MINISTRY OF AGRICULTURE & FISHERIES
FISHERIES MANAGEMENT DIVISION

A REPORT ON THE RANGITATA RIVER FISHERY IN RELATION TO ITS WATER REQUIREMENTS FROM THE RESOURCE

AUGUST, 1975

BY: C.J. HARDY
FISHERIES MANAGEMENT DIVISION
CHRISTCHURCH, NEW ZEALAND

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INTRODUCTION

This report has been prepared at the request of the Ashburton and South Canterbury Acclimatisation Societies to provide information for consideration in the preparation of submissions to the South Canterbury Regional Water Board concerning the water requirements of fisheries, wildlife and recreational use in the Rangitata River, in relation to water allocation and management planning.

The Rangitata River forms a boundary between the two societies who are jointly responsible for the administration and conservation of its freshwater fishery and wildlife resources.

THE RANGITATA RIVER

Originating in the Southern Alps (Main Divide) of the South Island the Rangitata flows south and east for about 120 km, crossing the Canterbury Plain, to enter the Pacific Ocean in the Canterbury Bight. (Figure 1)

Most of its 1735 km^2 (670 sq.mi.) catchment is steeply mountainous, the highest point being Mt Arrowsmith at 2796 m (9171 ft).

For convenience the river can be divided into two sections:

1. the upland or mountain catchment (about 70 km linear distance) and,

2. a lowland or plains section (about 52 km distance) to the coast.

UPLAND SECTION

This is characterised by steep mountain slopes, flat-floored glaciated valleys and basins in which the river channels present a constantly-shifting, intertwining pattern in wide, (1.0 km or more) unstable, floodbeds of eroded mountain debris.

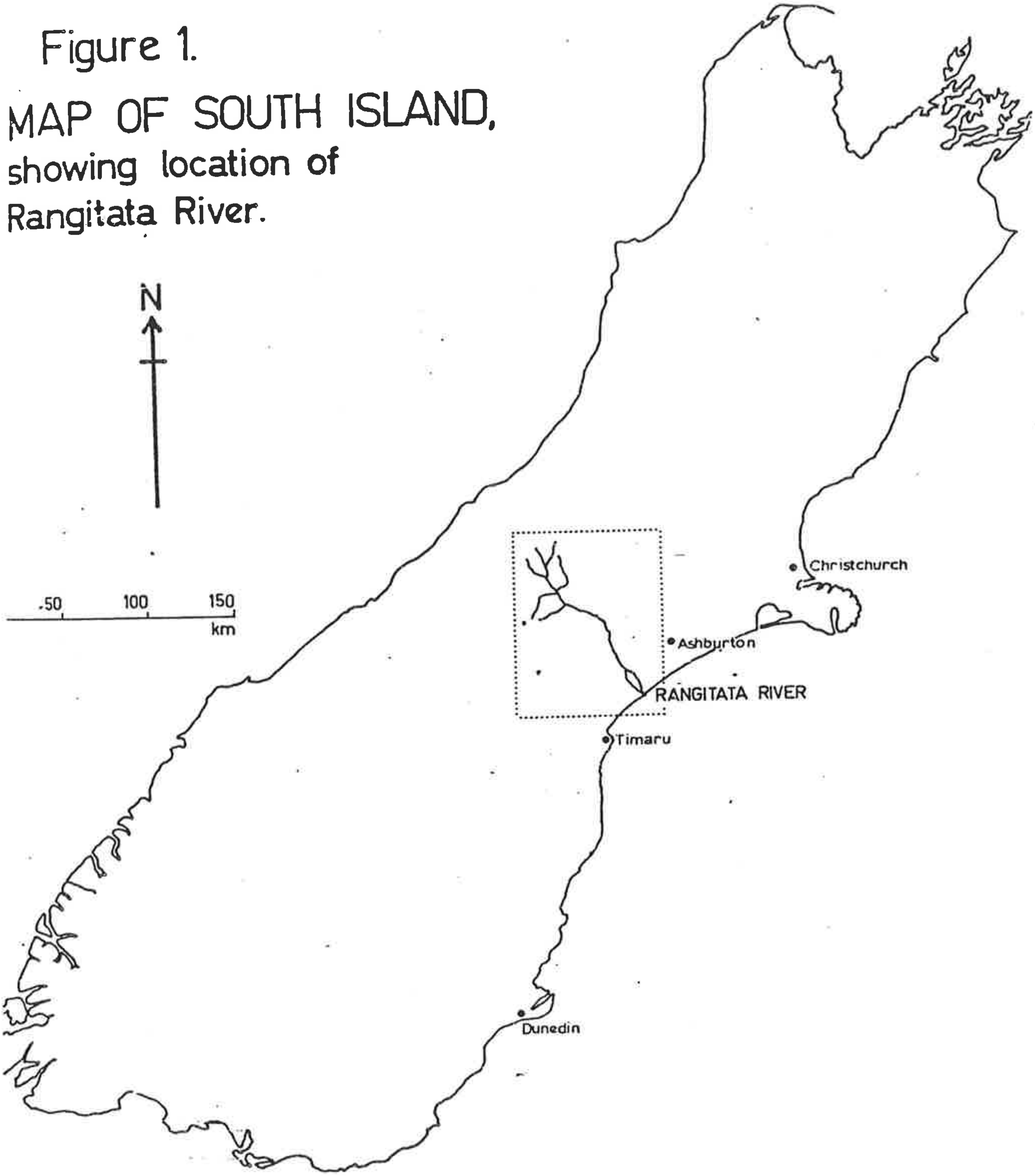
LOWLAND SECTION

On leaving the mountains the river is entrenched between high terraces of glacial outwash material, and river-borne alluvium, deposited in past ages to create the coalescing fans extending eastward to form the Canterbury Plain.

The river remains entrenched for a considerable distance. On the north bank a steadily-reducing terrace exists to

Figure 1.

MAP OF SOUTH ISLAND, showing location of Rangitata River.



the river mouth, and on the south bank to about 4 km downstream from the State Highway 1 bridge.

Within its trench the riverbed gradually widens and reaches the sea on a 2.5 km wide front where it is separated from the ocean by a loose gravel bank thrown across its course by the wind-driven action of the sea on to the shore. (The river mouth is referred to in more detail in a later part of this report.)

In the lowland section the character of the river is again a braided ribbon of streams wandering across an unstable floodbed of alluvium.

In this report the lowland, or plains section of the river is chiefly considered.

RANGITATA GORGE

Joining the upland and lowland sections is a length of about 10 km where the riverbed is constricted between two low mountain ranges. About 2 km of this is even more constricted into a rock-bound gorge where the river flow is confined, swift and turbulent.

It has a major cataract at one confined point. During the upstream migration of sea-run quinnat salmon, fish tend to collect, at low river flows, in good numbers below the cataract, waiting to attempt a passage through it. It looks a formidable barrier, but is, in fact, a surmountable obstacle to the migration. It may delay the passage of individual fish for a period, more at low-flow conditions, than at higher flows. Occasionally, weaker fish, or those that misjudge their leap, fall back onto rock ledges and may die, or be damaged sufficiently so that they cannot make further passage. By all accounts these are few in number.

Two attempts have been made in recent years to modify this obstacle with explosives. The first achieved some success; the second did not. Fish passage difficulties are not serious enough to warrant consideration of a fish pass around the cataract.

From the point of view of an interested observer, it has an attraction in that it is the only place in New Zealand - or for that matter in the Southern Hemisphere - known to the writer, where full-grown, sea-run salmon can be seen leaping from the water to clear a natural obstacle in their passage to high-country spawning grounds. To the writer's mind, this seems a good reason, since the fishery appears not to be damaged by it, to leave the cataract as nature intended.

LOWLAND TRIBUTARIES

Several minor streams (Mill, Lynn and Boundary streams and several lesser ones unnamed) drain steeply off the slopes of Mt Peel. Apart from these there are no other significant tributaries joining the lowland section of the Rangitata.

RIVER GRADIENT

From just above the junction of the Clyde and Havelock rivers to the start of the Gorge section the gradient of the river bed is about 4.6 m/km (24.0 ft/mile).

In the 10.0 km Gorge section the gradient averages 7.6 m/km (40.0 ft/mile).

From the end of the Gorge section to the river mouth the average gradient is 6.7 m/km (35.0 ft/mile). Within the lowland section from its start to the Arundel Bridge (S.H. 72) the gradient averages 6.7 m/km (35.3 ft/mile);

from Arundel to the S.H.1 bridge, 6.1 m/km (32.1 ft/mile); and from the S.H.1 bridge to the sea 5.8 m/km (31.1 ft/mile).

Figure 3 shows this information in profile and in comparison with the Rakaia and Opihi rivers.

RAINFALL IN THE CATCHMENT

Figure 4 illustrates the seasonal rainfall pattern near to, or within, the upland catchment, as recorded from 1964 to 1972 at five meteorological reporting stations (N.Z. Meteorological Service records):

1. The Hermitage (which is close to the Main Divide and the nearest alpine station to the Rangitata catchment)

2. Erewhon Station (about 23 km east of the Main Divide)

3. Mesopotamia Station (about 13 km eastward of Erewhon)

4. Orari Estate (near the start of the Canterbury Plain)

5. Coldstream No. 3 (on the Plain, closer to the coast)

Average annual rainfall for the three upland stations is:

Hermitage	4071 mm	(160.2 in)
Erewhon	1602 mm	(63.0 in)
Mesopotamia	1012 mm	(39.8 in)

and for the Plains stations:

Orari Estate	667 mm	(26.2 in)
Coldstream No. 3	599 mm	(23.6 in)

It is evident that rainfall decreases sharply in a gradient from the Main Divide to the east.

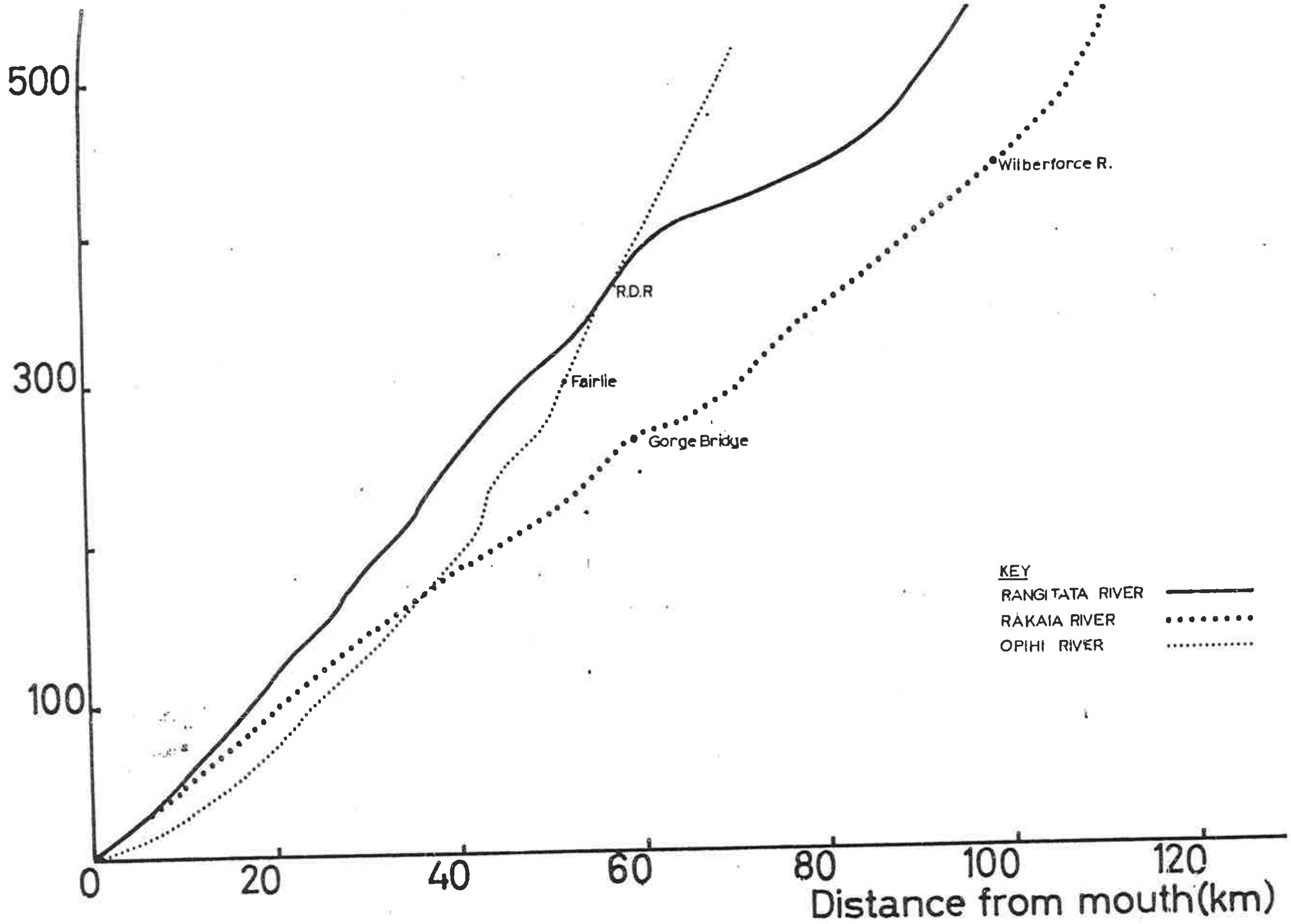
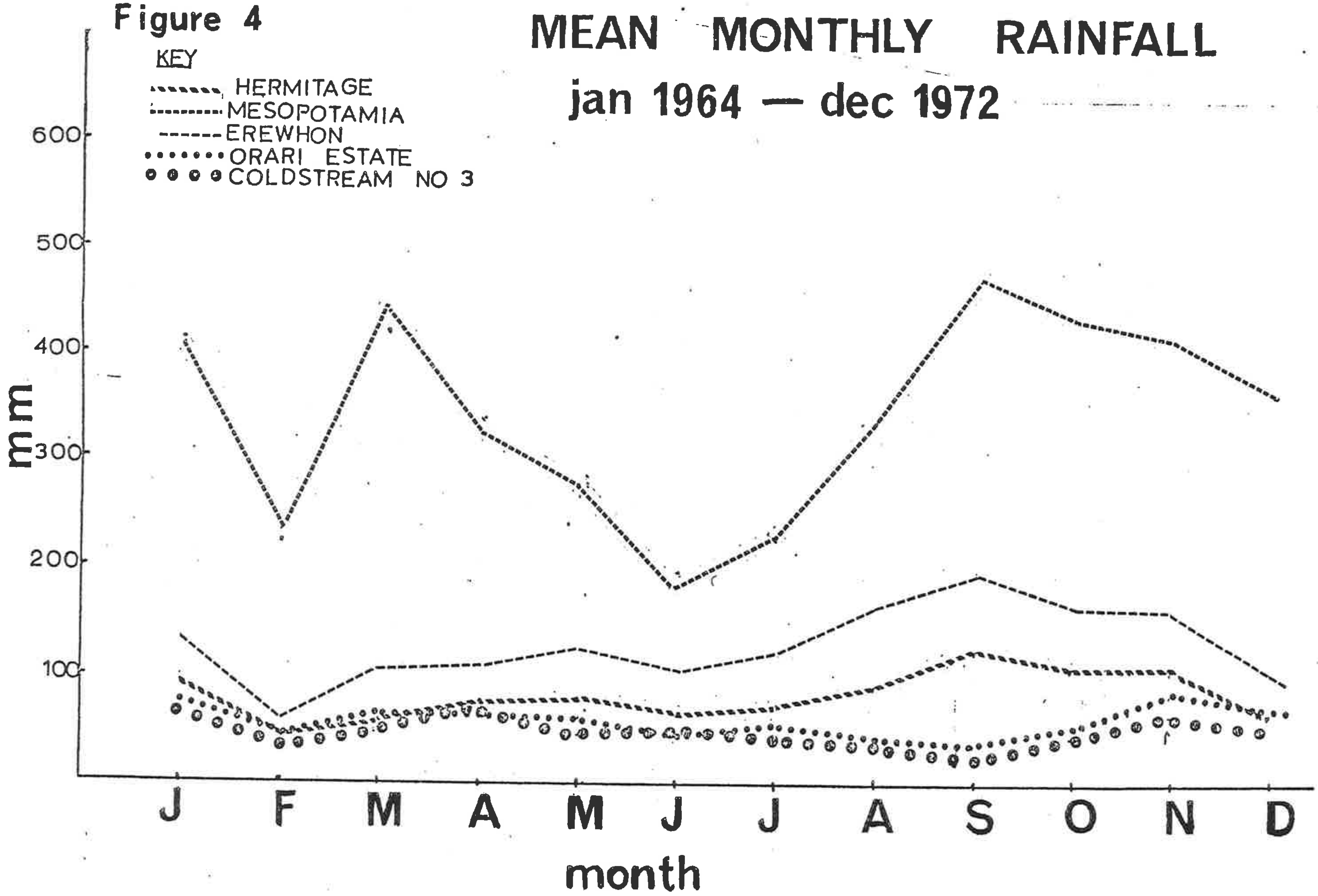


Figure 3. Comparison of River Profiles.

Figure 4


MEAN MONTHLY RAINFALL
jan 1964 — dec 1972
KEY
HERMITAGE
MESOPOTAMIA
EREWHON
ORARI ESTATE
COLDSTREAM NO 3
600
500
400
300
200
100
mm
J
F
M
A
M
J
J
A
S
O
N
D
month

THE FLOW OF THE RANGITATA RIVER

The order to gain an understanding of the flow pattern of the Rangitata river available flow records (S.C.C.B.) have been examined and consideration given to the factors which effect them.

Our data are primarily records of daily discharge derived from the Foxboro recording hydrograph installed near the mouth of the Gorge at map reference S91:767284. These data cover a continuous period from September 1967 to March 1974.

Other flow data from an earlier hydrograph operated by the Public Works Department (now Ministry of Works & Development) for a discontinuous period from 1936 through to 1955, have also been examined.

RANGITATA RIVER SEASONAL DISCHARGE

Because of its high-mountain sources, some in permanent snow and ice, and a winter snowline of approximately 900 m altitude, the Rangitata, as with other similar South Island rivers is often described as being "snow-fed". However, its discharge is more directly related to precipitation as rain from the west and north-west.

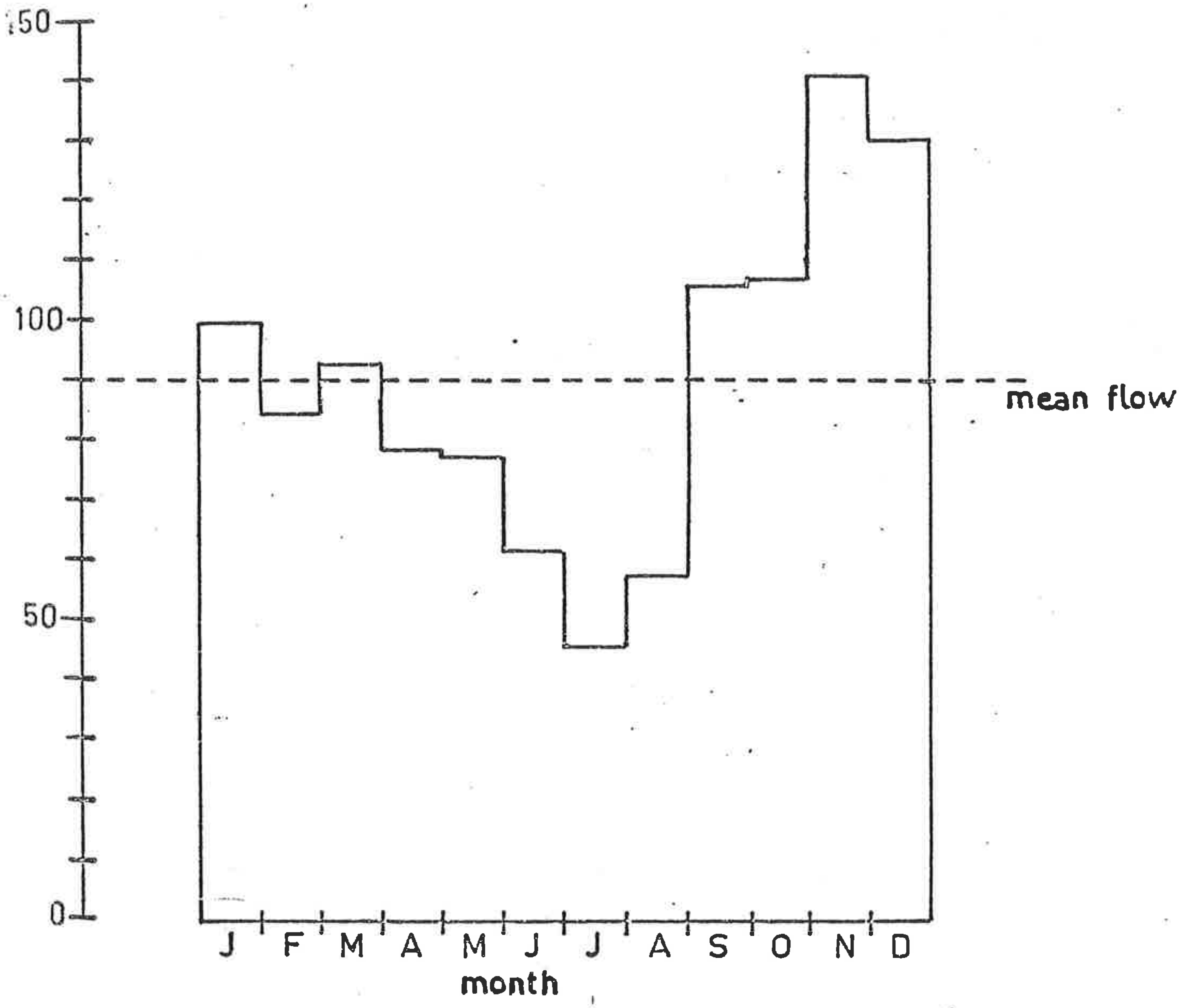
Figure 5 demonstrates the seasonal discharge pattern. (It has been derived by summing the mean monthly discharges, rather than the daily discharges, and averaging these. This may not be the most accurate method, but is considered adequate, in this instance, to give a generalised picture of the seasonal discharge.)

Although the discharge will be discussed in more detail later in the report the figure does show the lowest discharge to occur in the winter months when the high country

RANGITATA RIVER DISCHARGE PATTERN

averaged mean monthly flows in cumecs
(from gorge recorder)

SEPT. 1967. to MAR. 1974.



experiences snowfall and freezing temperatures. The highest mean discharge occurs in the spring and early summer, due to both thaw in the spring and high rainfall in the Alps at that time.

Long-term flow patterns are of less immediate interest to the fisheries manager than short-term flows. Extremes of flow - flood or drought - are of vital concern.

