DEPARTMENT OF FISHERIES AND FAUNA
WESTERN AUSTRALIA

REPORT No. 10

# AN INVESTIGATION INTO THE STATUS OF INTRODUCED TROUT

*(Salmo spp.)*

IN

WESTERN AUSTRALIA

By

Dr. N. M. Morrissy

Published by the Director of Fisheries and Fauna, Perth, under the authority of the Hon. Ron Davies, M.L.A., Minister for Fisheries and Fauna

1972

Department of Fisheries and Fauna

Western Australia

---

# AN INVESTIGATION INTO THE STATUS OF INTRODUCED TROUT (*Salmo* spp.) IN WESTERN AUSTRALIA

By

Dr. N.M. MORRISSY

1971

# C O N T E N T S

# I INTRODUCTION

Both brown (Salmo trutta L.) and rainbow (S. gairdnerii Richardson) trout have been introduced into inland waters of the south-west of Western Australia to provide an amateur sport fishery on a gamefish. The large indigenous marron (Cherax tenuimanus Smith) is present in most of these waters. The only large native fish present is the cobbler (Tandanus bostocki Whitley) which, while highly edible like the marron, has no game-fish qualities.

Hatchery production of trout for stocking waters has been centred at Pemberton in the lower south-west since 1931 when Mr. Cyril Glew, acting in a private capacity, succeeded in hatching imported ova and releasing fry in the Warren District (See Annual Reports of the Pemberton -Warren Trout Acclimatization Society, 1943-1961, for accounts of activities of historical interest).

Despite the prolonged stocking activities lasting more than 36 years, when the present appraisal was commenced, in 1967, there was no clear information on whether trout acclimatization could be judged a success or failure. In fact informed opinion varied from the conclusion that the waters provided insufficient food for a successful trout fishery (Jenkins 1951-53) to the view that fishing comparable with the best in the eastern states was available (Francois, 1966).

For a full appraisal of the current situation the following questions require consideration:

(1) How does the distribution and abundance of wild populations of trout here compare with waters elsewhere where there are fisheries of acknowledged quality?

(2) What is the extent of present attempts at exploitation in terms of number of anglers, sophistication of angling techniques, and places fished?

(3) How successful are the anglers, who do fish here, in comparison with fishing returns elsewhere?

It is also important to compare the situation in Western Australia with the history of introduced trout in Eastern Australia and New Zealand where there has been:

(1) An initial stocking of streams which in all these other fisheries resulted in the establishment of self-sustaining wild populations of trout in the latter half of the last century (usually very small liberations, 500 - 2000 fry, were successful). Followed by,

(2) fishing of high quality on relatively unexploited stocks in waters little interferred with by man. And in recent years,

(3) fishing of gradually declining quality, particularly near large centres of population, due to over fishing and destruction of habitat. This situation has started since the 1950's.

Phases (1) and (2) have been called, respectively, the acclimatization and maintenance stages (Hobbs 1937). Phase (3) may be called the destructive stage. Hobbs (1937) in New Zealand and Nicholls (1958) in Tasmania showed that releases of artificially propagated trout had often been continued unnecessarily into stage (2) since trout, once established, reproduce satisfactorily. This situation exists in N.Z., Tasmania, most of Victoria and N.S.W., and a small part of S.A. for streams. However, there are some parts of these fisheries which have had to continuously be restocked since their inception because natural spawning is inadequate since survival of fish is poor due to summer climate. For example stocking is necessary in dams, lakes or streams where there are no feeder streams with suitable spawning gravel. Stocking is also necessary to maintain fishable stocks in marginal areas where survival is poor, in some years, due to high summer temperatures. The latter is the case for streams in western N.S.W., as Lake (1957) pointed out, as well as in western Victoria, and in S.A. These points become relevant when the latitude of the south-west, the altitude of the waters, and the hot dry summer climate are considered.

A distinction between the growth rate and density of fish is needed in evaluating the success of the fishery in terms of angling benefits. To many anglers the capture of a few large trout per day is comparable with the capture of many small fish only a few of which are just legal size. Trout in marginal waters where density is limited by summer conditions usually grow extremely rapidly reaching legal-size in a year or so. In contrast waters in colder regions usually have a high density of fish but the fish grow more slowly.

## II DISTRIBUTION

(a) Areas covered by stocking activities.

There is fragmentary evidence that some attempts were made before the turn of the century to establish trout in W.A. as in other parts of Australia. Streams mentioned are those in the areas of the Darling Ranges which, in retrospect, should have offered the highest chance of successful establishment e.g., at Serpentine, Harvey and Bridgetown. Since the fish had to be transported by ship from the eastern states there is no doubt that the number of fry released were small as was generally, the case, for example, in S.A., in those days. There is no evidence whatsoever that trout persisted from these stockings.

Later, in 1931, more determined efforts were made and, from a hatchery at Pemberton, streams over a wide area have been stocked to the present day. The extend of this activiity and the areas covered can be generally appreciated by considering the Trout Acclimatization Societies which largely existed, until repealed in 1965, for the purpose of stocking streams fished by members (Table 1). Experience of such activities has shown that because fish are released in springtime, when streams appear most suitable to the laymen concerned, that stocking has been extended into areas where summer conditions are obviously hostile for trout (e.g., at Gingin and Beverley).

There is no doubt that the waters of the South-West have been more than adequately stocked in terms of likely suitable places and numbers of introduced fish, i.e. for the phase of acclimatization of trout as defined in the introduction. The question that remains is whether by continued annual stocking the same mistake which has been made in other places in Australasia during phase two of the fishery, or whether the stocking is necessary to maintain trout here. Assessment of the status of wild populations as self-reproducing units is made difficult by this situation.

(b) Waters in which trout occur.

There are a number of different types of waters which should be considered (Table 2):

Type 1. Rivers and their tributaries.

Type 2. Water supply dams and irrigation dams.

Type 3. Small lakes, or lagoons, or dams with clear water.

Type 4. Small dams with turbid water.

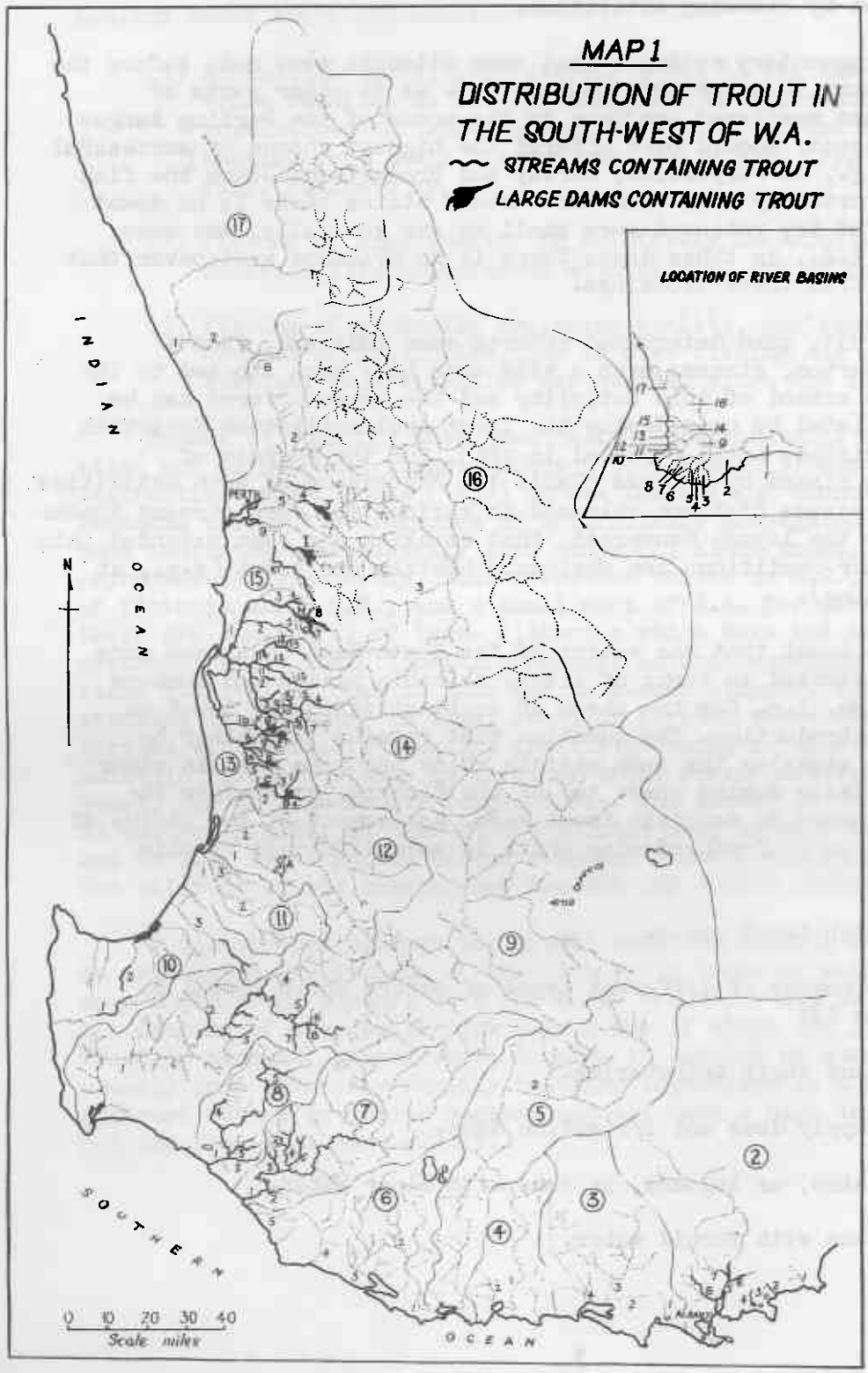
MAP 1
DISTRIBUTION OF TROUT IN THE SOUTH-WEST OF W.A.
STREAMS CONTAINING TROUT
LARGE DAMS CONTAINING TROUT
LOCATION OF RIVER BASINS
INDIAN OCEAN
SOUTHERN OCEAN
N
0 10 20 30 40
Scale miles

Table 1

TROUT ACCLIMATIZATION SOCIETIES

INCLUDED IN ACT BY FISHERIES ACT

AMENDMENT ACT 1940

| Name of Society | Appd. by Ex. Co. | Gazetted |
|---|---|---|
| Harvey Fish and Game T.A.S. | 18.4.51 | 27.4.51 |
| Serpentine-Jarrahdale-Beverley | 2.7.48 | 16.7.48 |
| Blackwood | 15.5.49 | 3.6.49 |
| Pemberton-Warren | 23.12.42 | 31.12.42 |
| Murray-Dwellingup | 19.5.47 | 6.6.47 |

Registrations cancelled by repeal of Part IIIA, (Trout Acclimatisation) by Fisheries Act Amendment Act passed 9.11.65. Gazetted 19.11.65.

