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INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA

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Fish Capture Committee

A SIMULATION MODEL TO DETERMINE THE OPTIMAL FREEZING RATE OF A STERN TRAWLER FOR A GIVEN CATCH INPUT

by

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Abstract
In order to determine the optimal internal arrangement of a stern trawler a simulation model is developed, written in the computer language Personal PROSIM. The process of catching and storing fish is modelled with a stochastic catch input. For a given catch, represented by the parameters size and inter-arrival time of probability distribution functions, a particular minimum freezing rate is necessary to avoid queueing of fish in the vessel. The advantages of a stochastic model over a deterministic model are discussed. Queueing phenomena are better described by a stochastic model. The use of the means of the distributions (deterministic model) will lead to a freezing rate value, that is too small.

Contents

1: Introduction.

It is for a vessel designer essential to determine the dimensions of the various components of which a fishing vessel consists. Preliminary studies on the landing capacity of stern freezer trawlers are given in [2], giving the basic variables and their relative importance. As fishing operations and catches fluctuate strongly with time a straightforward deterministic model like the one in [2] may not be the most adequate one to determine the size of these components. Literature on operations research and queueing theory reveals, that phenomena related to random variability in input and throughput can not be described satisfactory with deterministic models [1].

Figure 1[a] shows the basic components of a waiting line or queueing system. Arrivals of clients, which may be items or persons occur at unknown points in time. The time between the arrival of two successive clients is called the **inter-arrival time** Δt_a. Some action takes place to serve these clients by the service mechanism. The time needed to complete this **service** is called **service time** Δt_s. If the server is busy when a new client arrives, a waiting line will form, normally called the **queue**. The server may utilize a specific strategy in his service, called the **service discipline**. He may pick out the client waiting the longest time (First Come, First Served) or the client who arrived most recently (Last Come, First Served) or pick out the client at random. A general objective is to ensure, that the queue length will remain limited in order to keep attracting new clients or to avoid clients to leave the queue. On the other hand the serving mechanism should be utilized to a great extent in order not to be idle and therefore too expensive. Some important conclusions can be drawn from literature like [1].

The use of <u>mean</u> values for inter-arrival and service times will lead to misleading conclusions concerning the optimal service capacity.

<u>Without variability</u> in the inter-arrival times and the service times a queue will form if $\Delta t_s > \Delta t_a$. When $\Delta t_s < \Delta t_a$ the server will be idle for a period of $1-(\Delta t_s/\Delta t_a)$ time-units and when $\Delta t_s = \Delta t_a$, the server will be fully occupied and able to finish the service before the next client arrives. But <u>with random variability</u> in these times, a queue will form even if the mean service time is much less than the mean inter-arrival time. Simple mathematical models like stationary Markov Chains using negative exponential probability densities for the inter-arrival and service times, reveal that the objective of having full utilization of the server will create infinitely long queues.

A certain percentage of idleness of the server must be tolerated to ensure that the queue length remains reasonably small.

Many examples exist of so-called waiting-line systems, like gas-stations, supermarket registers, parking lots, airfields, ports etc. The input of these systems is not fully predictable, but shows a variability, that can be described by random draws from a probability distribution. The art is to determine the dimensions of the space for clients to wait in and the optimal serving capacity. The conclusions given here also apply to the design of fishing vessels with variable arrivals (catches) and a service mechanism (catch handling, processing and storage). The components of the vessel should similarly be optimally dimensioned in relation to the input.

2: Problem description.

The process of filling a boat with fish at sea can also be described as a queueing phenomenon. It is not known exactly at what moment a catch comes onboard and neither its quantity or its exact contents. Whatever the exact time, the catch should be hauled in, processed and stored in the holds of the vessel within a limited time span, as fish quality deteriorates fast. Therefore the input and the processing capacity must be in tune. Otherwise fish will pile up and loose quality or need to be discarded at sea.

When the input per unit of time is too small for the size of the vessel and the processing plant, the boat will be too expensive to run and the income will not exceed the costs. This paper gives a method of adjusting the variable freezing rate to the existing throughput. Figure 1b depicts the basic components of a typical Dutch stern trawler. The catch is lifted onboard in bags, put on deck in parts, stored in Refrigirated Sea Water (RSW)-tanks to be pre-cooled shifted by conveyor belts or pumps to sorting machines, transported to filliting machines if necessary, frozen in platefreezers, packed and stored in the fish holds. This flow is interrupted by creating bufferspace at several spots. Normally the processing of fish follows an almost continuous pattern after the first haul.

3. Model in PROSIM.

Personal PROSIM, created and licensed by the company Sierenberg & De Gans (Waddinxveen, The Netherlands) is a special software package to create computer simulation models. It enables modelling of continuous and discrete events and is therefore suitable for modelling fishing operations. Arrivals of fish happen at discrete points in time, while temperatures of coolingtanks, platefreezers and quantities of fish vary continuously. A system is described by the state of its **components**. Components are described with **attribute variables**, which can be real or integer numbers, but also strings, logicals or references to other components. Components can be **activated** or **passivated** by others or by run control modules. The language is orientated to process descriptions, where the important issue is <u>what components do</u> and not what the computer has to do to determine the state of these components in time. The software is menu-orientated and userfriendly and enables verification and validation of a model through a **state-analysis**. Special statements can be included in a model to create an **animation** after running. **Statistical analysis** of data is also possible with a special Supplement.

The source text of model **TRAWLERØ** is given in Appendix 1. This is a small model consisting of 4 modules:

MOD DEFINE	Serves to define the various components of the model.
MOD MAIN	Initialises the model and takes care of run control.
MOD GENERATE	Creates catches at random times and with random sizes and determines the time needed to process the catch depending on the freezing capacity of the plate freezers. It puts the catch in a queue and monitors queue parameters. The time for shooting and hauling the net is taken constant at 10 and 20 minutes respectively.
MOD PROCESSING	Describes the process of freezing and storing fish. Catch is picked out of the queue (cooling tank) and put in the plate freezers for the time necessary to freeze the total amount, determined by the attribute value called freezingrate. When the fishholds are filled the simulation is terminated.

4. Evaluation of model results.

4.1 Stochastic model.

4.1.1 General.

Observations on board of a stern trawler show a certain pattern for the inter-arrival times and sizes of catches. The size and time of appearance of a catch can be generated by random draws from a probability distribution function with a given mean, a given shape and with a given standard deviation. This stochastic way of modelling can be compared to throwing dices. We know the result is variable, but we do not want to describe the exact mechanism that determines the outcome. In the case of a large amount of draws or throws the relative frequency approaches a stable value (For a dice 1/6). In reality the inter-arrival times of the catches will **not be independent** from the state of the processing line onboard. When all the storage tanks are fully loaded, the skipper will postpone the next haul. Sometimes the strategy is to load all the bufferspace to stop fishing, on sundays for instance. This behaviour is described by the probability distribution function for the times between two successive hauls, which is based on actual recordings onboard. The catching process can also be modelled in more detail including gear and fish behaviour aspects, which will be done in future models.

Another problem is to determine how many experiments or hauls are needed to ensure the answer to be within a certain confidence limit. In most cases a trip on a fishing vessel counts a limited number of hauls. Another run of the model with a different seed value in the random streams will generate different draws from the probability distribution functions as the generator of random numbers works sequentially from the seed value. This effect will be significant if the deviation used in the randomstreams is large compared to the mean value as in our case. **To overcome this problem, a series of 30 simulation runs with different seed values has been made, and the results has been averaged using the Statistics supplement of PROSIM.**

4.1.2 Variation of the variable freezingrate.

The stochastic model has been run for a range of freezingrates starting at 100 tons per day to 220 tons per day and a fishholdcapacity of 2600 tons of frozen fish. The time between the arrival of two successive catches onboard is drawn from a distribution type UNKNOWN, with a lowbound of **165** minutes, a mean of **480** minutes, and a deviation of **216** minutes, values that followed from actual data of one trip. The size of the catch was drawn from a similar type of distribution with a lowbound of 0 tons, a mean of **55.28** tons, and a deviation of **34.90** tons. Information on the waitingtime in the queue, or in other words the storage in front of the plate freezers was saved at each model run. When the waiting time is zero, the catch can be put in the freezers immediately, otherwise temporary storage in a buffer is needed. The bufferspace is of course determined by the volume of the cooling tanks. The duration of the temporay storage has a physical limit, beyond which fish cannot be kept any longer. The required buffersize is not investigated in detail here. It will follow from multiplication of the average queue length and the mean size of the catch. **The problem dealt with in this paper is to determine the optimal freezingrate needed to ensure a continuous flow of fish through the vessel.**

The plot facilities of PROSIM are used to create graphs of several variables of the system as a function of the simulation time. The following plots were made:

Selection V:	Fishholdfilling	(see 4.1.3)
Selection T:	Length of the queue Catchrow	(see Figure 2)
Selection U:	Now minus Arrivaltime of Fishpack (time to pass the freezing plant)	(see Figure 3)

These figures give results for one particular case and not for the average model behaviour over 30 runs. The results will be slightly different for other runs with different seed values in the random streams. At low freezingrates, the queue Catchrow grows continuously, indicating the arrivals to be too fast for the system to process. Fish is piled up. This regular pattern is gradually changed when the freezingrate is increased to higher values. At approximately 170 tons per day the maximum value falls beneath 6. The continuous growth of the number in the queue stops (see Figure 2). At higher freezingrates the number will become smaller than 1. All catches are frozen immediately. The time needed for a catch to pass the freezing plant is given in Figure 3 for different freezing rates. The congestion disappears at higher rates.

4.1.3 Variation of the mean of the size of the catch.

The mean taken from observations is 55.2813 tons of fish per catch. The effect of variation of this mean is studied for the range : **5.2813 to 105.2813** with increments of **10** tons can be seen in Figure 4, where the characteristics of the filling of the fishholds as are function of time is given. For thise case the freezingrate is kept constant at **220**

tons per day. At vary low mean catch values, the fishholdfilling plotted against time shows a stepwise function. This means that the input in catch is so low, that the freezing plant is idle for many moments. The total time needed to fill the fishhold is long. When the mean catch size is increased, this behaviour of the model alters. The stepwise character of the curve diminishes and gradually becomes continuous and the curve becomes steeper. At 85 tons and above it is a straight line, the freezing plant is in operation all of the time, and the total time needed to fill the fishholds decreases. The curves of holdfillingtime and No of hauls per trip vs mean size of the catch are given in Figures 11a and 11b. A dramatic decrease occurs between mean catches below 40 tons. Above this value the effect flattens out.
The maximum queuelength and the waiting time of the fish as a function of the variable Mean of Quantity, which is the mean size of the catch, increase with increasing mean (see Figures 12a and 12b). This means, that the freezing plant is overloaded at higher mean catch sizes and fish has to be temporarely stored. The volume of the coolingtanks to be installed in the vessel depends on the amount of fish waiting to be processed. When all the tanks are full fish has to wait on deck or be discarded at sea, which is an economic loss. This simple model is not suitable for determining the optimal size of these tanks. Apart from considerations related to the quality of the fish, the tank sizes affect the building and running costs of the vessel. A more elaborate model has to be made to answer this question.

