction with the AG 201 - Agriculture Practice Class and have that class irrigate their crop with the discharge water of the pond. Initial steps were taken to construct a few smaller ponds but there was no follow up. Plans for the smaller ponds should have been carried through and experimentation encouraged from the students of the AG 390 class.

The most important criticism I have about this course was that it failed to cover the variations in pond management. In
my opinion, the lectures should have dealt with a number of management strategies (this is how the course content is described in the official course description). As it was, the class was essentially a course in "backyard prawn aquaculture." Students were presented with and expected to follow the method of management of a prawn pond as prescribed by the Anuenue Fisheries Station. There were no supportive explanations given as to why the method was considered valuable. I felt that alternative management strategies should have been discussed along with their pros and cons in order to increase the student's awareness of existing possibilities and innovations. There were many aspects of pond management which I felt needed to be investigated for optimal efficiency, rather than accepted as being valid.

**AG 490: Problems in Aquaculture**

As I was only able to attend a few of the AG 490 lectures, I cannot offer a personal evaluation of the course.

**INSTRUCTOR'S PRESENTATION**

In the following section I would like to focus upon Ms. Morita's lecture presentations and performance as an instructor.

Ms. Morita's personal background in aquaculture was relatively brief. She first became involved in aquaculture in 1977 when she was asked to direct the section of the
AG 201 - Agriculture Practice Class which was to manage the Pearl City pond. She explained to me that her philosophy about teaching was that she need only to stay one step ahead of the students; that the role of an instructor does not require the instructor to have an extensive knowledge of the field but simply that he/she be able to present to the class information which the instructor deems as important.

Her lecture presentations lacked enthusiasm. She spoke in a monotone and had no facial expressions. One student expressed to me his opinion that "It's like it's a chore for her to teach." Many times Ms. Morita used technical terms without first defining them. Above all, she often read verbatim from her lecture notes. For example, a lecture on water quality in the AG 390 class consisted of reading parts verbatim out of a limnology text. When a student asked her to clarify a technical passage which she had just finished reading, Ms. Morita was unable to explain it in her own words. As another example, in the AG 290 class she read verbatim from the lecture notes on Hawaiian fishponds. One of my responsibilities as the instructor's aide had been to help prepare lecture material; however, I had written those lecture notes on the assumption that they would be used to supplement her own knowledge and research, not for direct presentation. It was apparent to me that she had not taken the time to familiarize
herself with the contents of the notes as she was unable to answer student questions on aspects which were contained in other parts of the notes.

All exams consisted of objective questions (see Appendix 2 for copies of exams). In general, the questions pertained to detailed points rather than principles. A number of the students with whom I spoke to felt that the exams were not valid indicators of their knowledge, because of the trivial nature of so many of the questions. Indeed, many of the questions pertained to facts which Ms. Morita had neither discussed nor stressed in the lectures. For an introductory level course the recall of such specific facts and figures did seem unreasonable, especially when one of the stated goals of the course was the student's familiarity with basic theoretical concepts.

The students were not adequately warned as to how they would be graded. Ms. Morita did not announce the percentage breakdown for grade determination until three-fourths of the way into the semester.

**EVALUATION OF PRESENTATION**

After working with Ms. Morita for almost six months, I felt that as an instructor she needed to improve, especially in the areas of student-teacher relationship, lecture presentations, and exam preparations.
PERSONAL RESPONSIBILITIES

As the instructor's aide my responsibilities included researching various topics, handling all audio visual arrangements, and obtaining needed supplies.

In July 1978 I began the researching of topics which were to be presented in the lectures. For example, I gathered information about Hawaiian fishponds (a copy of which is included, see Appendix 3), seaweed culture, and oyster culture. For much of my research I utilized the literature available at the library of the National Marine Fisheries Service located on Dole Street. The Department of Planning and Economic Development and Hamilton Library were also helpful sources of literature. As I had hoped, I learned a lot about aquaculture through this process. To supplement these lectures I made several overhead transparencies. With the cooperation of Mr. William Madden, I compiled a slide presentation on Hawaiian fishponds from his personal collection.

I previewed the available films and selected those which I felt were appropriate for class viewing. The widest collection of aquaculture related films is at the Department of Planning and Economic Development. I have included their listing of films as well as some of my personal comments of the films (see Appendix 4). An excellent compilation of all the marine related
films which are available in the State of Hawaii is the recent Sea Grant publication by Skippy Hau, entitled, "Marine Audiovisual Catalog."

For the Ag 390 - Pond Management course I picked up the needed supplies (such as the weekly gas, chicken feed, herbicide, and tools).

Other than the responsibilities mentioned above, I was available throughout the semester to run errands and perform tasks to assist Ms. Morita.

**EVALUATION OF PERSONAL EXPERIENCE**

Working as an instructor's aide was a valuable experience for my career development. Through the process of gathering literature, selecting films, and attending lectures and field trips, I was able to fulfill my first personal objective and greatly increase my knowledge in the field of aquaculture. The position was a means for me to more thoroughly explore the field of aquaculture. Through my conversations with various individuals, I have become aware of a future need for personnel who are trained in management. I am now pursuing a career in aquaculture and will be steering my career development in the direction of management.

