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.

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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 wich 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

[illegible]

The College [illegible] three classes in aquaculture beginning [illegible]

1. AG 250: [illegible]
   Instructor: [illegible]
   Meeting Time: Tuesdays, 2:30 - 5:00 PM
   Meeting Room: Watanabe 420
   Prerequisites: None
   Description:
   [illegible] field of aquaculture as it is practiced throughout the world [illegible] with basic theoretical concepts within the field of aquaculture and the techniques that can be applied [illegible] of different marine species as a food source [illegible] the goal of this [illegible] Specific [illegible] of the course will [illegible] through history [illegible] subsistence [illegible] practiced in Southeast Asia [illegible] capital [illegible] now in commercial [illegible] countries [illegible]

2. AG 390: [illegible]
   Instructor: [illegible]
   Meeting Time: [illegible] 10:30-[illegible]
   [illegible] 9-12:00 noon
   Meeting Room: [illegible] Lab - PCSP
   Prerequisites: [illegible] (limited to [illegible] students)
   Description:
   [illegible] techniques as well [illegible] experience with a pond, which will be [illegible] operation [illegible] and [illegible] be conducted [illegible] of Tropical Agriculture [illegible] students will be [illegible] and production [illegible] the pond.
   [illegible] will be supplemented with [illegible] used in aquaculture and guest speakers [illegible] on various management techniques [illegible]

3. AG 490: [illegible] (3 credits)
   Instructor: [illegible]
   Meeting Time: [illegible]
   Meeting Room: [illegible]
   Prerequisites: [illegible] (limited to [illegible] students)
   Description:
   Designed [illegible] problems that are [illegible] This will be held on a [illegible] the production and [illegible] aquacultural [illegible] the discussion [illegible] aquaculture.

For more information, [illegible]

AG 290 - INTRODUCTION TO AQUATIC AQUACULTURE

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

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

Course Schedule

Class #	Date	Lecture Subject	Readings
1	9/5	DPED slide show	Textbook pp. 1-28
2	9/12	Hawaiian Fishponds	Madden paper
3	9/19	Hawaiian Fishponds	Textbook pp. 75-120
4	9/26	Aquaculture in Southeast Asia	Textbook pp. 313-350
5	10/3	Aquaculture in Southeast Asia	Textbook pp. 32-42, 286-292
6	10/10	Importance of Hatchery and Nursery Functions to Aquaculture	Textbook pp. 450-502
7	10/17	Ocean Ranching	Textbook pp. 587-632
8	10/24	Midterm Prawn Farming in Hawaii	AFRC paper
9	10/31	Prawn Farming in Hawaii	Textbook pp. 674-742
10	11/14	Oyster Production in Hawaii	Textbook pp. 790-814
11	11/21	Plant Aquaculture	Textbook pp. 541-556, 633-650
12	11/28	Aquaculture of Other Species	Jokela paper
13	12/5	Waste Water Reclamation and Aquaculture	Rutka paper
14	12/12	Institutional Constraints	-----
15	12/19	Final Exam (6:00-8:00 p.m.)	

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

Class #	Date	Lecture Subject	Readings
1	9/7	An Overview of Aquaculture in Hawaii	Madden paper
2	9/14	Hawaiian Fishponds	Textbook pp. 6-40, 304-306
3	9/21	Pond Construction & Site Selection	AFRC paper
4	9/28	Water as an Environment	Textbook pp. 311-318
5	10/5	Water as an Environment	Textbook pp. 41-56, 318-327
6	10/12	Natural Productivity & Cultured Species	Textbook pp. 271-281
7	10/19	Natural Productivity & Cultured Species	-----
8	10/26	Mid-term	Textbook pp. 283-290, 356-359
9	11/2	Biological Variables of Pond Production	Textbook pp. 322-335
10	11/9	Feeding and Fertilization	Textbook pp. 291-301
11	11/16	Maintenance of Ponds	Textbook pp. 381-386
12	11/30	Harvesting	Textbook pp. 395-414
13	12/7	The Aquaculture Market	Textbook pp. 67-85
14	12/14	Spawning & Nursing	-----
15	12/21	Final Exam (9:45-11:45 a.m.)	