4.2 Deterministic model.

4.2.1 General:

Comparison of the results of the model with random draws and a model using the means of the distributions reveals insight in the necessity of using a stochastic description. Therefore the model is run again for the same input variables, and the means of the random streams : catch size **55.28 tons** and inter-arrival time **480 minutes**, shooting and hauling the gear excluded. This model is referred to as the deterministic model in the text. A sequence of events is given in Figure 1c. for this model. Heaving in the gear is estimated to take 20 minutes, shooting the gear takes 10 minutes, same as for the stochastic model. It takes 480 minutes for the next catch to arrive in the net after the beginning of the fishing operation. The total inter-arrival time is therefore 510 minutes. With the freezing rate of 100 tons/day catches with a mean size of 55.2813 tons are frozen away in 796 minutes. The waiting time for catch two is 796 - 510 = 286 minutes. In the next sequence this time is increased twice the amount, while the second catch waits for the first to leave the freezingplant.

4.2.2 Variation of the variable freezingrate.

At low values of the freezingrate the queue grows continuously in a stepwise manner. When the inter-arrival times are shorter than the freezingtime, catches will pile up and the queue grows continuously, as can be seen from Figure 5. The time needed to pass the freezingplant increases with simulation time for subsequent catches for freezingrates up to appr. 150 tons per day as can be seen in Figure 6. The freezingrate at which the inter-arrival time equals the service or freezing time can be calculated from the following formula:

$$\text{Freezingrate for } (\Delta t_s = \Delta t_a) = \frac{1440}{510} * 55.2813 = \mathbf{156 \text{ tons per day.}}$$

For freezingrates above this value the queue disappears completely, in other words all catches are frozen away without delay. This result is consistent with the remarks of Chapter 1. This deterministic model suggests that 156 tons per day is the maximum rate necessary to freeze all incoming catches without delay for this input. With the random draws from the probability distributions of the stochastic model a higher value is found for similarly small amounts of fish waiting to be processed. Apparently the variability of the input affects the optimal choice for the dimensions of the various components of the system. **A stochastic description leads to different conclusions concerning the optimal freezingrate.**

5. Discussion on the differences between the stochastic and the deterministic model.

Figure 7 shows the difference in the No of entries or No of hauls generated by the two models as a function of the freezingrate in tons per day. Above a certain level the number of hauls remains almost constant, no more hauls enter the queue. The values are not very different for both models. However, for the deterministic model the curve reaches a limiting value sooner, suggesting a lower optimal freezing rate. The maximum length of the queue of fish is depicted in Figure 8 for both models. For the stochastic model the queuelength drops fast between 100 and 150 tons per day and slowly above 150 tons per day. The deterministic model predicts the queue to disappear above 156 tons per day, which indicates this value to be the optimal rate to ensure that no catch has to wait to be processed.

The stochastic model suggests a larger freezingrate necessary to obtain acceptable queuelengths. Figure 9 gives the waiting times of the fish in the queue plotted against the freezing rate. The stochastic model predicts longer waiting times and therefore a higher freezingrate to be chosen to keep the waiting times below acceptable levels. The deterministic model suggests a value above 156 tons per day to ensure no waiting times any more as mentioned before. Figure 10 gives the time needed to fill the fishhold of 2600 tons as a function of the freezingrate. The overall values do not differ substantially.

6. Conclusions.

The most important conclusion is, that a deterministic model of problems concerning congestion will not lead to the right answers. A stochastic model must be used.

The use of <u>mean</u> values for the inter-arrival times and the service times, depending upon the size of the catch, instead of <u>random</u> draws from a probability distribution leads to underdesign of the freezingrate.

The problem of finding the best freezingrate for a given vessel with a given input of fish is solved, but this solution does not take into account the various elements determining the overall economy of the system. Only one input function has been studied. The variation of input with time and the dependency of fishing gear parameters still needs to be determined. The relation between the freezingrate, the size of the buffer tanks and the size of the fishholds with the building costs of the vessel and the resulting operating costs has to be known for a proper economic analysis.
Further studies are recommended to quantify such relationships. A start is given in [3], based on regression analysis. The simulation language Personal PROSIM seems a very adequate tool for this purpose.

7. References.

[1] Philips, D.T.; Ravindran, A. & Solberg, J.
"Operations research : principles and practice".
John Wiley & Sons, New York, 1976.
ISBN 0-471-02458-9.

[2] Van Marlen, B.
"A preliminary study on the landing capacity of stern freezer trawlers."
ICES C. M. 1989/ B:50

[3] Dai Tianyuan; De Wilde, J.W. & De Jager, J.
"Economic results of stern freezer trawlers in relation to technical parameters"
Report Agricultural Economics Research Institute (L.E.I.),
The Hague Netherlands, 1989.

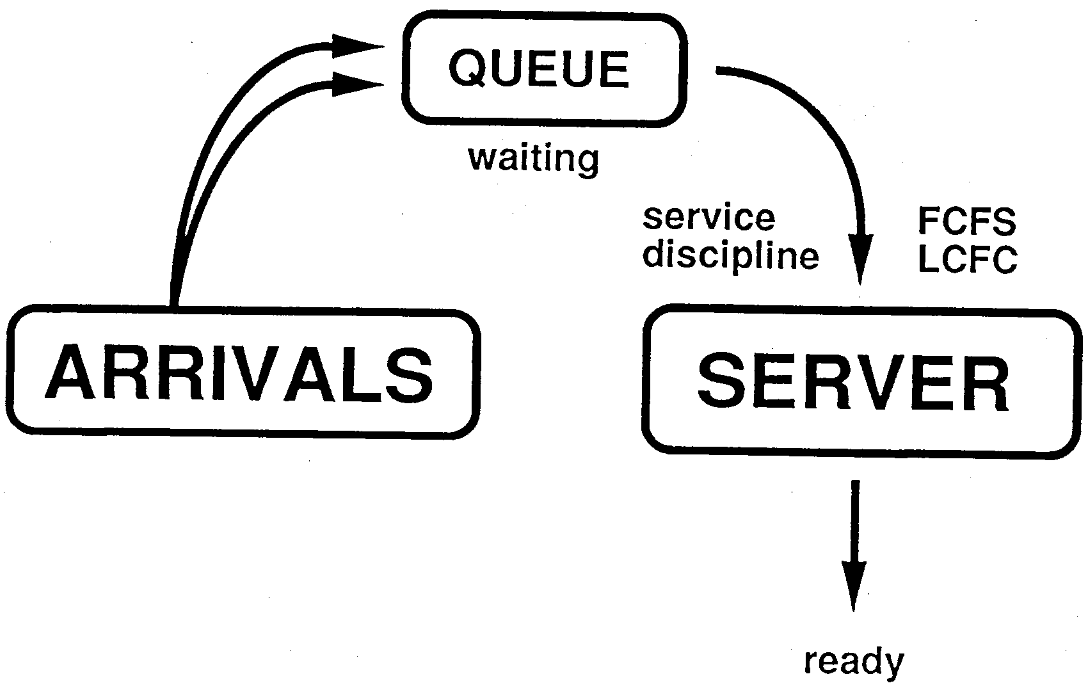
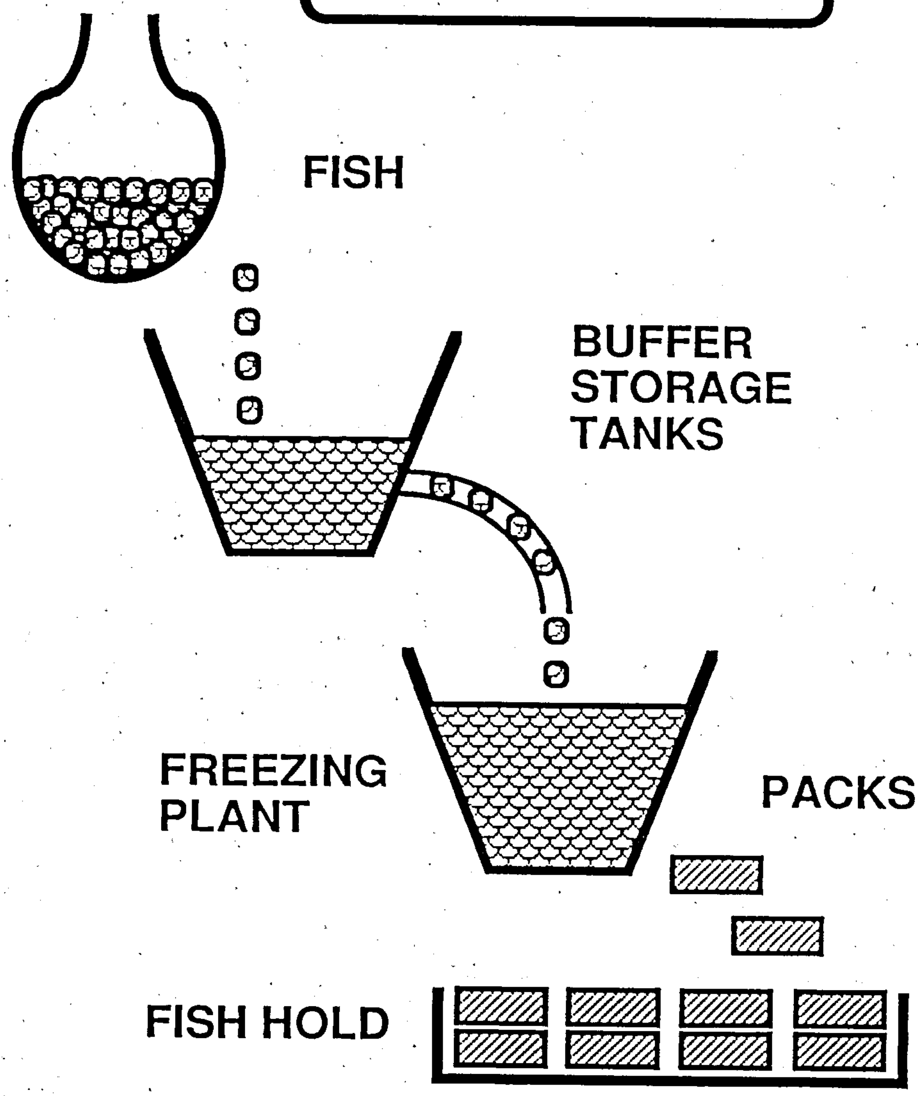