---

Collie and District 10.2.43 26.2.43

Society disbanded - lack of interest. Registration cancelled by Executive Council 2.7.58. Gazetted 11.12.58.

---

Gingin 10.3.52 21.3.52

Society disbanded because of lack of interest. Registration cancelled by Executive Council 2.7.58. Gazetted 11.7.58.

---

Albany, Denmark and Plantagenet 18.2.55 25.2.55

Society disbanded due to lack of interest. Registration cancelled by Executive Council 8.7.64. Gazetted 17.7.64.

---

Part IIIA of the Fisheries Act (Trout Acclimatisation) was repealed by the Fisheries Act Amendment Act passed on 9.11.65 and Assented to in the Government Gazette 19.11.65.

---

Table 2

## LISTING OF TYPES OF WATERS AND LEGEND FOR MAP 1

TYPE 1

Catch rates are taken from log book data supplied by anglers (See III,a). For an explanation of stream order see Fig. 2.

| River Basin | | Name of Stream | Stream Order | Brown Trout Present | Rainbow Trout Present | Highest Catch Rate (No. of Takeable fish per mile) |
|---|---|---|---|---|---|---|
| II Albany Coast | 1 | Waychinicup Riv. | 1 | | | |
| | 2 | King Creek | 1 | | * | 2.7 |
| | 3 | Angove Creek | 1 | | | |
| | 4 | Goodga River (Blackcat Creek) | | | * | |
| | 5 | Kalgan River | 1 | | * | |
| | 6 | Bull Creek | 2 | | * | |
| | 7 | Napier Brook | 2 | | * | 0.0 |
| | 8 | King River | 1 | | * | 4.0 |
| | 9 | Limeburner's Creek | 1 | | | |
| III Denmark River | 1 | Marbellup Creek | 1 | | | 0.0 |
| | 2 | Sleeman River | 1 | | | |
| | 3 | Hay River | 1 | | (*) | |
| | 4 | Denmark River | 1 | | | |
| IV Kent River | 1 | Kent River | 1 | | | |
| | 2 | Bow River | 1 | | | |
| V Franklin River | 1 | Franklin River | 1 | | | |
| | 2 | Gordon River | 2 | | | |
| VI Shannon River | 1 | Deep River | 1 | | | 0.0 |
| | 2 | Weld River | 2 | | | |
| | 3 | Shannon River | 1 | | (*) | |
| | 4 | Gardener River | | | | |
| | 5 | Meerup River | 1 | | | |
| VII Warren River | 1 | Warren River | 1 | ** | (*) | 6.0 |
| | 2 | Dombakup Brook | 2 | * | | |
| | 3 | Treen Brook | 2 | ** | (*) | 4.0 |
| | 4 | Lefroy Brook | 2 | ** | (*) | 13.1 |
| | 5 | Big Brook | 3 | * | | |
| | 6 | Eastbrook | 3 | * | * | 6.0 |

| River Basin | | Name of Stream | Stream Order | Brown Trout Present | Rainbow Trout Present | Highest Catch Rate (No. of takeable fish per mile) |
|---|---|---|---|---|---|---|
| VIII Donnelly River | 1 | Donnelly River | 1 | * | ** | 3.00 |
| | 2 | Fly Brook | 2 | | * | |
| | 3 | Carey Brook | 2 | | * | 0.0 |
| | 4 | Barlee Brook | 2 | | * | 8.0 |
| | 5 | Manjimup Brook | 2 | | * | |
| IX Blackwood River | 1 | Blackwood River | 1 | | * | 2.0 |
| | 2 | St. John Brook | 2 | | * | |
| | 3 | Nannup Brook | 2 | | * | |
| | 4 | Balingup Brook | 2 | | (*) | |
| | 5 | Dalgarup Brook | 2 | * | * | 11.2 |
| | 6 | Geegelup Brook | 2 | | * | 4.0 |
| | 7 | Mokerdillup Brook | 2 | * | * | |
| | 8 | Shepherds Brook | 2 | | * | 0.7 |
| X Busselton Coast | 1 | Margaret River | 1 | | * | |
| | 2 | Vasse River | 1 | * | | |
| | 3 | Capel River | 1 | * | | |
| XI Preston River | 1 | Preston River | 1 | | (*) | |
| | 2 | Joshua Creek | 2 | | (*) | |
| | 3 | Ferguson River | 2 | | | |
| XII Collie River | 1 | Collie River | 1 | | | |
| | 2 | Brunswick River | 2 | | (*) | |
| XIII Harvey River | 1 | Harvey River | 1 | * | * | 3.0-4.0 |
| | 2 | Mornington Creek | 3 | | (*) | |
| | 3 | Waterfall Creek | 2 | Sp | | |
| | 4 | Tallanalla Creek | 2 | * | | |
| | 5 | Clarke Brook | 2 | | * | 2.0 |
| | 6 | Logue Brook | 2 | | * | |
| | 7 | Bancell Brook | 3 | | * | |
| | 8 | Samsons Brook | 2 | | * | 5.0 |
| | 9 | McKnoes Brook | 3 | | * | 3.0 |
| | 10 | Drakesbrook | 2 | | * | 1.5 |
| | 11 | Wiskey Brook | 3 | | * | |

| River Basin | | Name of Stream | Stream Order | Brown Trout Present | Rainbow Trout Present | Highest Catch Rate (No. of takeable fish per mile) |
|---|---|---|---|---|---|---|
| XIV Murray River | 1 | Murray River | 1 | (*) | * | 35.2 |
| | 2 | Oakley Brook | 2 | | * | |
| | 3 | Marrinup Creek | 2 | * | * | 0.4 |
| | 4 | Davies Brook | 2 | | * | 17.6 |
| | 5 | Holyoake Creek | 3 | | (*) | |
| | 6 | Dwellingup Brook | 2 | | * | 0.0 |
| | 7 | Swamp Oak Brook | 2 | | Sp | |
| | 8 | Nanga Brook | 2 | | Sp | |
| | 9 | Farley Brook | 2 | | Sp | |
| | 10 | Cypress Brook | 2 | | * | |
| | 11 | South Dandalup Riv. | 2 | | * | 1.4 |
| | 12 | Conjurinup Creek | 3 | | * | |
| | 13 | Banksiadale Creek | 3 | | (*) | |
| | 14 | North Dandalup Riv. | 3 | | * | 4.0 |
| | 15 | Cronins Brook | 4 | | * | |
| | 16 | Fosters Brook | 5 | | (*) | |
| XV Canning - Serpentine Rivers | 1 | Serpentine River | 1 | | * | 0.7 |
| | 2 | Dirk Brook | 2 | | * | |
| | 3 | Whitby Falls Brook | 2 | | (*) | |
| | 4 | Cooralong Brook | 2 | * | * | 3.4 |
| | 5 | Snake Brook | 2 | | Sp | |
| | 6 | Bull Brook | 2 | | Sp | |
| | 7 | Big Brook | 2 | | * | |
| | 8 | 39 Mile Brook | 2 | | * | |
| | 9 | Canning River | 1 | * | | |
| | 10 | Wongong Brook | 2 | | * | 2.0 |
| XVI Swan-Avon Rivers | 1 | Swan River | 1 | | | |
| | 2 | Avon River | 2 | | | |
| | 3 | Dale River | 3 | | (*) | |
| | 4 | Jane Brook | 2 | | * | |
| | 5 | Helena River | 2 | * | | |
| | 6 | Lennards Brook | (1) | (*) | | |

| River Basin | Name of Stream | Stream Order | Brown Trout Present | Rainbow Trout Present | Highest catch Rate (No. of takeable fish per mile |
|---|---|---|---|---|---|
| XVII Moore-Hill Rivers | 1 Moore River | 1 | (*) | | |
| | 2 Gingin Brook | 2 | (*) | | |

* Trout present and persist naturally.

(*)Trout do not persist without regular stocking.

** Species designated is more abundant.

Sp Small stream holding mature fish during spawning season.

TYPE 2

| River Basin | Name of Dam | Brown Trout Present | Rainbow Trout Present | Highest Catch Rate (No. of takeable fish per hour) |
|---|---|---|---|---|
| (i) Larger water supply and irrigation dams. | | | | |
| 12 Collie River | A Wellington | - | - | - |
| 13 Harvey River | B Stirling | * | * | 1.0 |
| | C Harvey | * | * | 2.7 |
| | D Logue Brook | * | ** | 2.9 |
| | E Samsons | | * | 3.6 |
| | F Drakesbrook | * | * | 4.0 |
| | G Waroona | | | 11.3 |

TYPE 2

| River Basin | Name of Dam | Brown Trout Present | Rainbow Trout Present | Highest Catch Rate (No. of takeable fish per hour) |
|---|---|---|---|---|
| 15 Canning-Serpentine Rivers | H Serpentine + | | * | |
| | I Canning + | * | | 1.0 |
| 16 Swan-Avon Rivers | J Mundaring + | * | | |
| (ii) Smaller dams | | | | |
| 15 Canning-Serpentine Rivers | ( Bickley | | * | |
| | ( Victoria + | | (*) | |
| | ( Churchman's Brook+ | | | |
| 14 Murray River | Banksiadale | | (*) | |
| | Oakley | | (*) | 0.7 |
| 13 Harvey | Mornington Mill | | (*) | |
| 11 Preston River | New irrigation dam | | | ) |
| 8 Donnelly Riv. | Bunn's | | * | 0.4 |
| 7 Warren River | Scabby gully + | * | * | |
| | Lefroy | * | * | 1.2 |
| 6 Shannon River | Shannon Mill | | (*) | |
| 2 Albany Coast | Angove | | (*) | |

+ Not open to public fishing.