HIGH DISCHARGES

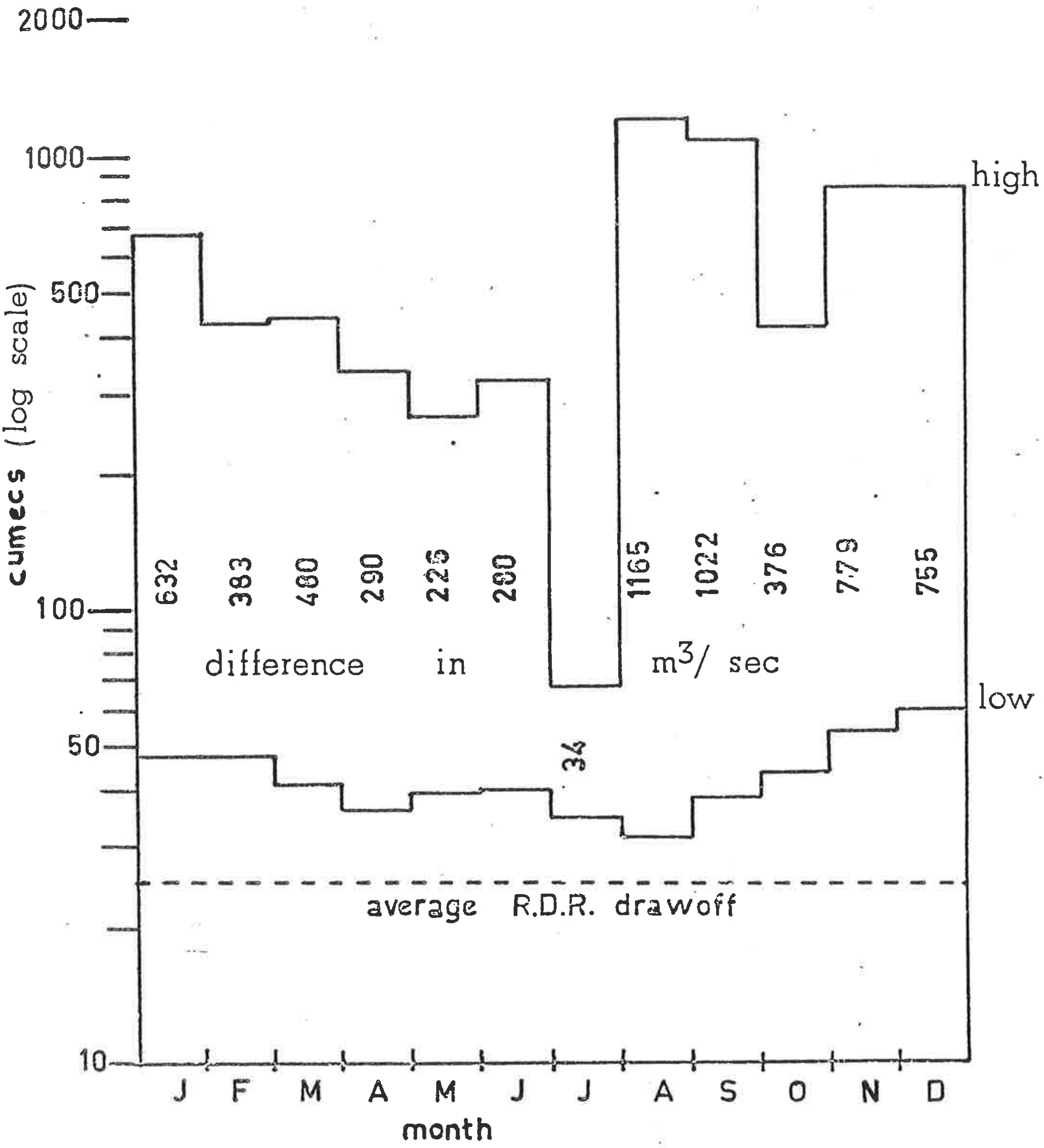
Figure 6 shows the highest and lowest discharges recorded at the Gorge in each month for the period September 1967 to April 1974. It is plotted on a logarithmic scale. July shows the least difference. August shows the greatest difference - and also the highest and lowest individual discharges recorded during the period - from a low of 31.28 m^3/s (1104 cusecs) to a high of 1195.5 m^3/s (42 220 cusecs).

Floods of greater magnitude than this have occurred in the Rangitata in the past. The incomplete hydrograph records from 1936 to 1955 show a flood of 2266 m^3/s (80 000 cusecs) in late October 1942 and another of 1983 m^3/s (70 000 cusecs) at the end of February in 1940.

LOW DISCHARGES

Additional to the low monthly discharges given in Figure 6, the earlier P.W.D. hydrograph records show that discharges of about 28.0 m^3/s (1 000 cusecs) appear to have occurred in late June 1936; late September 1948; for most of May 1950 and in mid-July 1951. (The accuracy of these records is suspect because of a lack of check gauging to rate the recorder.)

RANGITATA RIVER
monthly range of highest and lowest
discharge (from gorge recorder)
SEPT. 1967 to MAR. 1974



A check gauging at the recorder site on June 6 1947 gave a discharge of 34.5 m^3/s (1217 cusecs) which is the lowest accurate record for this period. 1947 was also a year the discharge did not rise above 85 m^3/s (3 000 cusecs) from the beginning of April until the end of September, except for a brief rise to 92 m^3/s (3 250 cusecs) in late June. Consistently lower than usual discharges persisted until September 1948.
From the reliable data which are available it would seem that discharges of less than 50 m^3/s (1765 cusecs) have occurred in all months except November and December (Figure 6).

Figure 7 shows, among other matters, a hydrograph of the daily mean river discharge (recorded at the Gorge) from October 1 1973 until April 30 1974 (S.C.C.B. records).

It is characterised by a number of "freshes" and floods with January/early February having the only "lengthy" period of steady discharge. The heaviest flood occurred in November (following the spring seasonal discharge pattern shown in Figure 5) a time when many juvenile salmon would be migrating down river. Freshes and moderate floods shown from February onwards were beneficial in maintaining a good open river mouth and water in the river for the adult upstream migration, and were probably a stimulus to the run since adult quinnat are known to "run" more freely in such conditions.

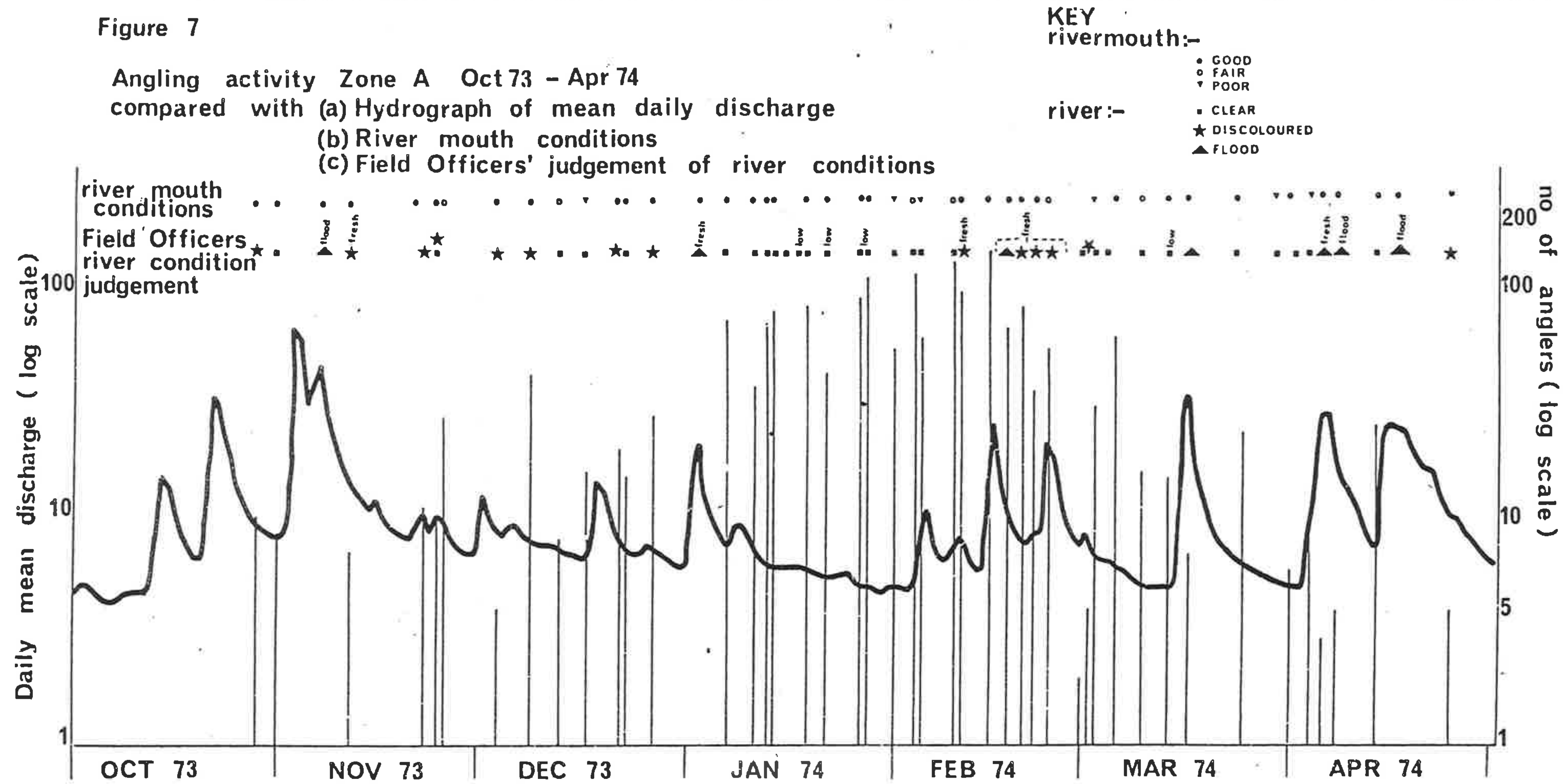
Only in early October and late January did the discharge fall markedly below 50 m^3/s, and it approached this for even briefer periods in mid-March, late March/early April.

SEASONAL DISCHARGE SUMMARY

A tentative conclusion from this information is that while floods of much greater magnitude than those recorded between 1967 and 1974 may be expected in the Rangitata, extreme low flows in this period are of much the same

Figure 7

Angling activity Zone A Oct 73 - Apr 74
compared with (a) Hydrograph of mean daily discharge
(b) River mouth conditions
(c) Field Officers' judgement of river conditions



order as those observed in the past. Floods and freshes of differing magnitude may occur in any month except July, and extreme low flows tend to occur mostly in late autumn and winter.

A feature of the Rangitata discharge is a characteristic of an often extremely rapid rise from a low, steady value, to a high value, and back down to a similar low, steady value within a week. This is a reflection of the rapidity of run-off in the upland catchment, which because it is steep, with impermeable rock and little dense vegetative cover, has only small capacity to absorb and store rainfall.

DISCHARGE DURATION

Information on discharge duration is usually produced in the form of a "flow duration curve" graphically showing the period of time a particular level of discharge is equalled or exceeded, expressed as a percentage of the time period.

Figure 8 is a flow duration curve for the Rangitata mean discharges for the complete years 1968 to 1973. As an example it shows that a discharge of 50 m^3/s (1 765 cusecs) was equalled, or exceeded, for 73.0% of the period. Conversely discharges of less than 50 m^3/s existed for 27.0% of the time.

Figure 9 is a flow duration curve for one year, 1968, which can be described as the year within the period having the highest mean monthly discharges. From it can be seen that the example of a 50 m^3/s (or greater) discharge occurred for 92.0% of that year.

Figure 10 is the flow duration curve for 1971, which had the lowest mean monthly discharges of the six years. In it a 50 m^3/s discharge was equalled, or exceeded, for only

RANGITATA RIVER MEAN FLOW DURATION CURVE 1968 - 1973

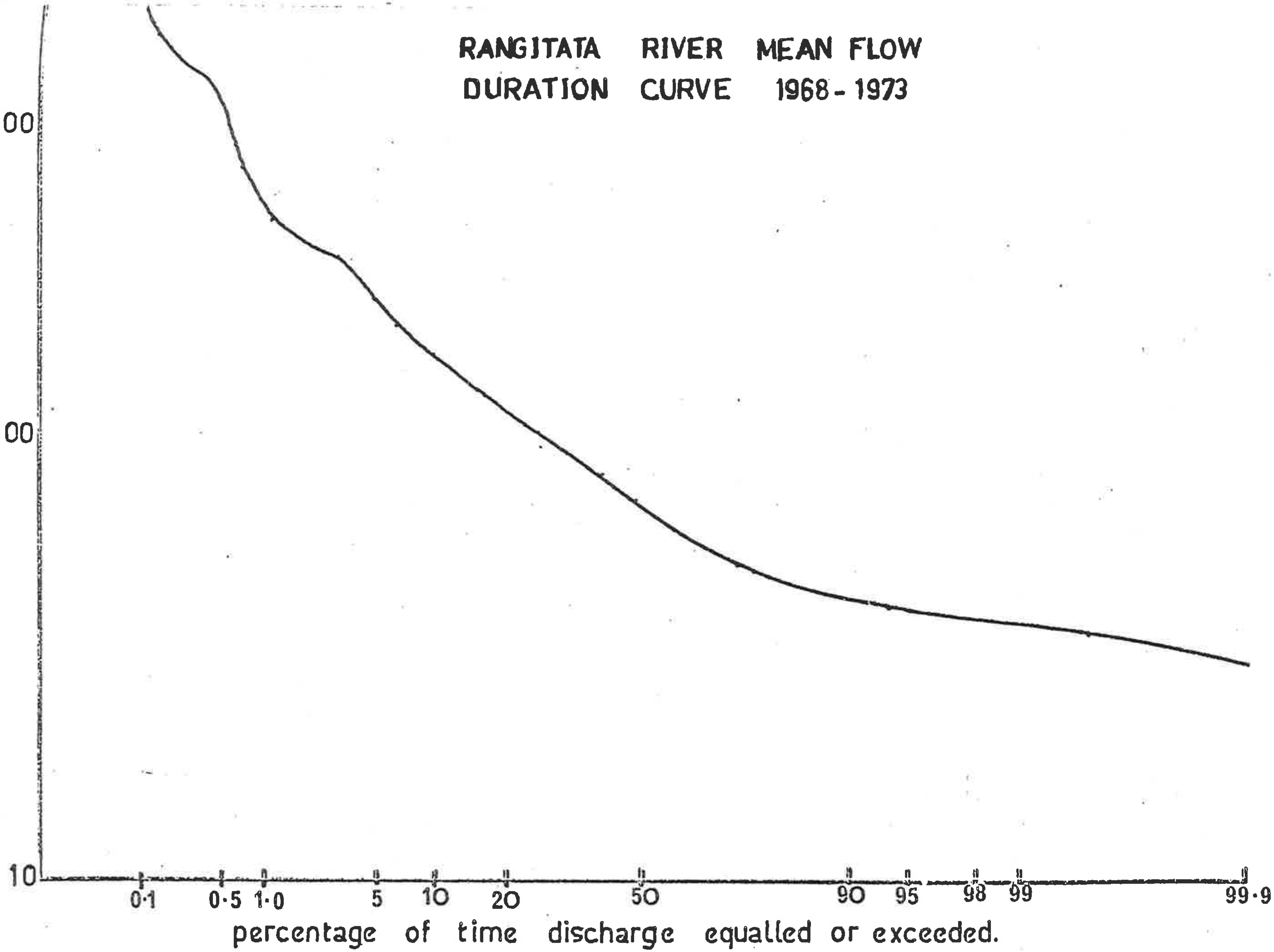


Figure 9

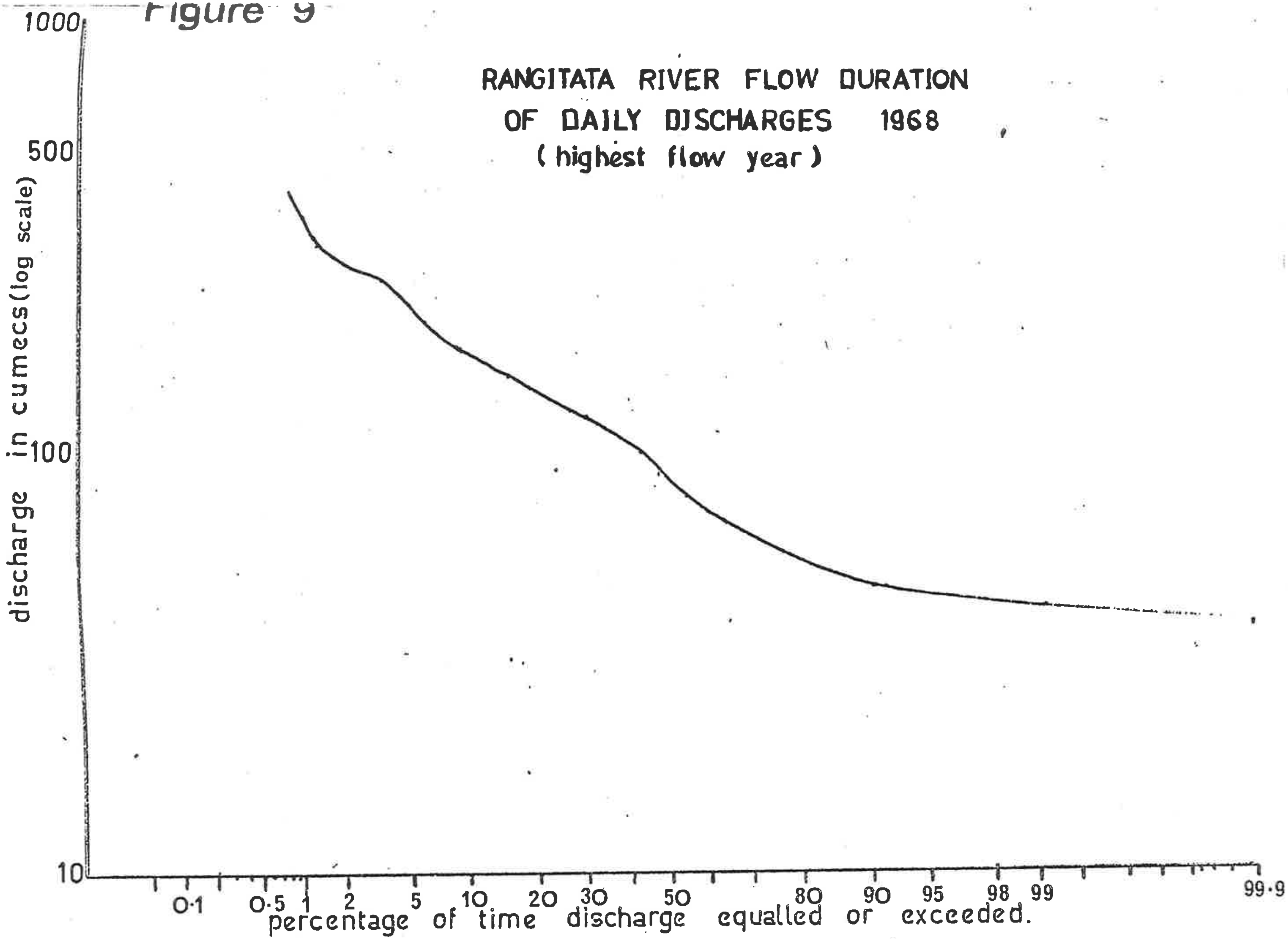
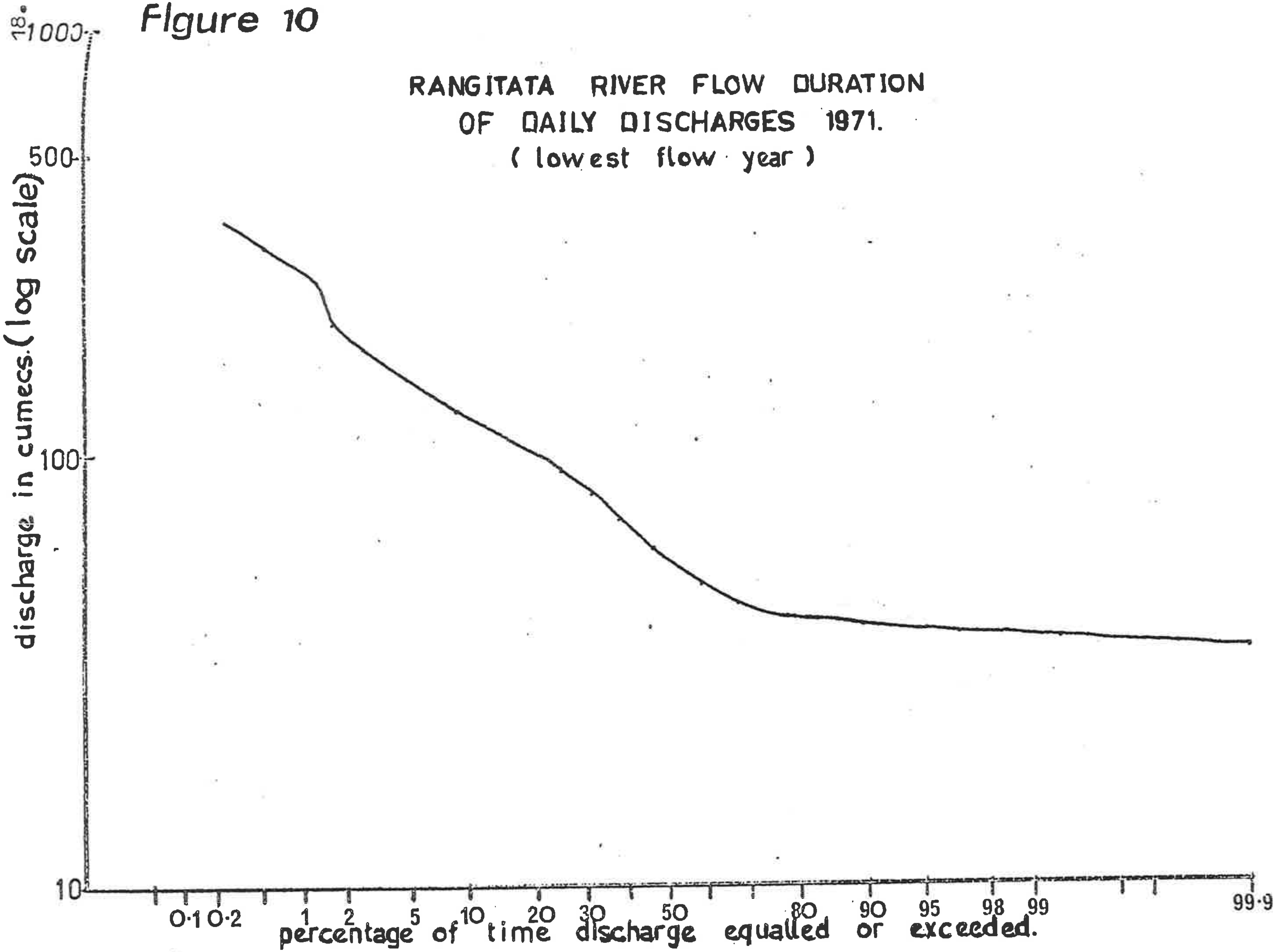

RANGITATA RIVER FLOW DURATION
OF DAILY DISCHARGES 1968
(highest flow year)
discharge in cumecs (log scale)
1000
500
100
10
0·1
0·5
1
2
5
10
20
30
50
80
90
95
98
99
99·9
percentage of time discharge equalled or exceeded.

Figure 10


18.
1000
500
100
10
discharge in cumecs (log scale)
RANGITATA RIVER FLOW DURATION
OF DAILY DISCHARGES 1971.
(lowest flow year)
0·1 0·2
1
2
5
10
20
30
50
80
90
95
98
99
99·9
percentage of time discharge equalled or exceeded.

59.0% of the year.

WATER ABSTRACTION

To this point the discussion has mainly concerned the natural discharge of the river, as measured by the Gorge recorder. Just below the Gorge (at map reference S91:768284) a major abstraction of water takes place, by gravity diversion, into the intake of the Rangitata Diversion Race (commonly abbreviated to R.D.R.).

This abstraction modifies the natural discharge in the remaining ("lowland") section of the river.

Other gravity abstractions occur lower down the river. These are minor in amount and insignificant in effect, on the river discharge. They are principally to supply localised stock watering races, and are possible sources of migratory fish loss.

R.D.R. DESCRIPTION

An account of the physical characteristics of the R.D.R. and its operation is given in Hardy (1972) but for the purposes of this report the following points are restated:

1. The R.D.R. began operating in 1945.

2. It was constructed by the then Public Works Department, and is now operated by its successor, the Ministry of Works and Development.

3. The R.D.R. supplies water to 3 major farm irrigation schemes in the Ashburton County (usually from September until April) some county stock-watering races, and, for the remainder of the year, or when there is a surplus to irrigation needs, for generating electric power for the national grid at the Highbank power station, situated on the bank of the Rakaia

river some 40 miles to the northeast of the intake.

4. The design capacity of the intake channel from the Rangitata river at Klondyke is 32.6 m^3/s (1150 cusecs).

5. The intake is gate-controlled, but not screened to prevent the ingress of fish.

RATE OF WATER ABSTRACTION BY THE R.D.R.

While the intake design capacity of the R.D.R. is 32.6 m^3/s, this level of abstraction is not evident in the figures for the average monthly drawoff during the period January 1967 to June 1974. For the 90 months the average monthly abstraction ranged from 0.34 m^3/s (12 cusecs) in May 1973* to 29.5 m^3/s (1042 cusecs) in March 1974.