Figure 1a : Basic components of a queueing system

FIGURE 1[b]: **MODEL OF FISHING BOAT**



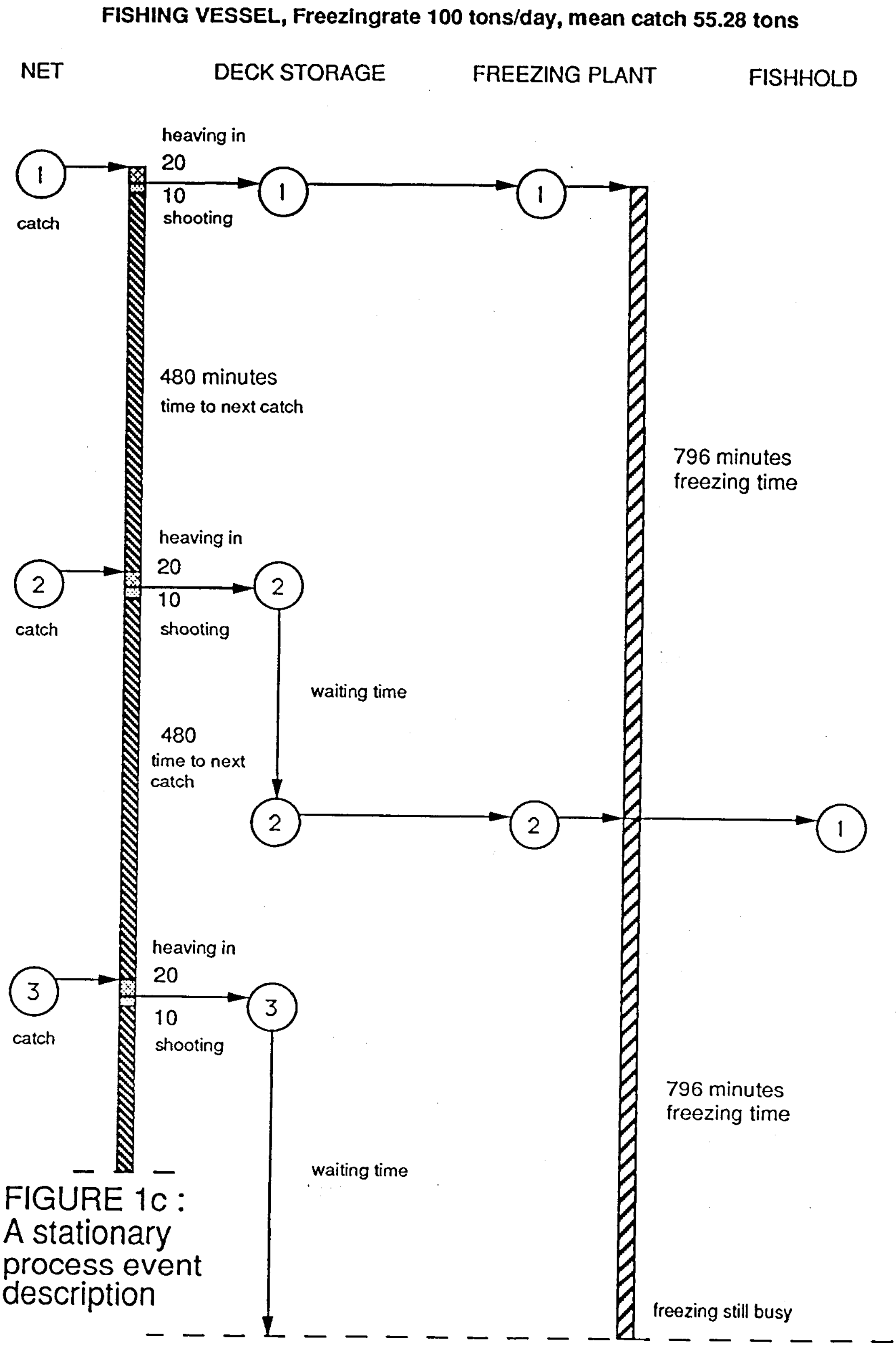


FIGURE 1c :
A stationary
process event
description

FIGURE 2 : Number of catches in the queue vs. simulation time for different freezing rates.
Stochastic model
Fishholdcap. : 2600 tons, Mean catch : 55.3 tons.

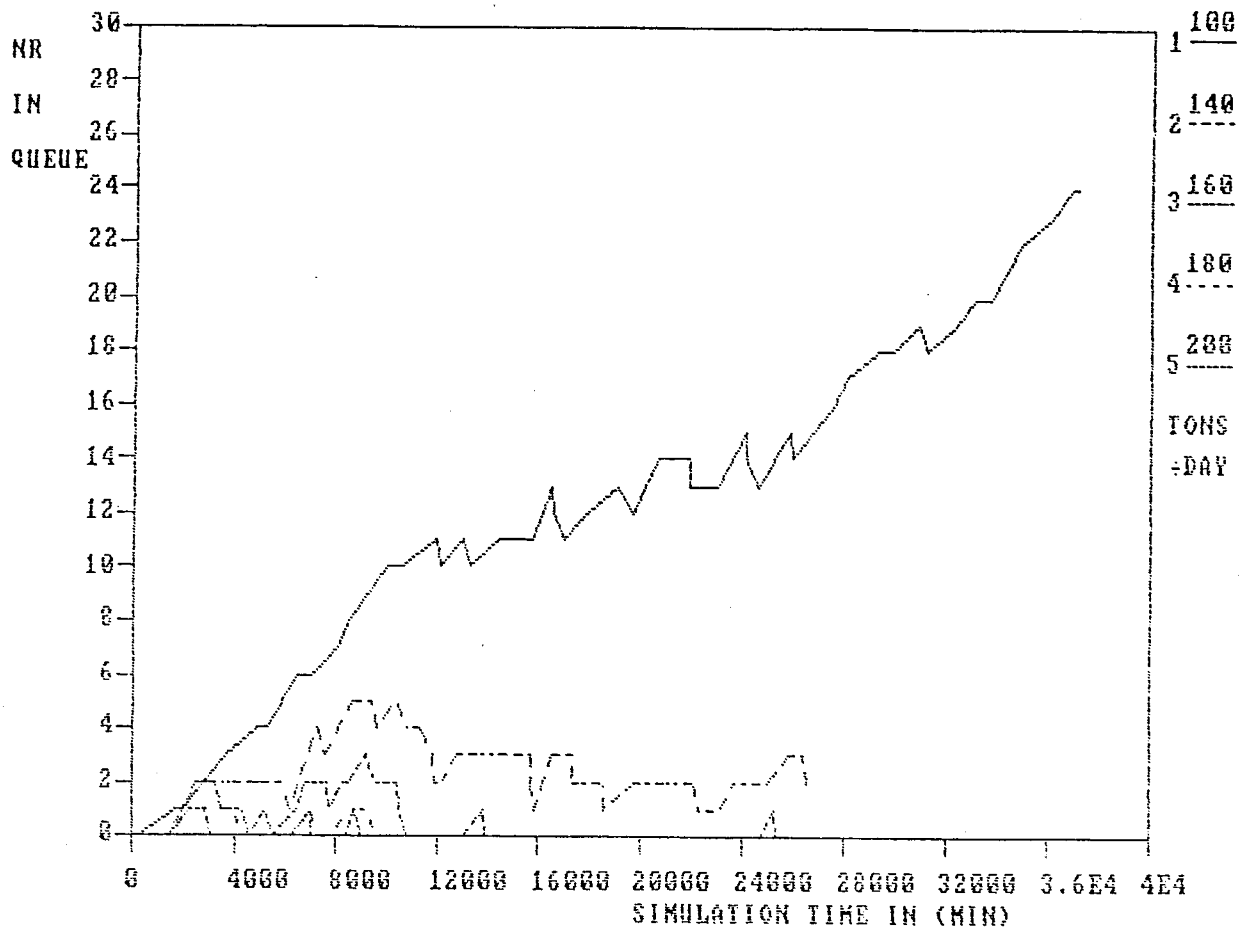


FIGURE 3 : **Time to pass the freezing plant vs. simulation time for different freezing rates.**
Stochastic model
Fishholdcap. : 2600 tons, Mean catch : 55.3 tons.

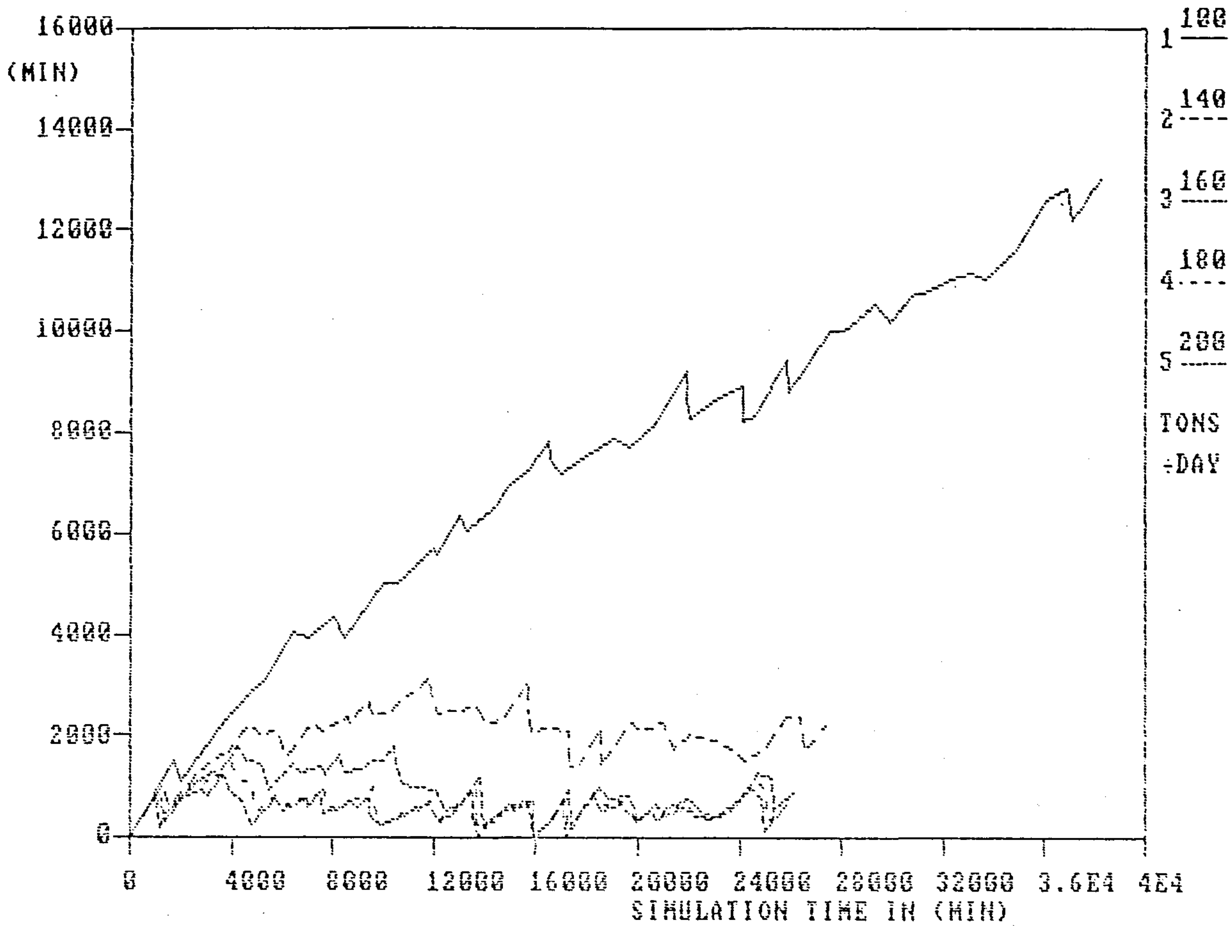


FIGURE 4 : **Fishholdfilling vs. simulation time for different values of the mean of the catch size. Stochastic model. Fishholdcap. : 2600 tons, Freezingrate: 220 tons/day.**