In the process of making field trip arrangements, obtaining resource literature, and other events, I was able to meet my
second objective of initiating many of the personal contacts which
I had hoped to establish.

My third objective was likewise fulfilled through this
experience. Although I was not able to learn specific teaching
techniques, I did gain much insight into the teaching field. I
was able to view the teaching profession from a different
perspective through my observations in and out of the classroom
and interacting with college instructors on a new level. However,
I was disappointed in Ms. Morita's performance as an instructor.
I began this project with great enthusiasm, but was frustrated during
the semester by what I viewed as a lack of motivation and effort
on the part of Ms. Morita.

I would like to thank the Marine Option Program for its
support of this learning experience. It was a personally
rewarding experience for me and I would like to urge the
continued support of similar student positions.
Appendix 1

The College of Agriculture offers 12 one-credit-hour classes in agriculture each year.

1. AG 250: Introduction to Aquaculture
   Instructor: D. A. Martin
   Meeting Time: Tuesdays 2:30-5:00 PM
   Meeting Room: Watanabe 420
   Pre-requisites: None
   Description:
   This course introduces students to the field of aquaculture and the techniques that are
   applied in breeding aquatic species. The course will include an overview of the major
   aquaculture practices and their impact on the environment. Students will also learn
   about the economics of aquaculture and the regulatory issues that affect the industry.

2. AG 350: Aquaculture Practices
   Instructor: D. A. Martin
   Meeting Time: Mondays 10-11:30 AM
   Meeting Room: Watanabe 420
   Pre-requisites: AG 250
   Description:
   This course covers the various techniques used in aquaculture practices. Students will
   learn about the various methods used to breed and raise aquatic species, as well as
   the environmental considerations that must be taken into account.

3. AG 450: Aquaculture Economics
   Instructor: D. A. Martin
   Meeting Time: Fridays 1-2:30 PM
   Meeting Room: Watanabe 420
   Pre-requisites: AG 250
   Description:
   This course focuses on the economic aspects of aquaculture. Students will learn
   about the costs and benefits of aquaculture practices, as well as the market
   dynamics that affect the industry.
AG 290 – INTRODUCTION TO AQUATIC AQUACULTURE

LECTURE: Tuesday, 6:00-8:30 p.m.          INSTRUCTOR: S.K. Morita
FINAL EXAM: 12/19, 6:00-3:00 p.m.

TEXTBOOK: Aquaculture–The Farming and Husbandry of Freshwater and Marine Organisms, Bardach, et. al.

<table>
<thead>
<tr>
<th>Class #</th>
<th>Date</th>
<th>Lecture Subject</th>
<th>Readings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9/5</td>
<td>DPED slide show</td>
<td>Textbook pp. 1-23</td>
</tr>
<tr>
<td>2</td>
<td>9/12</td>
<td>Hawaiian Fishponds</td>
<td>Madden paper</td>
</tr>
<tr>
<td>3</td>
<td>9/19</td>
<td>Hawaiian Fishponds</td>
<td>Textbook pp. 75-120</td>
</tr>
<tr>
<td>4</td>
<td>9/26</td>
<td>Aquaculture in Southeast Asia</td>
<td>Textbook pp. 313-350</td>
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<tr>
<td>5</td>
<td>10/3</td>
<td>Aquaculture in Southeast Asia</td>
<td>Textbook pp. 32-42, 286-292</td>
</tr>
<tr>
<td>6</td>
<td>10/10</td>
<td>Importance of Hatchery and Nursery Functions to Aquaculture</td>
<td>Textbook pp. 450-502</td>
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<td>7</td>
<td>10/17</td>
<td>Ocean Ranching</td>
<td>Textbook pp. 537-632</td>
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<tr>
<td>8</td>
<td>10/24</td>
<td>Midterm</td>
<td>AFRC paper</td>
</tr>
<tr>
<td>9</td>
<td>10/31</td>
<td>Prawn Farming in Hawaii</td>
<td>Textbook pp. 674-742</td>
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<td>10</td>
<td>11/14</td>
<td>Oyster Production in Hawaii</td>
<td>Textbook pp. 790-814</td>
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<td>12</td>
<td>11/28</td>
<td>Aquaculture of Other Species</td>
<td>Jokela paper</td>
</tr>
<tr>
<td>13</td>
<td>12/5</td>
<td>Waste Water Reclamation and Aquaculture</td>
<td>Rutka paper</td>
</tr>
<tr>
<td>14</td>
<td>12/12</td>
<td>Institutional Constraints</td>
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<tr>
<td>15</td>
<td>12/19</td>
<td>Final Exam (6:00-8:00 p.m.)</td>
<td></td>
</tr>
</tbody>
</table>
AG 390 - POND MANAGEMENT

LECTURE: Thursday, 10:30-11:45 a.m. INSTRUCTOR: S.K. Morita
LAB: Saturday, 9:00-12:00 noon