TYPE 3

(i) Natural lakes and lagoons.

| | | | |
|---|---|---|---|
| Albany area: | Swan, Sepping, Moates Lagoon, | --- | |
| Pemberton : | Deadmans, Charley, Fly Brook, | --- | See Text |
| Perth : | Bibra, Yanchep, Wanneroo, | --- | |

Types 3 and 4 usually offer no spawning facilities for trout and management, i.e. periodic stocking at about three year intervals, is necessary as each year-class grows to takeable size and is removed.

Type 4 waters are turbid farm dams in the dryer, hotter areas east of the Darling coastal ranges. These dams were the basis of an extensive sales promotion campaign by the Pemberton Trout Board in the 1950's which, for climatic reasons, was a failure. Growth of trout is poor in these dams and oxygen depletion may occur during the summer in the bottom water due to temperature stratification.

Type 3 waters are either natural lakes or lagoons near the coast, or man-made gully dams in the ranges. Some waters of the former class have sufficient depth of water to provide refuge from summer heat for trout. These occur in the Albany district, south of Pemberton and on the Perth coastal plain. With frequent restocking introductions are known to have been successful, e.g., in Deadmans Lake south of Pemberton and in Lake Yanchep. Currently lakes near Albany, Pemberton and Perth have been restocked and will be evaluated shortly.

The small man-made dams of type 3 are found in the ranges from Perth around to Albany. Usually these are small dams on private land. There is no doubt that trout do extremely well in these dams and that if trout are preferred to marron the dams could represent the largest source of trout for food and sport. Restocking is necessary because the trout usually will not reproduce naturally.

Type 2 waters comprise water supply dams, not open to public angling, and irrigation dams open to public multi-recreational use. The larger dams of interest are situated on rivers in the Darling Scarp between the latitudes of Perth and Bunbury (Map 1). Mundaring, Canning, and Serpentine are public water supply dams. Serpentine dam was built in 1961 on the Serpentine River which by repute had been the best trout angling stream in W.A. until this date. Serpentine dam contains Rainbow trout of large average size as determined from observations of spawning in streams which feed into the dam. The existence of some self-reproducing trout is also known for Mundaring and Canning dams.

The irrigation dams Waroona, Samsons, Logue Brook, Harvey, Drakes - Brook, Stirling, and Wellington can be rated in that order from containing trout in abundance at the present time to not containing trout (Wellington). Drakesbrook and Harvey have Waroona and Stirling dams, respectively, upstream from them on the large supply rivers. Waroona, Samsons and Logue Brook have only very small streams entering them.

This type of dam is subject to extreme changes both seasonally and during the first few years after filling for the first time. There is a very large yearly drop in water level from winter and spring, when they are full, to autumn, due to summer demands for water. When a dam of this type first fills (e.g. Logue Brook Dam in 1964 and Waroona Dam in 1967) the drowning of terrestrial plant material leads to abundant food for trout in the form of invertebrate food chains based on the decomposing plant debris. There is inevitably a decrease in growth rate of trout after several seasons due to the disappearance of the plant material. The annual drawdown does not allow the growth of emergent plants along the shorelines. In 1965 when Dr. Francois visited W.A., Logue Brook Dam was in the early stages of this transition and producing large trout. He therefore gained the impression that Logue Brook Dam was indicative of trout waters in general. Although Logue Brook still contains adequate numbers of trout for fishing the growth of the fish now is relatively slow (see later).

Similarly in the last two years, the newly-filled Waroona Dam has provided an excellent stock of fast-growing fish. The activity of fish feeding in the drowned vegatation near the shoreline is another attraction to anglers (see Plate 1).

There are three main areas of type 1 waters (rivers and tributaries) containing trout (Map 1 and Table 2). The heaviest concentration of trout streams occurs between Perth and Harvey in the Serpentine, Murray and Harvey River systems. Secondly there are the Blackwood, Donnelly and Warren River systems. And thirdly, and least in importance, are the King and Kalgan Rivers and tributaries at Albany together with very small streams just east of Albany.

(c) Climate

All the streams lie between latitudes $32^{\circ}$ and $35^{\circ}$. The Blackwood area is about 50 miles from the coast while other streams are within 30 miles of the coast. None of the stretches of perennial streams are located above 1000' altitude although some peaks in the Darling Scarp and Albany watersheds rise above this height. Usually the streams are located below 500'. Annual rainfall over the area of distribution of trout exceeds 30 inches; foci of maximum intensity (50 - 60 inches) are located on the Darling Ranges, the Margaret River area and on the south coast from the Donnelly River to the Denmark River (Climatic Surveys for Region 16 - south-west, and Region 12 - Albany). The greater part of the rain falls in winter from May to October inclusive. Summer rainfall exceeds 8 inches only on the south coast. Mean maximum air temperatures for the hottest summer month (usually February) increase in a northerly direction from the South coast area ($74 - 80^{\circ}$F) and from the west coast, in an easterly direction to about $88^{\circ}$F on the eastern border of the Darling Scarp.

TABLE 3

AREAS, ANNUAL DISCHARGES, AND MINIMUM SUMMER FLOWS OF SOUTH WEST STREAMS
1 acre-foot = 43,560 cubic feet  Cusecs = cubic feet per second

| Stream | AREA Square Miles | ANNUAL DISCHARGE ACRE FEET | | MINIMUM FLOW Rate for 1962 CUSECS |
|---|---|---|---|---|
| | | AVERAGE | FOR 1962 | |
| Dwellingup Br. East | 0.15 | 141 | 136 | 0.004 |
| Dwellingup Br. North | 0.30 | 428 | 448 | 0.23 |
| Balingup Br. | 0.72 | 163 | - | 0 |
| Bolganup Dam | 1.87 | 228 | 6.9 | 0 |
| Turtle Br. | 2.13 | 983 | 491 | 0.10 |
| Limeburner Cr. | 2.24 | 442 | 377 | 0.32 |
| Joshua Cr. | 3.50 | 824 | 610 | 0 |
| Bolganup Cr. | 3.75 | 331 | 86 | 0 |
| Scabby Gully | 4.48 | 1128 | 1142 | 0.09 |
| Logue Br. | 13.7 | 13430 | 14360 | 4.6 |
| Davies Br. | 16.6 | 8722 | 4776 | 0.1 |
| Gooralong Br. | 19.5 | 7990 | 6078 | 0.04 |
| Joshua Cr. | 22 | - | 3846 | 0 |
| Yarragil Br. | 30 | 3478 | 2152 | 0 |
| Gingin Br. | 39 | 7782 | 7356 | 2.1 |
| Thomson Br. | 40 | 8384 | 9650 | 0 |
| Ferguson R. | 45 | 18040 | 13700 | 0 |
| Brunswick R. | 50 | 29530 | - | 0.4 |
| Wongong Br. | 51 | 21620 | 17760 | 0.37 |
| North Dandalup R. | 60 | 27340 | 18540 | 0.5 |
| Lefroy Br. | 120 | 57790 | 60480 | 4.5 |
| Capel R. | 127 | 41310 | 37260 | 3.0 |
| Harvey R. | 140 | 14110 | 8960 | 0 (dam) |
| South Dandalup R. | 150 | 26840 | 26170 | 1.0 |
| Harris R. | 155 | 35050 | 19910 | 0 |
| Wooraloo R. | 166 | 16200 | 16950 | 0 |
| Wilgarup R. | 168 | - | 28720 | 3.7 |
| Margaret R. | 180 | 55560 | 54630 | 0 |
| Canning R. | 200 | 19100 | 17660 | 0 (dam) |
| Preston R. | 230 | 51880 | 52920 | 1.3 |
| Collie R. | 257 | 48300 | 12990 | 0 (dam) |
| Kent R. | 275 | 59300 | 58400 | 1.8 |
| Donnelly R. | 300 | 138100 | - | 11.5 |
| Warren R. | 1430 | 267300 | 226300 | 19.6 |
| Frankland R. | 1520 | 151500 | 88760 | 1.0 |
| Murray R. | 2720 | 240500 | 132100 | 13.6 |