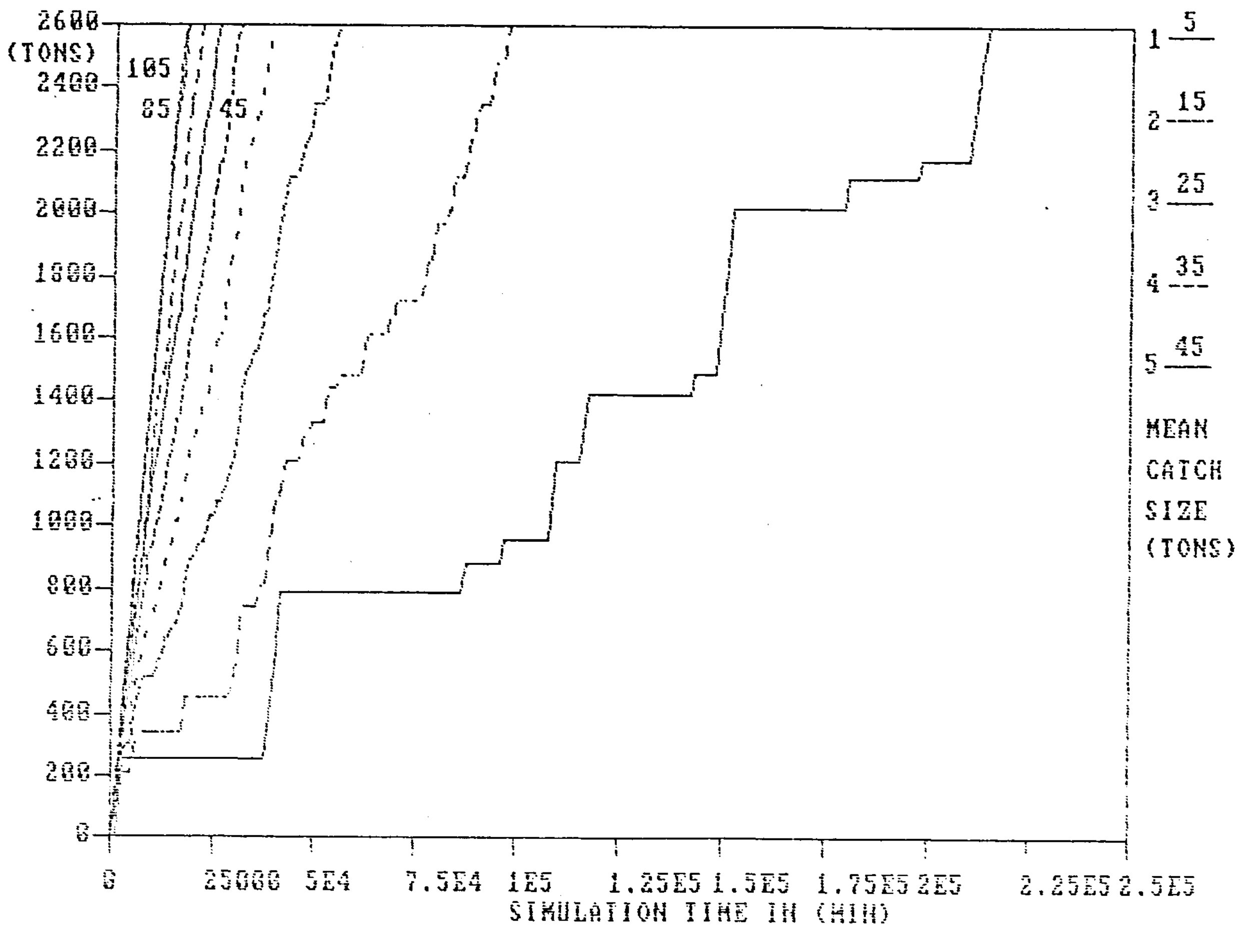


FIGURE 5 : Number of catches in the queue vs. simulation time for different freezing rates. Deterministic model

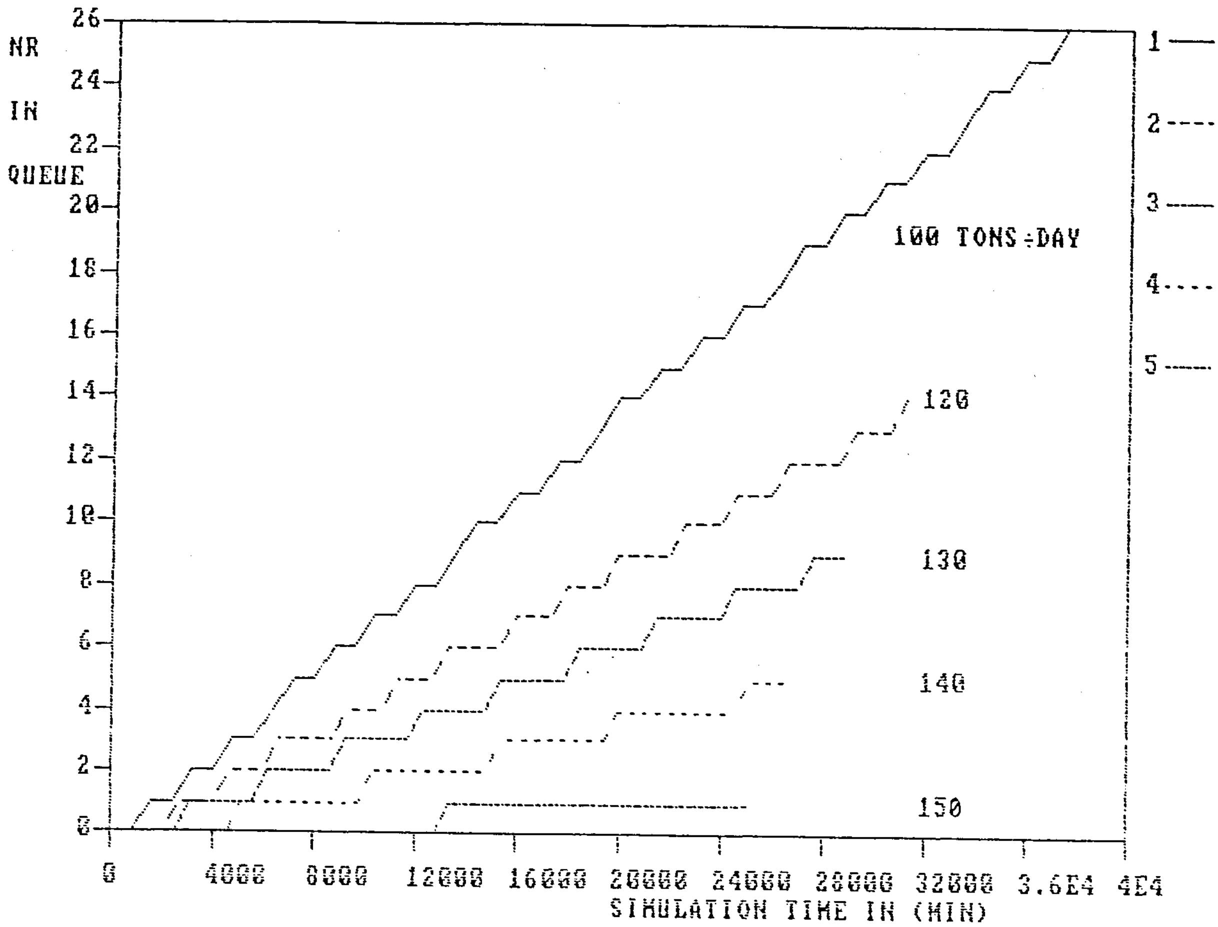


FIGURE 6 : **Time to pass the freezing plant vs. simulation time for different freezing rates. Deterministic model**