TEXTBOOK: Textbook of Fish Culture by Marcel Huet, 1976

Course Schedule

<table>
<thead>
<tr>
<th>Class #</th>
<th>Date</th>
<th>Lecture Subject</th>
<th>Readings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9/7</td>
<td>An Overview of Aquaculture in Hawaii</td>
<td>Madden paper</td>
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<tr>
<td>2</td>
<td>9/14</td>
<td>Hawaiian Fishponds</td>
<td>Textbook pp. 6-40, 304-306</td>
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<tr>
<td>3</td>
<td>9/21</td>
<td>Pond Construction &amp; Site Selection</td>
<td>AFRC paper</td>
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<td>4</td>
<td>9/28</td>
<td>Water as an Environment</td>
<td>Textbook pp. 311-318</td>
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<td>10/5</td>
<td>Water as an Environment</td>
<td>Textbook pp. 41-56, 318-327</td>
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<td>6</td>
<td>10/12</td>
<td>Natural Productivity &amp; Cultured Species</td>
<td>Textbook pp. 271-281</td>
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<td>Natural Productivity &amp; Cultured Species</td>
<td>Textbook pp. 283-290, 356-359</td>
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<td>8</td>
<td>10/26</td>
<td>Mid-term</td>
<td>Textbook pp. 322-335</td>
</tr>
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<td>9</td>
<td>11/2</td>
<td>Biological Variables of Pond Production</td>
<td>Textbook pp. 291-301</td>
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<td>10</td>
<td>11/9</td>
<td>Feeding and Fertilization</td>
<td>Textbook pp. 381-386</td>
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<td>11</td>
<td>11/16</td>
<td>Maintenance of Ponds</td>
<td>Textbook pp. 395-414</td>
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<td>12</td>
<td>11/30</td>
<td>Harvesting</td>
<td>Textbook pp. 67-85</td>
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<td>12/7</td>
<td>The Aquaculture Market</td>
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<td>Spawning &amp; Nursing</td>
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<tr>
<td>15</td>
<td>12/21</td>
<td>Final Exam (9:45-11:45 a.m.)</td>
<td></td>
</tr>
</tbody>
</table>
**Lecture: Tuesday, noon**

**Instructor:** S.A. Jordan

**Textbook:** None. Papers will be distributed in class.

### Outline

<table>
<thead>
<tr>
<th>Class</th>
<th>Date</th>
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</tr>
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<tbody>
<tr>
<td>1</td>
<td>9/5</td>
<td>DEAD Orientation</td>
</tr>
<tr>
<td>2</td>
<td>9/12</td>
<td>Site Selection and Institutional Constraints</td>
</tr>
<tr>
<td>3</td>
<td>9/19</td>
<td>Financing</td>
</tr>
<tr>
<td>4</td>
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<td>Hatchery and Nursery</td>
</tr>
<tr>
<td>5</td>
<td>10/3</td>
<td>Discussion</td>
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<td>10/17</td>
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</tr>
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</tr>
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<td>14</td>
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<td>Discussion of Aquacultured Systems</td>
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<td>15</td>
<td>12/21</td>
<td>Paper due at 9:30 a.m.</td>
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</table>
FINAL EXAMINATION  
AG 290

PART I. TRUE/FALSE: Write 'T' for true or 'F' for false in the designated blanks for the following statements. Each blank is worth 1 point.

F 1. According to the Bardach text, only a small percentage of the cultured species may be considered estuarine.

F 2. The stocking rate of M. rosenbergii is 1.5 to 2 prawns per square yard.

F 3. The method of harvesting in Hawaiian prawn ponds is normally done by mechanical harvesters made up of nets.

T 4. The grass, Paspalum, is grown on the sides of prawn ponds for habitat.

F 5. The Oceanic Institute is a public institution supported by State funds.

T 6. Oysters may well have begun marine aquaculture according to Bardach.

T 7. Artificial seeding of Porphyra is done by placing oyster shells with chopped thalli in concrete tanks.

F 8. Clams are sessile animals.

F 9. Puffers are a low-income item in places such as Japan, Korea, and China.

F 10. The high prices demanded by the red porgy is due to its high nutritional value and its unique flavor.

T 11. The culture of fish in brackish water systems is of greater economic significance worldwide than fish culture in marine environments.

F 12. Though difficult, it is possible to completely control the species composition of brackish water impoundments.

F 13. The American lobster cannot be cultured in tropical waters due to the high temperatures that exist in this kind of climate.

T 14. According to the Jokela paper, waste water contains nutrient levels that are too high for the successful culture of fish.

T 15. Due to the nature of the permit process, the major impact of the process means that financial resources will determine who will enter the aquaculture field.

F 16. Catfish fry are sold by a hatchery in Maui.

F 17. Yields of catfish per acre are equivalent to yields of prawns per acre.

F 18. Chinese carp are monocultured in Hawaii.
19. To keep temperatures constant in a raceway culture system, the most economical method would be to enclose the raceways in a building.

