An Analysis of the Salmon Statistical Information System

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National Bureau of Standards
Washington, D. C. 20234

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PREFACE

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statistical information system of the Washington State Depart-
ment of Fisheries relative to the changing data requirements
of the Department. Recommendations are given for revising the
current system in order to assure the availability of complete,
accurate statistics on a timely basis. In addition, the
principal requirements are identified for the development of
improved procedures for generating input to the hatchery and
fishery management models in use by the Department. This
project was sponsored by the Washington State Department of
Fisheries under Service Contract No. 626.

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SECTION I. INTRODUCTION

The salmon statistical information system (also called the catch record system) of the Washington Department of Fisheries is the computerized data system which serves as the official information repository for salmon fishing activity in the State. The system has developed over the years in response to requirements for statistical reports on catch activity both from within the Department and from outside agencies and users. Generally, these reports have been required on an annual basis, and the catch record system has not been a major source of information for the day-to-day management of the salmon fisheries.

The data requirements for effective salmon fishery management have radically changed in recent years. In order to provide the fisheries management necessary to satisfy catch division requirements and to harvest the resource effectively, accurate and timely catch statistics must be available to the decision-making process. In response to this need for day-to-day catch statistics, the Department has developed the Anadromous Fish Catch Record System (AFCRS), which is also called the soft-data system. AFCRS provides computerized catch activity reports to all interested parties, both within and outside of the Department, using a combination of data obtained from fish tickets and sampled catch data. The system was successfully introduced for the 1975 fishing season, and the statistical reports provided by the system have achieved a wide acceptance.

In order to further improve the accuracy and timeliness of salmon catch statistics, the Department has undertaken a complete examination of all aspects of the official catch record system. The purpose of this document is to evaluate the catch record system relative to the changing data requirements of the Department and to provide recommendations for revising current procedures. This report also identifies the principal requirements for using the catch record system to provide input to the hatchery management model and the fishery management model which have been developed by the Department.

SECTION II. THE FISH TICKET SYSTEM

Section II-A. An Analysis of Current Procedures

The process of collecting official data on the commercial salmon fisheries begins with the preparation of a fish ticket document when the salmon are sold by a fisherman to a fish receiver. The contents of this document are specified by regulation, and it must contain the following information:

(1) name of purchaser or receiver,

(2) name of seller or deliverer,

(3) name or Coast Guard number of landing vessels,

(4) commercial fishery license number, delivery permit number, or the Department of Fisheries boat registration number.

(5) exact geographic location of catch,

(6) specific type of gear used in taking each species of food fish or shell-fish,

(7) date of receipt,

(8) total amounts of each species of food fish or shellfish,

(9) certification whether food fish or shellfish was taken within or without Washington territorial waters, and

(10) value-price paid.

Copies of the fish ticket must be mailed to the Department of Fisheries within a specified time. The time period permitted for reporting fish tickets varies from the end of the working day to 1 week from the date of issue. Several types of preprinted fish ticket forms are provided by the Department of Fisheries to the fish receivers.

When a fish ticket is received by the Department of Fisheries, a multi-step process occurs which culminates with the entry of the information contained on the ticket into the computerized fish ticket master file. Four principal processes

occur between the receipt of the fish ticket and master file data entry:

(1) the fish ticket is dated in and an inventory log is updated,

(2) numerical codes are added,

(3) the information is keypunched onto cards, and

(4) validity checks are made by the computer in an editing run.

Maintenance of a fish ticket inventory file is an important check on the validity of the catch statistics. Each preprinted fish ticket is sequentially numbered, and a log is maintained of the tickets sent to each dealer and also of the tickets returned. Spoiled and missing tickets must be accounted for, in writing, by the dealer. Currently, however, fish ticket blanks may be carried over from one year to the next by the buyers, and no end-of-the-year accounting of unused tickets is required. Thus, the inventory control system can detect gaps in returned fish ticket numbers, but tickets which are missing from the end of a sequence cannot be detected.

The addition of numerical codes by hand has been one of the major tasks of fish ticket processing. Codes which must be added to the ticket include a district code, port code, dealer code, gear code, boat code, tax code, and area code. Each of these codes is either the numerical equivalent of information written on the ticket (e.g., gear code and area code) or is new information not contained on the original ticket (tax code). The addition of the area code is particularly time-consuming since the written descriptions on the fish ticket can vary widely in descriptiveness and detail.