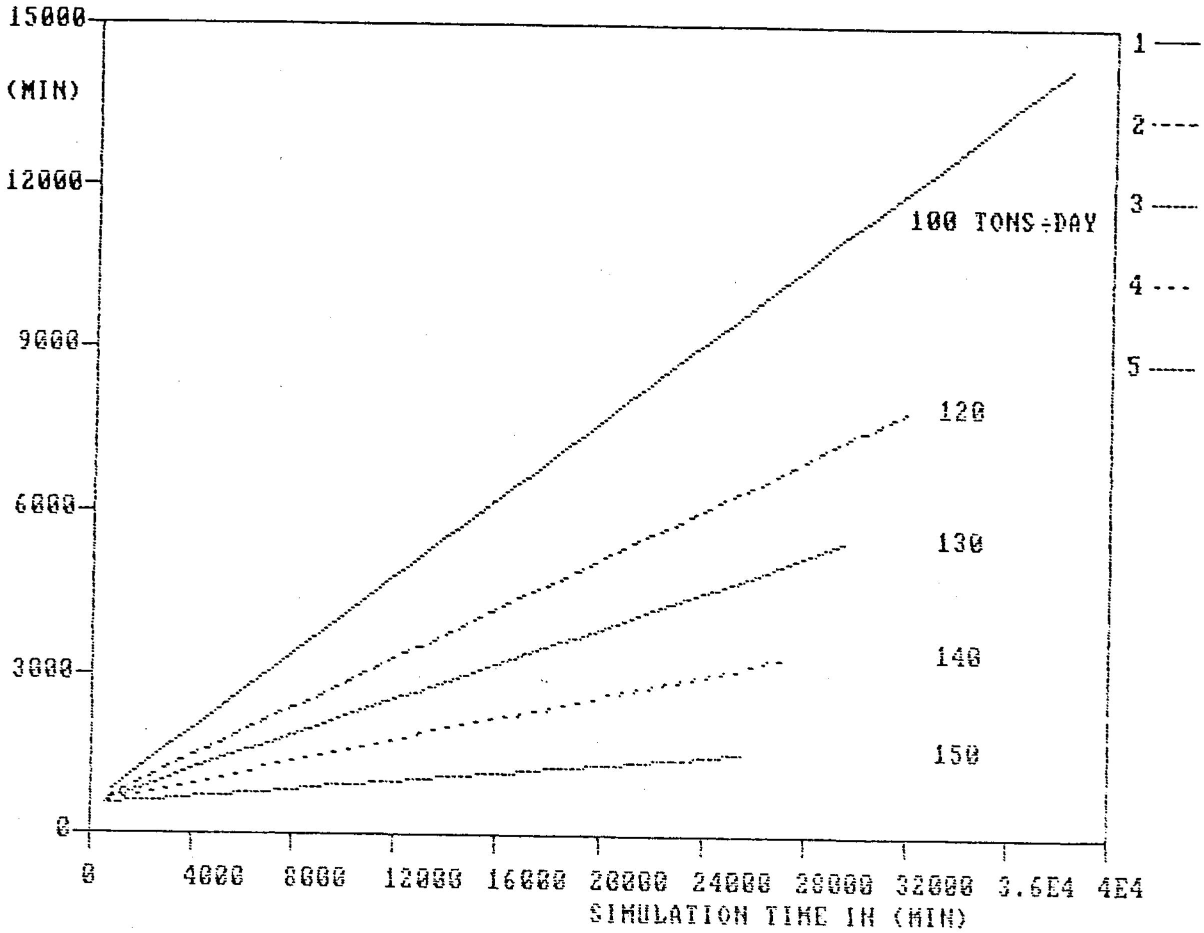
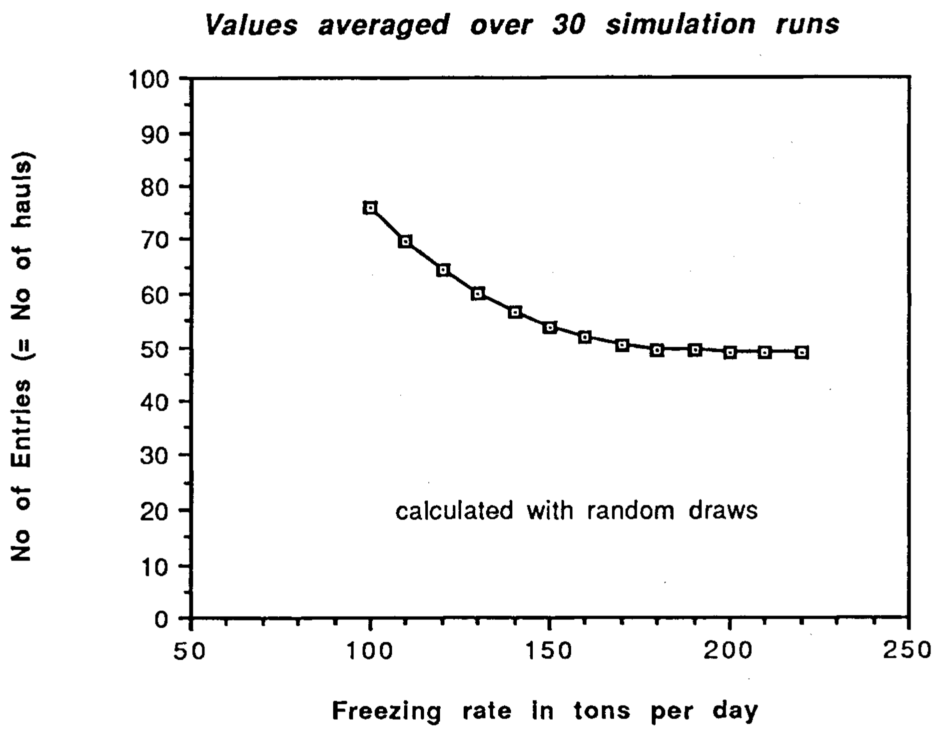


FIGURE 7a,b : Number of hauls (entries) vs. freezingrate



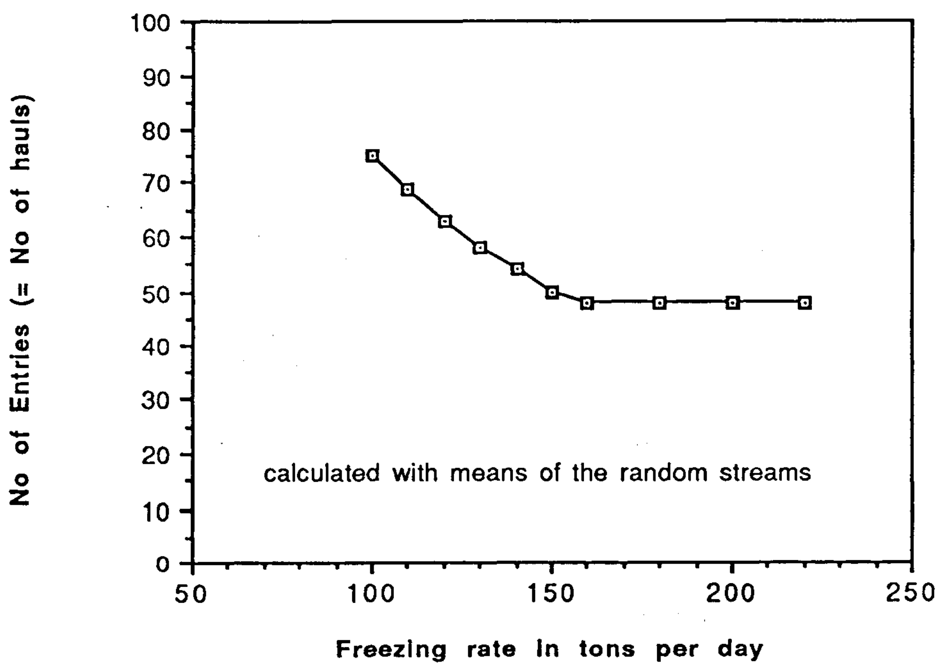
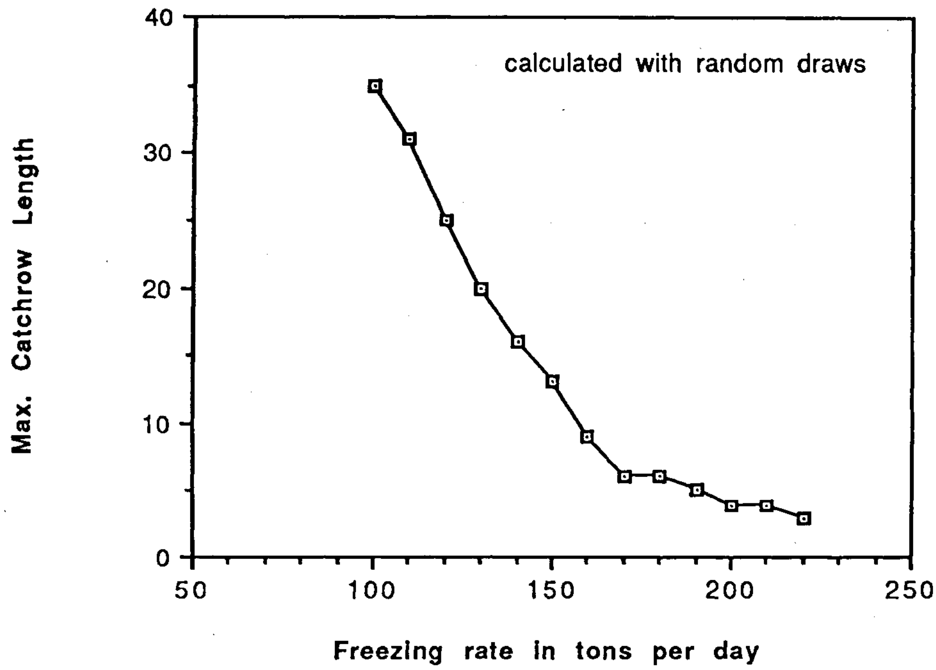


FIGURE 8a,b : **Maximum length of queue Catchrow vs. freezing rate**

Values averaged over 30 simulation runs



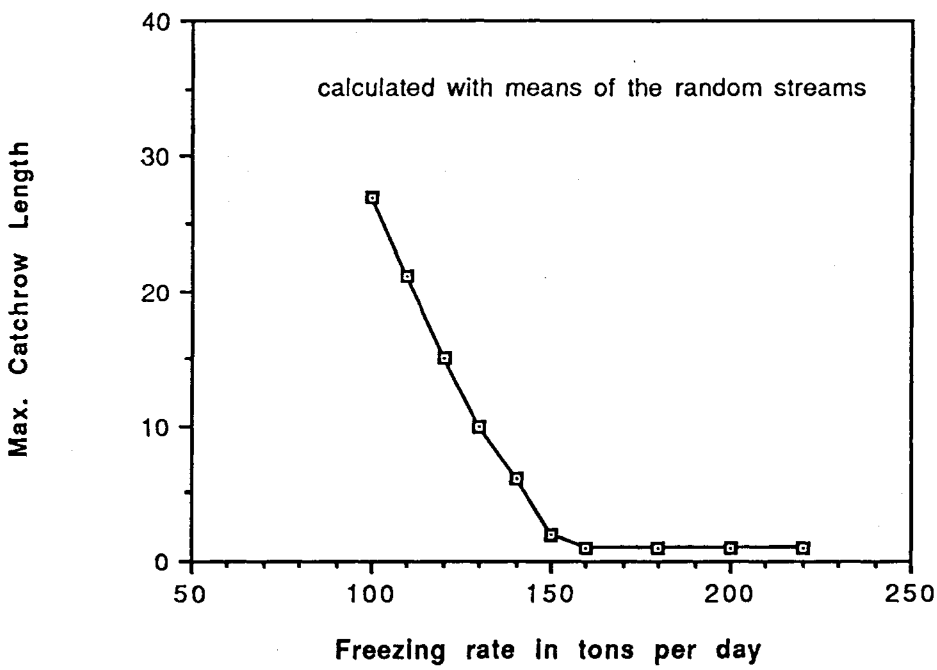
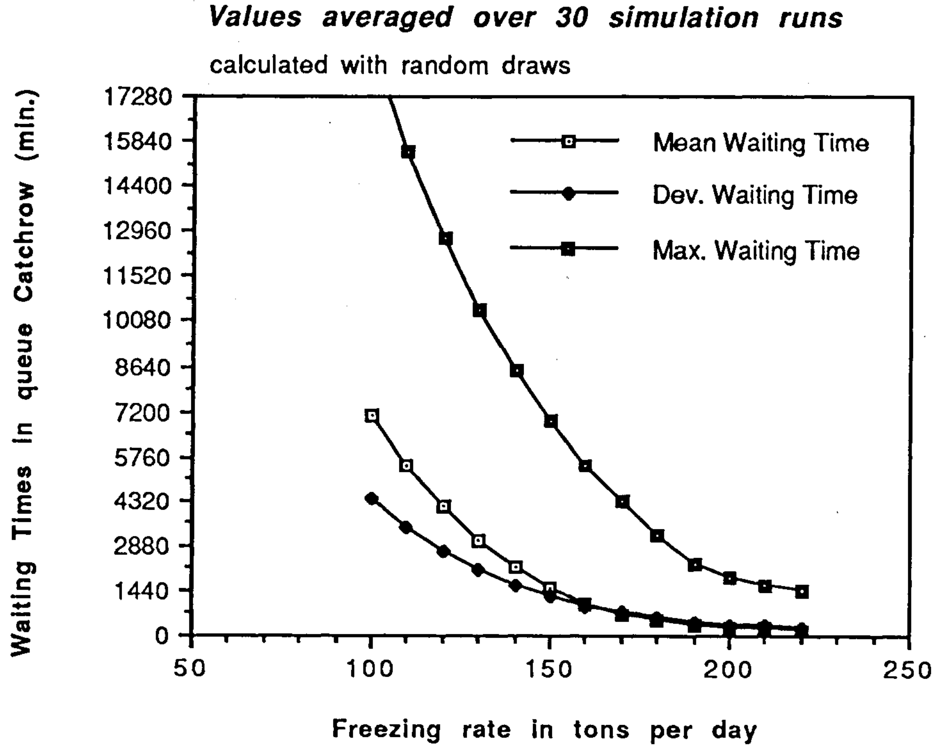