(* May and June are the months in which the R.D.R. is usually shut down for maintenance if necessary. May 1973 was such a month.)

The year round average drawoff by the R.D.R. during the period was about 25.5 m^3/s (900 cusecs).

RELATIONSHIP BETWEEN THE R.D.R. ABSTRACTION AND THE RIVER DISCHARGE

The relationship between the R.D.R. drawoff and the river discharge can be seen in Figure 6.

From this the general statement can be made that the discharge in the lowland section of the Rangitata river, is the natural flow less (on average) 25.5 m^3/s (900 cusecs).

This would result, in the two extreme levels of discharge recorded for August (low 31.28 m^3/s, high 1195.5 m^3/s) in 5.78 m^3/s (204 cusecs) remaining in the lowland section at the minimum, and 1170 m^3/s (41 301 cusecs) at the maximum. In other words in the extreme low-flow situation the R.D.R. abstracted 81.5% of the available Rangitata flow, and in the extreme high-flow situation, 2.1%.

It is evident that in a low-flow situation the R.D.R. seriously modifies and reduces the natural flow in the lowland section of the Rangitata, but in high-flows the reduction is negligible.

EXAMINATION OF THE EXTREME LOW-FLOW SITUATION REPORTED ABOVE

A residual flow in the lowland section of the Rangitata of 5.78 m^3/s (204 cusecs) in August seems a most unlikely occurrence. It warrants further examination.

There are two factors in the relationship which could be wrong: (a) the recorder was faulty, or (b) the R.D.R. was abstracting less than its average 25.5 m^3/s (900 cusecs).

(a) Until August 6 there is no break in the daily mean discharge record from the recorder. (For 7 days after August 6 there is no record, suggesting a malfunction.)

Prior to August 4 (the day of the lowest record) the last significant increase in discharge occurred on June 3 when 191.63 m^3/s (6765 cusecs) was recorded. This had receded completely by June 15/16. For the next 49 days the hydrograph recorded a steadily-declining discharge until August 4.

The conclusion is that the hydrograph was recording correctly to August 6.

(b) On the assumption that the R.D.R. gravity intake might have increasing difficulty in abstracting water as the river flow reduced, a check was made of the average monthly drawoff for July and August 1973. Instead of being below the monthly average of 25.5 m^3/s (as it should have been if the assumption was correct) the drawoff in July averaged 28.5 m^3/s (1006 cusecs) and in August, 26.7 m^3/s (943 cusecs).

From this information it is concluded that the R.D.R. intake is quite efficient at drawing off the amount of water needed, even when the natural river discharge is at its recorded lowest. (The loose rock weir constructed across the Rangitata bed below the intake would contribute to this efficiency).

The examination of this extreme low-flow situation supports the initial statement that on August 4 1973, the residual flow in the lowland section of the Rangitata, after abstraction by the R.D.R. was 5.78 m^3/s (204 cusecs).

"WASTED" WATER

Some of the flow taken by the R.D.R. during the irrigation season is later "wasted" back into the Rangitata at waste discharge points constructed at Ealing and Coldstream.

Although at times the waste is significant, it is an operational convenience for the race system, rather than an intention to replenish the river flow at these points. The amount discharged is highly variable; at times it is nil. The influence of "wasted" water is not taken into account, even though it has some fisheries effects (see Boud and Eldon, 1959).

WATER ALLOCATIONS

90% FLOW DURATION

A discharge which is equalled, or exceeded for 90% of the time has been proposed recently by water resource managers as a possible "residual", or "base" flow to remain unallocated in a river for fisheries, wildlife and recreational needs.

This reasoning seems based on the premise that 90% of the time there is enough water (for what?) and not much biological harm can occur (surely) in only 10% of the time? There is not much wrong with this reasoning, if one considers the natural flow regime of a river, because it is the natural situation and one which the aquatic biological community endures continually and is adapted to.

The 90% and 10% flow duration periods are not distinct divisions of the river flow, each complete in itself and able to be considered in isolation from the other, but rather the summing, over an extended period, of the continual variations in discharge levels.

Considering the Rangitata natural flow duration curves (Figures 8, 9 and 10) in relation to this 90% proposition it would mean that over the longer-term curve (Figure 8) about 43 m^3/s (1518 cusecs) would be the "residual" amount for 90% of the time. In the low-flow year (1971) 43 m^3/s was available for about 71% of the time, and in the high-flow year (1968) it was there for 99.8% of the time. Since these are simply the natural variations in the flow regime of the river, they are interesting but of no immediate concern. The fishery exists with them.

But since 1948, when the R.D.R. began operating, the lowland section of the river, below the Gorge recorder, has not had a completely natural flow in it. It has had a flow which is continuously reduced by the abstraction of about 25 m^3/s by the R.D.R. intake.

If the premise is soundly based that the 90% duration level of the natural flow is a satisfactory amount for the maintenance of the needs of fisheries, wildlife and recreation, then it can be seen from the figures above that the lowland section of the Rangitata does not get this much on any occasion the discharge falls below 68 m^3/s at the Gorge recorder.

It has been shown that in an extreme situation the "residual" flow below the R.D.R. intake dropped to 5.78 m^3/s; a level that has never been even closely approached in any natural flow prior to the advent of the R.D.R. abstraction.

In the writer's view the 90% flow duration proposition, based on natural flows recorded at the Gorge, certainly cannot be applied to the lower Rangitata situation, because the R.D.R. exists and makes nonsense of it.

EQUAL SHARING

Another way of looking at the allocation of Rangitata, water between competing uses, could be that the allocation to the "residual" flow would be, as a minimum, an amount equal to the abstraction by the R.D.R. It has been shown that the average, year-round abstraction of the R.D.R. is 25.5 m^3/s - for convenience say, 25.0 m^3/s. This means that the natural flow of the river at the recorder site would have to be a minimum of 50.0 m^3/s to support this proposition.

Table 1 lists the percentage of time for each month that a 50.0 m^3/s or greater discharge was measured by the Gorge recorder. (The time period is from September 1967 until March 1974. The daily discharges of this magnitude were tabulated for each month as monthly groups, all Februaries, all Marches etc, over the whole period and the percentage of time determined as an average monthly unit.

TABLE 1: MONTHLY FREQUENCY OF RECORDED 50 m^3/s, OR GREATER, DISCHARGES

Month	No. of Months in Period	% of Monthly Time 50.0 m^3/s, or Greater, Discharge Available at Gorge Recorder
January	7	92.92
February	7	91.92
March	7	80.18
April	6	76.11
May	6	63.13
June	6	54.76
July	6	17.76
August	6	28.49
September	7	67.00
October	7	89.40
November	7	100.00
December	7	100.00

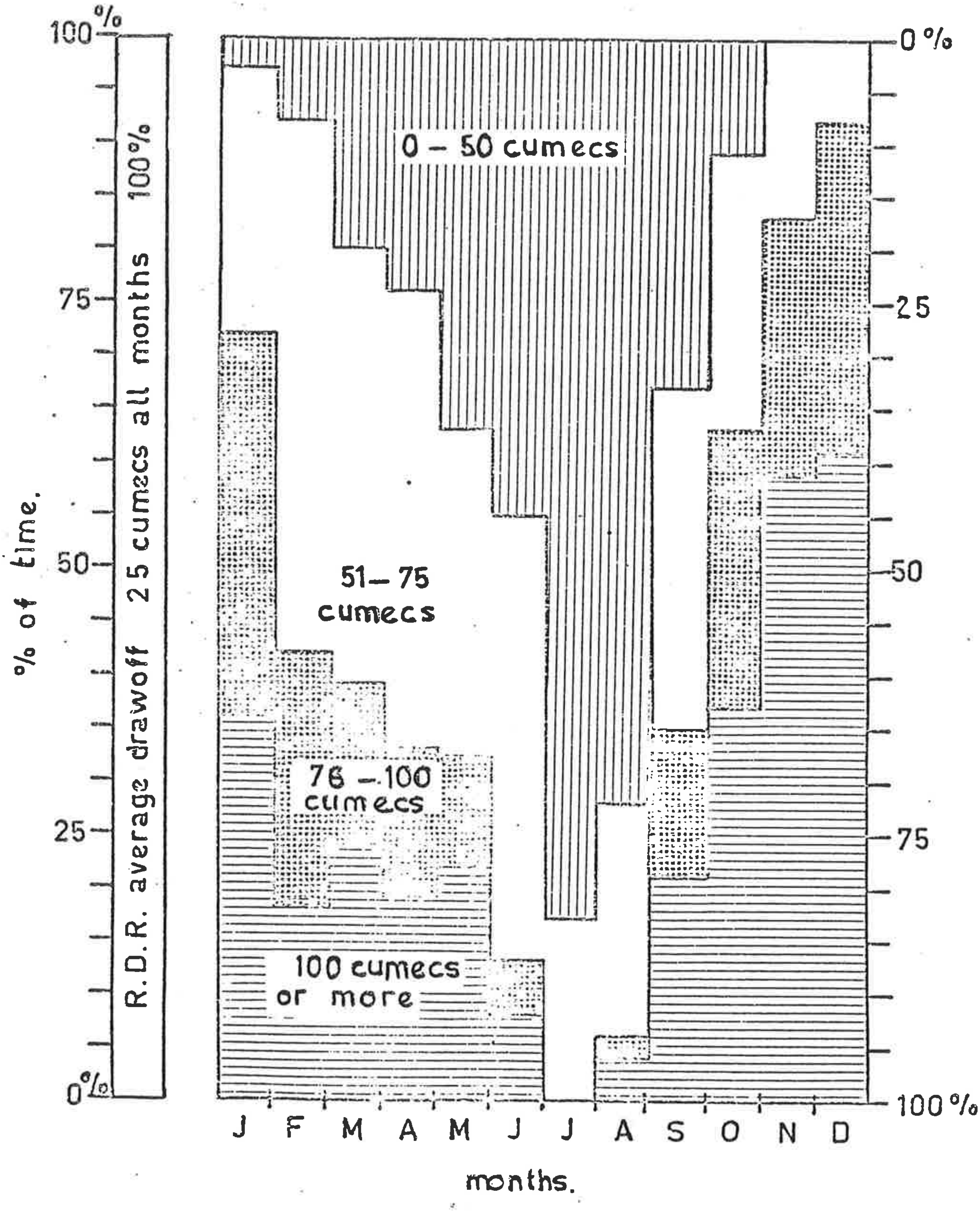
Clearly, only in November and December could the "residual" user confidently expect to get an amount of water equal to the R.D.R. abstraction for 100.00% of the time.

Figure 11 shows this information as a histogram, together with 3 other levels of discharge and the R.D.R. abstraction.

Figure 11

RANGITATA RIVER
% of time in months that flows of 4 ranges occur. (in cumecs from gorge recorder daily data).

SEPT. 1967. to MAR. 1974.



THE FRESHWATER & ESTUARINE FISHES OF THE RANGITATA

In common with many New Zealand waters the fish stocks of the Rangitata have not been examined in detail. Practical problems of time and resources precluded any specific examination of them for this report, except an attempt to carry out a "drift-diving" survey (referred to more fully later).

This section therefore is an assessment of the probable situation derived from the published work of a number of New Zealand workers; the published results of the analysis of various angling diary schemes; the information emerging from the quinnat salmon research being carried out on the upper Rakaia River by Fisheries Research Division, Ministry of Agriculture & Fisheries, and the observations and experience of the fisheries personnel involved with this report.

NATIVE FISH

The native freshwater species in the Rangitata will be similar to those in the other major Canterbury "snow-fed" shingle rivers.

The fast-water torrent fish (Cheimarrichthys fosteri); the common lowland bully (Gobiomorphus basalis); the common upland bully (Philypnodon breviceps); the swift-water bully (P. hubbsi); the rarer red-finned bully (G. huttoni); the large estuarine bully (G. gobioides); the two freshwater eels (Anguilla australis) and (A. dieffenbachii); several species of the Galaxiidae, of which the most notable is the common whitebait (Galaxias maculatus); the estuarine smelts of the family Retropinnidae; less commonly, the lamprey (Geotria australis); and around the river mouth, the marine kahawai (Arripis trutta); yellow-eyed mullet (Aldrichetta forsteri) and the black flounder (Rhombosolea retiaria). (Burnet, et al 1969).

Many of the "freshwater" species have a marine phase in their life cycle and are therefore migratory within the river. (McDowall, 1966, 1970).

ACCLIMATISED FISH

Three species, all introduced salmonids, are known to be present in the Rangitata:

Quinnat salmon	(*Oncorhynchus tshawytscha*)
Brown trout	(*Salmo trutta*)
Rainbow trout	(*S. gairdnerii*)

The quinnat salmon is anadromous; brown trout are at least partly sea-going, but no sea-going behaviour has been recorded for rainbow trout in New Zealand.

BEHAVIOUR, DISTRIBUTION AND SPAWNING OF ACCLIMATISED FISH

SEA-RUN QUINNAT SALMON

Following their anadromous habit quinnat salmon re-enter the river from the sea in late summer and autumn as adults approaching sexual maturity. Most are 3-4 years old, some 2 years old, and a few 5 years old (Flain, 1972). They range from 1.0 kg to 20 kg in weight, depending on their age and the abundance of food in the ocean.

Although some may "run" into the river in the early months of the angling season (October to December) significant numbers are not seen until late January. By early April the bulk of the sea run is over, but some adults continue to enter after the angling season, even as late as July.

Their upstream migration is to spawn and it is the second and final journey sea-run quinnat will have made through the river mouth. As juveniles (smolts) years before, they came down the river to enter the sea.

The early-running adult salmon do not spawn before the normal spawning time, late April/early May. Until then the river must provide shelter for them and the salmon that follows. The waiting period may therefore last for months for the earliest fish, but as the time for spawning looms closer, the later fish will spend only weeks, and the latest, only days, in passage of the river to their spawning grounds.

Since adult salmon do not feed after entering freshwater from the sea, the river simply provides them with holding and resting places while they finish maturing, and is in essence, a highway from the sea to their spawning grounds, which, for the majority, are sited in the high-country region.

Although it is probable that all the possible salmon spawning areas in the Rangitata system have not yet been identified, it is known that the Deep Stream system (Mesopotamia) and the Deep Stream system (Erewhon) are principal areas. Other spawning is known in the Potts River, a stream on the flat near Mt Harper, around the mouth of Lynn Creek, and in some of the smaller high-country tributaries above Mesopotamia/Erewhon.

Almost nothing is known of spawning in the main river channels and side runners, but since it does occur in other large Canterbury salmon rivers, it is likely to occur in the Rangitata also.

Observations at the Glenariffe trap (upper Rakaia) over several years, show that spawning salmon enter this tributary some 100 km from the sea, from January until August. The peak of the spawning movement is usually between April 13 and 20, (Galloway, 1972). Such precise information is not available for the Rangitata, but there appears to be little reason to doubt that the situation there will be similar, if not the same, as at

Glenariffe.

For the juveniles spawned by these adults much is reversed. They begin feeding in the river after emergence from the gravels. They migrate downstream, transforming into smolts, able to make the transition from fesh to salt water, as they enter their ocean life stage.

The time taken for the juveniles to traverse the river, from the spawning grounds to the sea, is not precisely known for Canterbury rivers. What is known from the studies being made at Glenariffe is that the outmigration of fry begins in August, peaks in September and continues decreasingly until October the following year. It has been estimated that about 95% of the outmigration occurs within the first three months; the remaining 5% in diminishing numbers over the final months. Juvenile size, for the first 3 months of the outmigration, remains at about 3.0 cm length; the yearling migrants average about 10.0 cm length (Woolland, pers. comm.)

Since the size at which quinnat juveniles become smolts (able to make the transition from fresh to salt water safely) is about 5.0 gm weight, 7.5 cm length, it is clear that the early fry outmigrants must either,
(a) grow quite vigorously within a short time in the river, or (b) make a slow passage downstream to enable them to grow sufficiently over the short length of the Canterbury rivers (compared to the longer rivers of their native, North Pacific habitat) if they are to survive the sea. Present information tends to suggest that this fry group is extremely vulnerable, demonstrably so to flood flows during the time of migration, and probably in any case, to too short a passage time, because of the swift-flow characteristics of the "snow-fed" Canterbury rivers.

The 3-months, and older, larger, outmigrants appear to have a higher survival ratio to adulthood, than the early fry outmigrants, (Woolland, pers. comm.).

BROWN TROUT

Little is known of the behaviour of brown trout in our large, swift, unstable rivers such as the Rangitata.

They are a self-maintaining stock, reproducing in the rivers and/or their tributaries. As is the habit with this species some of the stock will remain "resident" within the river throughout its life, being born, living and dying without leaving it, possibly within a quite limited area. Some will adopt a migratory habit, either migrating within the river from their "living" area to suitable spawning grounds, or downriver into the sea and back again, in response to spawning demands. (The brown trout, unlike the quinnat, may spawn several times during a lifetime.)

The sea-going brown trout is not truly anadromous, but rather diadromous. Its sea-going may simply consist of movement around, and in and out the river mouth, feeding on the seasonal shoals of whitebait and silveries. However, it has been clearly established from tagging in past years, that some brown trout undertake lengthy sea journeys from one river system to another. For example, a brown trout tagged in the Ashley River was later recovered from a butterfish net well north of Kaikoura. Others tagged in the Selwyn/Lake Ellesmere system were recovered from the Rakaia and rivers further south along the coast.

The time spent at sea will be variable, weeks, months or possibly longer, but once mature, it must spawn in freshwater if not annually, at least each second year.

Spawning time for brown trout is in the autumn and early winter with juveniles emerging from the gravels in spring.

In spring and early summer brown trout are much in evidence around the Rangitata river mouth and in the lagoon, feeding avidly on the shoals of whitebait and silveries. Some are probably spent fish (kelts) which have dropped back down the river after spawning to recover condition on the rich feeding available there.

Particular spawning areas favoured by these fish have not been identified. Deep Stream (Mesopotamia) is a known spawning area and, judging from the situation recorded in the Glenariffe Stream, it has a "resident" trout population, but will also have an influx of spawners from the main river. Other tributaries will also provide spawning and, wherever pockets of suitable gravel occur in favourable water conditions, brown trout, particularly "resident" fish, will no doubt spawn in the main river channels and siderunners.

Within the Rangitata system brown trout are widely distributed, probably in small numbers with individual fish fairly well dispersed, by contrast with the smaller and more stable Opihi and Ashburton rivers.

RAINBOW TROUT

Almost all that can be said about rainbow trout in the Rangitata is that they do occur since they are taken occasionally by anglers, mainly on spinning lures of the kind used for salmon fishing.

Presumably they form a self-maintaining, "resident" population, because, as yet, no sea-going behaviour has been reported for rainbow in New Zealand waters. (In their native range - the North Pacific Ocean Basin - some rainbow are strongly anadromous, producing the "steelhead" runs of angling renown.)

Similar river-dwelling populations, seemingly of small numbers, exist in other large Canterbury rivers, such as the Waimakariri and Rakaia. In the latter rainbow have been recorded in small numbers entering the Glenariffe Stream to spawn. Rainbow feature frequently in anglers' catches in the Waitaki system (Graynoth & Skrynski, 1973) where their apparently greater abundance, by comparison with other large Canterbury rivers, is possibly linked to more stable river conditions and the river's associated lake system.

Rainbow trout spawn in the spring. Whereabouts in the Rangitata is not known, but it is probable that, to some extent, they are migratory within the river system.

DRIFT-DIVING SURVEY

In June 1974 Fisheries Management Division personnel attempted to make observations of trout numbers in the length of river from Peel Forest, down to the Arundel Bridge area.

(In drift diving two, or more, wet-suited, snorkel-equipped, trained divers, drift downstream with the water current, their heads submerged, recording on hand-held tally counters any fish seen. For safety reasons a boat - in this case an inflatable dinghy - accompanies the divers. It is a technique which has been used with success elsewhere (Hardy, 1973).

Unfortunately the water velocity in this part of the Rangitata proved to be too strong and swift for the divers to maintain a steady and positioned "drift". In addition the water was discoloured making underwater visibility poor.

No trout or salmon were observed.

FACTORS EFFECTING TROUT DISTRIBUTION IN THE RANGITATA

INVERTEBRATE FAUNA

Our drift divers noted significant gravel movement on the riffles they passed over in the Peel Forest/Arundel bridge section. Gravel riffles are a prime site of invertebrate fauna production in a trout stream. The invertebrate fauna is the "bread and butter" food supply for these fish.

The overall character of the Rangitata - swift, unstable, with considerable bedload movement - would limit invertebrate fauna production to low numbers of the few species of mayflies, caddises and snails, adapted to this swift, constantly-changing environment. By comparison with a stable, high invertebrate fauna-producing stream, the Rangitata would provide a limited amount of food from a source which also supplies the needs of the native fish population.

Although the gradient of the river slackens a little as it approaches the river mouth, and finer gravels, sands and silt become deposited in greater quantities, it is still not a good environment for invertebrate fauna production in quantities which would increase markedly its value as a trout habitat. Production will be increased to a degree, and this, coupled with the abundance of estuarine forage fishes, probably accounts for an increase in numbers and the size of trout in the lower reaches of the river.

COVER

When food resources and spawning are not limiting factors, cover becomes an important feature of trout distribution.

It can take the form of vegetation on the banks, or growing in the water, pools, stretches of deeper water, rocks or larger stones forming less swift water areas on their downstream side, or even the wind-ruffled surface of the water.

In general the Rangitata river channels are open with shelving beaches and little, if any, vegetative cover either on the banks or in the water. Pools tend to be few in number and impermanent in form - with the exception of the pools on the rock-bound stretch of gorge. There are deeper water "runs" in many places and, particularly above Arundel, rocks and large stones.

TROUT STOCK SUMMARY

All things considered, it would be unreasonable to expect a dense, or even moderately dense, trout population throughout the length of the Rangitata. On the other hand it does seem to provide a useful quantity of brown trout in the lower river/lagoon/river mouth area for a number of anglers.

ABUNDANCE OF THE ACCLIMATISED FISH STOCKS OF THE RANGITATA

This is an area of very little knowledge, except that in the case of quinnat salmon counts have been made, for a number of years, of numbers of spawning fish, and their redds, or nests, in the Deep Stream system, (Mesopotamia). The records are given below (Hardy, 1974):-

TABLE 2 SPAWNING SALMON NUMBERS IN PART OF DEEP STREAM SYSTEM - MESOPOTAMIA (TRAP STREAM)

5 June 1973. Calm and sunny.
* Section 1 - from upper limit of spawning downstream to first bridge.

Section 2 - from first bridge downstream to second bridge.
Section 3 - from second bridge downstream to junction with Scour Stream.

(N.B. * These 3 sections form only part of the Deep Stream spawning system surveyed on other years. Therefore the figures given below are indicative of spawning abundance in a smaller index area and not of the Deep Stream system as a whole.)

Section	Redds	Live Salmon	Dead Salmon
One	64	20	20
Two	66	54	27
Three	89	29	56
TOTAL	219	103	103

The Technical Field Service, who have surveyed the system for a number of years, have made available the following figures of surveys on this stream.

Year	Redds	Live Salmon	Dead Salmon
3 June 1962	645	435	192
17 June 1963	457	42	228
21 June 1964	379	21	172
26 June 1965	357	11	47
15 June 1966	464	94	269
1967*	627		
1968*	409		
1969		No survey	
31 May 1970	202	116	152
1971	584	562	443

* (N.B. In these 2 years a separate count for this stream was not recorded. The figure for the number of redds is a percentage estimate for this stream derived

from the spawning count for the whole Deep Stream system.)

The Technical Field Service consider that considerably more fish use Trap Stream than the figures indicate. Two or three surveys have been made each year and in between surveys earlier redds become covered with algae and therefore may not be recorded as fresh redds in a later count. They note that from 1969/70 the available spawning area in other streams in the system has become less and this has probably caused salmon to make more use of Trap Stream.

COMMENT

From the above records it can be seen that the 1973 spawning season in Trap Stream was one of the lightest so far recorded.