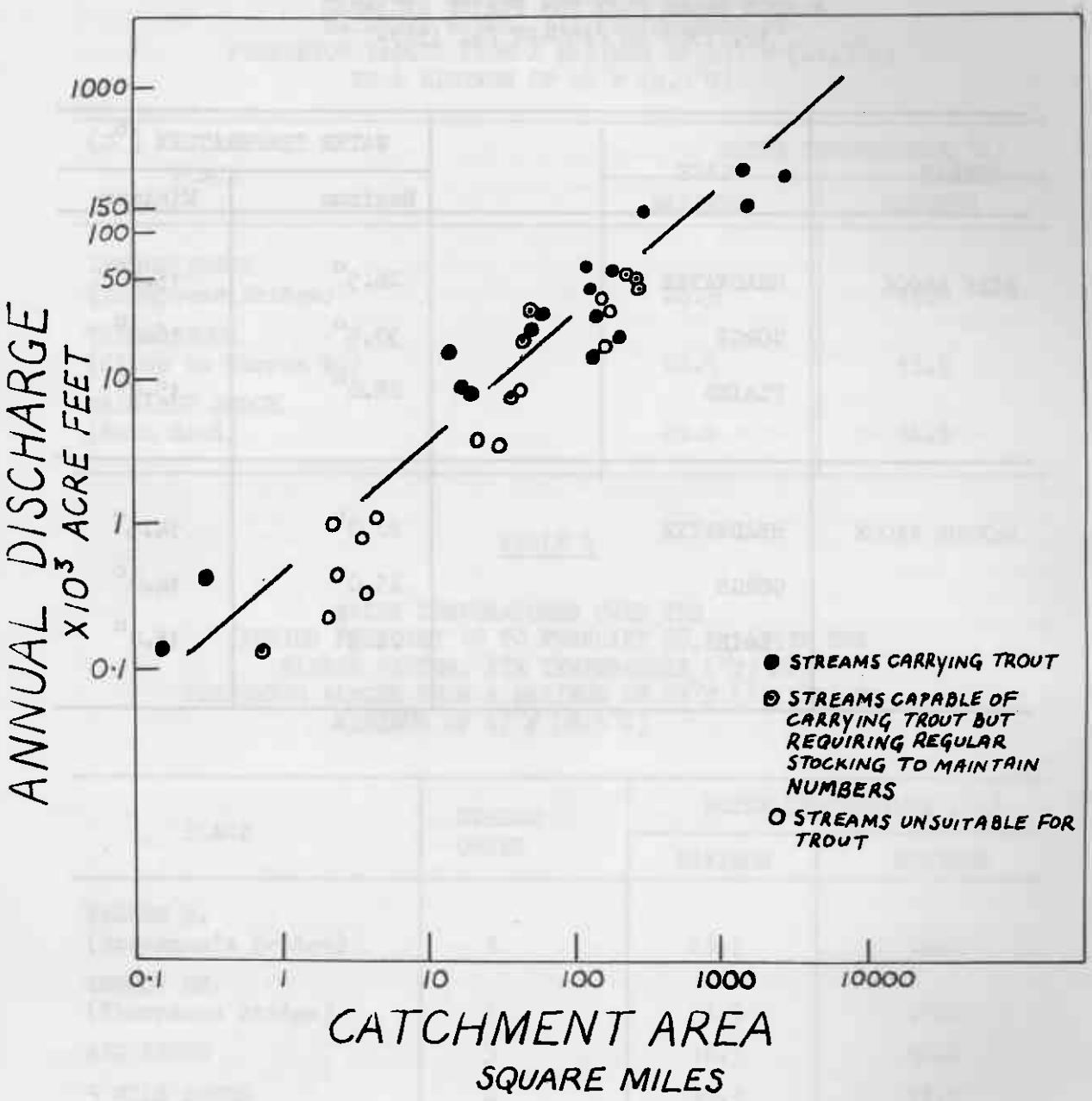


Fig. 1.

Stream characteristics in relation to suitability for trout.
(based on Table 3)



99247—3

TABLE 4

WATER TEMPERATURES FROM DIRK AND McKNOE BROOK OVER THE PERIOD DECEMBER 10, 1968 to JANUARY 24, 1969.

| STREAM | PLACE | WATER TEMPERATURE (°C) | |
|---|---|---|---|
| | | Maximum | Minimum |
| DIRK BROOK | HEADWATER | 26.5° | 15.0° |
| | GORGE | 30.5° | 16.0° |
| | PLAINS | 28.0° | 15.0° |
| McKNOE BROOK | HEADWATER | 20.0° | 14.5° |
| | GORGE | 23.0° | 14.0° |
| | PLAINS | 24.5° | 15.0° |

## TABLE 5

SUMMER WATER TEMPERATURES
(DECEMBER 19, 1968, TO JANUARY 22, 1969) IN
LEFROY BROOK, TREEN BROOK AND
DALGARUP BROOK. AIR TEMPERATURE AT
PEMBERTON RANGED FROM A MAXIMUM OF 107°F (41.5°C)
TO A MINIMUM OF 48°F (9.0°C)

| PLACE | WATER TEMPERATURE(°C) | |
|---|---|---|
| | MAXIMUM | MINIMUM |
| LEFROY BROOK (Thompsons Bridge) | 26.5 | 16.0 |
| TREEN BROOK (Close to Warren R.) | 22.5 | 13.5 |
| DALGARUP BROOK (Main Road) | 29.0 | 14.5 |

## TABLE 6

WATER TEMPERATURES OVER THE
PERIOD FEBRUARY 18 TO FEBRUARY 28, 1969 IN THE
WARREN SYSTEM. AIR TEMPERATURE (°F) AT
PEMBERTON RANGED FROM A MAXIMUM OF 89°F (31.7°C) TO
MINIMUM OF 47°F (8.5°C)

| PLACE | STREAM ORDER | WATER TEMPERATURE (°C) | |
|---|---|---|---|
| | | MAXIMUM | MINIMUM |
| WARREN R. (Brockman's Bridge) | 1 | 23.5 | 19.0 |
| LEFROY BR. (Thompsons Bridge) | 2 | 22.5 | 17.0 |
| BIG BROOK | 3 | 16.5 | 12.0 |
| 5 MILE BROOK | 4 | 18.5 | 13.5 |
| TRIBUTARY | 5 | 18.5 | 13.5 |
| TRIBUTARY | 6 | 18.0 | 13.0 |

Daily maximum air temperatures exceed 100°F occasionally during summer, the frequency of occurrence increasing to the north and east.

The areas of the South-west where streams contain trout are those receiving the highest rainfall and lowest summer air temperatures; the determining factors of land form are altitude and distance from the coast in the path of the prevailing oceanic airstreams from the west.

(d) Flow of Streams.

The maximum flows of streams in the South-west occur during winter. In contrast to the winter floods the summer flows of these streams (those considered worth metering by the Public Works Department with a view to future or present water storage) are extremely low (Table 3; extracted from "Hydrological Data to the 1962 Water Year"). The annual discharge of these streams is linearly related to catchment area. Streams located above the trend line are more likely to maintain a small flow during summer and be suitable for trout than those below the trend (Fig.1).

(e) Water temperatures.

In streams subjected to high summer daytime air temperatures trout are much more likely to survive if there are deep pools where temperature stratification, with depth, is sufficient to maintain favourable temperatures. Large turbulent flows will not permit stratification. All that is required is a small flow (or a sufficiently large deep pool with flow absent) to maintain the pool depth.

Temperatures between about 25 to 30°C have been found to be lethal to trout in S.A., depending on the duration of exposures (several hours at 28° and ½ an hour at 30°) and the water temperatures previously experienced.

Table 4 shows the extremes of summer water temperature found in small tributaries of the Serpentine River and Samsons Brook. These streams contain self-sustaining populations of trout (see later). They flow through the most favourable areas of the Darling Scarp and in the Darling Range McKnoes Brook is very well shaded by jarrah forest while Dirk Brook also has tree shade along its length (Plates 2 and 3). Except on the plains, pools are too shallow to permit temperature stratification (a minimum of 3' is necessary).

The period of measurement of water temperatures included several days when the maximum air temperature in Perth reached 109°F. These heat-waves are reflected in the maximum water temperatures while the minima are reached overnight during cool periods.

McKnoes Brook is probably the coolest stream in the Darling Scarp, while Dirk Brook has one of the best self-reproducing populations in this area. Electro-fishing showed that trout survived these summer water temperatures in Dirk Brook.

It is fairly obvious that the trout, isolated in W.A., have developed a higher resistance to extreme water temperatures, genetically, than fish elsewhere in cooler climates. Even so, dead fish are usually seen each summer by the land owner on Dirk Brook when the flow is stopped by pumping for short periods during hot weather.

Table 5 shows water temperatures for the Pemberton area during the same period as above. Heat deaths are observed in the Lefroy Brook during most summers (Plate 4).

Treen Brook is probably one of the coolest trout streams in the South-west and electro-fishing showed (see later) a large population of trout (Plate 5). However, mass mortalities are known to occur (summer of 1966-67) when the flow is stopped by excessive pumping.

Dalgarup Brook, a small tributary of the Blackwood River at Bridgetown produces large trout by angling (the water was too conductive for electro-fishing due to salt pollution). Measurement of temperature stratification showed the following water temperatures at 3.45 p.m. on February 26, 1969 in a deep pool with a slight inflow: 23.05°C (surface), 23.0° (1'), 22.85° (2'), 22.7° (3'), 20.0° (4'), 19.9° (5'), and 19.9° (5½' - bottom).

Records of water temperatures in the Warren System during a cooler period in late summer 1969, show the increase in water temperature from a source tributary to the main river (Table 6). Lowest temperatures occurred in the Big Brook as it flowed through a dense karri forest reserve.

A comparison of Lefroy Brook temperatures from Table 5 to Table 6 will show that lethal summer temperatures occur in the Warren River.

Some temperature stratification was found in a pool on the Warren River although the flow of the river gave erratic measurements.

On February 27, 1969: 21.7°(surface), 21.45° (1'), 21.1°(2'), 19.0° (3'), 18.8°(4'), 18.7°(5'), 18.6°(6'), 18.45(6½' - bottom).

Large trout in the Warren River have been observed to congregate at the confluences of the river with small streams and springs. This behaviour