Errors in the fish ticket are corrected and missing information is added to the fish ticket at this time by utilizing the experience of the coding staff. To illustrate, for fish tickets which contain only the number of pounds but not the number of fish, an estimate of the number of fish may be derived using an average weight obtained from other fish ticket data.

It is important to recognize that with this coding and error correction process, the Department of Fisheries has been providing a service which could as well be performed by the fish receivers. Because of the willingness of the Department to undertake this function, it has proved difficult to adequately enforce the requirements for a properly completed fish ticket.

After the codes have been added to a ticket, it is sent to be keypunched. Keypunching of fish tickets is complicated by two problems--ticket layout and diversity of tickets. The design of any document which is to be keypunched can greatly affect the ease of keypunching since the data fields on the punched card must appear in serial order. If the corresponding fields on the source document are not arranged in a similar order (or reasonably so), it becomes more difficult to keypunch the document since the eye must pick up data fields in an unnatural sequence. This problem is compounded by the number of different types of pre-printed fish tickets used to report salmon catch. A total of six different for-mats (five commercial tickets and one treaty Indian ticket) is currently in use. The number of different commercial tickets in use has occurred because of an effort by the Department to develop specialized formats for different types of fish receivers. However, this cooperative policy has resulted in complicating the keypunching process. Actually, the number of different fish tickets in use is not the problem. Keypunching is slowed by the number of different ticket formats in use.

The final step of the data preparation process is the computerized editing pass. A well-designed data editor is of prime importance when large amounts of data must be processed. The basic task of the editing pass is to apply validity checks to as much of the data as possible. Validity checks may be applied both to individual fields and to groups of fields. Many validity checks are made in the current system, and a list of desired features for data editing is given in

Section II-C. After the successful completion of all validity checks, the fish ticket records are entered into the master file for use in statistical reports.

As the above description of current fish ticket processing procedures shows, the task of getting statistical data from the dock to the computer requires a substantial amount of extra work by the Department, and this delays the ultimate availability of the data. Because of these delays, current procedures are not adequate to meet the data requirements of the Department. However, as will be seen from the recommendations in Section II-C, radical changes in fish ticket processing will not be required in order to achieve substantial improvements.

Section II-B. Data Acquisition and Transmission Alternatives

Because of the unavoidable delays which occur in the transmittal of fish tickets by mail to the Department of Fisheries, and because of the time required to encode and keypunch the tickets, a logical starting place for improving the system occurs at the very first step--data acquisition and transmission. Several alternative methods of accomplishing these tasks were evaluated. The methods considered fall into three major categories:

on-line and off-line computer terminals,

data imprinting systems,

facsimile transmission.

Computer terminal systems are used to simultaneously solve both acquisition and transmission problems, while each of the other two categories deals with one specific problem. The capabilities of each of these methods and an evaluation of their suitability for use in the fish ticket system follows below.

On-line and off-line computer terminals

By far the most powerful data acquisition and transmission equipment falls
into this category, and considerable effort was made in attempting to find equip-
ment suitable for use in the fish ticket system. The term computer terminal is
used here to mean any electronic device which could be used by the buyer to assist
in the preparation of an original fish ticket document and to simultaneously
encode the fish ticket data in a form suitable for direct use by a computer. An
on-line terminal is one which is connected directly to the computer through the
use of telephone lines. An off-line terminal, on the other hand, is not directly
connected to the computer but instead produces computer compatible output using a
magnetic cassette or disk. In either case, these terminals have the capability of
simultaneously recording data and producing a printed fish ticket document. The
use of computer terminals for data entry and transmission is a widely accepted
concept with thousands of terminals in use over a wide range of applications.

The suitability of any computer terminal for use in the fish ticket system
hinges on two key factors: operator training and physical environment. Operator
training is an important issue because the operators of any terminal device would
not be employees of the State, and any system which would require substantial
training would place a large burden on the users of the system. Because of train-
ing problems, terminals which use typewriter-like keyboards are unsuitable for use
in the fish ticket system.