This information, while it does give an indication of the relative abundance of quinnat salmon in the Deep Stream system from year to year, is subject to limitations in its use and should not be taken to be the actual or total number of salmon spawning in the Deep Stream system in any year. Its relationship to salmon numbers, or spawning elsewhere in the Rangitata system is not at all clear. Recently similar counts have been conducted in the Deep Stream (Erewhon) area of the river, and these indicate numbers comparable to parts of the Deep Stream (Mesopotamia) system. (Table 3)

TABLE 3 SPAWNING SALMON NUMBERS IN THE DEEP STREAM SYSTEM - EREWHON STATION ‡

27 May 1973. Clear but breezy day.
Section 1 - from opposite Ski Field Road to a point approximately 1.5 miles downstream.

Section 2 - from the end of Section 1 for a further 1.5 miles downstream. (N.B. these sections will be more closely marked for next season.)

Section	Redds	Live Salmon	Dead Salmon
One	58	44	27
Two	35	12	38
TOTAL	93	56	65

COMMENT

‡ This area was first surveyed by a University of Canterbury party in the 1950's. Their survey sections would not be comparable to the above.

Anglers' catches of trout and salmon, as recorded in the various angling diary schemes operated in past years, (Graynoth & Skryznski, 1973) and in the survey discussed later in this report, provide too few data to use as a reliable indicator of abundance.

It would seem unlikely, considering the size and character of the Rangitata, that any practical investigation - except the examination of consistent angling success records over a period of years - could be made which would give any meaningful estimate of trout abundance.

Techniques, based mainly on aerial counts, being developed for the estimation of adult quinnat salmon numbers in the Rakaia, may, in the future, enable seasonal estimates to be made of the abundance of this species in the Rangitata.

THE RANGITATA RIVER FISHERY

FOR NATIVE SPECIES

Some fishing by rod and line is done around the river mouth and its adjacent beaches for marine and estuarine species. Surf-casting is popular.

The most important native fish fishery is for juvenile whitebait (*G. maculatus*) as they run into the river in shoals from the sea. They are caught, in a regulated season lasting from September 1 until November 30, in hand-held scoop nets, or wire-mesh set nets.

This is a popular and useful recreational fishery enjoyed by numbers of people (see Table 8 in the section on recreational survey). Catches are highly variable and fishing is affected by the level of the river discharge.

FOR ACCLIMATISED FISH

Sea-run quinnat salmon and brown and rainbow trout are utilised solely in a recreational rod-and-line fishery. The angler requires an annual licence, which is issued for a fee by an acclimatisation society.

The fishing methods permitted, the lures which may be used, and the size and number of fish which may be taken, are controlled by regulation.

The daily bag limit is 15 acclimatised fish, of which not more than 4 may be quinnat salmon, and not more than 12 may be trout. Trout and salmon may not be less than 10 inches in length when taken.

The open season for acclimatised fish begins on October 1 and ends on April 30, with the following exceptions:-

In the months of March and April fishing is prohibited in (a) Lynn Stream and its tributaries;

(b) In the Rangitata Gorge, from Boundary Creek upstream to a white marker post at the west end of the Gorge;

(c) In the headwaters above white marker posts sited about 1 mile below Forest Creek.

These prohibitions are a conservation measure to protect quinnat salmon approaching spawning.

The pre-Christmas months are almost entirely the preserve of the trout fishermen - few sea-run quinnat are available to be caught. However, from January on, sea-run quinnat begin to enter the river mouth in numbers, and angling interest then centres on these.

(N.B. More detailed information on the trout and salmon fishery of the Rangitata will be found in the recreational activity/angling activity surveys discussed later in this report and in Graynoth and Skrzynski, 1973, and Graynoth, 1974.)

RIVER MOUTH HUT SETTLEMENTS

A feature of the Canterbury rivers is the hut settlements which have grown up over many years at their river mouths. Starting out as basic hut accommodation for overnight or short-term shelter for fishermen, some have become small, self-contained, serviced townships with permanent residents. Others have retained their seasonal-use character and are occupied occasionally at weekends, on holidays, in the salmon or whitebait seasons or whenever the recreational needs of the owners demand. Many are family holiday centres for a variety of recreational pursuits.

Without exception these settlements are neat, well-ordered and in many cases have cottages of a standard substantially better than the word "hut" implies. Some would not disgrace a suburban street in larger centres.

The administration of these settlements is accomplished in several ways; some by local body control, domain boards and a few by acclimatisation societies as fishing villages under the provisions of the Fisheries & Wildlife Acts. Often the daily management of the settlements is conducted by associations of the hutholders who provide and maintain amenities and generally oversee the interests of the community.

These settlements can be regarded as assets to the districts where they are situated. They provide revenue for the local body in the form of property rating and fees for services (electric power, water, rubbish disposal etc.) and bring into the district sometimes large numbers of people who purchase goods and services from the surrounding business community.

Their value as places of recreation for people is harder to assess, but judging from casual observation on the use made of them, it is considerable.

At the time of this report the two settlements either side of the Rangitata river mouth had the following valuations on their respective county council property rating lists:-

TABLE 4 VALUATIONS OF RIVER MOUTH HUT SETTLEMENTS - 1974

Hut Settlement - North Side

		$
Land value	=	4 000
Improvements	=	89 650
Capital value	=	93 650

(Market value of 81 huts (at $3 000 each) estimated at $243 000.)

Hut Settlement - South Side

		$
Land value	=	5 000
Improvements	=	66 950
Capital value	=	71 950

LOSS OF MIGRATORY FISHES TO THE RIVER BY WATER ABSTRACTION

In this context the fish automatically brought to mind is the sea-run quinnat salmon. Very little thought is ever given to the loss, to the river, of the other fishes, both trout and native species, which might result from water abstraction.

As discussed earlier, a number of these species is migratory to some extent, during their life history and are likely to be effected by water abstraction. For example, it is well known that the R.D.R., and its connected irrigation race systems, harbour stocks of brown trout. The inference is that they have found their way in through one, or more, of the intake points - they were not artificially planted there. Similarly there are stocks of native fishes (bullies and eels for example) in these waterways.

To say that these fish are lost is perhaps too strong a term. Technically they are removed from the parent river populations, and may be physically lost when parts of the race system are dried out, or when water is turned out onto irrigated paddocks. Certainly the trout are a loss to the fishery because angling is not encouraged in the 40 mile-long main canal, and the sub-systems of irrigation races do not lend themselves to angling.

But on the other side of the coin, it is probable that these populations would not have materially added to the stocks in the parent waters because of the population limiting factors earlier discussed, and only exist because the construction of the race system has artifically provided new, and additional, water areas for the species to spread into. Two other factors must also be considered; one is that not all the water taken into the R.D.R. system is used, in season, for irrigation - variable amounts are "wasted" back into the Rangitata, Hinds and Ashburton and presumably fish go also; the second is that as a result of this "wasting" (and the use of water for power generation at Highbank) there is a redistribution of fish into these waters and the Rakaia.

However, there is even less positive information available about trout and native fish loss by abstraction, than there is about quinnat salmon. At least the outlines of the two annual salmon migrations (juvenile and adult) are fairly clear and able to be understood in some relationship to other events.

It would be foolish to suggest that water abstraction does not pose a fisheries problem. It does, and although no intensive study of the problem has yet been undertaken in Canterbury rivers, there is enough information available from overseas, where migratory fish/water abstraction relationships have been closely studied, coupled with scattered observations made locally (Boud and Eldon, 1959) to demonstrate that where water abstraction takes place at a time of fish migration, a problem is created - unless steps are taken to prevent it!

It is not intended in this report to try to enumerate the possible loss of migratory fish to the Rangitata by water abstraction. The writer carried out a hypothetical exercise (Hardy, 1972) to try to estimate the loss into the R.D.R. of downstream-migrating quinnat salmon during 1967/68. Similar exercises could be attempted for the later years for which flow and irrigation draw-off data is now available, but they would serve little point until enough field research is carried out on the fisheries aspects involved, to validate the conclusions drawn.

However, it is pertinent to again draw attention to the facts that (a) the R.D.R. abstracts from the Rangitata all year round, (b) at times it takes the major portion of the natural flow of the river, (c) quinnat salmon migrate twice-yearly past its intake, (d) the intake (as are other smaller intakes from the Rangitata) is unscreened to prevent the ingress of fish, (e) during the irrigation season an increasing amount of the water abstracted is turned out onto irrigated paddocks, and (f) numbers of adult salmon enter the system and are lost to the fishery and most probably to the breeding population.

The records of the Ashburton Society field officer, published in the Society's annual reports, of numbers of juvenile salmon salvaged annually from the Glassworks Hole, Ashburton (the terminal point of one lateral in the irrigation system) and, with the assistance of M.W.D. race staff, from various drops in the races at the end of the irrigation season, give a minimum indication of the extent of the problem. (Table 5)

TABLE 5 TROUT & SALMON SALVAGE IN THE ASHBURTON COUNTY IRRIGATION SCHEMES

Year	No. of Fish	Source
1965	863 (trout & salmon)	75 irrigation race drops.
1966	3 406 salmon	irrigation race.
1967	4 650 (trout & salmon)	Hind River and irrigation races.
1968	2 690 salmon	irrigation races.
1969	17 060 salmon	Ealing and Lyndhurst irrigation schemes.
1970	No report	
1971	3 212 juvenile salmon	Cracroft and Lyndhurst irrigation schemes.
	10 adult "	" " "
	480 brown trout	" " "
	6 rainbow trout	" " "
1972	273 (about 5%	Rangitata race Montalto
	3 500 brown trout)	"Grassworks" Hole (Ashburton)
	4 100	Lyndhurst scheme
	1 672	Cracroft "
1973	300	" "
	600 trout & salmon	Lyndhurst "
	3 000	"Glassworks" hole.
1974	300 juvenile salmon	Cracroft scheme.
	100 " "	Lyndhurst scheme.
	2 200 " "	"Glassworks" hole.
	950 brown trout	Cracroft scheme.
	250 " "	Lyndhurst "

(N.B. The "Glassworks" hole is difficult to net, and the number of fish salvaged is only a proportion (possibly the majority) of fish present.)

Reference has already been made to the role of the R.D.R. and the irrigation systems in providing some additional habitat for fishes and in effecting their redistribution to other river systems. Migrating quinnat salmon would be most influenced, in the writer's view, by the operation of these factors. It is considered that a probably slower passage of juveniles through the race system would, where these fish are safely returned to a river by "wasting", improve their chances of survival to adulthood.

The redistribution of downstream-migrating juveniles originating in the Rangitata to the Hinds, Ashburton and Rakaia rivers, has some significance in the return run of adult fish to these waters; most noticeably to the tailrace of the Highbank power station when its operating pattern results in an attracting discharge at the time of a consequential adult return run. The attraction is considered to be the functioning of the salmon's "homing" instinct sensing the "waterpath" leading back to its natal water in the Rangitata.

(See Cunningham, 1972, for the record of adult quinnat salmon salvaged from Highbank, between 1950 and 1962. They have also been salvaged from there over the past 3 years.)

RECREATIONAL USE OF THE RANGITATA RIVER - 1973/74

SURVEY

A survey was made by the field officers of the two societies of the recreational activity on the river between October 1973 and April 1974. Its purpose was to ascertain the kind of recreational use made of the river and to try to gauge the level of activity involved.

SURVEY METHODS

The period selected (the angling season) totalled 212 days. Clearly it was beyond the resources of the societies to survey the river every day and it was decided that 52 days (25.0% of the possible days) spread over the period, would be a reasonable target to aim for.

Six survey zones were established (Figure 2). These were:-

Zone A - the whole river mouth/lagoon area, upstream to a line drawn across the river joining the Orton - Rangitata Mouth Road and the Hinds-Rangitata Mouth Road.

Zone B - from the top of Zone A upstream to the State Highway No.1 bridge.

Zone C - from the S.H.1 bridge upstream to the Arundel bridge.

Zone D - from the Arundel bridge up to the confluence with Boundary Creek.

Zone E - from Boundary Creek upstream to a line drawn across at the Potts River confluence.

Zone F - from the Potts River upstream (principally on the northern size to the Havelock - Clyde rivers junction.

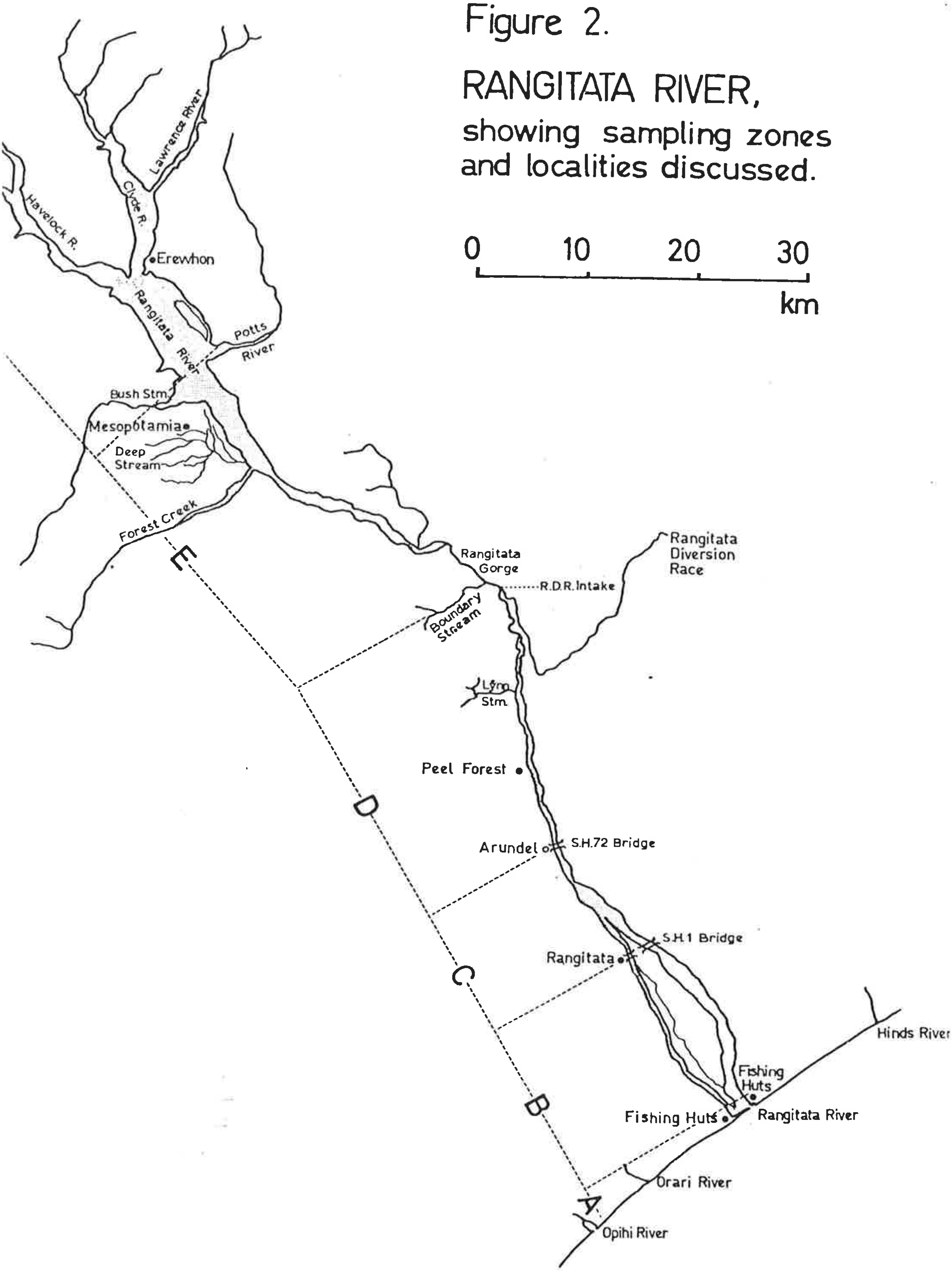


Figure 2.

RANGITATA RIVER, showing sampling zones and localities discussed.

In planning the survey some assumptions had to be made. These were:-

(a) that it would not be possible to survey the whole river on any survey day

(b) that it would not be possible to study the recreational activity over a whole day

(c) that Zone A would produce the main activity

(d) that activity would decrease as one progressed up the river, and

(e) that most activity would occur during weekends and holidays.

(They were based on the experience of the field officers who, over many years, had developed a comprehensive knowledge of the river.)

The final plan provided for 2 zones to be surveyed on each of the 52 days; Zone A (always) and one other. The frequency on which any zone was surveyed depended on a prior estimate of the likely activity there and, as a result, some zones were surveyed less frequently than others. An attempt was made to randomize these zones. Table 5 shows the frequency with which the zones were surveyed.

TABLE 6 PLANNED FREQUENCY OF SURVEYS IN VARIOUS ZONES

Zone	No. of Surveys	% of Total Survey Effort
A	52	50.0%
B	20	19.0%
C	14	13.5%
D	10	9.5%
E	5	5.0%
F	3	3.0%
	104	100.0%

The 52 days available for surveys were subdivided in the ratio of 26 weekend days, 4 public holidays, 22 weekdays. Since the survey could not begin before October 22 (Labour Day) only 191 days comprised the overall period, instead of 212 days if the survey had begun on October 1 (opening day of the angling season). This meant that the 26 weekend days represented 50% of the available weekend days; the 4 public holidays 50% of those, and the 22 weekdays 17% of the total weekdays. The 52 survey days were distributed among the monthly periods as shown in Table 6, with more being allocated to January, February and March (months of greater anticipated activity) than in the other months.

TABLE 7 DISTRIBUTION OF SURVEY DAYS X MONTH AND ZONE

Month	Kind of Day			Surveyed Zone	
	Weekend	Holiday	Weekday	A	Other
October 1973	1			A	C
		1	1	A	B
November 1973			1	A	B
	1		1	A	C
	2			A	D
December 1973	1		2	A	B
	1	1		A	C
			1	A	D
	1			A	E
January 1974	2	1	1	A	B
	1		1	A	C
			1	A	D
	1		1	A	E
	1		1	A	F
February 1974	2		1	A	B
			2	A	C
	1		1	A	D
	1		1	A	E
	1			A	F
March 1974	4		2	A	B
	2		1	A	C
	1		1	A	D
				A	E
April 1974			1	A	B
	1	1		A	C
	1			A	D
			1	A	F
TOTAL DAYS	26	4	22		

All the days of the week were sampled and, so far as was possible, the times of the day a zone was to be surveyed were to be varied with the hours of daylight.

The field officer was to observe the activity in the zone on a single pass through it, either passing up or down, but not both. His observations were recorded on special forms designed for the purpose (appendix A).

ANALYSIS

The data collected have been analysed in simple form. No statistical testing of its validity was attempted. It is a single season's observation and more surveys would be needed, probably in a different form, to give statistically reliable results. No correction of the bias resulting from the survey design was made.

RECREATIONAL ACTIVITY SURVEY RESULTS

Bearing in mind the comments above, the following results relate only to the recreational activity observed in a particular zone, at a particular time, on a particular day. They cannot be said to identify and measure all the recreational activity which took place on the Rangitata between October 1973 and April 1974. However they probably represent reasonably well the kind of activity undertaken, and the pattern of it through a season (since they tend to support other casual observations). The level of activity recorded may, or may not, be typical of a Rangitata angling season because there are many unmeasured factors which could influence this (e.g. a good or bad sea-run salmon season; frequent floods and freshes, or extended periods of low, clear river flow). It was probably not an atypical season (as a consensus among the personnel engaged) but there is no real way of judging this at present.

The programme specified for the survey was not in the event strictly adhered to. For various reasons a few observations were missed out for particular days. These were usually made up on another similar day during the month and two or three extra observations (not included in the plan) were made. One public holiday planned (Labour Day) was missed and resulted in a 38% effort for this group instead of the 50% intended. On two occasions when the secondary zone was surveyed before Zone A, the river was found to be in high flood and the weather bad; Zone A was not surveyed, but has been assumed to be a nil activity return.

In general the planned programme was followed fairly well and the total observations made were close to the intended number. Since the variations were small, and of little consequence, the results are expressed in the terms of the original outline for the sake of simplicity.

ACTIVITY IN ZONES

Nine kinds of activity were classified. These and the number of persons engaged in these activities in each zone are shown in Table 8.

TABLE 8 NO. OF PERSONS IN EACH ZONE ENGAGED IN SPECIFIED ACTIVITIES ON SURVEY DAYS

Activity	No. of Persons Within Zone						Total	% Overall
	A	B	C	D	E	F		
Angling*	1994	154	31	56	12	2	2250	69.3
Fishing*	46						46	1.4
Onlookers*	356	16	10		1	1	384	11.8
Whitebaiting	106						106	3.3
Boating	41			76[1]			117	3.6
Swimming	24	4					28	0.9
Picnicking	99	22	60				181	5.6
Walking	87	2					89	2.7
Unspecified+	31	4		9			44	1.4
	2784	203	101	141	13	3 =	3245	100.0%

(* A distinction was made between anglers fishing for acclimatised fish ("angling") and for native species ("fishing"). The onlookers recorded were associated with these two fishing activities.

[1] Boating concerned in canoe slalom championships.)

Obviously judgements had to be made by the field officers of the kind of activity they were observing and into which category it should go. In the main these were fairly clear, but in the case of the persons in the unspecified+ category no specific activity could be assigned to them. Since they comprised men, women and children and could not be associated with any work activity, they have been recorded as a recreational activity.

Zone A accounted for the major part of the activity observed.

TABLE 9 THE PERCENTAGE OF ACTIVITY FOR EACH ZONE

Zone A	-	85.8%
Zone B	-	6.2%
Zone C	-	3.1%
Zone D	-	4.4% *
Zone E	-	0.4%
Zone F	-	0.1%
		100.0%

Although this was influenced by the pattern of survey, it indicates a rapidly-decreasing trend of activity away from the river mouth upstream.

(N.B. * More than half the activity observed in Zone D occurred on one day, and was concerned with a canoe slalom championship.)

During the survey it was observed that angling and fishing were predominately adult male activities, although women and children also took part. In all zones adult males comprised 85%, women 6% and children 9% of the participants. In Zone A women (42%) and children (39%) made up the bulk of the onlookers.

Swimming (mainly in Zone A, and a little in Zone B) was largely a children's activity. Picnicking in the lower three zones was a family-group activity.

ZONE A RIVER AND WEATHER CONDITIONS

During the 52* days surveyed the river was in flood on 4 occasions, in fresh on 7 more and was judged to be normal or low on 39 days (* 2 survey days - no record). Since water clarity effects fishing a note was made of this factor; on 5 days the river was judged dirty, on 14 days as being coloured and for the remaining 29 days it was clear (4 survey days - no record).

Fine weather prevailed on 20 days, on 15 more it was partly cloudy, on 11 overcast, and it was raining on 4 days. On 68% of the days the wind was up to breeze strength, 12% were calm and 20% were unpleasantly strong or stormy (2 days - no record).

For 88% of the days when the wind was noticeable it was from the sea, predominately north-east 57%, south-east 31%. Nor-westers occurred on 5 days (12%) and no sou-westers were noted.

TRANSPORT AND ACCOMMODATION

1283 motor cars were counted associated with recreational activities, over 50 days (on 2 days no activity was recorded). By far the greatest number of these were in Zone A (1044). (Although these are individual motor car sightings, some would, of course, be the same car sighted on more than one occasion.) In Zone A this is an average of about 20 cars per survey day. In fact, the greatest numbers sighted on any one day were 67 (February 9 1974) 66 (February 14 1974).

Except for the canoeists in Zone D, boating was confined to Zone A; their use being predominately to provide transport and access from the two hut settlements down and across the lagoon to the river mouth. Children were often seen boating. Zone A boat sightings totalled 234; an average of about 5 boats each survey day.

Zone A contains two hut settlements (predominately short-term recreational accommodation rather than permanent residences). (Fuller reference to these settlements is made in another section.) The larger settlement is sited near the river mouth on the north side; the other is similarly situated on the south. Each provides, as well as huts or cottages, camping areas with facilities for tents or caravans. In these areas a total of 15 tent camps and 1109 caravan sightings were made on the 50 survey days when activity was recorded. (As with the motor cars, the same camp or caravan would be sighted on more than one occasion.) This gives an average, per survey day, of about 23 camps or caravans. The greatest numbers sighted on any one day were 68 (February 14 1974); 61 (February 23 1974).