AG 490 - PROBLEMS IN AQUACULTURE PRODUCTION

LECTURE: Tuesday, noon INSTRUCTOR: S. A. Morain

TEXTBOOK: None. Papers will be distributed in class.

COURSE SCHEDULE

Class #	Date	Subject
1	9/5	DPED Orientation
2	9/12	Site Selection and Institutional Constraints
3	9/19	Financing
4	9/26	Hatchery and Nursery
5	10/3	Discussion
6	10/10	Design and Construction
7	10/17	Feed and Fertilization
8	10/24	Harvesting Techniques and Technology
9	10/31	Discussion
10	11/14	Markets for Aquacultured Products + Processing
11	11/21	Economics of Aquaculture
12	11/28	Discussion
13	12/5	Waste Disposal and Aquaculture
14	12/12	Discussion of Aquacultured Systems
	12/21	Paper due at 9:30 a.m.

NAME: _____
DATE: _____
INSTRUCTOR: S.K. MORITA

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 estruarine.

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.

T 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.

F 19. To keep temperatures constant in a raceway culture system, the most economical method would be to enclose the raceways in a building.

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

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

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

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

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

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

5. Some of the growing methods for oysters are trench, bottom, long-line, and raft culture.

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

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

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

9. To reduce cannibalism in puffers older than 20 days, aquaculturists should sort by size or feed more often.

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

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

12. Mating in decapod crustaceans occurs only after molting 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 Engineer.

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, hatchery, 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

B 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)

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

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

B 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

B 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

B 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

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

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

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

B 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

B 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

AG 390
Mid-Term

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 9. Below the thermocline CO_2 and oxygen remain stable.

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.

T 19. The branchiospines are large on fish that are voracious.

F 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 loko i'a kalo.
2. A kuapa is a fishpond seawall.
3. Fan Lee's work is the oldest publication on aquaculture and was written in 5 A.D..
4. Density of water decrease with temperature and increase with salinity.
5. Loss of heat takes place through radiation, evaporation and conduction 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 mesomictic.
7. Lakes with Spring and Fall turnovers are called dimictic lakes.
8. The surplus amount of carbon dioxide that must be free when CO_2 is used for the solution of limestone and for calcium bicarbonate to be stable is called free carbon.
9. The return of CO_2 to the water at night is largely due to "dark" reaction.
10. There will be a major decrease in selicic acid after a bloom of diatoms.
11. In zooplankton, the three phyla represented in freshwater are rotifers, arthropods, and protozoa.
12. For prawn ponds, the optimal ratio of width to length in terms of harvesting is 1:2.
13. The sluice gate 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. increasing natural productivity of the pond
    b. increasing predator control

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.

B 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

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

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

C 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

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

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

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

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

C 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

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

A 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

B 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

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

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

A 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

B 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

C 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

C 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

B 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

B 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?

HAWAIIAN FISHPONDS

by Debra Shiraishi

Almost every culture in the world has practiced aquaculture to some degree;[1] 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. (485,000 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

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 umeiki 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 umeiki - 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 tne fishponds ranged from one acre to 90 acres per pond.

CONSTRUCTION

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

a) kuapa (seawalls) - the kuapas were constructed either out of lava rocks or corallfne 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 descendents of Kamehameha. The loko umeiki fishtraps, loko a'i 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'i loko. If there was a massive damage the konohiki 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 possesions of the alii (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. Appeasements 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'i 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 useable 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.