A relatively new type of terminal, which greatly reduces the training problem
is gaining acceptance. This is the point-of-sale terminal which is essentially an
electronic cash register connected to a computer. A point-of-sale terminal,
together with a small output printer for preparing copies of the fish ticket for
buyer and fisherman, is an extremely attractive method for substantially improving
the timeliness and accuracy of the fish ticket system. However, we now run-up
against the second factor--physical environment.

The physical environment in which the fish tickets are filled out actually represents the major obstacle to the use of any type of electronic equipment and, in particular, point-of-sale equipment. The corrosive nature of the saltwater atmosphere and the temperature regime in which large number of fish tickets are prepared greatly exceed the operating requirements of any of the terminal devices now available. In addition, the preparation of fish tickets by electronic means would result in power supply problems for the tenders. Consequently, in spite of some very attractive features, the use of computer terminals for fish ticket preparation and data transmission cannot be recommended.

Data imprinting systems

The current fish ticket system has provisions for the optional use of an imprinting device for fish ticket preparation. The imprinting device is simply a credit card imprinter which prints data on the fish ticket from a plastic card (the commercial gear license) obtained from the fisherman and a metal plate which contains buyer information. Both the commercial gear license card and the dealer plate are supplied by the Department of Fisheries. The imprinting system has the advantage of being easy to use, relatively (compared to terminal systems) insensitive to environmental problems, and can quickly transfer a large amount of information to the fish ticket in a legible form.

The current imprinting system works very well with only one or two problems. Some difficulties do occur because of saltwater corrosion affecting the imprinting device. This problem has been recognized by the Department, and several alternatives for elimination of this problem are under consideration.

A second problem with the imprinter system is not at all inherent in the system. The current design of both the fisherman plate and the dealer plate does not fully utilize the capabilities of the imprinter system for simplifying the

keypunching process. Code numbers appearing on these plates are not sufficiently isolated. This creates unnecessary confusion and is a source of error. The problem is very easily corrected by redesigning the fisherman and dealer plates, which are issued annually. This is covered further in Section II-C.

All in all, the use of imprinters in the fish ticket system is an excellent method for reducing the amount of information which must be hand-written on the ticket. Not only should the use of imprinters be continued, but it is recommended that their use be made mandatory for all buyers.

Facsimile transmission

Facsimile transmission uses special equipment to transmit copies of documents over the wires of the telephone system. Facsimile transmission equipment is currently being used by AFCRS to transmit catch summary information from the field to Olympia. However, because of the time required to transmit a document (from 2 to 4 minutes), facsimile transmission is not suited to the peak volume of fish tickets which occurs during the height of fishing in Puget Sound. Therefore, it is recommended that the current system of mailing fish tickets to Olympia be retained. This will, of course, be a source of delay in obtaining catch data. However, because of the success of AFCRS in the first year of operation, any adverse effects caused by a mail delay can be eliminated through the use of a combined fish ticket/ AFCRS system. This is discussed further in the next section.

Section II-C. Recommended Changes in the Fish Ticket System

To summarize Section II-B, it is recommended that the use of an imprinter device be made mandatory for all salmon fish tickets, and that copies of the completed tickets should be mailed to Olympia. It is also recommended that all tickets be posted in the mail on the same day that they are completed. Currently, this requirement applies only to Puget Sound catch.

The mandatory use of the imprinter should be accompanied by a redesign of the fish ticket, the fisherman plate, and the dealer plate. Two data elements should be isolated for ease of keypunching on both of these plates. On the dealer plate, the dealer number and the port code are the keypunched data items, and these should be as large as possible for legibility. The fisherman plate should contain the gear code and the boat code, also in large, legible numbers. Additionally, the data from the fisherman plate and the dealer plate should be aligned as much as possible to lie on one line.

A minimum amount of preprinted material should appear on the fish ticket where the dealer plate and the fisherman plate are imprinted. This is to insure the maximum legibility for keypunching purposes. The date of transaction should be imprinted on the ticket in the same order as keypunched.

The top portion of the fish ticket should contain all information that is common to all species on the ticket. In addition to the codes on the plates, the catch area, effort, and certification of whether caught in Washington waters should appear here. Effort should be reported in number of days fished for all gear types, not just troll gear.