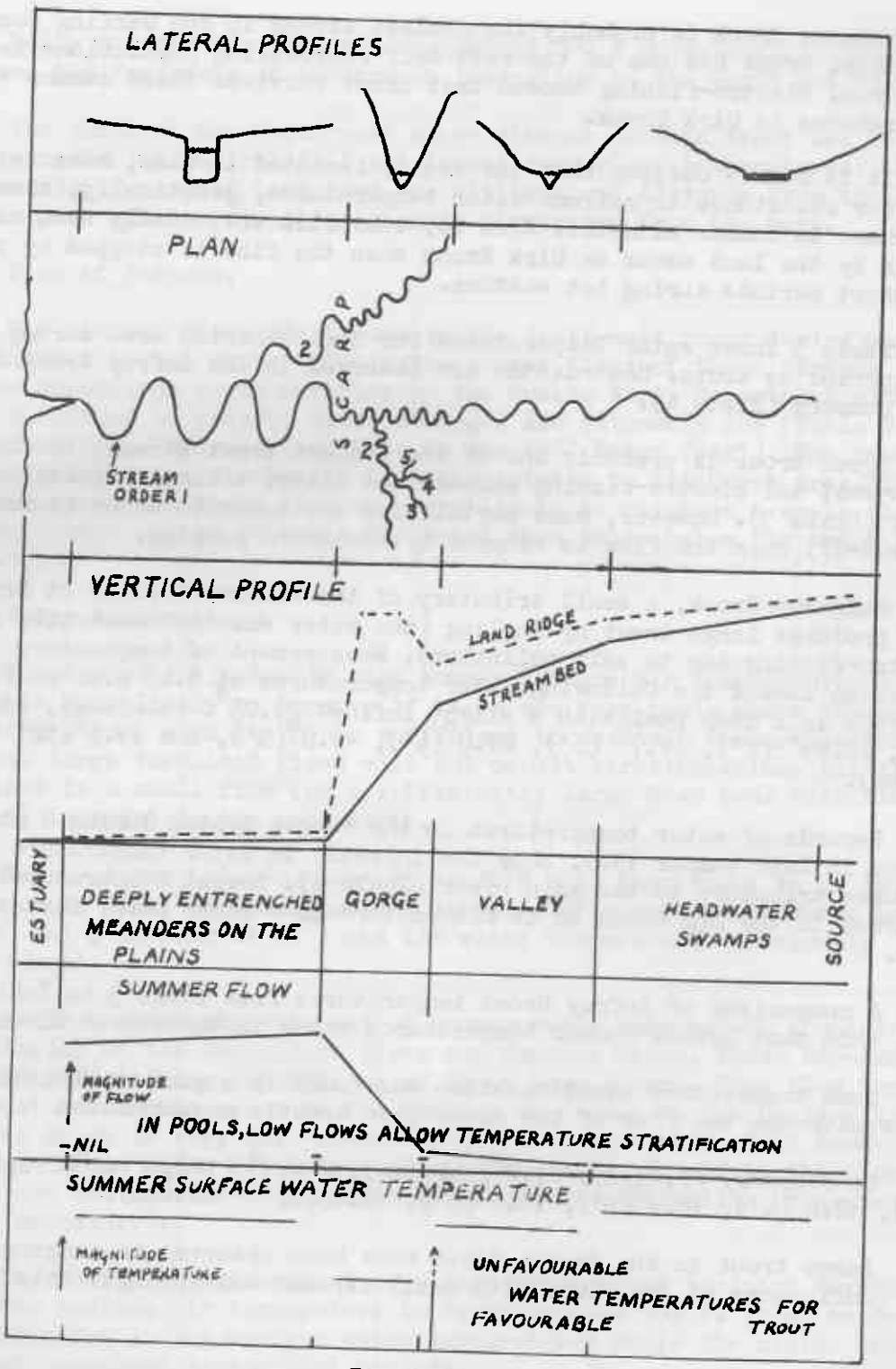


Fig. 2.

Diagrammatic summary of the general physical characteristics of streams.

also occurs in other large streams such as the lower Donnelly. At one spot on the Warren River where many large fish were observed lying in the inflow of spring water, the following temperature comparisons were made in the period January 23 to February 27, 1969.

| | | |
|---|---|---|
| River | 25.0° (max.) | 18.0° (min.) |
| Spring | 20.5° (max.) | 12.5° (min.) |

The large rivers in the South-West, e.g., the Murray, Blackwood, Donnelly and Warren, are antecedent streams, that is the most "youthful" stage of these rivers, instead of occurring in the headwaters, occurs in their middle reaches. This is particularly noticeable in streams flowing westward through the Darling Ranges. The steepest gradient and best flows occur in the gorge opening out onto the plains. None of these rivers have trout in their upper reaches, while, if trout are present at all in the river they occur in the gorge section.

Smaller tributaries which join the rivers on the plains or in the gorge also are antecedent. It is only these tributaries which may have trout. These characteristics are summarized, in Fig. 2.

(f) Spawning facilities.

Trout streams in the South-west do not have the plentiful reaches of spawning gravel present in streams in Tasmania or New Zealand. The larger streams have no spawning facilities and the fish must migrate, with the first rains, up into small tributaries. In these tributaries spawning gravel also is not plentiful. This condition is characteristic of streams with a very low summer flow.

The encroachment of bank vegetation during seasons of low flow results in narrow streams where the concentrated rush of winter flow does not permit deposition of small gravel. Streams, in the Darling Ranges particularly, flow through country with abundant surface gravel (laterite). An example of the results of widening a stream are shown in photographs taken on the Canning River. (Plates 6 and 7). The eroding power of these rivers tends to be diverted vertically instead of laterally so that the streams have deep pools which carry trout during times of low flow. (Plate 8).

## TABLE 7

### REFERENCES ON THE ABUNDANCE OF TROUT ELSEWHERE

Data from New Zealand given by

Allen, K.R. (1951) The Horokiwi Stream
N.Z. Marine Department, Fisheries Bulletin No.10

Anglers Size-limit of 11" (27.9 cms), fly fishing only, average of 10 years data.

Catch (takeable) per hour = 0.61
average size = 0.91 lbs.
(= $12\frac{3}{4}$ inches)
(= 32 cms.)

% undersized fish = 55.5

Sampling

total population lb/acre = 237

Allen quotes the following figures for density of trout in streams in the U.S.A.

| | |
|---|---|
| New Hampshire | 35.7 lb/acre |
| Michigan | 1.4 - 96.9 |
| New York | 13.8 |
| California | unfished 214 - 434 |
| | fished 40 - 146 |

Data from Eastern Australia given by

Lake, J.S. (1957). Trout populations and habitats in N.S.W.
Aust. Jour. Mar. Freshw. Res.
8, (4): 414 - 450

Anglers Size limit of 12", single season creel census
% of creel censuses returned = 3

| | Group 1 (warm water high growth rate) | Group 2 | Group 3 (cold water poor growth rate) |
|---|---|---|---|
| Number of takeable fish caught per hour | 0.17 | 0.25 | 0.36 |
| Average size of takeable fish (lbs.) | 2 11/16 | 1 13/16 | 14/16 |

**PLATE 1**

**WAROONA DAM:** Flyfishing to rising fish which are cruising over submerged vegetation in the springtime. Note the easy access to the water for anglers.

**PLATE 2**

**McKNOE'S BROOK:** Gorge Section.

PLATE 3

DIRK BROOK: Gorge Section.

PLATE 4

LEFROY BROOK: Sampling Section.

PLATE 5

TREEN BROOK: Sampling Section.

PLATE 6

CANNING RIVER: Widening of the stream by bulldozing has destroyed this stretch as a summer habitat for trout but has transformed the stretch into a series of gravel beds where trout can bury eggs.

PLATE 7

CANNING RIVER: A stretch of stream below that pictured in plate 6. There is no spawning gravel and the river is comparatively narrow, deep and rapid in flow.

PLATE 8

SOUTH DANDALUP RIVER: Springtime flows in the deep pool in the fore-ground and rapids in the background. Note the heavily overgrown banks.

% undersized $\frac{9.8}{25.3} = 38.7$ $\frac{654.3}{104.2} = 52.1$ $\frac{147}{207.2} = 70.9$

Sampling

density (lb/acre) 44-173. 64 - 135 66 - 84

Data from Tasmania given by

Nicholls, A.G. (1958) The population of a trout stream and the survival of released fish.
Aust. Jour. Mar. Freshw. Res.
2, (3): 319 - 350

Sampling

North Esk River System

Density 52 - 53 lbs/acre

quotes Carlander (1950, 53), range for trout streams, 0 - 300 lbs/acre

Shetter and Hazzard (1939) Michigan 1-40 lbs/acre

Stefanich (1952) Montana 44- 68 lbs/acre

Data from Tasmania given by

Nicholls A.G. (1958)

The Tasmanian Trout Fishery
II The Fishery of the North-West Region
Aust. Jour. Mar. Freshw. Res. 9, (1): 19 - 59

Anglers

North-west Rivers, Size limit 9"

1945 - 1954 Average number of takeable fish per day 3.0
mean length of fish 11.7 inches

Sampling

two small trout streams.

number of fish per mile 899 - 1415
density 48 - 179 lbs/acre.

Data from Tasmania given by Nicholls A.G., (1958)
The Tasmanian Trout Fishery
III The Rivers of the North and East
Aust. Jour. Mar. Freshw. Res. 9,(2): 167-190

Anglers

South Esk River System
(10 years data)

Average number of fish per day 2.0 - 4.1

Average number of fish per angler per season 13.9 - 66.8

Average size of fish 11.7 - 13.6"

North Esk River System
(10 years data)

number of fish per day 1.8 - 7.0

number of fish per angler per season 4.0 - 73.2

Average size of fish 10.7 - 12.2"

(size limit 9")

Data from New Zealand given by

Allen, K.R. and Cunningham B.T. (1957)
N.Z. Angling 1947 - 52
Results of the Diary Scheme.

Anglers

Range for various districts

Hours fished per day 2.35 - 4.40

Number of fish per hour 0.39 - 0.97

Fish per angler per season 14.7 - 69.0

Number of fish per day (trip) 1.2 - 3.6

Data from Frost, W.E. & Brown, M.E. (1967),
The Trout, Collins, London.
Density of trout in streams

| | |
|---|---|
| Two small streams flowing into Lake Ellesmere, Tasmania | 40 - 135 lb/acre |
| Walla Brook, Dartmoor | 5 - 20 |
| Thego River, Kenya | 140 |
| Sagana River, Kenya | 200 |
| Kiringa Riv., Kenya fished | $36\frac{1}{2}$ |
| Kiringa Riv., Kenya unfished | 129 |

TABLE 8

SUMMARIZED LOG BOOK DATA

(a)

| Water | Number of Hours Fished per Day (Trip) | Number of Yards of Stream Fished per Hour |
|---|---|---|
| RIVERS | 2.83* | 627 |
| TRIBUTARIES | 1.76 | 533 |
| WAROONA DAM | 2.55 | NA |
| OTHER DAMS | 1.97 | NA |

* Calculated Regression Coefficients

## III ABUNDANCE

(a) Anglers' catches.

A log book system was used during the 1967-68 fishing season to provide data on the success of angling. In August, 1967, 94 log-books were distributed to anglers and a request for the return of the books was made in May 1968. Logbooks were mainly sent to the anglers (about 70) who were enthusiastic enough to attend the inaugral meeting of the W.A. Trout and Freshwater Angling Association in early August, 1967. No logbooks were returned in 27 cases, logbooks with inadequate data, or replies to the effect that no fishing had been done, were received in 25 cases, and 42 books with usable data were received. There were 15 logbooks from anglers living in Perth, 16 from the country towns south of Perth down to Harvey, 7 from the Pemberton-Bridgetown area and 4 from Albany.