Zone D with the Peel Forest Park motor camp and the canoe slalom championships (February 8 1974, 31 cars, 23 camps) was the next most used for camping/caravanning. Small numbers were recorded in Zone B, but none in Zones C, E and F.

Figure 12 shows the level of recreational activity throughout the period surveyed, as reflected by angling activity.

RECREATIONAL USE SUMMARY

It is quite clear that Zone A (the river mouth, the lagoon and the hut settlements) was the focus of recreational activity on the Rangitata River in the period. The survey shows that angling is the chief recreational activity by a large margin, and that the majority of the other activities in Zone A are closely associated with this.

In the 1973-74 survey recreational activity rapidly declined upriver from Zone A. In our view the river above Zone A is suited to angling over most of its length, to picnicking around the road bridges adjacent to the Peel Forest motor camp, and where there is road access (road access is limited). It is not suitable for swimming in the usual sense (our divers found some difficulty in snorkel drifting - a specialised kind of swimming) because of the water velocity, but is suitable for boating with specialised swift-water craft (inflatables, canoes, or jet boats). (None of the latter were recorded in the upper zones B, C, D, E & F during the survey.)

There is possibly a potential for angling over longer stretches of river between Arundel and Zone A, where land access is generally poor, by the use of inflatable craft to float the river.

RECREATIONAL ACTIVITY - ANGLING

While surveying the river for general recreational activity the field officers obtained some specific information on angling activity. Opportunities for this were limited since it was subordinate to the main task. The information was recorded during interviews in the field on forms designed for the purpose (appendix B) and later transferred to edge-punched cards for analysis.

RANGITATA ANGLER ORIGIN

We were interested to learn whether the anglers fishing the Rangitata were local or came from further afield. 201 anglers were interviewed and 99 (49.5%) came from the South Canterbury district, 46 (23.0%) from the Ashburton district, 37 (18.5%) from North Canterbury, 10 (5.0%) from Waitaki Valley and the remaining 9 (4.5%) were made up of 3 from Wellington, 2 from Otago, and 1 each from Nelson and the West Coast districts. Two were Canadian visitors.

Based on this sample the indication is that angling on the Rangitata River is primarily an activity for local anglers from the two adjacent society districts (145 anglers or 72.5%). The majority of the remainder came from other South Island districts (51 anglers or 25.5%) and most were from districts where there are salmon fisheries (49 anglers or 24.5%) and only 5 anglers (or 2.5%) were visitors from the North Island or from overseas.

Graynoth and Skrzynski (1973) estimated that about 30% of the fishing effort in the Ashburton district was from visiting anglers, mainly from South and North Canterbury; they were estimated to account for 20% of the fish caught. In the South Canterbury district visiting anglers were estimated to catch 10.0% of the fish taken. Anglers living in these two districts were estimated to spend at least 10.0% of their fishing time outside their own districts. Boud, (1957) also reported on angling activity.

The information suggests to us that while there is a substantial core of local angling effort on the Rangitata, the river also provides numerous angling opportunities for those from other districts. In common with other Canterbury-Otago "snow-fed" rivers where there are sea-run quinnat salmon and brown trout, the Rangitata is utilised, not only by local anglers, but by significant numbers of anglers with a wide-ranging distribution of origin.

QUINNAT SALMON ANGLING VERSUS TROUT ANGLING

The question was asked of each angler interviewed, "was he, or she fishing for salmon or for trout?" 155 (77.0%)

said they were fishing for salmon; 46 (23.0%) were fishing for trout. This result is probably influenced by the date of the interview and the zone in which the angler was fishing.

It has been shown in other surveys of "snow-fed" Canterbury rivers that interest in the earlier part of the season is on "sea-run" or diadromous brown trout angling, and later in the season the emphasis changes towards sea-run quinnat salmon. (Boud, 1958) (Dougherty & Cudby, 1965-66)

In this survey each angler interviewed was asked their preference, salmon or trout? Table 10 is the result.

TABLE 10 ANGLER PREFERENCE OF TROUT OR SALMON FISHING

18 (9.0%)	had	a	100%	preference	for	salmon
6 (3.0%)	"	"	"	"	"	trout
71 (35.0%)	"	"	75%	"	"	salmon
39 (19.0%)	"	"	"	"	"	trout
67 (33.0%)	"	"	50/50%	"	"	both trout and salmon.

Despite the clear margin shown in favour of quinnat salmon in the kind of angling being done by the 201 anglers, personal preferences do not so clearly indicate this. Notwithstanding the preferences expressed, it is a fact that 181 (90.0%) of the anglers had threadline (or spinning) tackle, more suited to quinnat salmon or rainbow trout than brown trout fishing. All the salmon they caught were caught on threadline tackle, as well as the only two rainbow trout caught. The latter were taken by professed salmon fishermen in Zone C. All the brown trout taken by this group of anglers were taken on a wet fly or feather lure.

DISTRIBUTION OF ANGLERS ON THE RIVER

The distribution of the 201 anglers interviewed is shown in Table 11, although this information is biased and affected by the survey design.

TABLE 11 DISTRIBUTION OF ANGLERS INTERVIEWED, BY ZONE

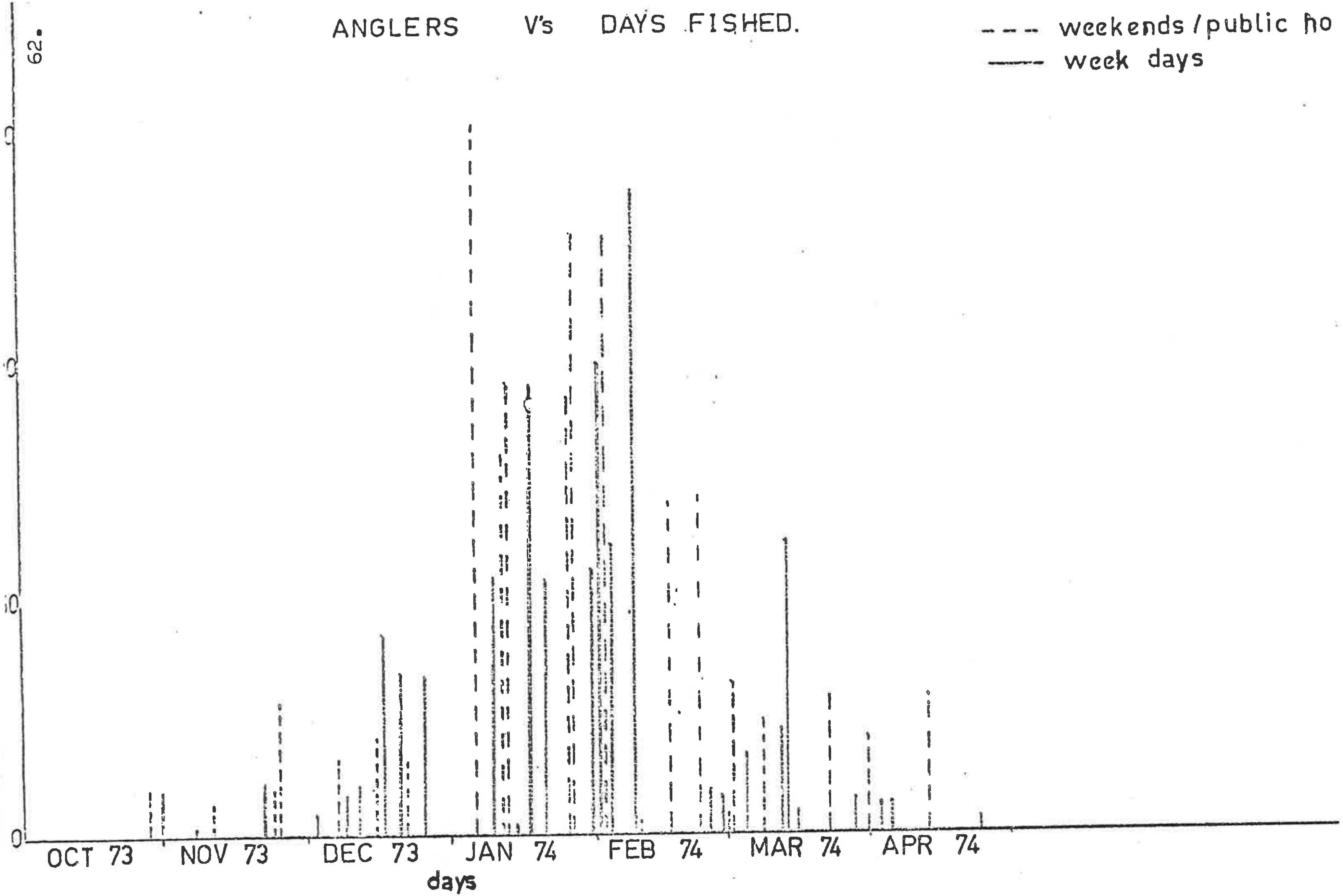
Zone A	-	149	(74.1%)	
Zone B	-	31	(15.4%)	
Zone C	-	10	(5.0%)	
Zone D	-	9	(4.5%)	
Zone E	-	-	-	
Zone F	-	2	(1.0%)	(our two Canadian visitors)

This reinforces the view that Zone A is the most important angling area, and that angling effort sharply decreases up the river. As described in an introductory section most of Zone E and all of Zone F is closed to angling at the end of February.

ANGLING EFFORT AND CATCH DURING THE SURVEY

No attempt was made to determine the total angling effort and catch on the Rangitata river during the 1973-74 angling season (October 1 to April 31, with the exceptions noted earlier). At present this is beyond the resources available to us.

Figure 12 shows the level of angling activity observed during the survey days. From this it may be possible to gain some impression of the total effort over the season, but even so, it would be difficult without a properly-programmed survey, designed for the purpose, to assign numerical values to it, or to compare it with any past season.


ANGLERS V's DAYS FISHED.
--- weekends / public ho
—— week days
0
OCT 73
NOV 73
DEC 73
JAN 74
FEB 74
MAR 74
APR 74
days

It is generally accepted by those who are able to make judgements relative to other seasons, that the 1973-74 angling season on the Rangitata was a poor one.

Of the group of 201 anglers interviewed most had no success. No limit bags of either quinnat salmon or trout were recorded. (The daily bag limit for salmon is 4, and for trout 12). The 201 anglers caught 35 acclimatised fish amongst them: 20 were sea-run quinnat salmon, 13 were brown trout and 2 were rainbow trout.

To catch this number of fish the anglers put in a total of 620.25 hours; this averages out at 17.72 hours per fish. It has been shown in many similar surveys here and overseas, that salmon are caught at a much slower rate than trout: in the 1973/74 Rangitata season our interviewed salmon fishermen caught one salmon for every 24.4 hours expended in angling, and our trout anglers caught one trout for each 8.8 hours expended.

CATCH RATE COMPARISON WITH EARLIER INFORMATION

The catch rate for salmon and trout of 17.72 hours per fish is much slower than Graynoth and Skrzynski (1973) record.

1962	-	3.33 hours per fish	(163 salmon, 248 brown and 16 rainbow trout)
1967	-	2.86 " " "	(85 salmon, 104 brown and 1 rainbow trout)
1973 - 74	-	17.72 " " "	(20 salmon, 13 brown) and 2 rainbow trout)

For the individual species the 1973 - 74 catch rate of the 201 anglers was much slower than previously recorded. An approximation would be between 10 and 15 hours per salmon and from 1 to 4 hours per trout. The 1973 - 74 figures may be a reflection of the ability of this particular group of anglers, but is more likely a confirmation of the previously expressed view that it was a poor angling season.

FACTORS EFFECTING ANGLER EFFORT AND CATCH

Factors contributing to a poor season would be chiefly

(a) poor river conditions:- i closed river mouth,
ii dirty or discoloured flows,
iii prolonged low clear flows, or

(b) lack of trout or salmon to be caught.

CLOSED RIVER MOUTH

On all the days Zone A was surveyed the river mouth was reported to be open. On 31 survey days the condition of the mouth was judged "good", on 6 days "fair", and on 7 days "poor". (There was no comment for the remaining 6 survey days).

We have no other report that the mouth was closed at any time during the 1973-74 season, so it would seem this presented no serious fisheries problem.

The Rangitata river mouth does close on occasions. It was reported to have done so for a brief period of hours in April 1973, at an estimated flow of 8.5 cumecs (300 cusecs). Seemingly total mouth closure is an uncommon occurrence of brief duration. However river flows low enough to create the possibility of the mouth closing are less likely to induce sea-run salmon to enter the river, particularly early in the season. A low river flow and a strong sou-westerly combined would tend to reduce if not close the river mouth.

A contributing factor to a poor mouth, other than a low river discharge, would be the position of the mouth. The width of the river channel at the coast is about 2.6 km (3000 yards). A loose, permeable gravel bank separates the river and the sea. The position of the mouth wanders over this 2.6 km front from year to year, and even during a year. If the river develops an outlet through the gravel bank more or less straight out in a direct line with its flow, then even a comparative small discharge will produce a satisfactory mouth. However when the mouth is to the extreme northerly edge of the 2.6 km, the river flow turns at right angles and follows along parallel to the gravel bank, often for a considerable distance. This creates a lagoon situation inside the gravel bank, but also permits a low river flow to gradually filter away through it. By the time the remaining water reaches the mouth there is not very much left to create or maintain a good outlet into the sea.

Figure 7 shows the field officers' assessment of the condition of the river mouth on the survey days. In the 1973/74 angling season there was no suggestion that the mouth would close at any time, although there were a few occasions following a period of "low" flow when they considered its condition "fair" or "poor" in angling terms.

However on other occasions when the assessment was "fair" or "poor", this was a result of sea conditions producing heavy swells, or breaking seas, into the river mouth, making it poor and dangerous for fishing.

On the majority of surveyed occasions the mouth condition was assessed as "good", presumably in adequate width and flow for angling and to permit sea-run fish good access.

DIRTY AND DISCOLOURED RIVER FLOWS

The kind of lure a trout or salmon angler can use in specific fisheries and in certain situations is controlled by regulation. In general in rivers like the Rangitata, the lures used are more effective in clear or lightly-discoloured water. This does not mean that they are not used in quite opaque water, but their attraction is mostly related to visible phenomena (e.g. the "flash" of a spinning metal spoon, or an action which simulates the movements of an injured "bait" fish) and to an extent to vibrations producing sound or pressure variations detectable by the sensory organs of the fish. Lures, or bait, which may be more effective in dirty water by producing odours, as for example, salmon roe, a proven bait for salmon in such conditions overseas, are either prohibited by regulation or considered "unsporting" locally.

Obviously, in a high flood stage, the larger Canterbury rivers are unfishable. Besides being dangerous to life, they become extremely dirty with heavy silt loads. At their worst it is more a matter of survival for the fish than a time of personal debate as to whether it will take this or that lure. But on rising and falling flows, or during lesser "freshes" there are stages when the water becomes fishable; it is neither "dirty" nor "highly discoloured", rather "milky", "lightly discoloured" or "clear". Which is a fishable stage depends on the experience and judgement of the angler.

The point is that angling success, and hence the recreational use made of the Rangitata, depends not only on the availability of fish, the right choice of lures - and the angler's skill in using them - but also on the water conditions obtaining at the time.

The field officers recorded the water conditions at the time of survey. These were a matter of judgement. All three officers are experienced and familiar with the river and as can be seen in Figure 7 their judgements accurately reflected the picture of the water conditions as revealed in the hydrograph of daily mean river discharge recorded at the Gorge.

It is less easy, on the same Figure, to analyse the activity of the angler in relation to the hydrograph discharges, for they appear to be out fishing over a wide range of river stages, including at least one occasion when, in the field officer's judgement (supported by the hydrograph) the river was in flood and "dirty". (The activity shown in the Figure is that recorded in Zone A only.)

Overall, considering the limited number of observations recorded in the period, the impression gained is that early and late in the season there is a less serious angling effort than in the period January, February, March (when the sea-run of quinnat salmon is at its height) when river conditions - except perhaps the worst - appear to have slight influence on angling effort.

However, it does not necessarily follow that angling success is not influenced by river conditions. It may well have been. Unfortunately the survey effort did not permit a close check on numbers of fish caught and a more positive conclusion to the matter is not possible, but they did, on occasion, comment on their survey sheets that although numbers of anglers were about with rods during some "fresh" and flood conditions, their activities were limited to sitting on the bank gazing, one is tempted to say, unhappily, at the dirty water going by.

WATER ALLOCATION PLANNING AND MANAGEMENT

Manipulating numbers is an absorbing and necessary part of water resource planning. However, it can easily become a fruitless exercise unless the answers can be demonstrated to mean something in relation to the resource and its uses. The water resource manager is able, within limits which become more definable with time, to assess what the resource is, how it behaves and what can be expected from it. He is less able to relate this information to its management, because effective management means a complete understanding of the uses and their requirements. This, in turn, means he must have access to, or be supplied with, sufficient data and information on usage, its needs and the influence of many factors upon these, to be able to evaluate all aspects and integrate them into his planning.

In several fields, fisheries for example, much basic and vital data/information is not available - as evidenced in this report - and may not become available. The reasons are many-fold. In part it is a matter of the time and expertise to carry out studies, but much has to do with the complexities of relationships, both biological and otherwise. Some are, as yet, little understood, and some are so intrinsically imprecise that methods have not so far been developed to quantify them. None of this makes the job of the water resource manager, or the fisheries manager, an easy task at the present day, when they must jointly and conscientiously attempt to do their best for the interests they have a responsibility for.

In fisheries, or perhaps more broadly, the field of aquatic biological resources, there is a quickening of concern for environmental needs and an increasing awareness of the need to determine the problems, their parameters and to develop practicable solutions. Much of this is occurring overseas, and a leader in the field is J.C. Fraser (1972, 1972, 1973) who has collated widely-scattered information; reviewed the methods in use, and others which could be used; discussed the problems and suggested avenues that could lead to solutions of some of them. His work merits close study.

Despite this, at the present time there seems to be no simple formula, no clear outline of methods which can be used, either tentatively or confidently, to determine what part of a natural water resource must not be tampered with, or manipulated by man, if its aquatic biota is not to be altered adversely. (Fraser cites numerous sad examples of errors that have been made.) Somewhere there are limits to the stress we can impose upon the aquatic community; beyond these the biota fights a losing battle to remain a vital, living resource which we can fully enjoy and use to our benefit.

Stress limits may have, in certain situations, already been approached, perhaps reached, in the lower Rangitata. We do not know. There is no specific information, for example, on fish losses by stranding, known to us. There is no adequate baseline information prior to the advent of the R.D.R. abstraction to compare with the present situation. For that matter there is inadequate study and monitoring to assess even the present status.

CONCLUSIONS

The only conclusions possible in this report are:-

(a) the Rangitata has a fisheries resource which is used by people;

(b) the R.D.R. abstraction exerts a powerful influence on the extent of the water resources available in the lower ("lowland") portion of the river;

(c) the "lowland" portion supports the majority of the recreational use of the river;

(d) it would seem that if a water allocation and management plan is proposed now, there are two options open;

one is to ignore the existence of the R.D.R. abstraction and plan on the basis of the natural unmodified discharge at the recorder;

the second is to acknowledge the fact of the R.D.R. abstraction as an existing occurrence and develop a management plan only for the amount of discharge the R.D.R. leaves in the river.

(e) No specific instance of fisheries damage from reduced flows in the Rangitata has been established, however this is considered to be a result of inadequate knowledge rather than a true statement of the probable situation.

RECOMMENDATIONS

1. The fisheries managers must continue and increase their efforts to acquire knowledge of the resource they have to manage.

2. Should further water abstraction be proposed from the lowland Rangitata the requirement for fisheries must be considered with great care, since there seems, at times of significant low flow, little margin left for damaging error.

3. It is clear that available water resources must be allocated and managed, the principles of sharing among users, according to the greatest community need and benefit, and in times of shortage (the "sharing of adversity" principle established for the Opihi River) are commended for careful study.

ACKNOWLEDGEMENTS

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John Bull, Graham McClintock and Bryan Strange, field officers of the two societies, carried out the recreational and angling activity surveys and contributed valuable information. William Johnson, Arthur Turner and James Mace, Fisheries Management Division, Ministry of Agriculture and Fisheries carried out field work, analysis of the information collected and prepared the figures in the report.

Alan Coakley, Fisheries Management Division, Ministry of Agriculture and Fisheries, critically examined the manuscript and contributed much valuable advice.

The writer records his appreciation of their efforts.

APPENDIX A

Specimens of the forms developed for the Rangitata recreational activity survey, together with the instructions on how it was to be filled in in the field.

APPENDIX B

Similar forms and instructions for the angler activity survey.

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INSTRUCTIONS FOR RECREATIONAL ACTIVITY SURVEY FORM

1. Survey district - fill in, e.g., RANGITATA RIVER.
2. Zone - cross out the particular zone being surveyed, e.g. A.
3. Date - D is day, M is month, Y is year. Fill in, e.g. 1 11 73.
4. Time - the time period occupied by this particular survey. Fill in, e.g. start 10 am finish 2.00 pm, or start 2.00 pm and finish 8.00 pm.
5. Direction - whether survey carried out in upstream direction or starting at the upstream boundary and working down. Cross out whichever applies.
6. Day - cross out the kind of day it is. This will give a quick reference for later analysis.
7. Angling (A) - fishing for acclimatised fish. Cross space applying.
8. Fishing (N) - fishing for native species, e.g. kakawai. Cross space applying.
9. Headings - M is a man, W is a woman, J is a juvenile, UN is unspecified where the persons are too far off to be identified. Fill in number of individuals in each category in space provided.
10. Total - across for each activity, brought down to the grand total which should agree with the totals for each man, woman, etc., group. Fill in.
11. Angling or fishing is defined by three criteria:-
    (a) actually fishing;
    (b) near the water with gear but not actually fishing;
    (c) walking about or to the water with gear - say from a parked car.
12. Cars, boats, camps - fill in number seen or connected with known activity.
13. Weather - cross out the one that applies.
14. Wind - cross out apparent strength, fill in wind direction, e.g. SW.
15. Mouth - estimate condition - good, poor, etc., and fill in.
16. River - cross out the characters which apply.

INSTRUCTIONS FOR ANGLER FIELD INTERVIEW FORM

1. Survey district - fill in name, e.g. RANGITATA RIVER.
2. Zone - A - river mouth to road in on north side and a line across the river to the road in (Kallens Road) on the south side.
   - B - From the top of zone A to State Highway 1 bridge.
   - C - S.H.1 bridge up to the Arundel bridge.
   - D - Arundel bridge to the confluence with Boundary Creek.
   - E - Boundary Creek to the Potts River junction.
   - F - Potts River to the junction of the Havelock and Clyde rivers, north side.

   Cross out the zone in which the interview took place, e.g. A.
3. Date - D is day, M is month, Y is year. Fill in.
4. Time - Time period during which zone survey (as a whole) was undertaken, e.g. 10 am to 4 pm. Fill in.
5. Day - the kind of day, e.g., weekday not public holiday or Saturday or Sunday. Cross out the one which applies.
6. Licence number - look at licence and fill in.
7. Kind (of licence) - M is mens, W is womans, J is juvenile.
8. Category - WS is whole season, M is month, W is week, D is day. Cross out the category which applies.
9. Licence district - district where licence issued. A is Ashburton, SC is South Canterbury, WV is Waitaki Valley, NC is North Canterbury, space is for any other district. If one of first four cross out appropriate one, fill in space for others, e.g. Otago.
10. Home - is the angler's home town or rural area, e.g. Temuka.
11. Interviewed before - means in this season's survey. Cross out.
12. Tackle - T/L is threadline or spinning, F/D is dry fly, F/D is wet fly or lure. Cross out which applies.

13. Fishing for - is what the angler is intending to catch at that time. Space is for other kind of fishing, e.g. kahawai, herrings, eels etc. Cross out trout or salmon if fishing for one or other, fill in other kind of fishing.

14. Prefer - is what the fisherman has the greatest preference for, i.e. what he mainly wants to catch. Complete as 13 above.

15. Fishing hours - note mistake, second two time periods should be 6 pm and 12 pm not am. These are the hours the fisherman has fished this day. Hours in the period up to 6 am and so on to give the total hours he has fished for the day. Fill in.