One of the key recommended changes is that catch area be reported only by numerical code. All fishermen and buyers should be issued maps which contain numerical codes for all catch areas, and it should be made mandatory that these codes be used. This will eliminate a great problem in fish ticket processing and it will actually be quicker to fill out a ticket once all parties are accustomed to the codes. Since the Department has a complete area renumbering scheme under consideration, it is recommended that a system be adopted in which large catch areas, such as districts, are logically subdivided into smaller areas so that the numerical code of a small catch area is as meaningful as possible. In any case, any area renumbering scheme must take into account the fact that the computerized

historical data base from previous years must be converted. A complete set of conversion rules must be agreed upon before a new area number scheme can be adopted. This is particularly important if the new area boundaries do not coincide with the old boundaries.

The district code, which appears explicitly on some fish tickets and is added to others, should not be keypunched at all. This code is completely identified by the port code, and the editing program can add this code to the master file record. It is recommended that the tax code also be added to the master file record by the computer. Or, if the tax code is too complicated for a computer algorithm, then either the tax code must appear explicitly on the ticket, or the taxing structure should be simplified so that it may be automated.

The bottom portion of the fish ticket should contain species-oriented information in a standard format. It is important that the same information appear in the same order from left to right on all fish tickets. For example, the left-to-right ordering could be: (1) species and description in printed form, (2) species code (preprinted), (3) number of fish, (4) pounds, (5) price, and (6) amount of sale. It is not critical that the same species appear in the same order on all salmon tickets. It is critical that the same left-to-right ordering is maintained on all tickets.

The final recommendation concerning fish ticket format is motivated by the inventory control problem. In order to maintain strict control of fish tickets and catch reporting, it is absolutely necessary that unused tickets at the end of the year be accounted for. The simplest way to accomplish this is to adopt an annual fish ticket which has the year preprinted on it. A fish ticket should be valid only during the year printed on it, and all unused tickets should be returned to the Department within 1 week of the end of the year. In this manner, by early in January, any problems with missing fish tickets can be identified, and

appropriate action taken. The Department must be responsible for issuing new fish tickets before the old tickets expire.

The above paragraphs complete the recommended changes to the format of the fish ticket. We now look at the fish ticket process after the ticket has arrived at the Department of Fisheries. If the above recommended changes are adopted, the coding of salmon fish tickets by the Department on a regular basis will be eliminated. After a fish ticket has arrived and been dated in, it can proceed directly to keypunching since all codes have been placed on the ticket when initially completed in the field. The one remaining problem is what to do about missing data. The Department should not correct any missing data or other data problems on the fish ticket until it has passed through keypunching and editing. If data is missing from a card, a standard code, such as a negative one (-1) should be keypunched in its place. If a number is illegible, a different code, such as a negative two (-2), should be punched. Additional error codes can be adopted as necessary. The key point is that the keypunching of the ticket should be completed without intervention, even if there are data problems with the card.

After keypunching, a greatly expanded computerized data editing process should be applied to all tickets. The first step in the editing process is automated inventory control. Since the fish ticket number is punched on the card, the computer can be used to maintain a fish ticket inventory by buyer. Reports should automatically be issued, by buyer, of any missing or unaccounted-for fish tickets. These reports are intended to serve as official documentation for any missing ticket problems.

In addition to inventory control, the editing process should perform the following tasks:

1. data validation,

2. addition of codes,

3. report errors or missing data.

Data validation is used to check both for keypunch errors and erroneous data. Examples of the kind of tests to be made include:

    (a) all numerical codes valid,

    (b) gear code and boat code compatibility (no troll tickets from a purse seiner),

    (c) dealer code and port code compatible,

    (d) date on ticket should be no more than 1 week earlier than current date unless specifically allowed,

    (e) species of catch and gear code compatible, and

    (f) average weight/fish should lie between minimum and maximum bounds which may be species-dependent.

The above list is not intended to be exhaustive, but it serves to illustrate the type of validity testing that can and should be automated.

At the same time that the validity tests are made, any automatically computed codes, such as the district code, can be added to the master record. The final step of the editing process consists of the production of a report which identifies by buyer any tickets with invalid or missing data. As with missing tickets, this report should serve as official documentation of a data collection problem so that appropriate action can be taken. After this report is prepared, any troublesome tickets can be corrected by hand if possible, or, in the case of missing numbers of fish, the data could be automatically corrected by a special computer program.