20. "Unagi" elvers are being grown in Guam.

21. The quality of land used in the Kahuku Seafood Plantation would probably be considered a "high quality" input.

22. Catfish is normally polycultured in the U.S.

23. The albino channel catfish has a higher market value than the normal colored catfish because it has a higher nutritional value.

PART II. FILL-IN-BLANKS: Write the word or phrase you feel would best complete the following sentences. Each blank is worth 2 points.

1. ____________ (name of person) developed successful spawning and culture techniques of kuruma shrimp (Penaeus japonicus).

2. ____________ (name of person) is noted for closing the cycle of Macrobrachium rosenbergii and ____________ (name of person) has developed mass culture techniques of this species.

3. Kuruma shrimp prefer to have ____________ as the predominant phytoplankton species in their ponds.

4. The critical factor in determining the success or failure of an oyster hatchery is ____________. 

5. Some of the growing methods for oysters are ____________, ____________, and ____________ culture.

6. The only seaweed commonly eaten in the West is the red algae Rhodymenia palmata or better known as ____________.

7. The culture of Laminaria japonica is prevalent in Japan and ____________ according to Bardach.

8. In order to be commercially sold, oysters must go through a ____________ process for 24 hours as regulated by the State Department of Health.

9. To reduce cannibalism in puffers older than 20 days, aquaculturists should ____________ or ____________.

10. The wide variation in size distribution which occurs in a prawn pond has been attributed to a behavioral phenomenon known as the "__________" phenomenon.

11. A pioneer in American marine fish culture was ____________ of the Bear's Bluff Laboratories.

12. Mating in decapod crustaceans occurs only after ____________ by the female.
13. The aquatic species used in the waste water reclamation project in California were _______ water lily ________ fish ________, and _________ shrimp _________.

14. An aquaculture operation affecting "navigable" waters would require a permit from the _______ U.S. Corps of Engineers _________.

15. The catfish industry is presently threatened by imports from _______ Brazil _________.

16. The three major sub-systems of an aquaculture system are usually the _______ nursery ________, _______ hatching ________, and _______ grow out ________ systems and in intensive systems may be managed by separate managers.

17. Elvers for culture are transported from _______ N. Carolina _______ (name of state).

18. Commercial viability of top minnow culture are dependent on the _______ trials ________ which are still being held.

19. The nehu is popular as a baitfish for (2 out of 3 reasons) _______ schooling behavior ________ and _______ physical characteristics _________.

20. Oysters for the gourmet trade is served in the _______ half-shell ________ (product form).

21. The catfish "industry" began in the early 1960's in the state of _______ Arkansas _________.

PART III. MULTIPLE CHOICE: Write the letter, NOT the answer, which corresponds to the phrase or word of your choice in the designated blanks. Each blank is worth 1 point.

B 1. One of the advantages of kuruma shrimp to the aquaculturist is that a) the animals are docile and not prone to cannibalism b) they can be shipped alive in sawdust when they are chilled to 12°C c) they are ready eaters of all types of phytoplankton

B 2. Crustaceans have poor conversion efficiencies due to a) the lack of practical diet formulas b) the great losses of energy involved in moulting c) the high metabolic rate of the animal itself

B 3. The most serious management problem of prawn ponds is a) a disease called "red-tail" b) oxygen depletion c) timing of the restocking of post-larvae

B 4. The Kahuku Seafood Plantation has a production system which may be described as a) an open system b) a semi-closed system c) a closed system
5. The nutritional level of "nori" is
   a) insignificant, however the seaweed is tasty
   b) high and comparable to beef in terms of protein
   c) about midway in terms of protein (comparable to rice)

6. Polydora in oysters
   a) is fatal to oysters
   b) is fatal only in high concentrations
   c) is harmless and causes no marketing problem

7. According to Bardach captive spawning only occurs in
   a) the yellow tail
   b) the black porgy
   c) the red porgy

8. The spiny lobster
   a) has the advantage of being a more manageable animal when compared to the American lobster
   b) shows an increased growth rate of more than 260% at 28°C
   c) has had its biological cycle closed in the past few years

9. The Jokela paper suggested the use of aquaculture to reclaim water to be used in
   a) other commercial aquaculture operations
   b) wetlands such as coastal lagoons
   c) human consumption as done in Israel

10. Site selection for aquaculture operations should also include
    a) management strategies which will be used
    b) an additional 15% of costs for permit approval
    c) consultation fees for all aspects of the site

11. Catfish in Hawaii are grown in
    a) raceways
    b) ponds
    c) cages

12. Catfish are
    a) a cold-water species
    b) a warm-water species

13. Commercial baitfish operations are planned for
    a) Maui
    b) Molokai
    c) Big Island

14. Brine Shrimp
    a) supplies are very low and are projected to further decrease
    b) if harvested efficiently, are available in quantities
    c) can be replaced with artificial diets

15. Water flow in prawn ponds has been advised to be
    a) 5-10 gmp/acre
    b) 10-20 gmp/acre
    c) 20-30 gmp/acre
Part I. True and False. Write "T" for True or "F" for False in the blanks designated. Each blank is worth 1 point.