16. % time - this is an estimate of the percentage of the fisherman's whole fishing season he would spend fishing for the kind of fishing he has the greatest preference for, e.g. if he is a salmon fisherman he may put in 75% of his fishing effort into fishing for salmon. Fill in %.

17. Catch - the number and kind of acclimatised fish in his bag this day until interviewed. It might be useful to note in the comments space the number of other kinds of fish caught, if he is for example, a herring fisherman. Fill in.

18. Brown trout usually has 9 rays in the anal fin, but less than 12. If spotted will have black body spots but no spots on tail fin. If some spots are brown or reddish then it is a brown. Anal fin has a short base compared to its depth. Adipose fin no spots, usually edged with orange.

Rainbow usually has 11-12 anal rays. If spotted will have only black spots and these will also be present on the tail fin. No coloured spots - only black. Adipose fin edged with black with a few black spots. Rainbow stripe may not be obvious in sea-run, or maiden fish, darkens with age and maturity.

Quinnat usually has 15-17 rays in anal (Pacific salmons have always 13 or more rays). Anal fin has a long base in comparison to depth. Black body spotting and on tail fin. Inside of mouth has a black or dusky lining.

NOTE: If unusual fish are seen, try to obtain for examination. Otherwise photograph (if possible in colour) and note features.

19. Lengths taken with steel tape in centimetres to nearest .5 cm. Fork length from tip of snout to the apex of the fork of tail. Weights to nearest gram division of balance used. Check regularly against a known weight.
20. Ask if fisherman usually fishes the Rangitata only, or fishes other Canterbury rivers as well and note this in the comment section.

ASHBURTON & SOUTH CANTERBURY ACCLIMATISATION SOCIETIES
RECREATIONAL ACTIVITY SURVEY

SURVEY DISTRICT | | ZONE | A | B | C | D | E | F

	D	M	Y		AM	AM	PM	PM	
DATE				TIME					DIRECTION: UP / DOWN

DAY: WEEKDAY | HOLIDAY | WEEKEND

		M	W	J	UN	TOTAL	CARS	BOATS	CAMPS
ANGLING (A)									
FISHING (N)									
ONLOOKERS									
WHITEBAIT									
BOATING									
SWIMMING									
PICNICKING									
WALKING									
GRAND TOTAL									

WEATHER: FINE | CLOUDY | OVERCAST | RAIN — HOT | AVERAGE | COLD

WIND: GALE | STRONG | BREEZE | CALM — MOUTH: OPEN | CLOSED

DIRECTION | | | | — CONDITION

RIVER: FLOOD | FRESH | NORMAL | LOW

COLOUR: DIRTY | COLOURED | CLEAR

OBSERVER ....

COMMENT ....

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ASHBURTON & SOUTH CANTERBURY ACCLIMATISATION SOCIETIES
ANGLER FIELD INTERVIEW

SURVEY DISTRICT ________ ZONE | A | B | C | D | E | F |

	D	M	Y
DATE			

	AM	AM	PM	PM
TIME				

DAY: WEEKDAY / HOLIDAY / WEEKEND

LICENSE NO. ________ KIND | M | W | J | CATEGORY | WS | M | W | D |

LICENSE DISTRICT | A | SC | WV | NC | | HOME ________

INTERVIEWED BEFORE | YES | NO | TACKLE | T/L | F/D | F/W | |

FISHING FOR | TROUT | SALMON | | PREFER | TROUT | SALMON |

FISHING HOURS	6AM	12AM	6AM	12AM	TOTAL

% TIME | 25 | 50 | 75 | 100 |

CATCH | TROUT | | SALMON. | | TOTAL | |

BROWN L (cm)	BROWN W (gm)	RAINBOW L (cm)	RAINBOW W (gm)	QUINNAT L (cm)	QUINNAT W (gm)

COMMENT ....
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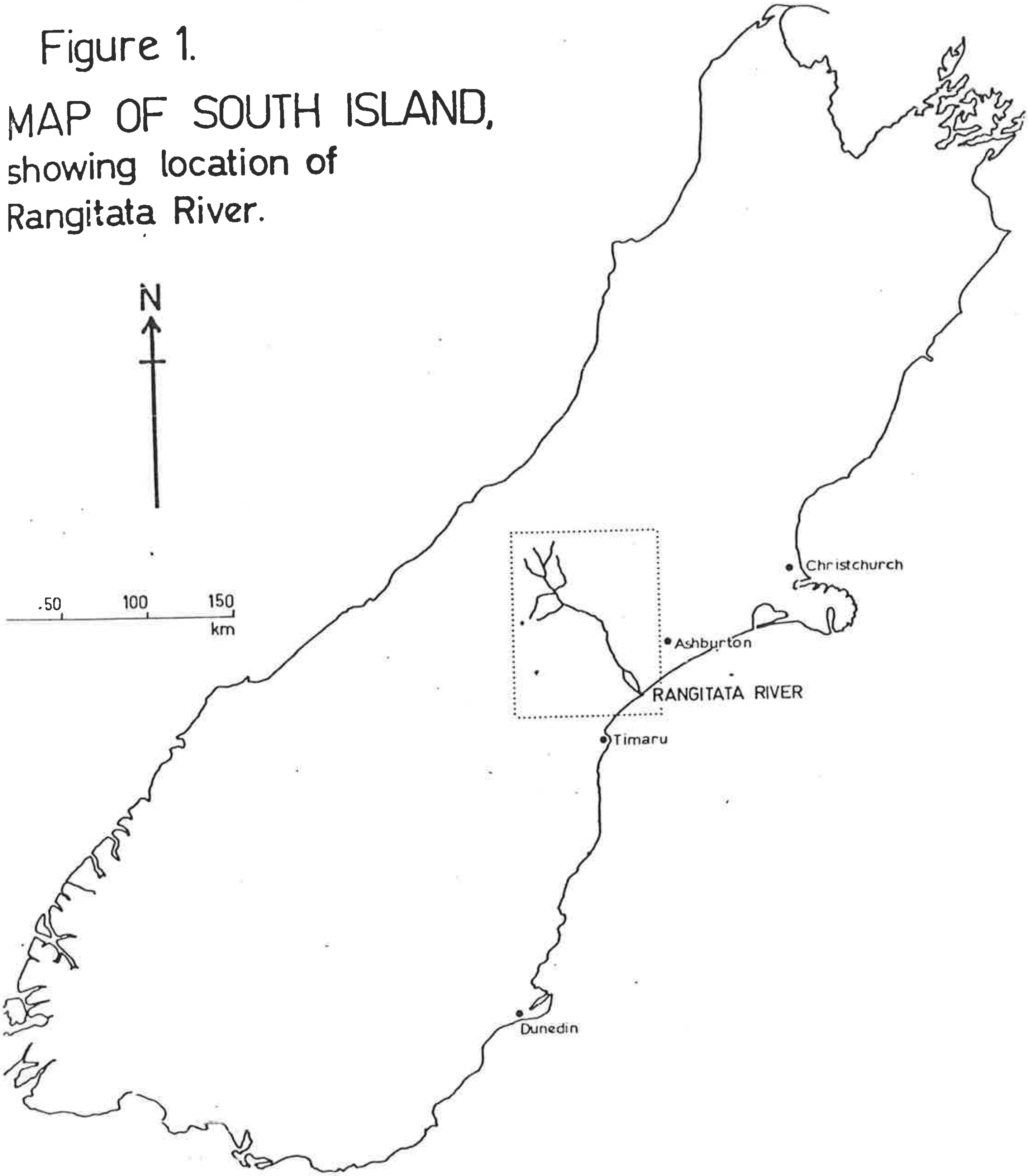
OBSERVER ....

Figure 1.

MAP OF SOUTH ISLAND, showing location of Rangitata River.



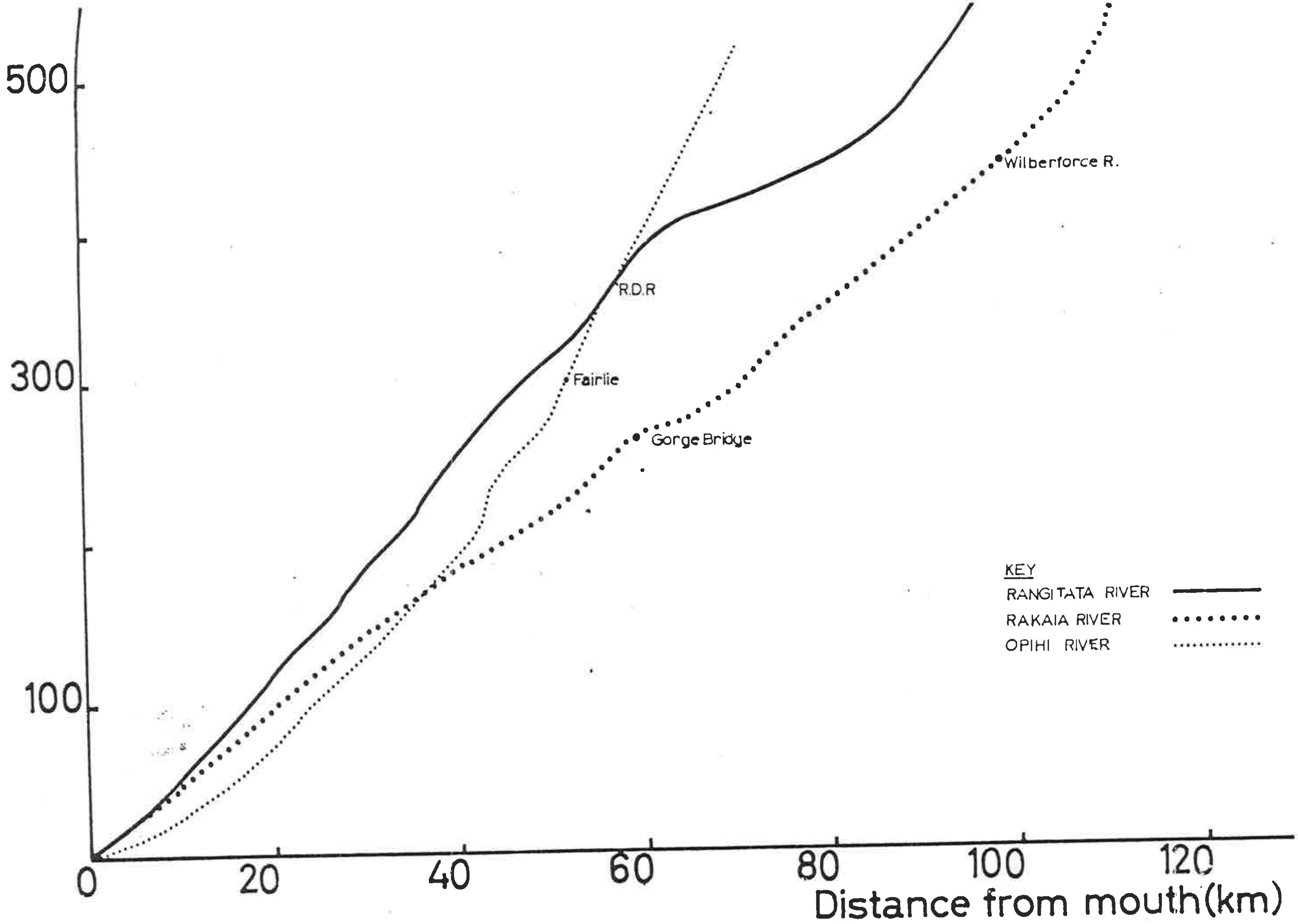


Figure 3. Comparison of River Profiles.

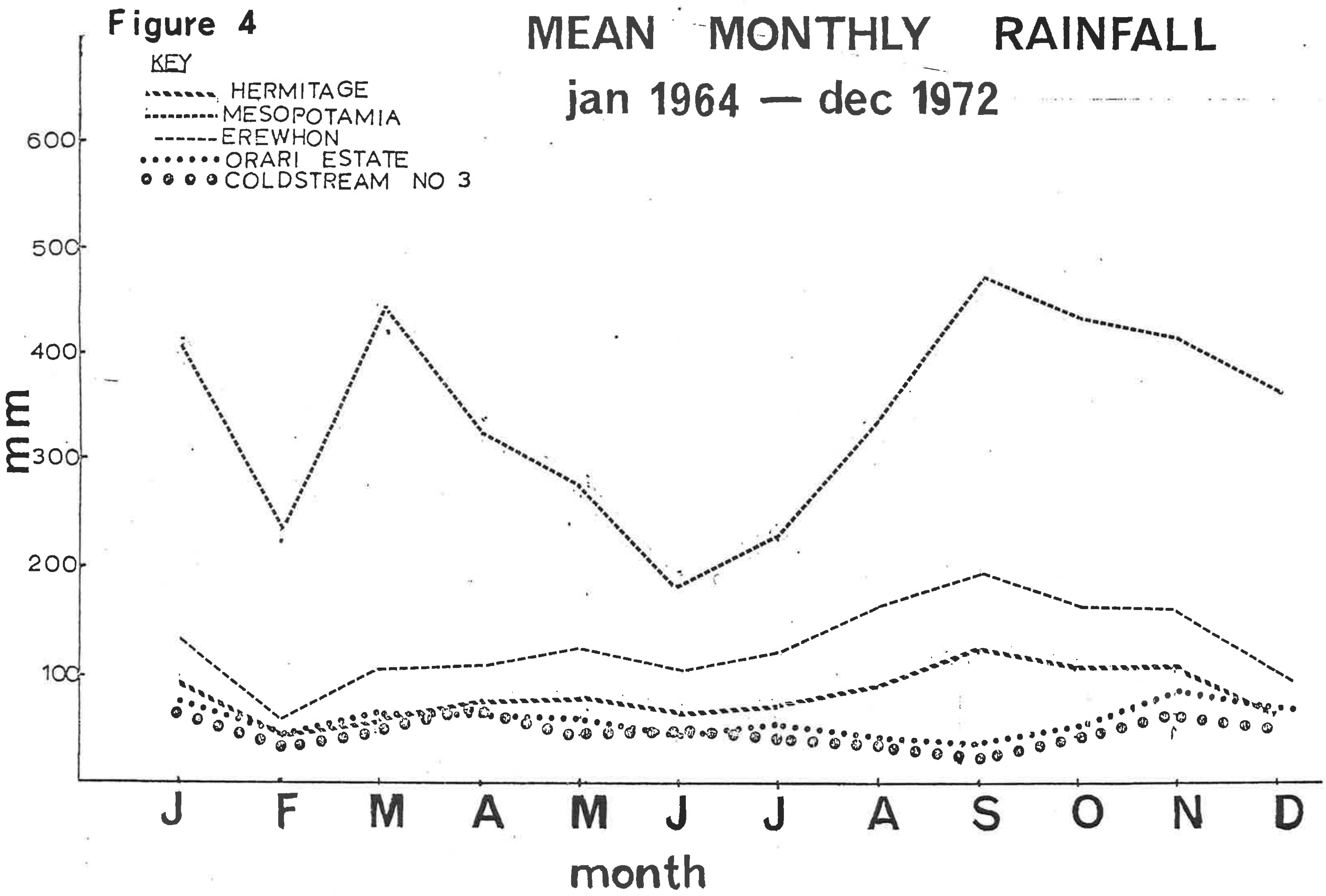


Figure 4
MEAN MONTHLY RAINFALL
jan 1964 — dec 1972
KEY
HERMITAGE
MESOPOTAMIA
EREWHON
ORARI ESTATE
COLDSTREAM NO 3
600
500
400
300
200
100
mm
J
F
M
A
M
J
J
A
S
O
N
D
month

RANGITATA RIVER DISCHARGE PATTERN

averaged mean monthly flows in cumecs
(from gorge recorder)

SEPT. 1967. to MAR. 1974.

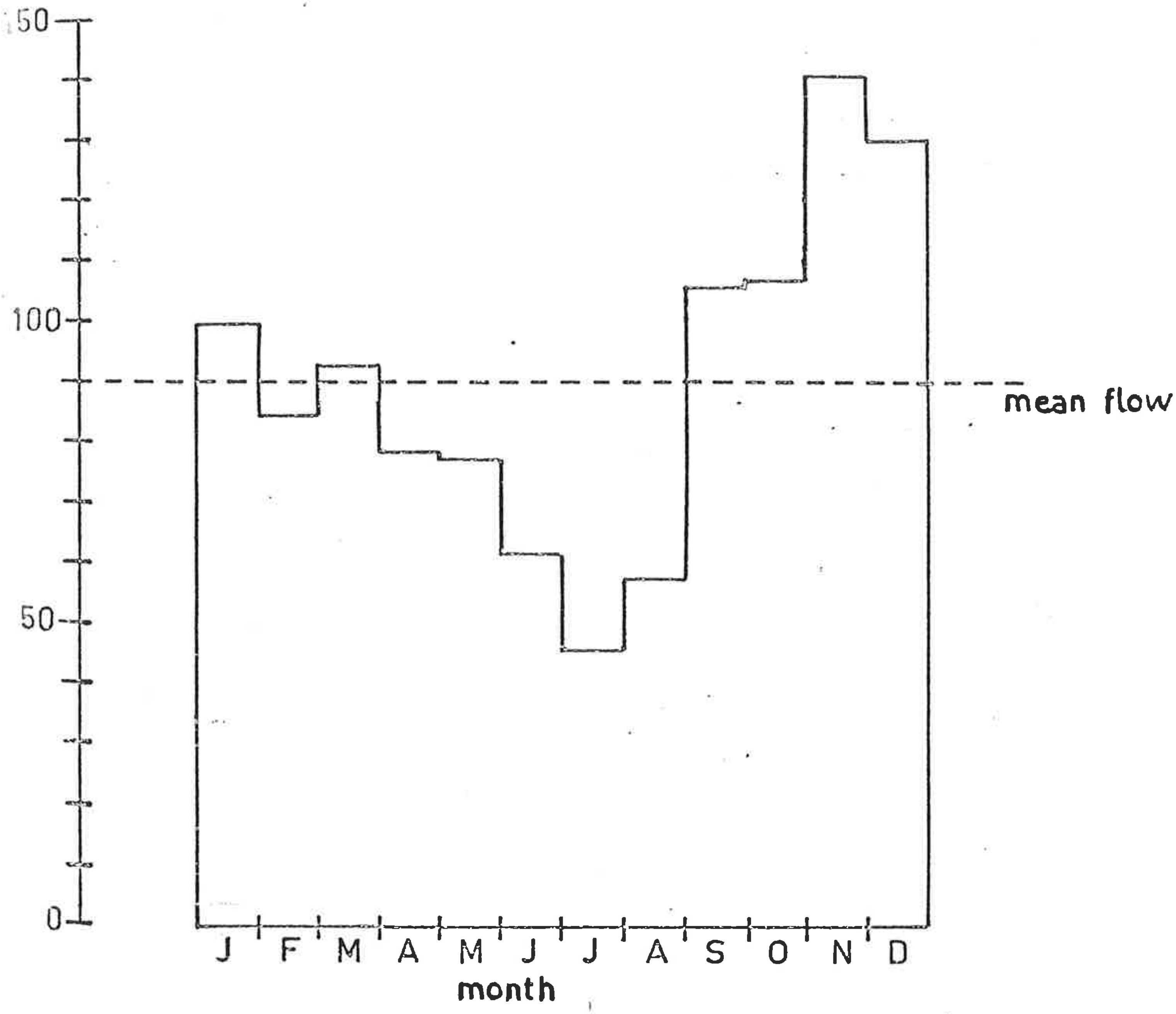
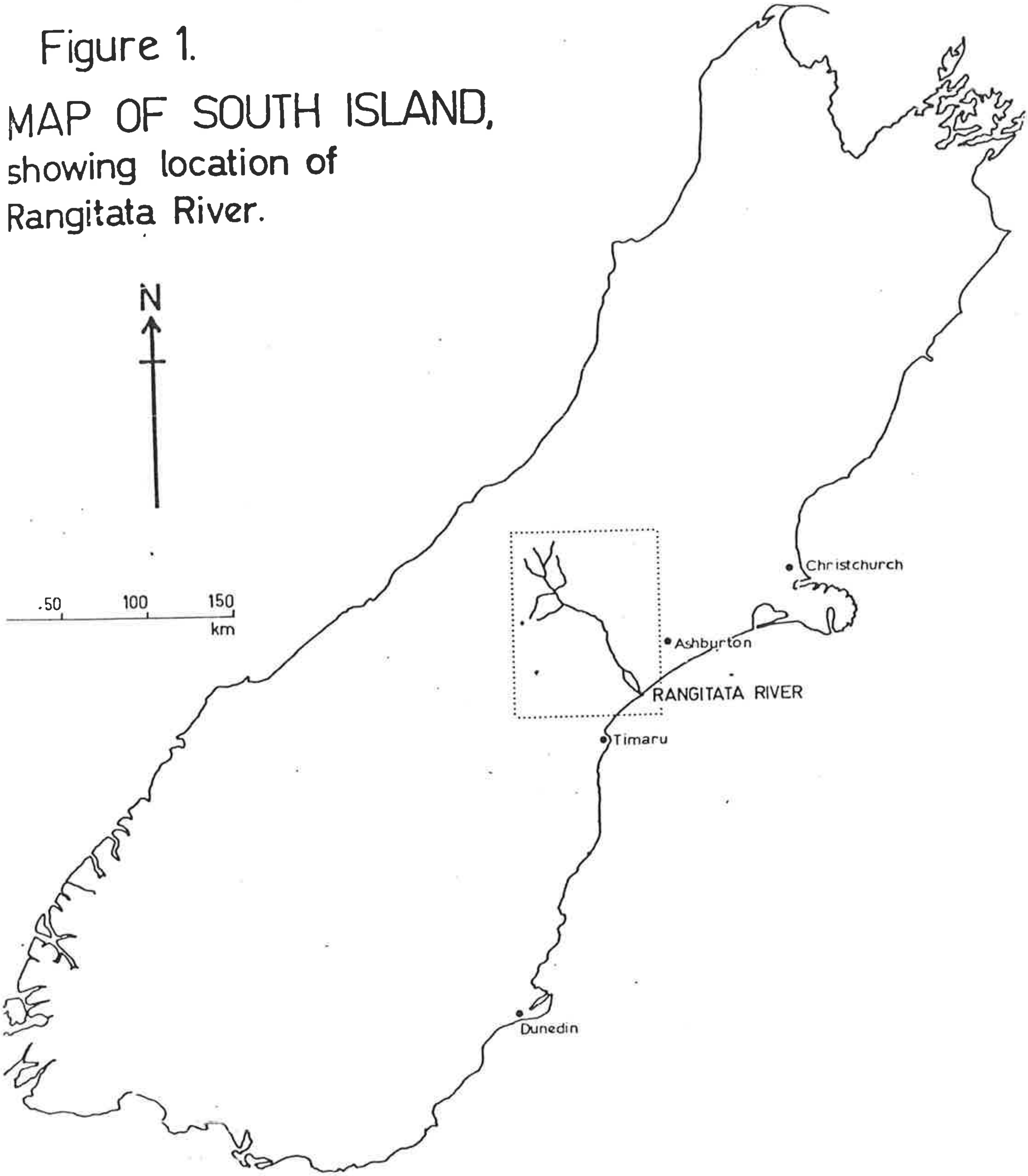


Figure 1.

MAP OF SOUTH ISLAND, showing location of Rangitata River.