The form of the log-book sheets is shown as Appendix I. The raw data were summarized by a computer programme.

To put the summarized values of catch per unit effort in proper perspective references on the abundance of trout (as measured both by angling and research sampling) have been extracted from the literature and presented in Table 7.

W.A. log book data have been summarized for "rivers" (stream order 1 and large tributaries flowing onto the plains) "tributaries" (stream order 2 or greater), Waroona Dam and "other dams". (Table 8, (a) - (e)). The places providing data are indicated in Table 2 by a value for the highest catch per mile (streams) or hour (dam) of takeable fish (greater than 12" fork length). Twenty "tributaries" and 14 "rivers" were fished by anglers returning log-books.

Anglers fished for 1.8 hours per day (or trip) on small streams and for 2.8 hours on rivers, covering about $\frac{1}{4}$ to $\frac{3}{8}$ of a mile, (Table 8,(a)). It should however be pointed out that anglers fish most streams here in a highly selective manner because of the overgrown nature of the banks and the occurrence of fish usually only in the deeper pools. The stream is not waded and thoroughly fished. From past experience, the angler moves rapidly from one pool to another without fishing the intervening shallow water (this is generally not possible). Anglers were requested to record the length of stream actually fished.

The proportion of Brown trout to Rainbow trout captured was low, being higher in small streams than in rivers (Table 8, (b) and (c)). Brown trout have not been stocked in streams in recent years; the Pemberton Hatchery considers that Rainbows are easier to raise.

(TABLE 8 Cont'd)

SUMMARY OF ALL THE LOG BOOK DATA FOR FISHING AND CATCHES IN FOUR TYPES OF PLACES

(b)

| | RIVERS | TRIBUTARIES | WAROONA DAM | OTHER DAMS |
|---|---|---|---|---|
| Number of Anglers | 28 | 31 | 19 | 22 |
| Number of trips | 106 | 141 | 121 | 95 |
| Hours spent fishing | 331 | 307 | 347 | 228 |
| Legal-sized trout taken | | | | |
| Brown | 12 | 30 | 0 | 7 |
| Rainbow | 145 | 124 | 368 | 111 |
| Sub-legal sized trout returned to water | | | | |
| Brown | 5 | 18 | 0 | 10 |
| Rainbow | 79 | 70 | 71 | 49 |
| % undersized | 34.9 | 36.4 | 16.2 | 33.3 |
| % brown/rainbow | 8 | 25 | 0 | 11 |
| Method of fishing % | | | | |
| fly | 4.7 | 1.4 | 2.5 | 3.2 |
| bait | 17.0 | 30.5 | 4.1 | 12.6 |
| spinner | 65.1 | 52.5 | 86.8 | 70.5 |
| fly and spinner | 0.0 | 0.0 | 3.3 | 0.0 |
| bait and spinner | 8.5 | 4.3 | 0.0 | 1.1 |
| No. of takeable fish per hour | 0.56 (0.01) | 0.60 (0.01) | 1.44 ( 0.01) | 0.64(0.01) |
| No. takeable fish per mile | 2.69(0.05) | 12.32 (0.33) | - | - |
| No. takeable fish per day (trip) | 1.48(0.02) | 1.09 (0.01) | 3.04(0.02) | 1.24(0.02) |
| Total weight fish taken (lbs) | 303 | 283 | 711 | 185 |
| Weight of fish taken per angler | 10.80(0.15) | 9.14(0.16) | 37.43(1.65) | 8.40(0.10) |

parentheses enclose standard error of the mean.

TABLE 8 (Cont'd)

SUMMARY OF LOG BOOK DATA FOR FISHING AND CATCHES IN FOUR TYPES OF PLACES USING THE MORE SUCCESSFUL TRIPS YIELDING 50% OF ALL FISH TAKEN

(c)

| | RIVERS | TRIBUTARIES | WAROONA DAM | OTHER DAMS |
|---|---|---|---|---|
| Number of Anglers | 10 | 13 | 7 | 9 |
| Number of trips | 15 | 21 | 28 | 14 |
| Hours spent fishing | 59.1 | 68.8 | 84.0 | 48.5 |
| Legal-sized trout taken | | | | |
| Brown | 6 | 14 | 0 | 2 |
| Rainbow | 69 | 62 | 183 | 55 |
| Sub-legal sized trout returned | | | | |
| Brown | 0 | 1 | 0 | 0 |
| Rainbow | 13 | 18 | 27 | 7 |
| % undersized | 14.8 | 20.0 | 12.9 | 10.9 |
| % Brown/Rainbow | 7 | 19 | 0 | 3 |
| Method of fishing % | | | | |
| fly | 0.0 | 0.0 | 3.6 | 0.0 |
| bait | 10.0 | 28.6 | 0.0 | 14.3 |
| spinner | 73.3 | 47.6 | 89.3 | 64.3 |
| fly and spinner | 0.0 | 0.0 | 3.6 | 0.0 |
| bait and spinner | 6.7 | 4.8 | 0.0 | 0.0 |
| No. takeable fish per hour | 1.62(0.06) | 1.38(0.05) | 3.03(0.10) | 1.73(0.09) |
| No. takeable fish per mile | 5.01(0.19) | 13.35(1.61) | - | - |
| No. takeable fish per day (trip) | 5.00(0.16) | 3.62(0.07) | 6.54(0.11) | 4.07(0.19) |
| Total weight of fish taken (lbs) | 157.8 | 152.8 | 366.6 | 98.1 |
| Weight of fish | 15.78 (0.56) | 11.75 (0.43) | 52.38 (6.42) | 10.90 (0.54) |

parentheses enclose standard error of mean.

TABLE 8 (cont'd)

SUMMARY OF LOG BOOK DATA FOR %
SIZE DISTRIBUTIONS OF TAKEABLE TROUT
IN FOUR TYPES OF PLACES

(d)

| LENGTH GROUP (Inches) | RIVERS | TRIBUTARIES | WAROONA DAM | OTHER DAMS |
|---|---|---|---|---|
| 12.0 - 13.9 | 14.4 | 21.2 | 6.9 | 55.3 |
| 14.0 - 15.9 | 26.0 | 25.7 | 24.0 | 27.1 |
| 16.0 - 17.9 | 27.9 | 20.2 | 46.1 | 12.9 |
| 18.0 - 19.9 | 17.3 | 15.6 | 17.2 | 3.5 |
| 20.0 - 21.9 | 11.5 | 9.2 | 3.4 | 0.0 |
| 22.0 - 23.9 | 2.9 | 7.3 | 2.5 | 0.0 |
| Greater than 24.0 | 0.0 | 0.9 | 0.0 | 1.2 |

Conversion values length/weight

| | | | | | | |
|---|---|---|---|---|---|---|
| Length (inches) | 13 | 15 | 17 | 19 | 21 | 23 |
| Weight (lbs) | 0.85 | 1.60 | 2.30 | 3.05 | 3.8 | 4.55 |

TABLE 8 (Cont'd)

SUMMARY OF LOG BOOK DATA FOR SPRING, SUMMER AND AUTUMN IN FOUR TYPES OF PLACE

(a)

| | RIVERS | TRIBUTARIES | WAROONA DAM | OTHER DAMS |
|---|---|---|---|---|
| SPRING | | | | |
| (1) Number of anglers | 21 | 26 | 14 | 17 |
| (2) Days fished | 53 | 92 | 64 | 50 |
| (3) Number of takeable fish per day (trip) | 1.36(0.02) | 1.26(0.01) | 3.69(0.04) | 1.92(0.03) |
| SUMMER | | | | |
| (1) | 14 | 13 | 6 | 3 |
| (2) | 32 | 28 | 7 | 7 |
| (3) | 2.25(0.07) | 1.93(0.04) | 2.57(0.19) | 2.86(0.18) |
| AUTUMN | | | | |
| (1) | 13 | 9 | 13 | 11 |
| (2) | 21 | 21 | 50 | 38 |
| (3) | 1.71(0.08) | 1.43(0.05) | 3.44(0.01) | 1.39(0.00) |

Self-reproducing populations of brown trout exist in the Warren and Harvey systems. Brown trout are much more difficult to catch than rainbow trout, particularly in large deep pools in rivers and in dams. When the two species of fish are present together with browns superior in numbers (brown trout successfully dominate streams when they are in competition with rainbows) rainbow trout often predominate in anglers' catches for this reason.

About 2/3 of the total fish captured were of takeable size except at Waroona Dam where the high growth rate resulted in takeable fish comprising 4/5 of the catch (Table 8,(b)).

The technique of angling used on the majority of anglers' trips was spinning. Because of the overgrown nature of the streams and lack of surface feeding activity by trout spinning is, in most places, the most appropriate method for fishing the large deep pools in streams. Fly fishing is the most difficult method of trout fishing to master initially. The small amount of fly fishing on Waroona Dam, where casting is not impeded by undergrowth and fish "rise" along the shoreline, is an indication that the anglers are comparatively unsophisticated in their fishing methods.

In Table 8, (b) and (c), three types of catch rate have been summarized, viz., the average number of takeable fish captured per hour of fishing, per mile of stream and per day (or trip). Waroona Dam provided higher catch rates than the other types of places.

The values for catch per hour and per trip from all areas are similar to those found in other trout fisheries but range from higher in some cases (e.g.,than in N.S.W.) to lower in other instances.

Even in well-established and recognised trout fisheries elsewhere, average catch rates taken from anglers of varying proficiency appear to non-anglers, to have very low values. The more successful trips (about 15% of the trips and just over $\frac{1}{3}$ of the anglers), which yielded 50% of all fish taken by log book anglers, however, gave appreciably larger catch-rates (Table 8, (c)).

Although the anglers caught about the same number of fish per hour in "rivers" and "tributaries", they caught many more fish per mile in "tributaries". The distance fished per hour on smaller streams was less than on larger rivers. If the catches per mile are taken to indicate a real difference then, since smaller streams have a smaller surface area per mile, the density of takeable fish is much lower per acre in "rivers" than in "tributaries".