FIGURE 9a,b : **Waiting times in queue Catchrow vs. freezingrate**



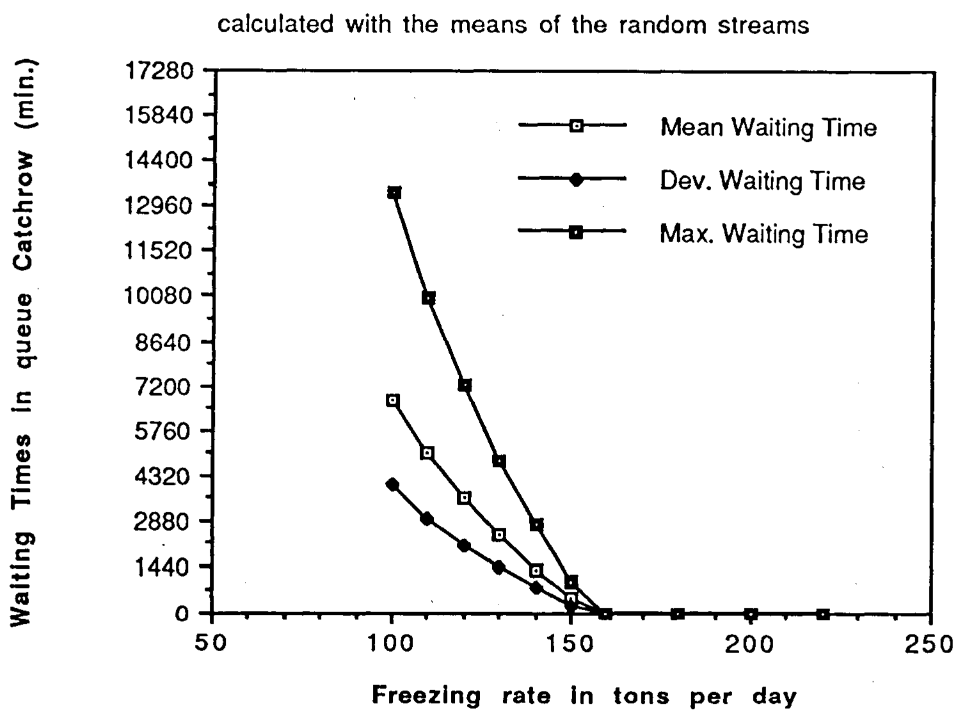
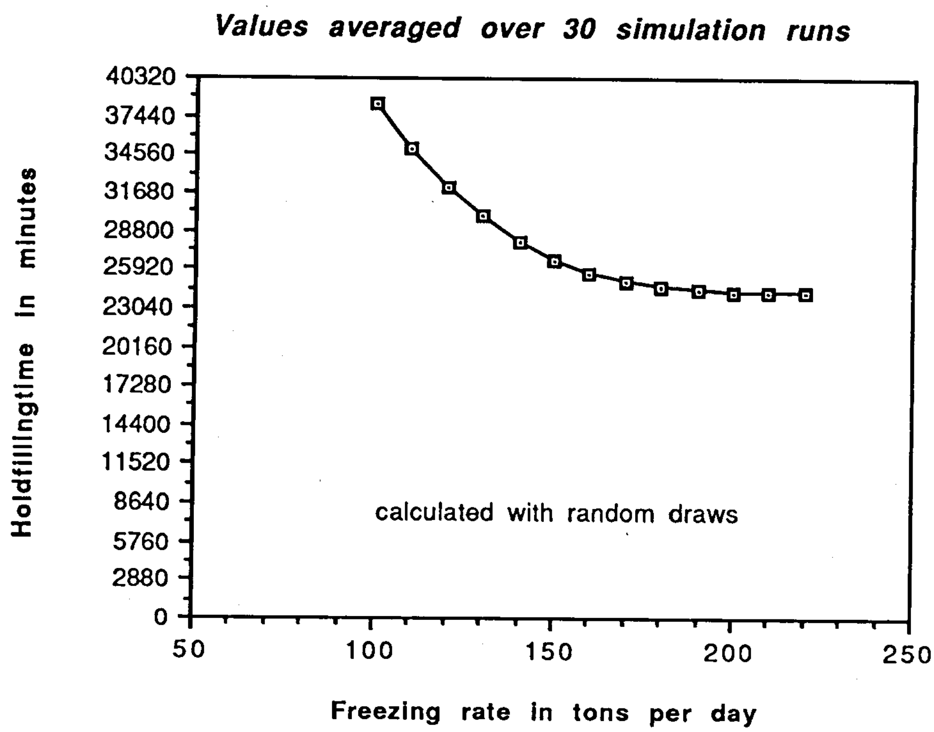