B. 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.

C. 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.

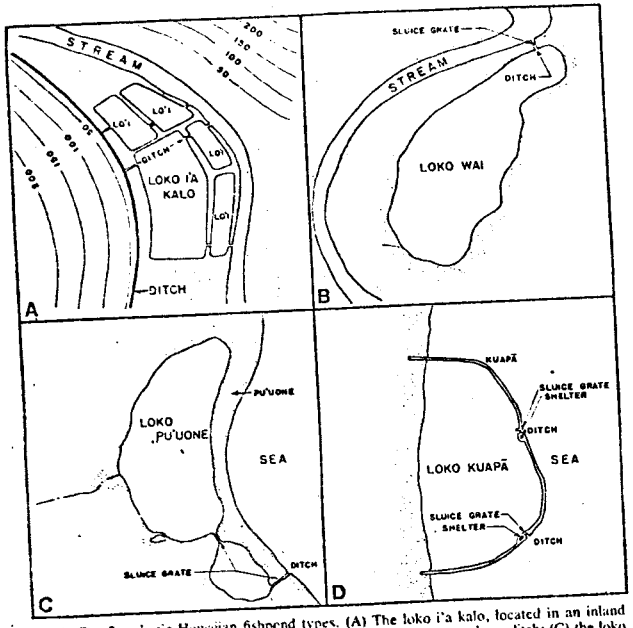


Fig. 2. The four basic Hawaiian fishpond types. (A) The loko i'a kalo, located in an inland area; (B) the loko wai, a natural lake artificially connected to a stream by a ditch; (C) the loko pu'uone, ponds created by coastal barrier beaches, artificially connected to each other, and drained by a ditch; and (D) the loko kuapā, two ditches and a seawall isolating a coastal body of water. No scale.

Table 8. Documented Acreage of Fishpon.

ISLAND	FISHPONDS A.	TOTAL ACREAGE	AVERAL
NI'IHAU	1	400.00	400.00
KAUA'I	23	356.04	15.43
O'AHU	158	3,720.68	23.54
MOLOKA'I	53	821.84	15.50
LANA'I	1	0.7	0.7
MAUI	16	114.81	7.18
HAWAI'I	52.	196.34	3.77
	304	5,608.48	465.46