F 1. Many areas in the Pacific practiced aquaculture in ancient times with the Hawaiians being only one of them.

F 2. The size of a fishpond varied according to construction materials within the area.

F 3. Water affects life within it in two ways: 1) by providing the medium in which plants and animals move or swim and 2) regulating the specific physiological variables of individual species.

F 4. Temperature variations in water range greatly as compared to temperature on land.

T 5. The metalimnion indicates the limit of the mixing currents from the surface.

F 6. Characteristic feature of lakes in the tropics is the high surface temperature.

T 7. The tropholytic zone is where decomposition takes place in a lake or pond.

T 8. The point of neutrality in pH brings about a sharp separation in the organic world.


T 10. The nitrogen content at all depths is approximately the saturation value.

F 11. According to Fry, limiting factors are defined as those factors which influence the metabolic rate without entering the metabolic chain.

F 12. A planktonic species has better flotation ability in summer than winter.

F 13. For every 1 acre of pond, 1.25 acres is required for facility and bank space.

T 14. Prawn pond banks should have a slope of 3 to 1 on the inside of the pond.

F 15. Lining a pond with butyl will stop seepage and increase natural productivity.

F 16. The barrage pond system is preferable to the diversion pond system.

F 17. Huet feels that a water inlet with a vertical screen is preferable to a horizontal screen.

T 18. In water with low alkalinity, liming will increase the pH level.
19. The branchiospines are large on fish that are voracious.

20. Quantity production seeks to produce as high a quantity as possible of graded fish either for eating or restocking.

Part II. Fill in blanks. Write a word or phrase in the blanks designated. Each blank is worth 2 points.

1. Polyculture was practiced with taro in the Hawaiian fishponds called ____________.

2. A kuapa is a ____________.

3. Fan Lee's work is the oldest publication on aquaculture and was written in ____________ A.D.

4. Density of water ________ with temperature and ________ with salinity.

5. Loss of heat takes place through ________, ________, and ________ to the air and bottom.

6. When there is a rise in temperature in the hypolimnion, thus exhibiting circulation only to a certain depth, this lake or pond may be called ____________.

7. Lakes with Spring and Fall turnovers are called ____________ lakes.

8. The surplus amount of carbon dioxide that must be free when CO₂ is used for the solution of limestone and for calcium bicarbonate to be stable is called ____________ carbon.

9. The return of CO₂ to the water at night is largely due to "dark" reaction.

10. There will be a major decrease in silicic acid after a bloom of ____________.

11. In zooplankton, the three phyla represented in freshwater are ____________, ____________, and ____________.

12. For prawn ponds, the optimal ratio of width to length in terms of harvesting is ____________.

13. The ____________ is an outlet system which is an integral part of the dike or bank and is formed by two lateral and parallel walls.

14. Drying ponds and working the soil is necessary for (2 out of 3 reasons):
   a. ________
   b. ________
Part III. Multiple choice. Write the letter (not the entire word or phrase) of your best choice in the spaces designated. Each blank is worth 2 points.

1. Mangroves in a Hawaiian fishpond
   a. are needed to provide shade for fish
   b. cause siltation
   c. have roots which are extensive and keep the soil from eroding

2. Density of water changes more rapidly at
   a. higher temperatures (20° and higher)
   b. lower temperatures (10° and lower)

3. The secchi disk is utilized to determine visibility. However, the reading is also determined by
   a. temperature
   b. turbidity
   c. pH

4. When the water column becomes stratified into three thermal parts, this is characteristic of
   a. autumn cooling
   b. winter state
   c. the midsummer state of lakes

5. Standing waves are caused by
   a. vertical convection currents
   b. change in density internally
   c. excess pressure on water surface

6. The zone of water where photosynthesis takes place is called
   a. Holomastic zone
   b. Trophogenic zone
   c. Tropholytic zone

7. The "absorption coefficient" increases
   a. with increasing temperature
   b. with decreasing temperature

8. The ferric form of iron is
   a. soluble
   b. insoluble

9. Nitrogen is used by plants and animals
   a. in the photosynthetic process
   b. as a basis for skeletal structure
   c. as constituents of the protoplasm of the cell

10. The long channel design for prawn ponds was developed by
    a. Gibson and Wang
    b. William Madden
    c. Linden Burzell

11. If you have a historic site on your farm, you may need a permit from
    a. Department of Land and Natural Resources
    b. Department of Health
    c. Board of Water Supply
12. If you are discharging water into a stream or river, you may need a permit from
   a. Department of Land and Natural Resources
   b. Department of Health
   c. Board of Water Supply

13. The worst choice of sites in terms of permits would be
   a. conservation district
   b. historic site
   c. wetlands

14. Ponds supplied by springs and rainwater are known as
   a. parallel ponds
   b. barrage ponds
   c. diversion ponds

15. To calculate the necessary quantity of water for a fish farm, it is necessary to base calculations on
   a. breathing requirements of the fish
   b. volume of ponds
   c. height of water in planned ponds