The average size of trout taken by the anglers was about 2 lbs in all places except "other dams". The average length of fish is considerably higher than the values quoted for other fisheries. The average size

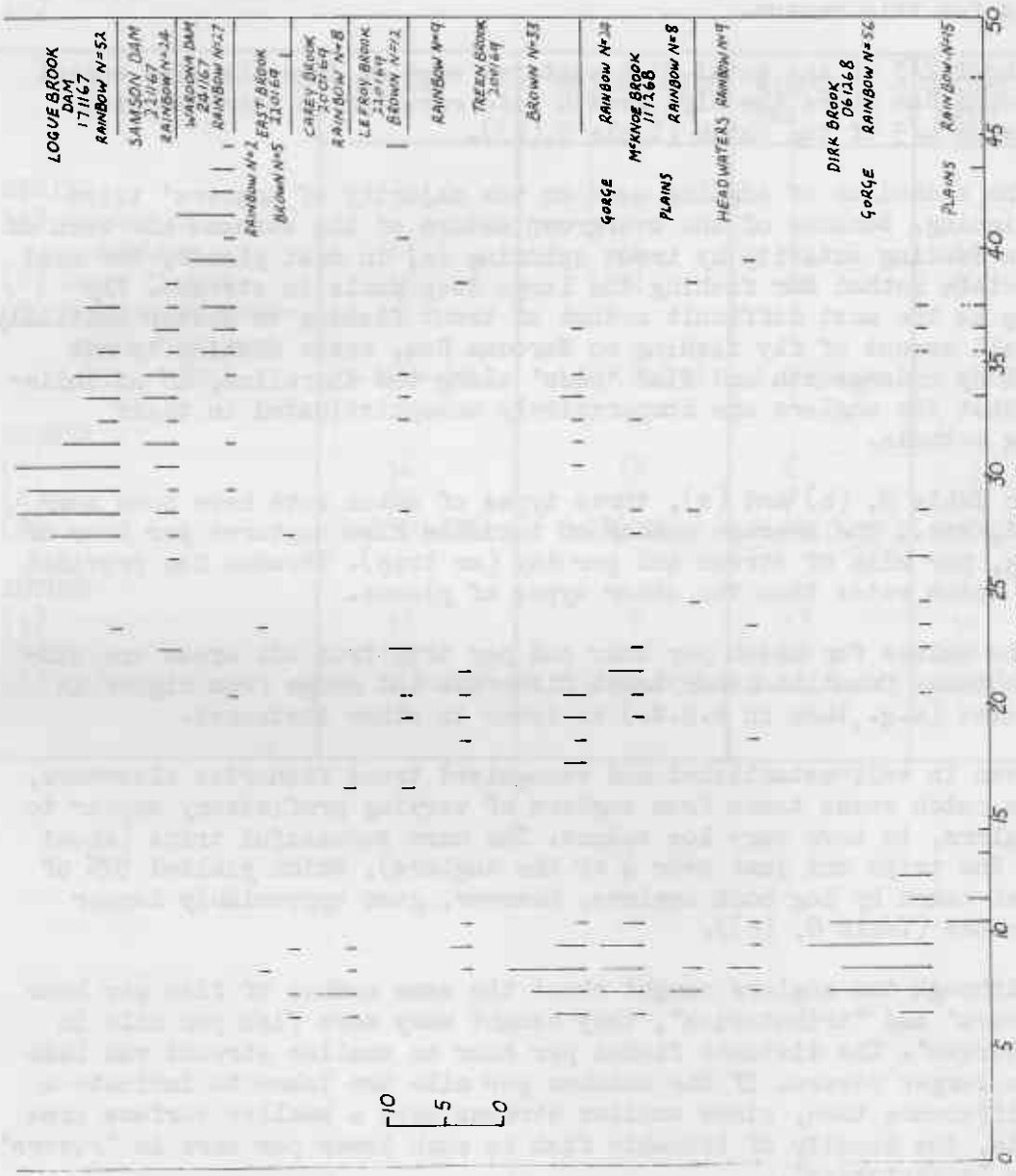


Fig. 3.

Length distributions from samples from dams and streams.

is mostly a reflection of the excellent growth rates of the trout although the small amount of fishing on trout stocks may also contribute.

Catch rates for rivers and tributaries were lowest during the spring when flows are high and a maximum in summer, although more fishing was done in the spring (Table 8, (e)). Catch rates were higher during spring and autumn at Waroona Dam but highest in summer at the "other dams."

The number of anglers who are enthusiastic enough to travel comparatively long distances, particularly from Perth, to fishing places and to explore the highly inaccessible streams, are few in relation to the quality of angling available. It is particularly noticeable, how (with publicity) an easily fished water such as Waroona Dam attracts anglers many of whom, it is known, are beginners to trout fishing.

(b) Sampling

1. Netting

Six irrigation dams were netted during November 1967. Wellington Dam was excluded because, despite the fact that it had been extensively stocked during the 1950's, both with fry and fingerlings by the Collie Society, there have never been any reports of trout there. Trout move into bays in dams as nightime approaches. The nets were angled out from the shoreline of a bay in each place. Catch rates (Table 9) and sizes of fish captured (Fig. 3) are related to the age of the dam for reasons explained previously (page 13). There is some evidence from angling catches that trout may move down into Harvey and Drakesbrook dam from the inflowing streams during summer and autumn.

2. Electro-fishing

A number of streams were electro-fished during December 1968 and January 1969. The numbers of fish captured were too small to allow use of a mark-release technique for estimating abundance. The stretches of stream were, however, fished very thoroughly, often several times, and very few fish were seen to escape capture in the clear water. A major problem in this work was to find stretches of streams which were accessible to the sampling technique.

Dirk Brook and McKnoes Brook, in the Darling Scarp, were each fished in the headwaters, in the gorge, and on the plains. The gorge and plains sectors of Dirk Brook, run through private property. Although the former brook is considered to be one of the best small trout streams near Perth, no fishing is permitted these days by the property owners. Mr. Hainge of Waroona, who has stocked and fished streams in the area for many years, considers McKnoes Brook to be an excellent trout stream. Fish cannot move upstream from the gorges to the headwaters because of waterfalls on both streams. No fish were captured in the remote headwaters of McKnowes Brook

in State Jarrah forests (Table 10). The highest densities of fish of all sizes were in the gorge sections which have previously been described as the most suitable sections of streams for trout. Takeable fish were however more numerous on the plains where the largest, deepest pools occur. Both brooks contained stretches of spawning gravel and fish age 0+ were prevalent particularly in the gorge section (Fig. 3) (age 0+ refers to fish in their first year of life).

Four streams were sampled near Pemberton. Carey Brook is used by mature fish as a spawning stream but these fish have moved downstream by summer; mostly 0+ fish were captured. The section of East brook sampled included the pool where one of the first trout planted in 1931 was captured in 1936 at 11½lbs. The stream has since deteriorated due to farming practices and now has a poor flow in summer. No 0+ fish were captured in Lefroy Brook. There is no spawning gravel in the Brook; the bed is sand and mud. Recruitment must come from the small tributaries further upstream. A spawning run of large mature trout occurs each year with the first rain in the Brook. The Lefroy Weir at Pemberton (downstream from the sampled section) prevents further movement upstream of many fish to spawning tributaries. Treen Brook gave the highest number per mile and weight per acre of trout of the streams sampled. The brook gave a lower catch rate for anglers than other streams near Pemberton. The only fishable section of the Brook is, in contrast to the rest of the stream, devoid of cover for approaching anglers and it contains mostly wary Brown trout.

Brown trout have not been stocked in Pemberton streams for some years but the waters contain predominantly Brown trout although Rainbow trout have been heavily stocked in recent years.

In summary, the best streams which were sampled in Western Australia had weights of fish per acre that were in the lower range of values for trout waters elsewhere in the world. However these values were largely due to the presence of large fish. The densities of fish (numbers per mile) were relatively low. The streams are lightly fished by a relatively small number of anglers who, however, are highly efficient and successful as shown by the log-book summaries.

3. Scale sampling

Samples of scales from trout were available, both from fish recorded in angling log-books and from fish taken by electro-fishing. The scales were "read" to determine the ages of the fish and the lengths at various changes in growth in life before capture.

Trout in cold temperate climates show an annulus on their scales in each year of life. Growth is faster in spring, summer and autumn (the circuli on the scales are widely spaced) and slower in winter(circuli are closely spaced) when mature fish also show a spawning mark of very closely spaced circuli. In warmer climates the aging of trout is often complicated by the formation of additional checks due to unfavourable

warm water conditions in summer. It is therefore indicative of marginal habitats, where summer conditions are unfavourable, that accessory checks will be formed. In addition trout grow well during winter and only show a winter (spawning) annulus when mature.

The scales of trout in the South-west showed erratic patterns of growth with often up to 5 checks (which are difficult to distinguish from spawning checks) on fish which were not mature. Trout at the Pemberton Hatchery mature when 2 years of age and this early maturity also occurs under similar warm-water conditions for fast growing trout in S.A.

Without a lengthy programme of monthly sampling it is impossible to age trout from their scales in W.A. with a high degree of certainty. However a previous experience of these types of scale patterns and supporting evidence from length distributions, from parr marks (immature fish), condition of gonads (presence of a few unspawned eggs in females), etc., have been used to calculate probable average lengths of trout in as many places as possible (Table 11). The small brooks give the lowest growth rates although these would be regarded as high rates in comparable streams in colder temperate climates. The growth rates for Waroona Dam, Donnelly River, and Dalgarup Brook would be exceptional compared to trout in colder climates, although about average for other marginal warm summer streams and new dams in Australia.

TABLE 9

CATCH RATES FROM NETTING IN IRRIGATION DAMS

| NAME OF DAM | HOURS NETTED | NUMBER OF TROUT NETTED | CATCH RATE NUMBER PER HOUR |
|---|---|---|---|
| Stirling | 30 (2 nights) | 1 | 0.03 |
| Harvey | 30 (2 nights) | 1 | 0.03 |
| Logue Brook | 15 (1 night) | 53 | 3.5 |
| Samsons | 15 (1 night) | 24 | 1.6 |
| Drakesbrook | 15 (1 night) | 0 | 0 |
| Waroona | 5 (after sunset) | 31 | 6.2 |

Nets used: 84 yards of 2" mesh, 132 yards of $2\frac{3}{4}$" mesh, and 46 yards of $3\frac{1}{4}$" mesh. Average depth of net 78".