This completes the recommended changes for the fish ticket process. It is our opinion that implementation of the above procedures will result in a fish ticket system in which all correctly filled out fish tickets will be entered in the master file within 1 to 2 days of receipt by the Department. With appropriate enforcement action which utilizes the special error reports, the incidence of troublesome fish tickets should be greatly reduced. Because of mail delays, however, the master

fish ticket file will always be 1 to 2 weeks behind. In order to cope with this problem and to further increase the accuracy of the daily catch reports, the use of a combined fish ticket-AFCRS system is recommended. This combination system can use official fish ticket data for catch that occurred more than 2 weeks in the past, and the most recent 2 weeks of catch estimates can be based on the usual AFCRS techniques. It should be noted that this procedure will require the careful coordination of AFCRS catch sample periods with the reports issued from the official fish ticket system. With proper coordination, the combined system can provide catch data that are both timely and accurate, and this system can meet all of the data management needs of the Department.

One final remark about fish ticket processing must be made. The data problems and requirements of the Department have changed very rapidly and may very well continue to change. Unanticipated data requirements are very likely to occur at any time. Consequently, it is highly important that flexible processing techniques be adopted by the Department. The fish ticket processing system must be able to respond rapidly to changes in data requirements, and this principle should be kept in mind during all phases of the development of any new salmon fish ticket system.

SECTION III. REQUIREMENTS FOR MANAGEMENT MODELS

The hatchery and fishery management models used by the Department have a somewhat different type of data requirement from the day-to-day fisheries management problems. The usefulness of both models can be substantially enhanced through the development of a coordinated data base program utilizing historical salmon catch data files.

The hatchery model is designed to combine hatchery production data, microtag study data, and catch data in order to analyze the economic productivity of a hatchery. The key to the success of this model is the simultaneous analysis of data from different sources--hatchery records, fishery tag sampling records, and catch records. The Department has recognized the need for the development of techniques for automating these records, and an effort is now underway to develop computer programs for processing hatchery production data and tag recovery data.

The fishery management model is a regulatory analysis model for evaluating the economic and biological effects of changes in fishery regulation. The principal input to this model is detailed catch data which are classified by stock, age, sex, maturity, fishery, and time period. The catch data required for this model are much more detailed than for the hatchery model, and the fishery model utilizes data on wild stocks as well as hatchery stocks. Because the fishery model has only recently been developed, no programs exist for data preparation for this model.

The data requirements of the hatchery and fishery management models can best be met through the development of a common data base which contains complete data on hatchery environment, hatchery production, marking and catch sampling, and detailed catch statistics. In addition, special programs should be developed for the automatic preparation of input data for the hatchery and fishery models.

It is recognized that the development of a master salmon data base for the Department is not a minor task, and the development of a unified system will require careful planning and implementation. However, the economic benefits of improved hatchery and fishery management more than justify the undertaking of this task. In view of the possibility of major new salmon enhancement programs, the development of a unified hatchery data system is of particular importance.

It is recommended that the development of the unified salmon data base and the associated analysis and support programs be established as a specific project within the Department. The core of such a project exists within the Research Division of the salmon program, and it is recommended that this core be expanded as quickly as possible in order to achieve the implementation of the data base system without unnecessary delays. Once implemented, the common data base will not only improve the utilization of the hatchery and fishery models, but it will be a major asset in providing data to other studies as well. The groundfish data base, which is in operation, is an excellent example of the usefulness of the common data base approach.

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15. SUPPLEMENTARY NOTES

16. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)

   This report contains an analysis of the official salmon statistical information system of the Washington State Department of Fisheries relative to the changing data requirements of the Department. Recommendations are given for revising the current system in order to assure the availability of complete, accurate statistics on a timely basis. In addition, the principal requirements are identified for the development of improved procedures for generating input to the hatchery and fishery management models in use by the Department. This project was sponsored by the Washington State Department of Fisheries under Service Contract No. 626.

17. KEY WORDS (six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons)

Anadromous Fish Catch Record System; Catch Record System; Fish Record System; Fishery Management Model; Fishery Modeling; Fisheries Statistics; Modeling; Salmon; Salmon Fishery; Salmon Information System; Washington State Fisheries.

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