16. Temperature influences
   a. the breathing, reproduction and behavior of fish
   b. the breathing, growth and reproduction of fish
   c. the growth, reproduction and behavior of fish

17. Due to the absence of the pylorus or caeca in non-voracious fish
   a. they should be fed only through natural production
   b. they should be fed as much as they can swallow
   c. they should be fed only small quantities

18. Water which is rich in humic matter in a colloidal form, with a yellow to brown color and a pH that is acid, is called
   a. oligotrophic
   b. eutrophic
   c. dystrophic

19. When a pond is overstocked
   a. all the natural food will be eaten
   b. the fish will stop growing
   c. natural production will decrease

20. The expression denoting the nutritive value of water examined for its feeding qualities for fish is
   a. natural production
   b. biogenic capacity
   c. not noted above

Bonus question: 10 points
What is Van t'Hoff's law?
Almost every culture in the world has practiced aquaculture to some degree; e.g. the ancient Egyptians stocked artificial ponds with fishes, the Greeks and Romans raised eels and the Taiwanese walled out tidal areas. Polynesians in the Tuamoto Society, Austral, Cook, Samoa, and New Zealand entrapped fish by various methods but only a few had fish ponds.

Hawaii is the only known place in the Pacific where the people practiced a true form of aquaculture. In contrast to the rest of Oceania, it had a sophisticated aquacultural system. Nowhere else in the Pacific did they have the types and widespread numbers of ponds as found in Hawaii. In fact only in Hawaii was there an intensive attempt to utilize practically every body of water for either agriculture or aquaculture.

It was estimated by Cobb in 1901 that prior to Western influence there were 340 to 360 fishponds in Hawaii. Cobb listed 104 ponds or 2,900 acres in commercial operation. For that year the total pond production was 680,000 lbs. (488,000 lbs. mullet and 193,000 lbs. of milkfish), or an average pond yield of 230 lbs./acre. Other estimates made of average pond yields have ranged from 175 lbs. to 350 lbs./acre. In 1975-76 the Division of State Fish and Game reported a total pond production of only 20,000 lbs. (only 1,200 lbs. of mullet) a mere 3 percent of the 1901 production.

The number of existing fishponds decreased due to a number of economic and social reasons:

1. money became the standard of exchange
2. competition from cheaper imported products
3. movement of the population from rural to urban
4. loss of management skills due to deaths and other employment
5. earthquakes

Of course the forces of nature have played a major role in the destruction of ponds. These forces include:

1. lava flows
2. tsunamis and sea storms
3. land erosion, which has filled the ponds with soil run-off
4. mangroves
5. earthquakes

In 1973 Kikuchi and Apple began a study to identify those Hawaiian fishpond remnants worthy of historic preservation. Searching through the literature Kikuchi found, listed, and plotted 335 ancient Hawaiian fishponds by a map. Using this map, Apple did a survey by helicopter and physically identified the remains of 157 fishponds. Apple and Kikuchi visited each of the 157 sites and evaluated their condition. At this point they eliminated 101 of the fishponds either because they were almost completely destroyed or overwhelmingly altered. Thus only 56 of the 335 ponds were even considered for further evaluation.

**Types**

The Hawaiians had five basic types of ponds: loko kuapa, loko pu'u'one, loko wai, loko umeki and loko i'a kalo.

a) **loko kuapa** - shoreline fishponds whose primary isolating feature was a seawall (kuapa) of lava and/or coral. Typically it had at least one sluice gate (makaha).

b) **loko pu'u'one** - a coastal fishpond, its primary isolating feature was a sand bar or barrier reef.

c) **loko wai** - an inland pond of freshwater.

d) **loko i'a kalo** - a taro patch used simultaneously to raise fishes, especially mullet.

e) **loko umeki** - actually a form of fishtrap which was built similar to the loko kuapa.
The size of the fishponds varied greatly and was dependent largely on the physical character of the shoreline. Cobb estimated that the average pond size to be 18.5 acres. In 1973 in his survey of 112 loko kuapas Kikuchi found that the fishponds ranged from one acre to 90 acres per pond.

CONSTRUCTION

All materials used for constructing a pond came from within the same akupua (major land division).

a) kuapa (seawalls) - the kuapas were constructed either out of lava rocks or coralline blocks. Smaller rocks and coral fragments filled the interior. The wall was permeable to water which permitted the circulation of water as well as reduced the wave energy. A well built flank (side) was an interlocking of large boulders and smaller rocks. It has been noted that there is a difference in the angle of inclination of the outer wall vs. the inner wall. The outer wall was generally more sloped, possibly to make it more resistant to the waves. The average kuapa is 5 feet wide and 3-5 feet deep. The widest and most massive kuapa is in Kaloko, Kona. This wall is 35-40 feet wide at its base and 6.5 feet high.

b) makaha - sluice gates were the most distinctive and unique feature of a Hawaiian fishpond. These sluice gates were completely stationary and without any moving parts. They consisted of strips of wood lashed vertically to two or three pieces of horizontal wood. They allowed the water to freely flow in and out of the pond for water circulation and flushing; yet it retained the fish. There was no traditional location for the makahas; but rather they were positioned to maximize the flow of current through the ponds.

c) auwai-kai (sluices) - channels which connected the fishponds with the sea. Mature fishes when ready for harvest, would congregate in the auwai-kai on the pond side of the makaha during the incoming tide and vice versa on the outgoing tide. Using this knowledge the kia'i loko positioned himself at the makaha and caught the fish using scoop nets.