FIGURE 10a,b : Holdfillingtime vs. freezingrate



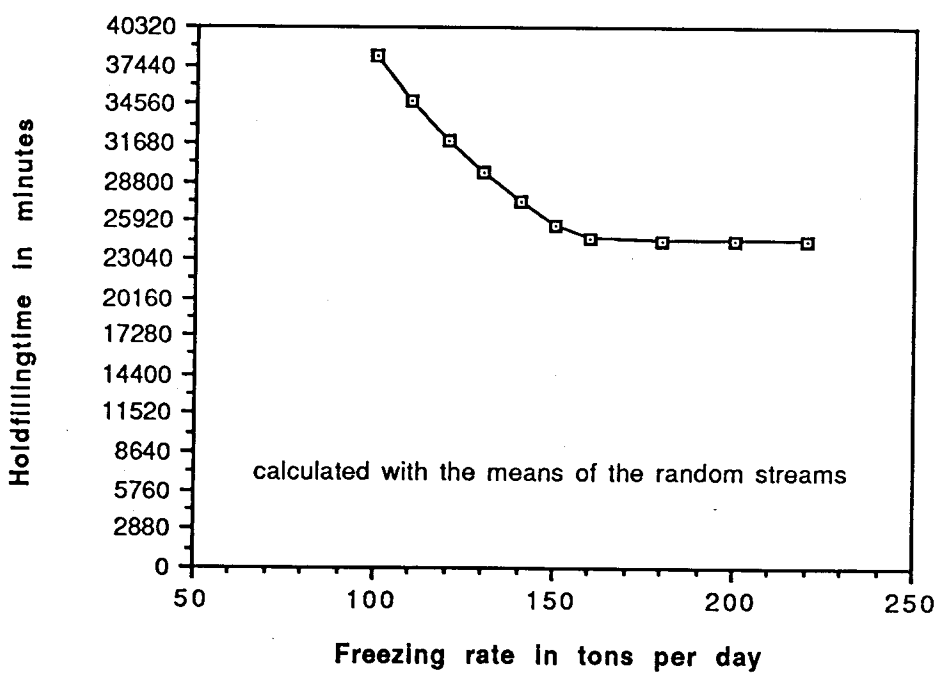


FIGURE 11a: Holdfillingtime vs. mean size of the catch

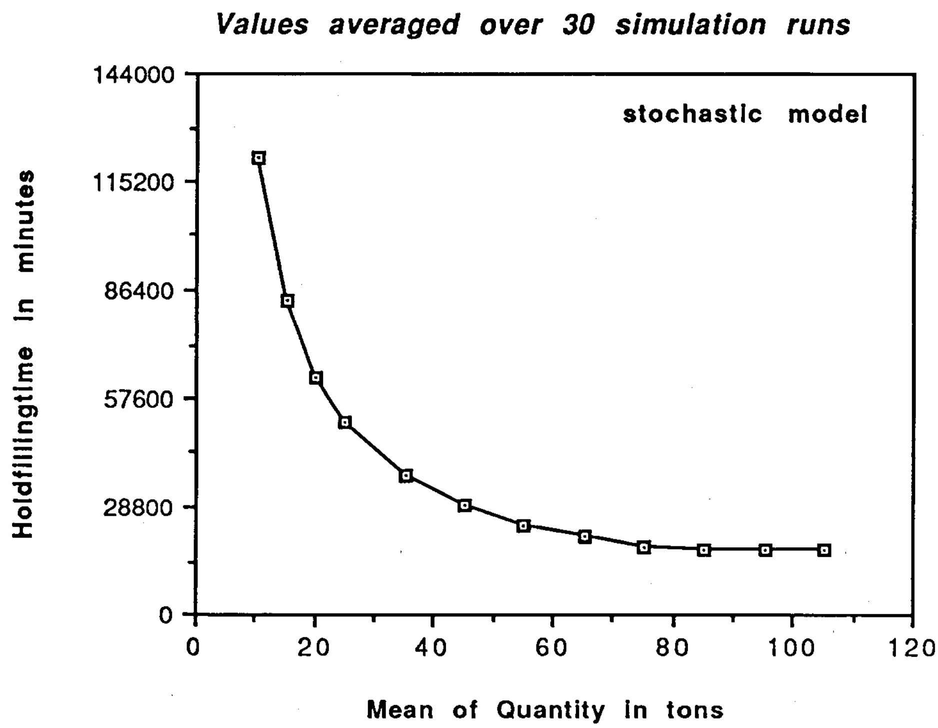


FIGURE 11b: No of hauls per trip vs. mean size of the catch

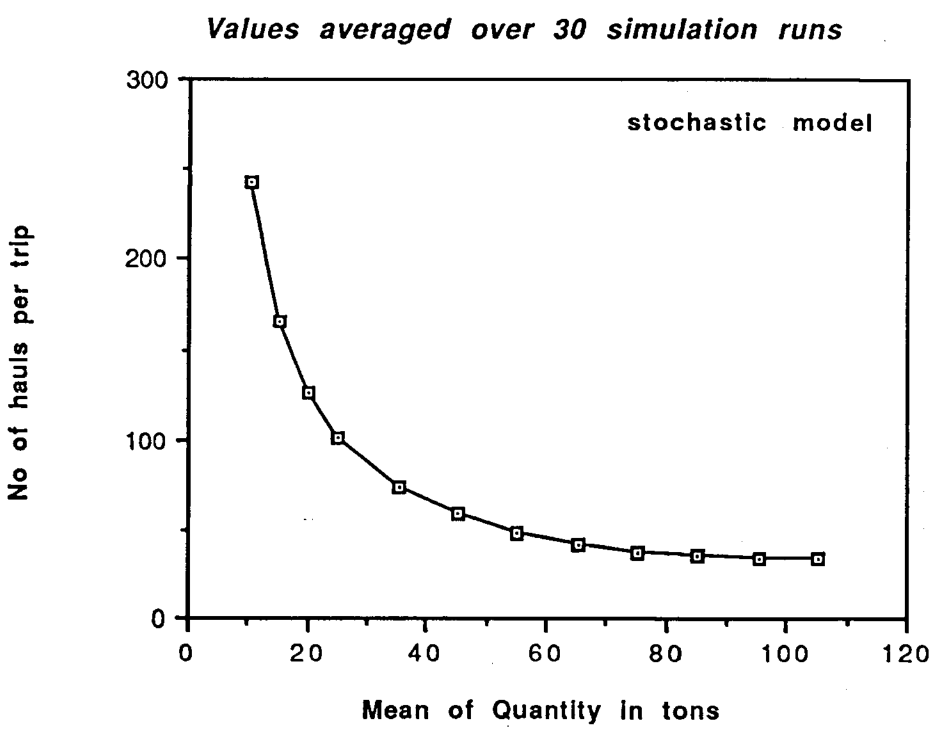


FIGURE 12a: Maximum number of catches in the queue vs. mean size of the catch. Stochastic model. Fishholdcap.: 2600 tons, Freezingrate: 220 tons/day.

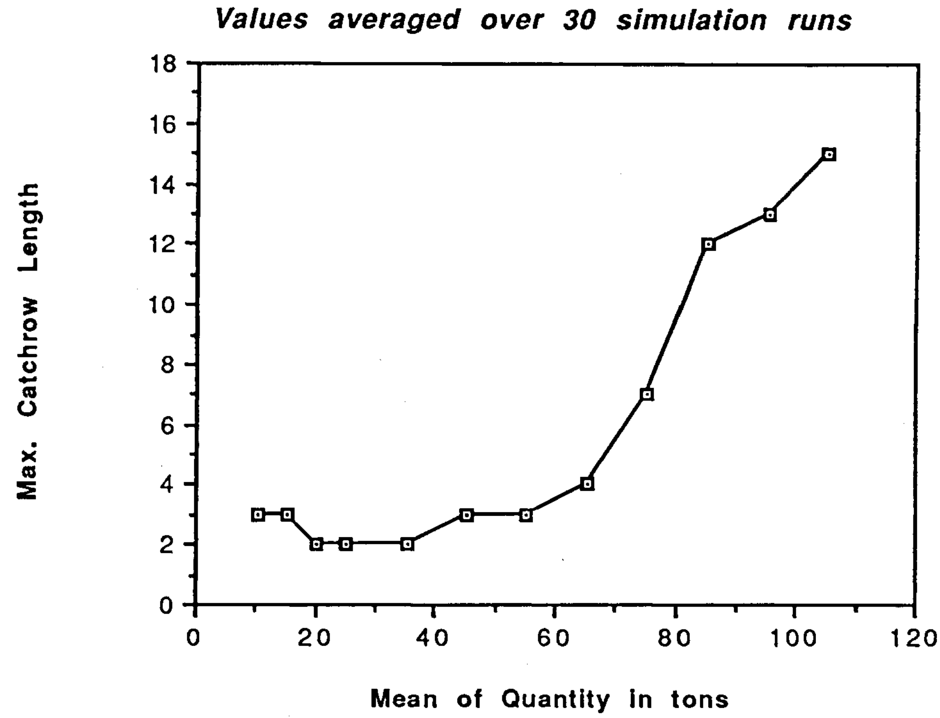
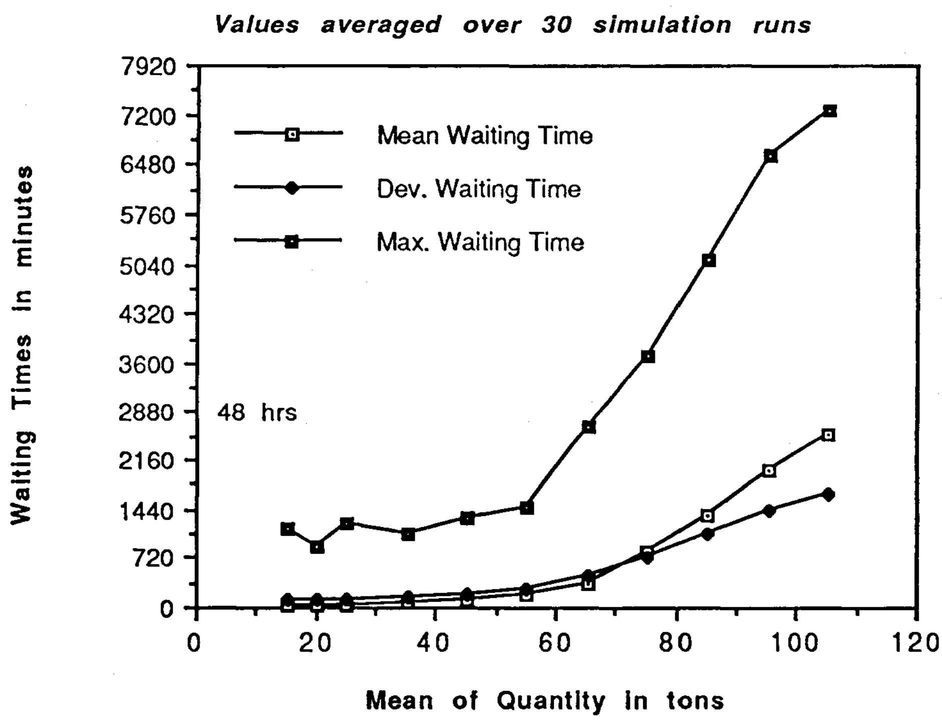


FIGURE 12b: Waiting times of catches in the queue vs. mean size of the catch. Stochastic model. Fishholdcap.: 2600 tons, Freezingrate: 220 tons/day.



MODEL TRAWLERO Date: 90/07/18
MOD DEFINE Time: 13:18:03

```
@ DEFINITION SECTION
COMPONENT                 :GENERATOR FISHPROCESSOR
CLASS                     :CATCH
QUEUE                     :CATCHROW FREEZER

ATTRIBUTE OF CATCH :
             REAL                     :SIZE EXECTIME TIMETONEXT

ATTRIBUTE OF GENERATOR :
             INTEGER                  :CATCHNUMBER

ATTRIBUTE OF FISHPROCESSOR :
             REAL                     :FREEZINGRATE HULP1 HULP2
             REAL                     :FISHHOLDCAPACITY FISHHOLDFILLING
             REFERENCE TO CATCH       :FISHPACK
             LOGICAL                  :FULL

ATTRIBUTE OF MAIN  :
             REAL                     :MN1 MN2 LB1 LB2 DEV1 DEV2 SEDINT SEDQAN
             REAL                     :STARTTIME FILLTIME
             CHARACTER(10)            :CHAR
             INTEGER                  :I NROFRUNS

TIMEUNIT                              :MINUTE
RANDOMSTREAM                          :INTERVAL QUANTITY
INPUTSTREAM                           :CONFIG ZAADLIST
FIGURE                                :FISHFIG CATCHROWFIG HOLDFIG FREEZERFIG
                                       INTERFIG
```

```
@ PROCESS OF MAIN

@ START INLEZEN VAN DATA VAN USER DATA FILE CONFIG
WRITE "MAIN IS AAN HET INLEZEN, WACHT DUS EVEN" WITH IMAGE
       xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
WHILE CHAR ≠ "END"
 CHAR ←CHREAD FROM CONFIG
 LB1  ←READ FROM CONFIG     @ INTERVAL PARAMETERS
 MN1  ←READ FROM CONFIG
 DEV1 ←READ FROM CONFIG
 LB2  ←READ FROM CONFIG     @ QUANTITY PARAMETERS
 MN2  ←READ FROM CONFIG
 DEV2 ←READ FROM CONFIG
 FREEZINGRATE     ←READ FROM CONFIG
 FISHHOLDCAPACITY ←READ FROM CONFIG
 CHAR             ←CHREAD FROM CONFIG
END                                         @ EINDE VAN INLEZEN
WRITE "INLEZEN IS GEDAAN" WITH IMAGE
       xxxxxxxxxxxxxxxxx

WRITE "GIVE TOTAL NUMBER OF SIMULATION RUNS" WITH IMAGE
       xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
NROFRUNS ← READ

FOR I←1 TO NROFRUNS
 WRITE "THIS IS SIMULATION NUMBER :";I WITH IMAGE
        xxxxxxxxxxxxxxxxxxxxxxxxxxx^^xxx

 SEDINT            ←READ FROM ZAADLIST
 SEED OF INTERVAL ←SEDINT
 SEDQAN            ←READ FROM ZAADLIST
 SEED OF QUANTITY ←SEDQAN

 RESHAPE INTERVAL AS SAMPLED FROM DISTRIBUTION UNKNOWN WITH PARAMETERS
                  LB(LB1) MEAN(MN1) DEVIATION(DEV1)

 RESHAPE QUANTITY AS SAMPLED FROM DISTRIBUTION UNKNOWN WITH PARAMETERS
                  LB(LB2) MEAN(MN2) DEVIATION(DEV2)

 STARTTIME ←NOW
 ACTIVATE GENERATOR FROM START1 IN GENERATE
 ACTIVATE FISHPROCESSOR FROM START1 IN PROCESSING

 WAIT WHILE GENERATOR IS ACTIVE

 WRITE " " WITH IMAGE x
 WRITE "THE LAST CATCH WAS NUMBER ";CATCHNUMBER OF GENERATOR WITH IMAGE
        xxxxxxxxxxxxxxxxxxxxxxxxxxx^^xxxx
 WRITE "INPUT CHECK :" WITH IMAGE
        xxxxxxxxxxxxx
 WRITE "SEED OF INTERVAL :";SEDINT WITH IMAGE
        xxxxxxxxxxxxxxxxxx^^^xxxxxxx
 WRITE "SEED OF QUANTITY :";SEDQAN WITH IMAGE
        xxxxxxxxxxxxxxxxxx^^^xxxxxxx
 WRITE "LOWBOUND OF INTERVAL    (LB1):";LB1 WITH IMAGE
        xxxxxxxxxxxxxxxxxxxxxxxxxxxxxx^^^xxxx.xx
 WRITE "MEAN OF INTERVAL        (MN1):";MN1 WITH IMAGE
        xxxxxxxxxxxxxxxxxxxxxxxxxxxxxx^^^xxxx.xx
 WRITE "DEVIATION OF INTERVAL  (DEV1):";DEV1 WITH IMAGE
```

```
         xxxxxxxxxxxxxxxxxxxxxxxxxxxxxx^^^xxxx.xx
48  WRITE "LOWBOUND OF QUANTITY    (LB2):";LB2 WITH IMAGE
         xxxxxxxxxxxxxxxxxxxxxxxxxxxxxx^^^xxxx.xx
49  WRITE "MEAN OF QUANTITY        (MN2):";MN2 WITH IMAGE
         xxxxxxxxxxxxxxxxxxxxxxxxxxxxxx^^^xxxx.xx
50  WRITE "DEVIATION OF QUANTITY  (DEV2):";DEV2 WITH IMAGE
         xxxxxxxxxxxxxxxxxxxxxxxxxxxxxx^^^xxxx.xx
51  WRITE " " WITH IMAGE x
52  WRITE "FREEZINGRATE :";FREEZINGRATE;"TONS PER DAY: FISHHOLDCAPACITY :";
    FISHHOLDCAPACITY;"TONS" WITH IMAGE
         xxxxxxxxxxxxxx^^^xxxx^^^xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx^^^xxxx^^^
   xxxx
53  FILLTIME <NOW - STARTTIME
54  STORE FILLTIME                                            AS "E"
55  STORE CATCHNUMBER OF GENERATOR                            AS "N"
56  REMOVE EACH CATCH IN CATCHROW FROM CATCHROW
57  REMOVE EACH CATCH IN FREEZER FROM FREEZER
58  WRITE "FILLTIME OF FISHHOLDS :";FILLTIME WITH IMAGE
         xxxxxxxxxxxxxxxxxxxxxxx^^xxxxxx.xxx
59  CANCEL ALL
60  PRINT STATISTICS
61 END   @ OF FOR I LUS VOOR INLEZEN VAN ZAADJES
62 TERMINATE
```