A. FISHPONDS WHICH HAD DOCUMENTED SIZE FIGURES.
B. IN ACRES PER FISHPOND.

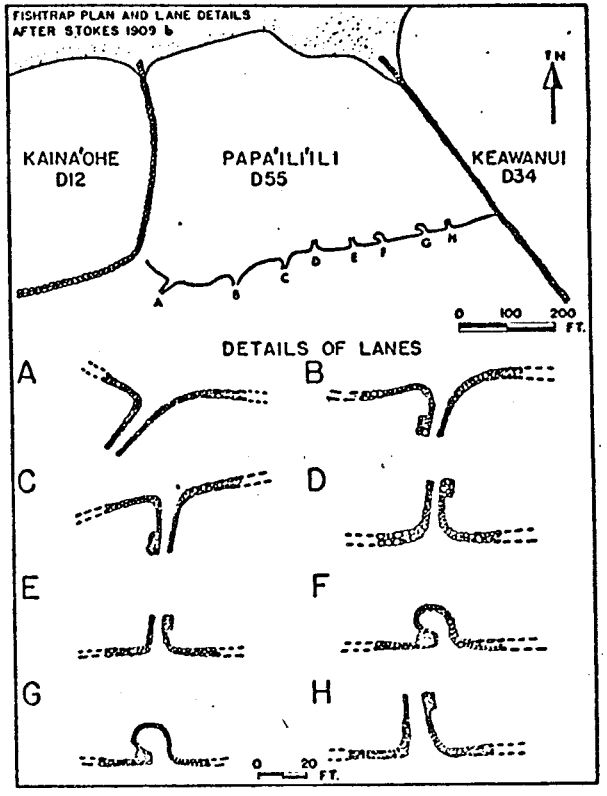
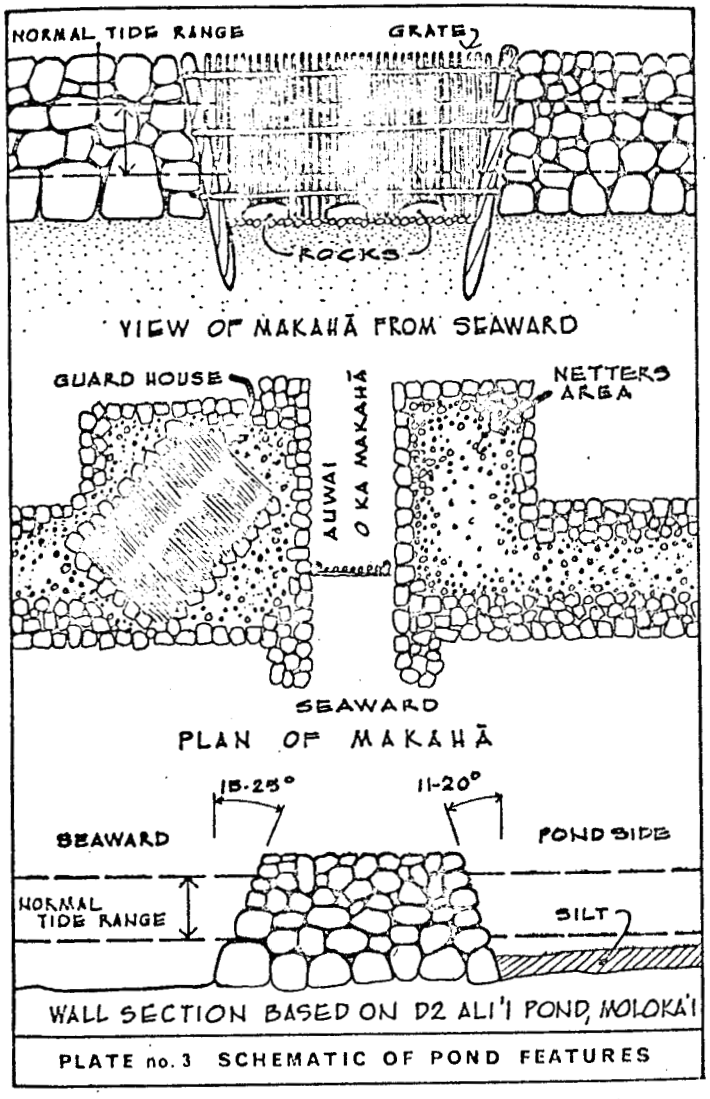


Fig. 31. Loko 'Umo'iki Details



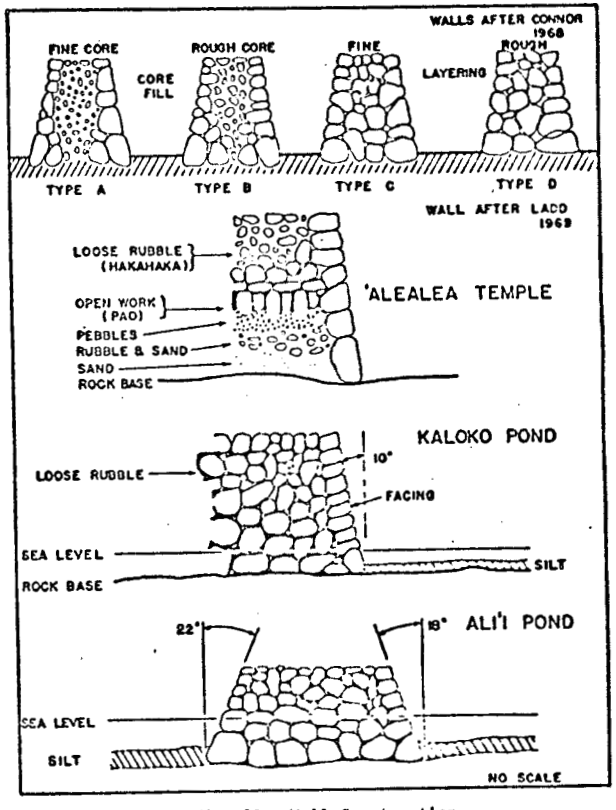


Fig. 27. Wall Construction

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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, 16mm, 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, 16mm, 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