Legend has it that the ponds were built by menehunes. Although there has been no documentation of a pond construction it is believed to have been labor intensive, lengthy, and costly. The only known tools to have been used were rope, litters and digging sticks. It is commonly accepted that as in the menehune legends, the rocks were transported by passing the rocks along a human chain.

MANAGEMENT

The first three types of ponds (loko kuapa, loko pu'uone, and loko wai) belonged solely to the royalty. Ownership of these ponds was considered a symbol of high status. The fishpond remained a symbol of power even after the Great Mahele. In one study on the leeward side of the Big Island, it was found that seven of the larger fishponds were owned by descendants of Kamehameha. The loko umeki fishtrap, loko a'ii kalo, and a few small fishponds belonged to the commoners. Because the chiefs were occupied with religious and political duties they appointed managers:

1. Konohiki - the land overseer for a district
2. Kia'i loko - the resident keeper of the royal fishpond, he was responsible for managing the fishpond, harvesting, and guarding against poachers.

The role of the royal fishponds was not to provide food for the general public nor for profit. They were solely to provide a reliable, convenient, and ever-ready supply of fresh seafood for the royal court.

Due to openings of the makaha the ancient Hawaiians had little control over the type of sealife in the pond. They did however capture
desired fingerlings outside the pond and stock them in the ponds. Seaweed was also intentionally transferred to the ponds.

Fertilization in the royal fishponds was both natural and artificial. The fish were fed taro, sweet potato, breadfruit, mussels, and seaweed. Religious beliefs did not allow the use of any type of animal waste for fertilizer.

Small maintenance jobs were done by the kia'ī loko. If there was a massive damage the kia'ī loko summoned all the male commoners to rebuild the damages. Periodic removal of seaweed was an all-hands female maintenance operation. A bamboo rake called a kope'ohe was sometimes used for pond cleaning. The kope'ohe was dragged behind a canoe and the mud was swept out by the current.

Besides the use of scoop nets the most effective and practical method of harvesting the royal fishes was the use of nets. Long seine and gill type of nets were used; they were the prized possessions of the ali'i (chief).

The physical parameters of the fishponds vary widely: pH - predominance of 8.0 to 9.0 readings, due to ever-presence of calcium carbonate; temperature - fluctuate during the day and year, with a mean of 76 degrees F.; oxygen - range of 6 ppm to 13 ppm with a mean of 7 ppm; apparently due to a high level of photosynthetic processes occurs within the ponds; salinity - varied widely 2.0 to 3.4 percent.

**RELATED CULTURE**

Royal fishponds were protected by cultural and religious restrictions. For example pollution in the form of sewage, rubbish and metabolites in the water was considered to be an insult to the guardian spirits. Appearances had to be made otherwise a territory might be denuded of its resources. Every pond had a guardian spirit or mo'o who guarded against polluters.

The Hawaiians apparently were aware of the need for conservation thus had kapus which restricted fishing. During certain months of the year designated areas of offshore water was considered kapu. A restricted area was marked either by a branch of hau or a white flag. Schooling fishes could also be declared kapu by proclamation. Poaching was punishable by plucking off the victim's eyeball or by death.

Around several fishponds there has been found a number of archaeological remains. The remnants of nearby terraces, canoe houses, and stonewalls indicate that there were some early settlements. However they were not large settlements and in fact it is believed that nearby settlements would have been discouraged. After all, the more neighbors, the greater the chances of poaching and pollution. Because the fishponds were the property of chiefs, their products would not have been available to the commoners, which would have been one less reason to settle nearby.

The only ceremonial structures associated with fishponds were called ku'ula or shrines. They honored the god Ku and his wife Hina. All fishponds had a guardian spirit or mo'o, which manifested itself either as a lizard or a mermaid like form. It was the duty of the Kia'ī loko to make regular offerings at designated times of the lunar month.

**Possible Future Uses:**

**A. Aquaculture:**

As the traditional function of these fishponds was the holding and fattening of captured fishes, it is logical to consider their possible use for aquaculture. However there are many factors which must be considered to determine whether it would be feasible to use these ponds for modern aquaculture. The primary consideration is the cost of restoring a pond. Restoration of any fishpond would include: 1) The majority of the ponds need some extent of seawall repair. 2) The mangroves which are
usually established within the ponds must be removed due to their extensive roots thrive in brackish water and eventually invade the ponds and decreases the usable area; 2) their shadow may have an inhibiting effect on the growth of algae; 3) the roots leach nutrients from pond waters; 4) dredging will often be required because neglect of many of the ponds has allowed the silt to build up. Turbidity caused by stirred silt can inhibit pond algal growth; 5) the population of Tilapia and other undesirable fish must be controlled.