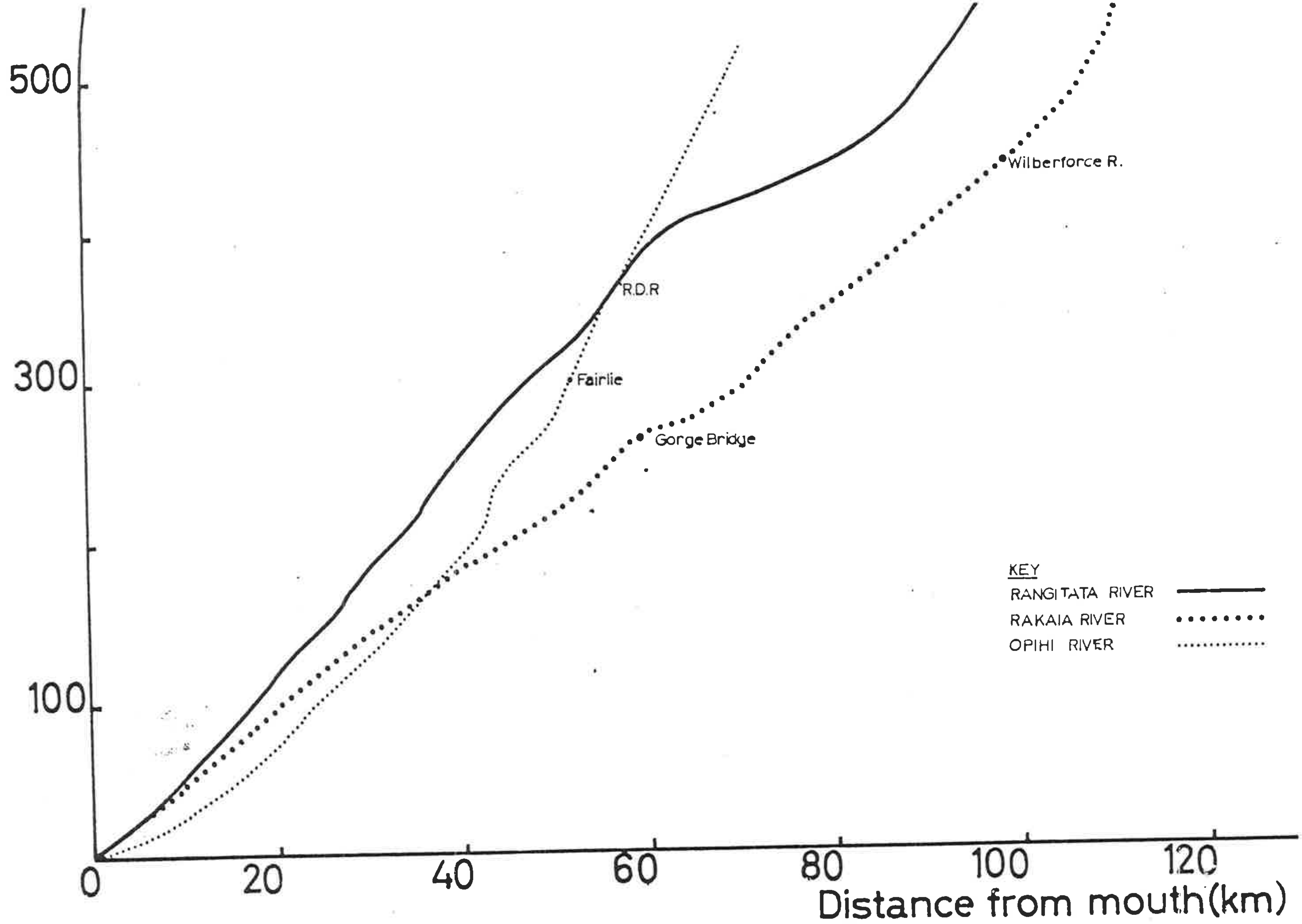
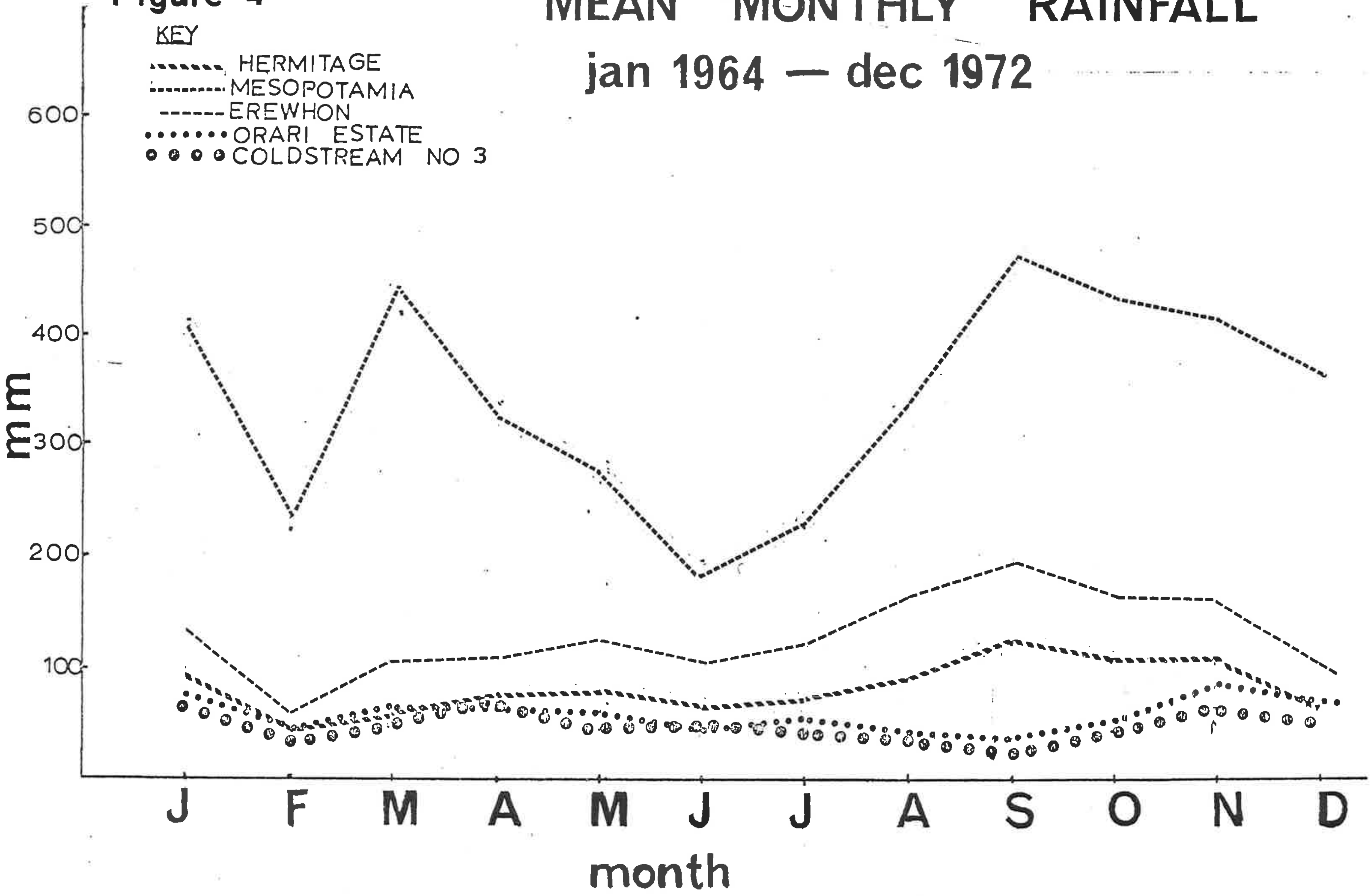


Figure 3. Comparison of River Profiles.

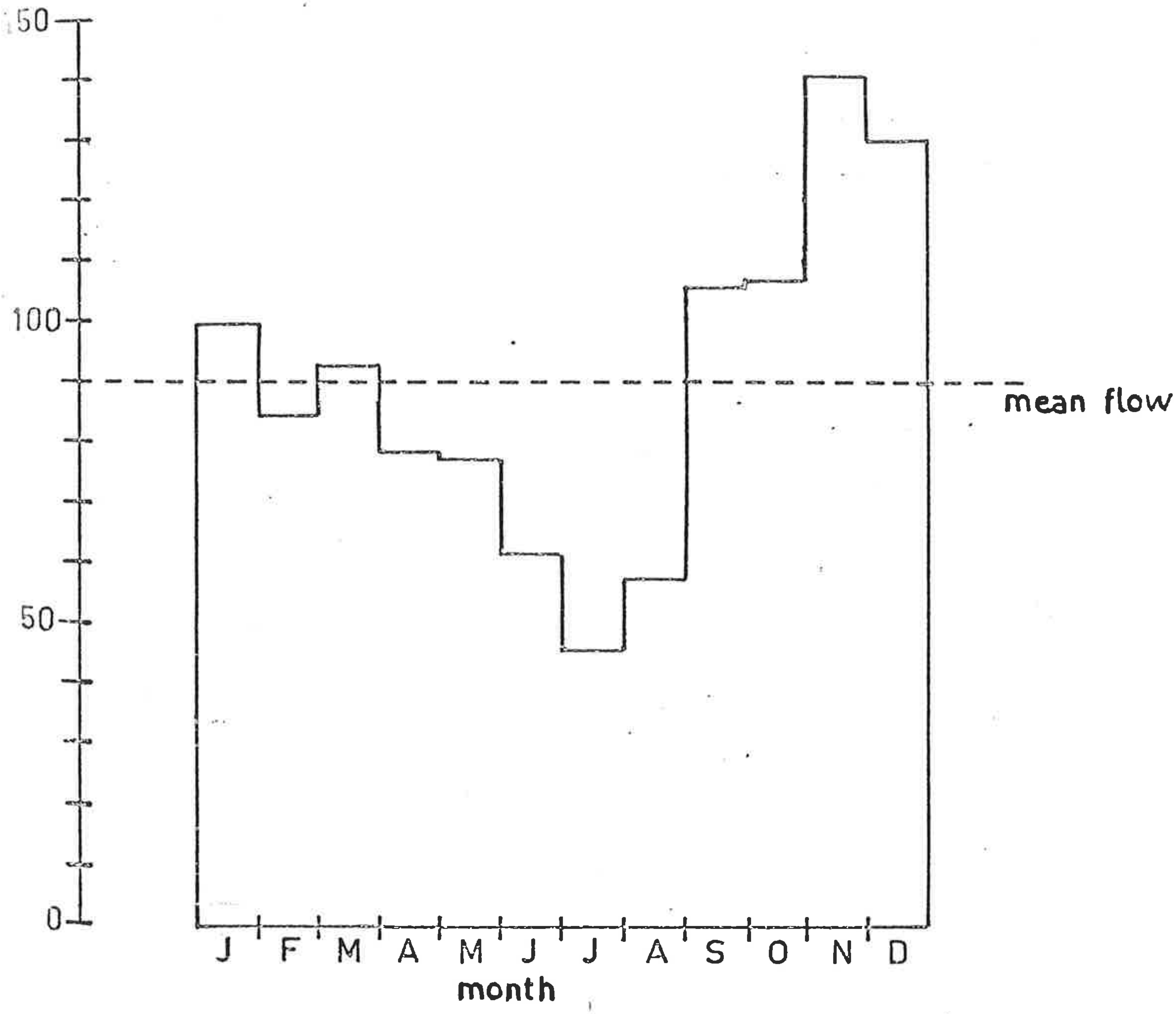
Figure 4 MEAN MONTHLY RAINFALL jan 1964 — dec 1972



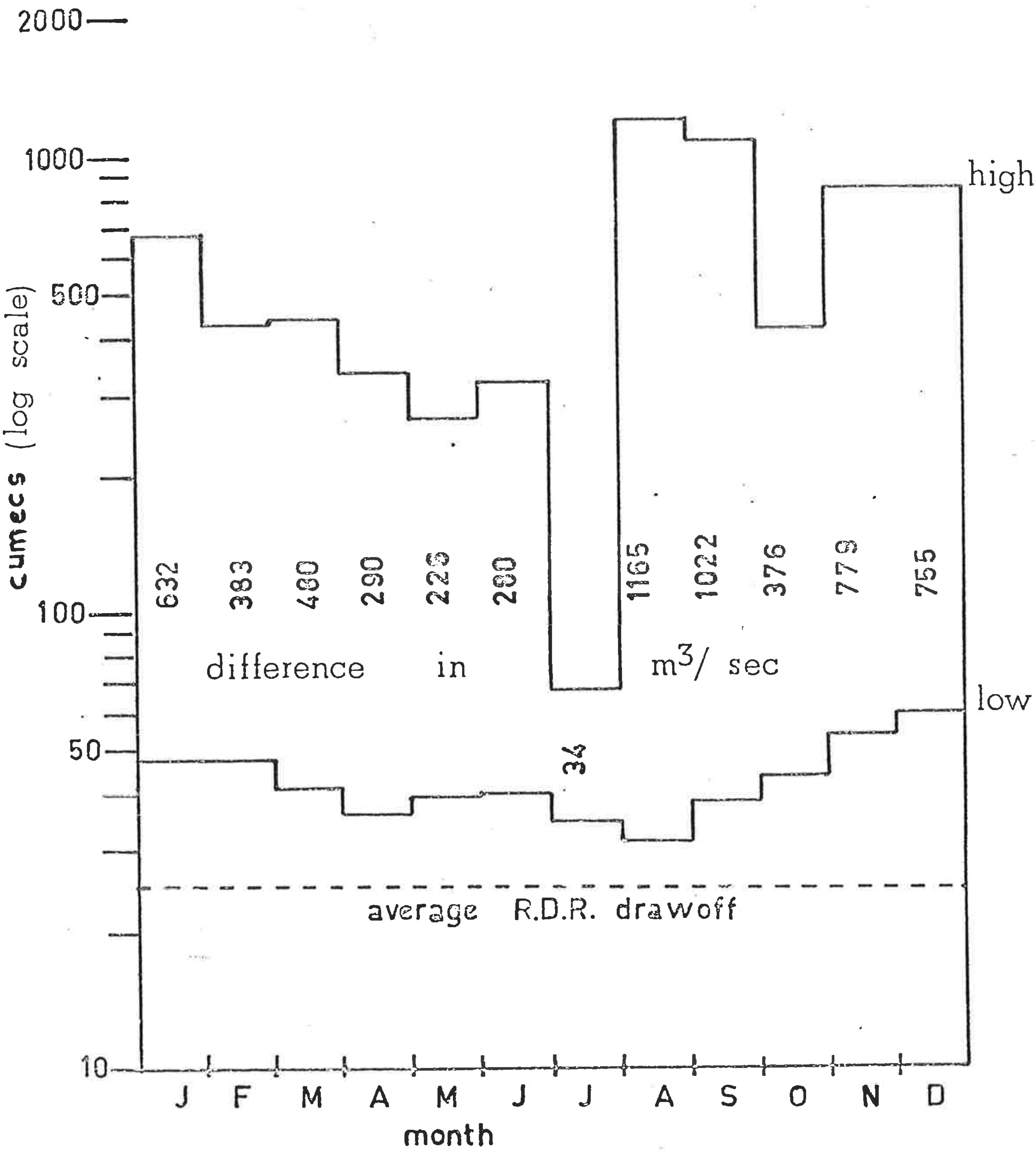
RANGITATA RIVER DISCHARGE PATTERN

averaged mean monthly flows in cumecs
(from gorge recorder)

SEPT. 1967. to MAR. 1974.



RANGITATA RIVER
monthly range of highest and lowest discharge (from gorge recorder)
SEPT. 1967 to MAR. 1974



RANGITATA RIVER
monthly range of highest and lowest discharge (from gorge recorder)
SEPT. 1967 to MAR. 1974

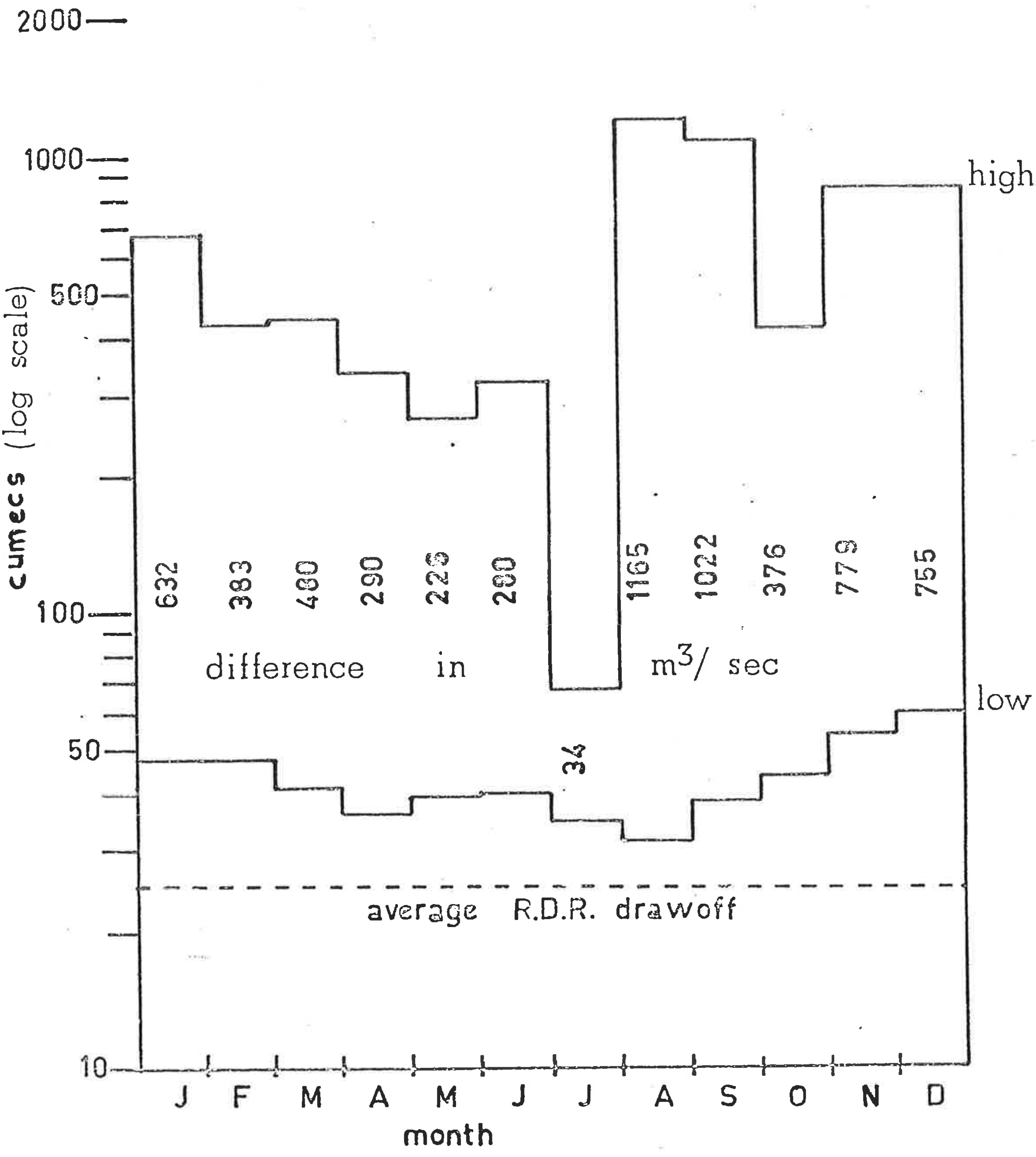
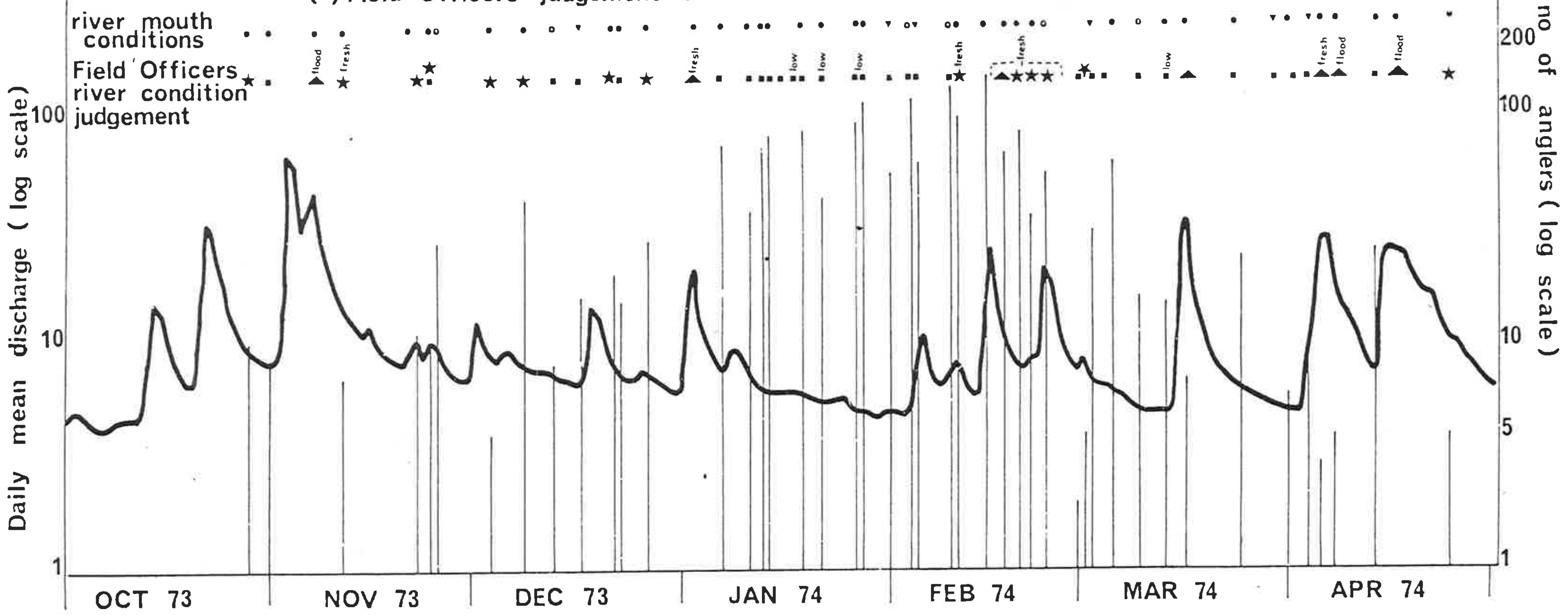


Figure 7

Angling activity Zone A Oct 73 - Apr 74
compared with (a) Hydrograph of mean daily discharge
(b) River mouth conditions
(c) Field Officers' judgement of river conditions

KEY
rivermouth:-
• GOOD
o FAIR
▾ POOR
river:-
▪ CLEAR
★ DISCOLOURED
▲ FLOOD



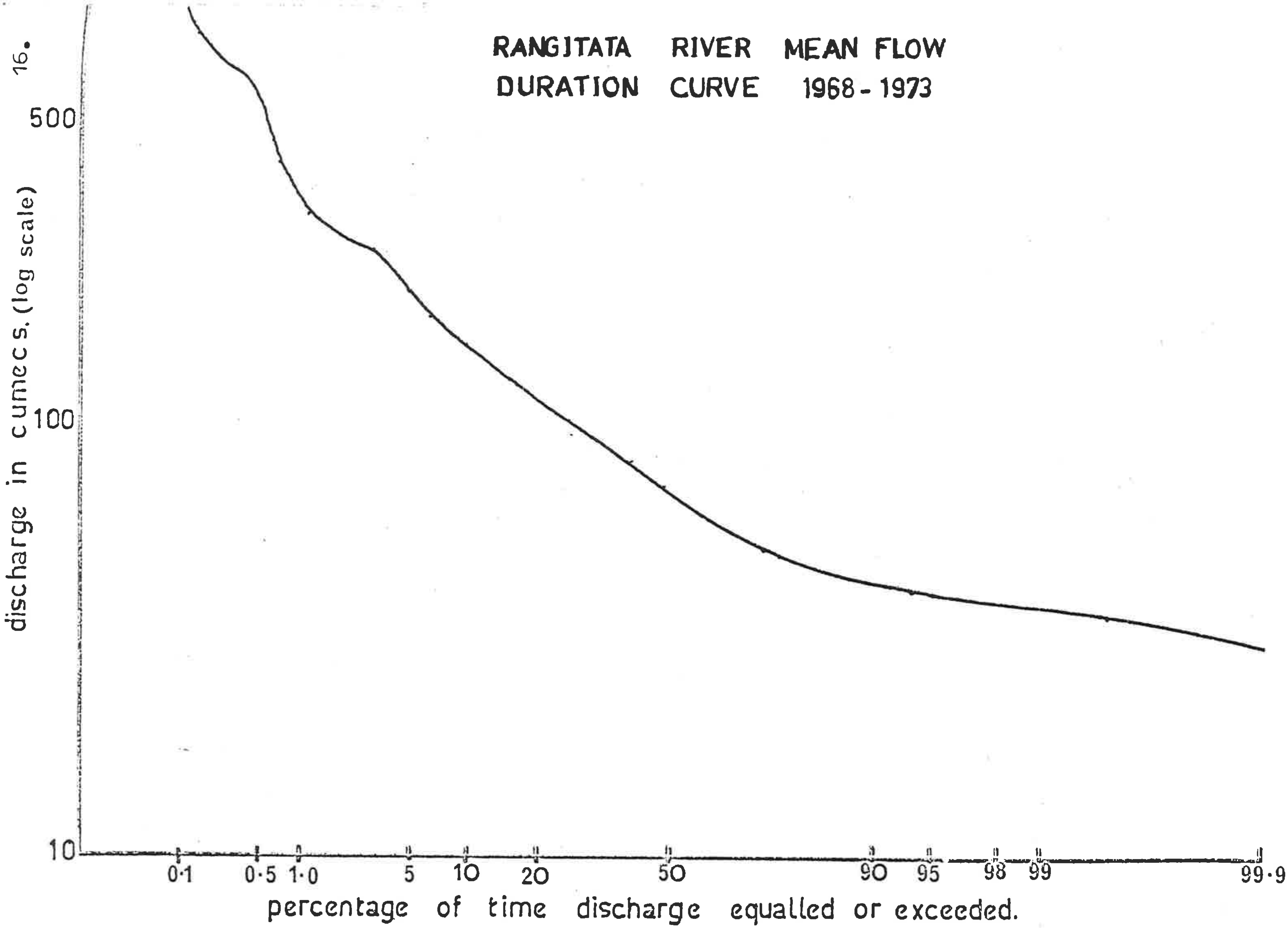

RANGITATA RIVER MEAN FLOW
DURATION CURVE 1968-1973
500
100
10
discharge in cumecs. (log scale)
0·1
0·5
1·0
5
10
20
50
90
95
98
99
99·9
percentage of time discharge equalled or exceeded.