TABLE 10

ESIMATES OF ABUNDANCE OF FISH
IN SOME STREAMS FROM ELECTRO-FISHING

| STREAM | LENGTH FISHED (FEET) | AREA FISHED (ACRES) | NUMBER OF FISH PER MILE (TAKEABLE) | WEIGHT OF FISH PER ACRE (LBS)(TAKEABLE) |
|---|---|---|---|---|
| DIRK BROOK | | | | |
| HEADWATER | 350 | 0.080 | 135.8 (15.1) | 28.5 (20.8) |
| GORGE | 550 | 0.150 | 537.6 (28.8) | 54.2 (26.4) |
| PLAINS | 780 | 0.272 | 101.5 (47.4) | 44.5 (43.2) |
| McKNOE BROOK | | | | |
| HEADWATER | 160 | 0.029 | 0 (0) | 0 (0) |
| GORGE | 465 | 0.128 | 272.5 (11.4) | 28.7 (7.3) |
| PLAINS | 610 | 0.125 | 69.2 (8.7) | 21.2 (12.8) |
| CAREY BROOK | 560 | 0.259 | 75.4 (0) | 6.9 (0) |
| EAST BROOK | 570 | 0.096 | 64.8 (9.3) | 44.3 (34.8) |
| LEFROY BROOK | 650 | 0.323 | 97.5 (48.7) | 35.5 (31.0) |
| TREEN BROOK | 680 | 0.081 | 326.1 (62.1) | 133.4 (105.1) |

TABLE 11

AVERAGE LENGTHS (INCHES) OF TROUT AT VARIOUS STAGES OF GROWTH

| WATER | $SU_1$ | R | $SU_2$ | 2 | 3 | 4 |
|---|---|---|---|---|---|---|
| Waroona Dam | 9.3 | 11.2 | 15.7 | 18.3 | | |
| | (1+; 15.4 in spring and 16.7 in Autumn. 2+; 19.4 in spring) | | | | | |
| Logue Brook Dam | 5.0 | 8.5 | 10.5 | 11.9 | | |
| Samsons Dam | 5.4 | 8.5 | | 11.2 | 13.1 | |
| Donnelly River | 5.1 | 9.0 | 12.9 | 16.9 | 19.9 | 22.8 |
| Dirk Brook | 5.6 | 9.9 | | 13.0 | | |
| McKnoes Brook | 5.9 | | 8.8 | 10.9 | | |
| Treen Brook | 5.6 | | 10.1 | 12.5 | | |
| Lefroy Brook | 3.4 | 7.1 | 10.3 | 12.1 | 15.9 | |
| Dalgarup Brook | 6.4 | 9.5 | 14.8 | 17.2 | 19.7 | 20.3 |

$SU_1$ - length at the end of first summer (0+)

$SU_2$ - length at the end of second summer (1+)

R - length when the early winter increase in flow of streams and rise in level of dams commences.

2, 3, 4 - lengths at the completion of spawning during winter.

## IV SUMMARY AND CONCLUSIONS

(a) Distribution.

Most of the apparently large number and lengths of water-courses in the south-west are unsuitable for trout. Many of the streams where the fish occurs must be classed as marginal for trout due to summer conditions. Distribution ( and therefore abundance) of trout over the south-west area and within each stream system is restricted by the amount of water and water temperatures in summer. Spawning gravel is not plentiful in the streams.

(b) Abundance.

The best streams sampled had weights of fish per acre which were in the lower range of values for waters elsewhere. These values were largely due to the presence of large (takeable) fish since growth rates are comparatively high. The densities of fish (numbers per mile) were relatively low. A knowledge of the fishing community and log-book summaries indicate that streams are lightly fished by a small number of anglers who, however, are relatively successful particularly in the size of fish taken.

There is no evidence at all to support a hypothesis that trout in the south-west are unsuccessful because of lack of food. The streams support abundant populations of crustacea (marron, gilgies, shrimps and amphipods) and small native fish, but the usual types of aquatic insects found in trout streams are not so prevalent. The best growth rates of trout in Australia and elsewhere are, however, attained by trout on diets of crustacea and small fish, and not small insects.

(c) Trout aclimatization in Western Australia can be judged as generally unsuccessful if the criterion which is used is the number of fish captured per unit of fishing effort. However, the excellent average size of fish which are captured appears to adequately compensate anglers for the sparsity of fish.

## V RECOMMENDATIONS

Regular stocking of streams should be continued to maintain the numbers of fish. Brown trout should be stocked in the smaller streams as fishing pressure increases and anglers become more sophisticated.

Particular attention should be paid to maintaining stocks of trout in large dams. New dams (which may be expected at regular intervals) should be stocked and publicized. More publicity should be given to farm dams in the ranges where, if trout are preferred to marron, trout can provide excellent sport and food if managed efficiently. Only Rainbow trout should be stocked in dams.

## VI REFERENCES


Climatic Surveys, W.A. (1965) Region 16 - South west.
(1962) Region 12 - Albany.
Commonwealth Bureau of Meterology, Melbourne.

Francois, D.D.(1966) Report on West Australian Freshwater Fisheries.
Report III, Department of Fisheries and Fauna, W.A.

Hydrological Data to the 1962 Water Year.
Public Works Department, W.A.

Hobbs, D.F.(1937) Natural Reproduction of Trout in New Zealand.
N.Z. Marine Department, Wellington.

Jenkins, C.F.H. (1951-53) The food of trout in Western Australia.
West Australian Naturalist 3: 139-141.

Lake, J.S. (1957) Trout populations and habitats in N.S.W.
Aust. Jour. Mar. Freshw. Res. 8, (4): 414-450

Nicholls, A.G. (1958) The population of a trout stream and the
survival of released fish.
Aust. Jour. Mar. Freshw. Res 9, (3) : 319 - 350

Pemberton-Warren Trout Acclimatization Society.
Annual Reports, 1943 - 1961.

APPENDIX I

DEPARTMENT OF FISHERIES AND FAUNA

108 Adelaide Terrace, Perth, Western Australia

August 1, 1967.

Dear Angler,

The stocking of the Game-fish, the Brown trout from Europe and the Rainbow trout from North America, has been pursued for over 30 years in the streams and still-waters of Western Australia.

The Government urgently requires an estimate of the success, or otherwise of these endeavours in terms of the return to you, as an angler, of trout in the bag. Without knowledge of your catches an official policy proclaiming regulations governing closed seasons, size and bag limits, etc., and ensuring year to year maintenance, and improvement, of trout stocks cannot be decided upon.

For this reason you have been sent the accompanying log book.

Please make every effort to record your catch accurately after every fishing trip.

I hope to meet you on the stream during the next year as I am also a keen trout angler.

So until then,

Tight lines,

(N.M. Morrissy),
RESEARCH OFFICER

P.S. A stamped addressed envelope will be sent to you in May of next year for the return of the log book to the Fisheries Department.

APPENDIX I (Cont.)

1.

No.

Name: .....

Address: .....

.....

## THE PURPOSE OF THE LOG BOOK

The brown trout (Salmo trutta) and rainbow trout (S. gairdnerii) have been introduced into many streams and still-waters in the South West of W.A. since the early 1930's. The Western Australian Department of Fisheries and Fauna has initiated a research program, the purposes of which are:- (a) to determine where trout have acclimatized successfully to local conditions; and (b) to collect the scientific data that are needed to formulate an effective policy for the maintenance of adequate stocks of trout for future angling in the places where acclimatization has been successful.

You, and a number of other experienced anglers who are also vitally interested in the future of trout in W.A., can help by collecting raw data in this log book. The information which anglers keep in these log books will be used to build up a picture of the growth and yield to angling of trout in the South West of the State.

The exact details of each angler's success in fishing specific localities will be strictly confidential. After analysis each log book will be returned to its owner so that he may have a permanent record of his fishing.

Please read the following two pages for details about the recording of data and the taking of scale samples.

APPENDIX I(Contd.)

Record the numbers of trout which you catch during each outing on these sheets. It is also important to record outings where no fish are caught. Use a new row for each effort at fishing. If you fish more than once on the same day, e.g. in the early morning and again in the evening, or at more than one place during the day, or both, record these efforts separately.

Under the headings provided on the sheets record:-

(1) Date

(2) Name of the stream, dam, or lake where you fished.

(3) Locality - the name of the nearest town.

(4) Times of day when you commenced and ceased fishing -- to the nearest half hour.

(5) Approximate length of the particular stretch of stream along which you walked during the period of fishing -- if a farm dam is fished substitute its capacity.

(6) Numbers of takeable (12", or longer in length) and under-sized trout landed of each species.

(7) Brief comments on the state of the water (e.g., "high and dirty" or low and clear") and the method of fishing used (B for bait, F for fly, or S for spinner).

## APPENDIX I (Contd.)



### THE PACKETS FOR SCALE SAMPLES

The rate of growth of trout can be found after "reading" the ages of fish of different lengths from their scales.

Please take a sample of scales from each of the trout which you bring back from an outing, in the following manner:- After wiping the side of a fish clean of loose scales and slime, take a small number of scales (About 1-2 dozen), with a clean knife or tweezers, from the area on the side of the fish shown as "X" in the sketch on the next page. Place these scales in a packet and seal the flat down. On this packet record:-

(1) Date of capture.

(2) Name of the stream, dam, or lake where the fish was captured.

(3) Species of trout.

(4) Sex of the fish.

(5) Length -- measured from the tip of the snout to the fork in the tail, with a steel tape, to the nearest 1/8th of an inch.

(6) A brief comment on the state of the gonads of the fish is often useful to the scale reader, e.g., in the case of a female fish, the note "a few large eggs" (accompanying many smaller eggs) indicates that the trout has spawned at least once. Or, when you catch a fish full of large deteriorating eggs, which should have been spawned during the previous winter, please comment "egg-bound".