Because of the open nature of the fishpond system there could be little control of the physical elements. Of course there is the potential hazard of flash flooding and tsunamis. In 1977 Madden did a feasibility study for the raising of mullet and milkfish in 67 ancient Hawaiian fishponds. Of the 67 ponds he assessed 6 of them as having excellent potential, 15 as good, 7 as fair and the remaining 39 as poor.

8. Demonstration ponds and/or scientific research:

One definite product with high potential which Hawaii has is the exportation of knowledge and technology that comes from applied research. It would not require extensive land and Hawaii has the available resource/technical persons to do this.

B. Tourist:

The fishponds could be incorporated into the designing and planning of a resort or restaurant. Its use would add authenticity and local flavor to the establishments. Anaehoomalu has plans for doing this.

D. Urban "villages":

Residential or retirement homes might be built centering around the fishponds.

E. Historic preservation:

Some ponds should be preserved for posterity for they are a part of the Hawaiian heritage as well as feats of engineering. The ponds were unique and distinctive to Hawaii. They are also monuments to the many men and man-hours which must have been involved in their construction.

F. Wildlife preserves:

Some ponds provide shelter and breeding ground for birds and other marine life; i.e., Alekoko Pond on Kauai is shelter for the endangered Koloa (Hawaiian duck), Hawaiian coot and Hawaiian Gallinule and the Kolea (Pacific Golden Plover).

G. Parks and Recreation:

Restoration and preservation of Hawaiian fishpond for their aesthetic and scenic value.
BIBLIOGRAPHY FOR HAWAIIAN FISHPODSS


(4) Kikuchi, W., Hawaiian Aquaculture System


(7) Kikuchi, W., Fishponds on The Leeward Coast of Big Island


MEMORANDUM

TO: Debra Shiraishi

FROM: Cynthia

SUBJECT: ADP Film Library

The following is a list of the films which we have, where they were produced, their length and a few brief notes as to their content. Hope it helps.

1. Experimental Fish Farming with Coho Salmon (Canada) 30 minutes
   Color, 16 mm, 1975. Describes steps in culturing Pacific coho salmon and bringing them to marketable size in one year: selection of brood stock, egg taking, fertilization, achieving rapid growth, diet, etc.

2. Domsea Farms (USA) 10 minutes
   Color, 16 mm, 1976. Documents commercial salmon and trout rearing techniques: Incubation, rearing, transition to salt water and harvesting and processing.

3. Aquaculture - Farming the Waters (USA) 8 minutes
   Color, 16 mm, 1975. Covers aquaculture industry from farming trout, catfish and catfish in freshwater to culture of oysters and salmon in the sea.

4. There's No Limit to Catfish Farming (USA) 8 minutes
   Color, 16 mm, 1970. Basic requirements and essential activities of catfish farming discussed.

5. Catfish Spawning (USA) 10 minutes
   Color, 16 mm, 1968. Depicts spawning of channel catfish after hormone injection.

6. Coming Back of Red Sea Bream (Japan) 30 minutes
   Color, 16 mm, 1969. Artificial propagation techniques to increase stocks of red sea bream discussed.

7. Take Two From the Sea (USA) 28 minutes
   Color, 16 mm, 1973. Two film makers and their adventures while filming documentary on oysters and clams.

8. Fish Cultivation (Japan) 40 minutes
   Color, 16 mm, 1968. Reviews artificial spawning and breeding of prawns, red sea bream, lionfish, salmon and octopus and shows the increased production due to scientific aquaculture techniques.
The following is a brief evaluation of each film in terms of their suitability for viewing in an introductory course, such as AG 290 - Introduction to Aquatic Aquaculture. At the end of each comment is a number rating of the films in my opinion.

1 - not recommended
2 - suitable
3 - strongly recommended

1. Experimental Fish Farming with Coho Salmon - This was an interesting film on the pen culture of salmon. The film observes a highly experimental project on the pen culture of the Pacific coho salmon. Rate: 3

2. Domsea Farms - The film is more of a promotional film for Union Carbide and thus presented some distorted information. Rate: 1

3. Aquaculture: Farming the Water - This film is a very good introductory film. It takes a brief look at a few contemporary aquaculture operations in the United States. Rate: 3

4. There's No Limit to Catfish Farming - Not too much information contained in this film. Yet, it provides a look at the catfish industry in the South. Rate: 2

5. Catfish Spawning - This film is old but the information is still relevant. Rate: 2

6. Coming Back of Red Sea Bream - This is an interesting film about an experimental project on ocean ranching. Rate: 3

7. Take Two From the Sea - There's very little information in this film besides pictures of harvesting clams and oysters. It detracts and tells more about the making of the film than provide information. Rate: 1

8. Fish Cultivation - A very interesting film about possible species for aquaculture. Rate: 3