Figure 9

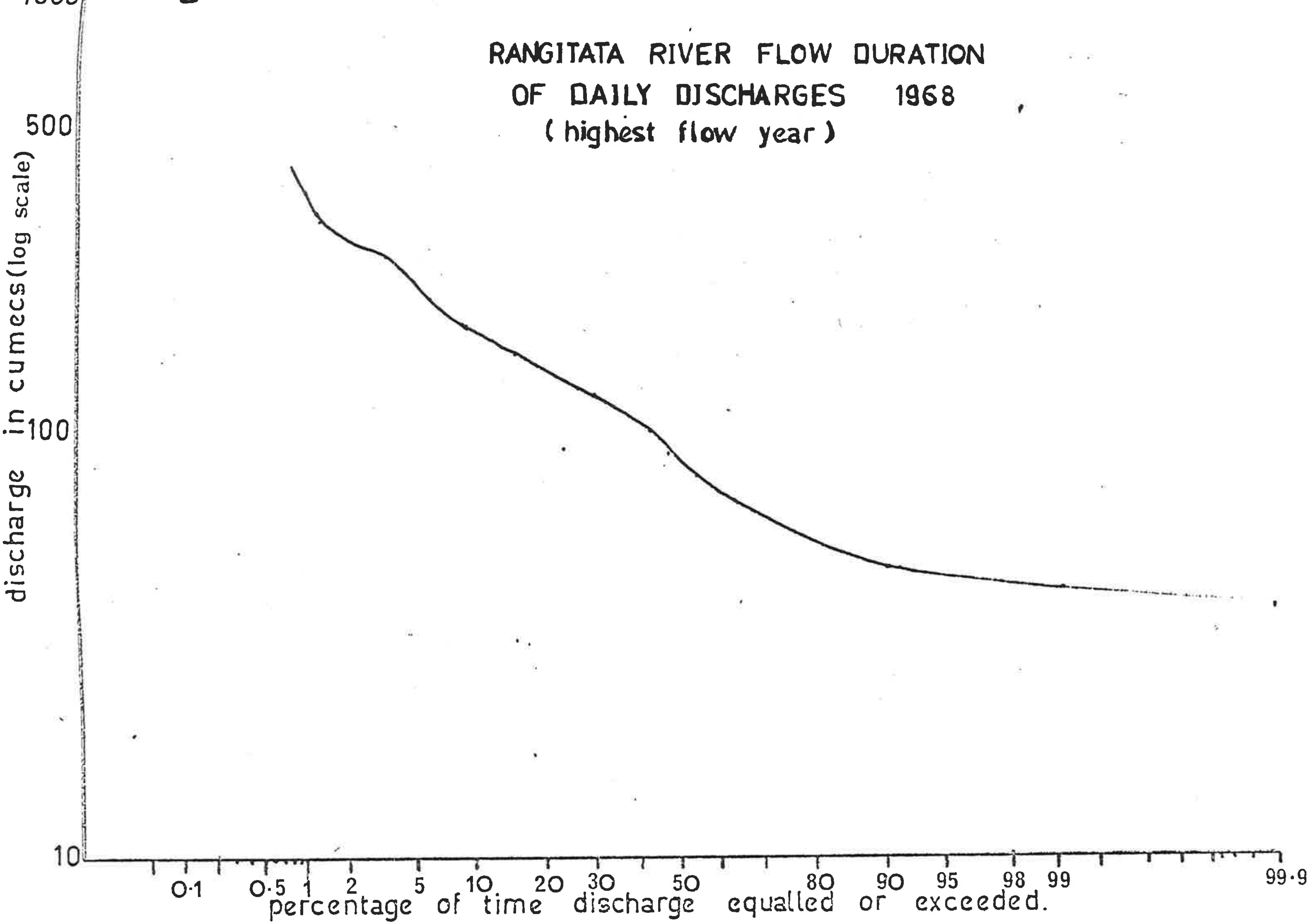

RANGITATA RIVER FLOW DURATION
OF DAILY DISCHARGES 1968
(highest flow year)
discharge in cumecs (log scale)
1000
500
100
10
0·1
0·5
1
2
5
10
20
30
50
80
90
95
98
99
99·9
percentage of time discharge equalled or exceeded.

Figure 10

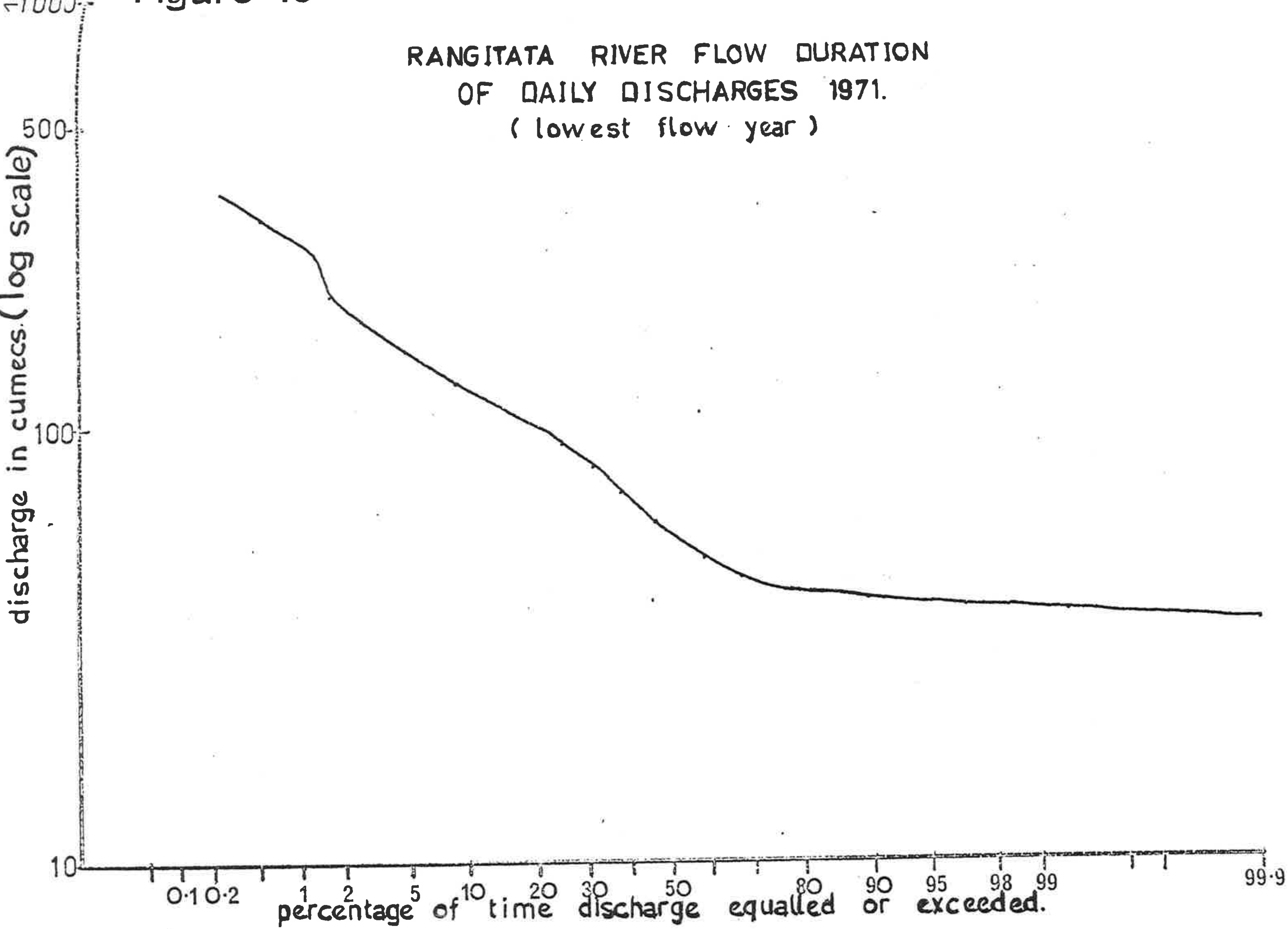

RANGITATA RIVER FLOW DURATION
OF DAILY DISCHARGES 1971.
(lowest flow year)
discharge in cumecs.(log scale)
1000
500
100
10
0·1
0·2
1
2
5
10
20
30
50
80
90
95
98
99
99·9
percentage of time discharge equalled or exceeded.

Figure 11

RANGITATA RIVER
% of time in months that flows of 4 ranges occur. (in cumecs from gorge recorder daily data).

SEPT. 1967. to MAR. 1974.

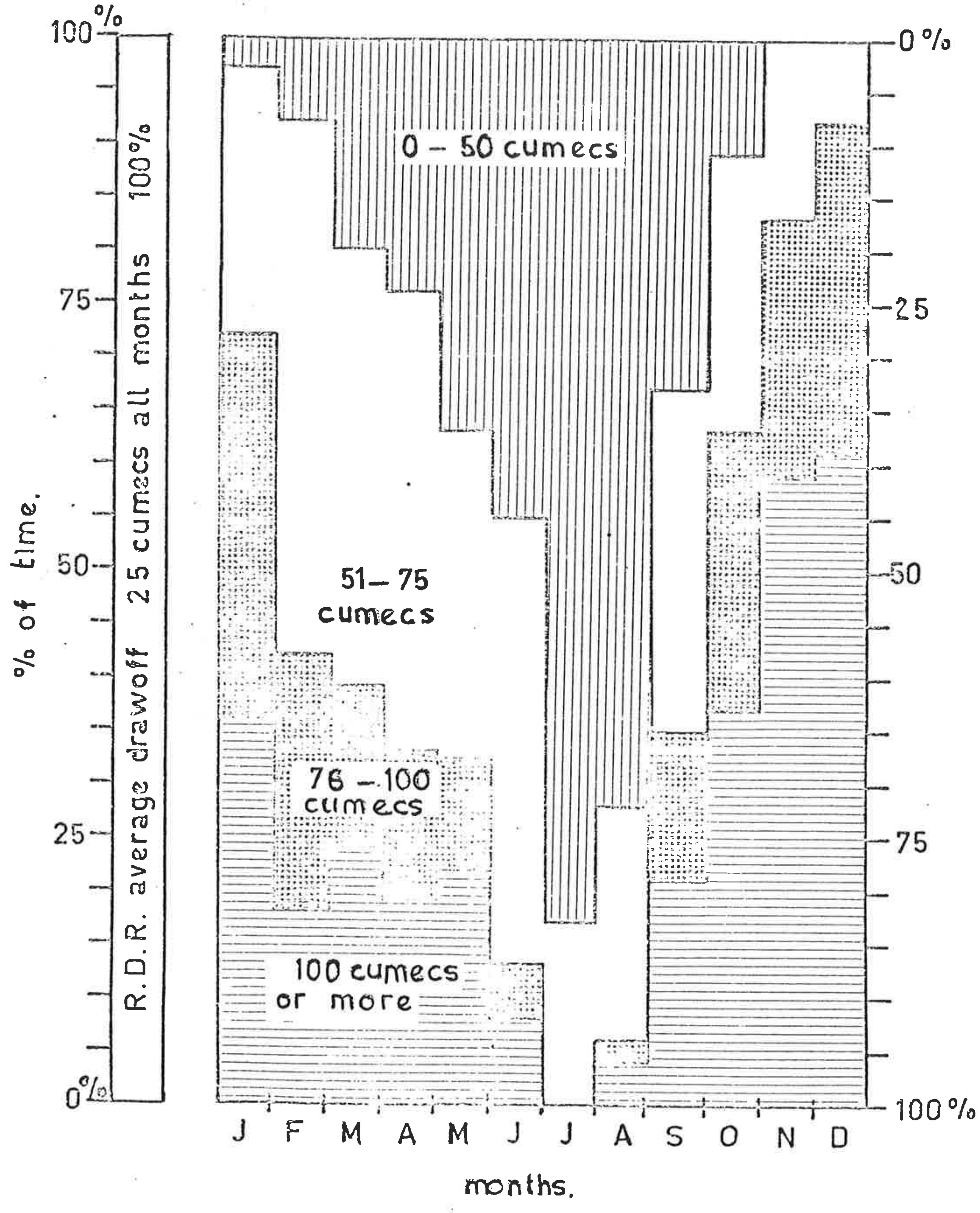
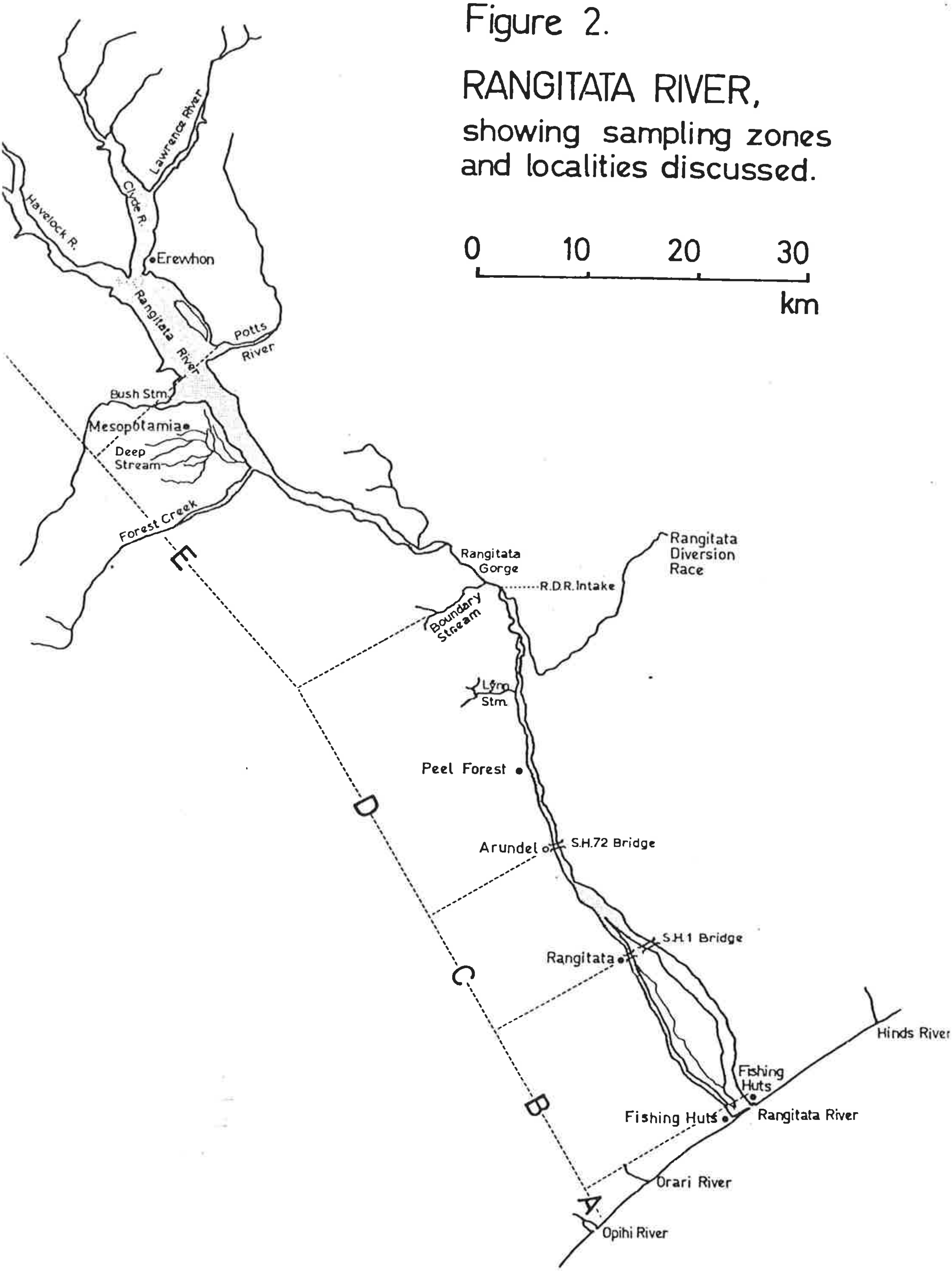
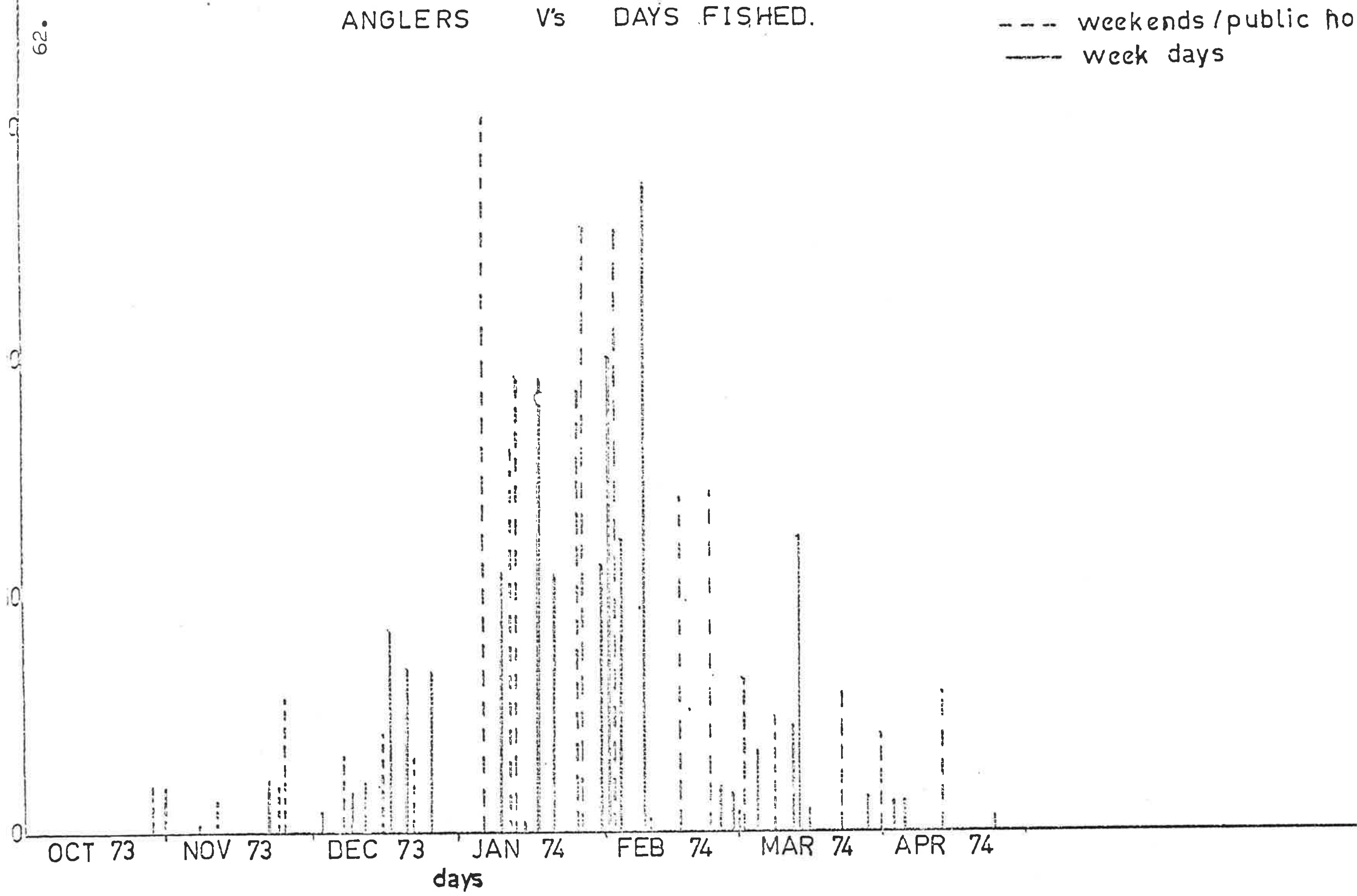


Figure 2.

RANGITATA RIVER, showing sampling zones and localities discussed.




ANGLERS V's DAYS FISHED.
weekends / public ho
week days
0
OCT 73
NOV 73
DEC 73
JAN 74
FEB 74
MAR 74
APR 74
days

ASHBURTON & SOUTH CANTERBURY ACCLIMATISATION SOCIETIES

RECREATIONAL ACTIVITY SURVEY

SURVEY DISTRICT [ ] ZONE | A | B | C | D | E | F |

	D	M	Y		AM	AM	PM	PM			
DATE				TIME					DIRECTION	UP	DOWN

DAY | WEEKDAY | HOLIDAY | WEEKEND |

		M	W	J	UN	TOTAL	CARS	BOATS	CAMPS
ANGLING (A)									
FISHING (N)									
ONLOOKERS									
WHITEBAIT									
BOATING									
SWIMMING									
PICNICKING									
WALKING									
GRAND TOTAL									

WEATHER | FINE | CLOUDY | OVERCAST | RAIN | HOT | AVERAGE | COLD |

WIND DIRECTION | GALE | STRONG | BREEZE | CALM |

MOUTH | OPEN | CLOSED |

CONDITION

RIVER | FLOOD | FRESH | NORMAL | LOW |

COLOUR | DIRTY | COLOURED | CLEAR |

OBSERVER ....

COMMENT ....

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ASHBURTON & SOUTH CANTERBURY ACCLIMATISATION SOCIETIES
ANGLER FIELD INTERVIEW

SURVEY DISTRICT [ ] ZONE | A | B | C | D | E | F |

DATE (D M Y) [ ] [ ] [ ] TIME (AM AM PM PM) [ ] [ ] [ ] [ ] DAY: WEEKDAY / HOLIDAY / WEEKEND

LICENSE NO. [ ] KIND: M | W | J CATEGORY: WS | M | W | D

LICENSE DISTRICT: A | SC | WV | NC | [ ] HOME [ ]

INTERVIEWED BEFORE: YES | NO TACKLE: T/L | F/D | F/W | [ ]

FISHING FOR: TROUT | SALMON | [ ] PREFER: TROUT | SALMON | [ ]

FISHING HOURS

6AM	12AM	6AM	12AM	TOTAL

% TIME: 25 | 50 | 75 | 100

CATCH

TROUT		SALMON		TOTAL	

BROWN

L (cm)	W (gm)

RAINBOW

L (cm)	W (gm)

QUINNAT

L (cm)	W (gm)

COMMENT ....
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OBSERVER ....