MODEL TRAWLERO
MOD GENERATE

Date: 90/07/18
Time: 13:24:24

```
@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
@      CATCH GENERATOR                                @
@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
START1 :
  CATCHNUMBER ← 0
 START2 :
  THIS CATCH  ← NEW CATCH
  SIZE        ← QUANTITY
  TIMETONEXT  ← INTERVAL

@ DYNAMIC CASE TO COMPARE WITH MEANS MODEL

@  SIZE         ← MN2
@  TIMETONEXT   ← MN1

  CATCHNUMBER ← CATCHNUMBER + 1
  MOVE INTERFIG TO TIMETONEXT
  HULP1     ← FREEZINGRATE ÷ 1440
  HULP2     ← SIZE ÷ HULP1
  EXECTIME ← HULP2                  @ TIME NEEDED TO FREEZE THE CATCH
  MOVE FISHFIG TO SIZE
  STORE SIZE         AS "Q"
  STORE EXECTIME     AS "R"
  WAIT 20 MINUTES                   @ TIME TO GET THE CATCH ONBOARD
  WRITE "AT TIME :";NOW;" CATCH :";CATCHNUMBER;" CAME ONBOARD." WITH IMAGE
         xxxxxxxxx^^xxxxx^^xxxxxxxx^^xxx^^xxxxxxxxxxxxxx
  MOVE FISHFIG TO SINK
  JOIN THIS CATCH TO CATCHROW
  MOVE CATCHROWFIG TO 1
  WAIT 10 MINUTES                   @ TIME TO SHOOT THE GEAR AGAIN
  STORE TIMETONEXT AS "S"
  MOVE CATCHROWFIG TO LENGTH OF CATCHROW
  WAIT TIMETONEXT MINUTES           @ TIME UNTIL THE NEXT CATCH COMES
  MOVE INTERFIG TO SINK
REPEAT FROM START2
```

MODEL TRAWLERO
MOD GENERATE

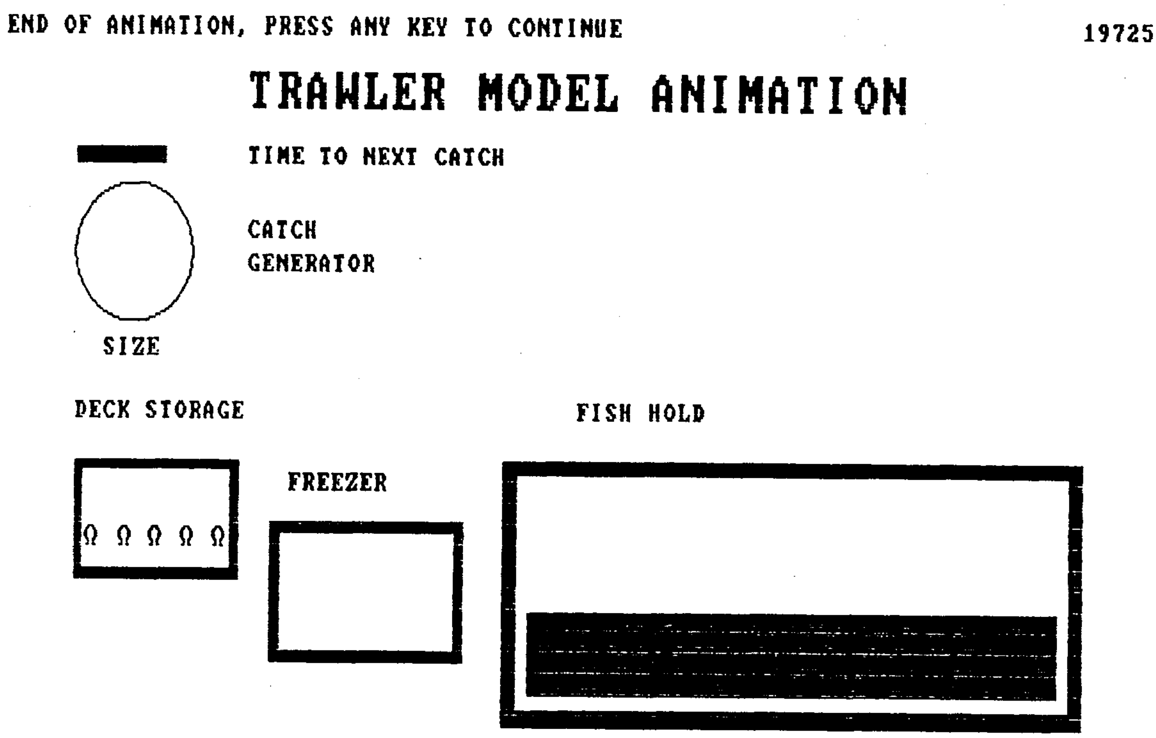
```
@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
@     CATCH GENERATOR                                 @
@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
START1 :
  CATCHNUMBER ← 0
 START2 :
  THIS CATCH  ← NEW CATCH
  @ SIZE        ← QUANTITY
  @ TIMETONEXT  ← INTERVAL

@ STATIONARY CASE TO COMPARE WITH RANDOM DRAWS

  SIZE        ← MN2
  TIMETONEXT  ← MN1

  CATCHNUMBER ← CATCHNUMBER + 1
  MOVE INTERFIG TO TIMETONEXT
  HULP1     ← FREEZINGRATE ÷ 1440
  HULP2     ← SIZE ÷ HULP1
  EXECTIME  ← HULP2                @ TIME NEEDED TO FREEZE THE CATCH
  MOVE FISHFIG TO SIZE
  STORE SIZE        AS "Q"
  STORE EXECTIME    AS "R"
  WAIT 20 MINUTES                  @ TIME TO GET THE CATCH ONBOARD
  WRITE "AT TIME :";NOW;" CATCH :";CATCHNUMBER;" CAME ONBOARD." WITH IMAGE
         xxxxxxxxx^^xxxxx^^xxxxxxxx^^xxx^^xxxxxxxxxxxxxx
  MOVE FISHFIG TO SINK
  JOIN THIS CATCH TO CATCHROW
  MOVE CATCHROWFIG TO 1
  WAIT 10 MINUTES                  @ TIME TO SHOOT THE GEAR AGAIN
  STORE TIMETONEXT AS "S"
  MOVE CATCHROWFIG TO LENGTH OF CATCHROW
  WAIT TIMETONEXT MINUTES          @ TIME UNTIL THE NEXT CATCH COMES
  MOVE INTERFIG TO SINK
REPEAT FROM START2
```

```
@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
@          PROCESSING DESCRIPTION                         @
@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
START1 :
  FISHHOLDFILLING ← 0.0
  STORE FISHHOLDFILLING                AS "V"
 START2 :
  WAIT WHILE CATCHROW IS EMPTY
  MOVE CATCHROWFIG TO 1
  FISHPACK ← FIRST OF CATCHROW
  MOVE CATCHROWFIG TO LENGTH OF CATCHROW
  STORE NOW - QUEUETIME OF FISHPACK IN CATCHROW  AS "W"
  REMOVE FISHPACK FROM CATCHROW
  STORE LENGTH OF CATCHROW             AS "T"
  JOIN FISHPACK TO FREEZER
  MOVE FREEZERFIG TO 1                                         @ ANIMATION
  WORK EXECTIME OF FISHPACK MINUTES                            @ FREEZING
  STORE NOW - ARRIVALTIME OF FISHPACK AS "U"
  MOVE CATCHROWFIG TO LENGTH OF CATCHROW                       @ ANIMATION
  REMOVE FISHPACK FROM FREEZER
  MOVE FREEZERFIG TO SINK                                      @ ANIMATION
  FISHHOLDFILLING ← FISHHOLDFILLING + SIZE OF FISHPACK
  STORE FISHHOLDFILLING                AS "V"
  MOVE HOLDFIG TO FISHHOLDFILLING                              @ ANIMATION
  IF FISHHOLDFILLING ≥ FISHHOLDCAPACITY
   FULL ← TRUE
   WRITE "THE FISHHOLDS ARE FULL AND WE STOP FISHING" WITH IMAGE
          xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
   CANCEL GENERATOR IF GENERATOR IS ACTIVE
   TERMINATE
  END
REPEAT FROM START2
```


END OF ANIMATION, PRESS ANY KEY TO CONTINUE
19725
TRAWLER MODEL ANIMATION
TIME TO NEXT CATCH
CATCH
GENERATOR
SIZE
DECK STORAGE
Ω Ω Ω Ω Ω
FREEZER
FISH HOLD