The River Dart SAP Consultation Document

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

PART 1 INTRODUCTION

In February 1996, the **National Salmon Management Strategy** (NRA, 1996) was launched by the Environment Agency's predecessor, the National Rivers Authority (NRA).

The Strategy concentrates on four main objectives for the management of salmon fisheries in England and Wales. These are primarily aimed at securing the well being of the stock but in doing so will improve catches and economic returns to the fisheries:

i) Optimise the number of salmon returning to homewater fisheries.
ii) Maintain and improve fitness and diversity of salmon stocks.
ii) Optimise the total economic value of surplus stocks.
iii) Ensure necessary costs are met by beneficiaries

These objectives (primarily i and ii) will be addressed by way of local **Salmon Action Plans** (SAPS) which the Agency intends to produce for each of its principal salmon rivers by the year 2003. Each plan will review the status of the stock and fisheries on a particular river, will seek to identify the main issues limiting performance, and will draw up and list options to address these.

A new concept introduced by SAPs is the use of Conservation Limits (CLs) or spawning targets to assess stock and fishery performance, providing a more objective approach than has previously been possible. The procedures used to set Conservation Limits and assess compliance are developing and will be improved upon in coming years. Nevertheless, the Conservation Limits described in this document represent a sound starting point for using this important technique in the management of salmon stocks in England and Wales, one which has been successfully applied on Canadian rivers for a number of years and is promoted by the North Atlantic Salmon Conservation Organisation (NASCO) to facilitate salmon management in the international context.

In delivering each SAP, it is essential that the Agency seeks the support (including in some instances the financial support) of local fishery and other interests. This collaborative approach is vital to secure the best way forward for our salmon rivers at a time when stocks are generally at an historic low level, environmental pressures are as great as ever, and funding for salmon fisheries is diminishing. Hence the document presented here is for consultation, will be circulated widely, and is open to refinement in the light of comments received.

PART 2 DESCRIPTION OF THE CATCHMENT

The Dart catchment extends from the centre of Dartmoor towards the south coast of the South West Peninsula and drains an area of 475 km^2. The River Dart runs in a southeasterly direction to reach the tidal limit at Totnes. Below the tidal limit, the River Harbourne, River Hems and other tributaries discharge into the Dart estuary.

The East Dart River rises at East Dart head at a level of 545 m Above Ordnance Datum (AOD). The West Dart rises at an altitude of 535 m AOD. The two run to Dartmeet at 250 m AOD to form the main river Dart.

Dartmoor comprises open moorland with high rainfall and acid, peaty soils. Much of Dartmoor is used for extensive grazing by cattle, sheep and ponies. Many of the headwaters also provide valuable spawning grounds for salmonid fish.
The perimeter of Dartmoor is typified by steep, undulating land with many of the valley sides comprising deciduous woodland. The area surrounding the open moorland is typified by small enclosures and is mainly used for small scale livestock farming. Field size becomes progressively larger as one moves away from the moorland.

The River Dart eventually flows under the A38 trunk road, close to Buckfastleigh. This not only marks the edge of Dartmoor National Park, but also serves as an approximate boundary between the granite mass and the relatively low lying but undulating area known as South Hams. This area is noted for its rich red soils which support more intensive livestock and arable farming. A number of watercourses (River Wash, River Hems, Bidwell Brook and Am Brook) have their source in this area. The River Dart continues through this area to its tidal limit at Totnes. The steep valley sides result in a minimal floodplain. Two major tributaries join the River Dart in its estuary, these are the River Hems and the Harbourne River.

The north of the River Dart catchment is included in the Dartmoor candidate Special Area of Conservation (cSAC), designated under the Council EC Directive 92/43/EEC, the "Habitats Directive". One of the conservation objectives for the cSAC is to maintain the habitat for Atlantic Salmon, *Salmo Salar* in favourable condition.

The River Dart is an important salmon, sea trout and brown trout fishery with no significant coarse fishery. However, eels are ubiquitous throughout the catchment and are lightly exploited.

2.1 Rainfall, flows and abstractions

Across the catchment, there is considerable contrast in rainfall. On the high grounds of Dartmoor average annual rainfall is greater than 2300 mm whilst in the more sheltered areas further south, rainfall averages at 1000 mm.

There are no major aquifers within the catchment. However, usable groundwater is present both in the weathered zone and in fissures in the bedrock. As a result of this, the rocks have been classified as minor aquifers. Groundwater discharges from these minor aquifers provide for river baseflow during dry weather.

River flow in the lower Dart has been measured at Austin's Bridge gauging station since 1958. The records show a mean daily flow of 11.25 cumecs and a measured Q95 of 1.52 cumecs and a Q5 of 35 cumecs. These statistics reflect the 'flashy' nature of the river resulting from the type of soil and subsoil, and the low groundwater storage. The river rises rapidly in response to heavy rainfall and recedes quickly in dry spells.

There are currently 461 abstraction licences in the catchment, 45 of which are surface water. Of the total licensed volume, 96 % is abstracted from surface water, 70 % is used for hydroelectric power and 16 % for public water supply. There are several significant surface water abstractions for hydropower, including Buckfast weir and Holne weir. A number of abstraction licences have neither minimum prescribed flow nor minimum acceptable flow conditions. Some of these abstractions are governed by licences of Right or Entitlement.

The Environment Agency is promoting several initiatives aimed at gaining an understanding of the impact of abstractions on the ecology of the river, with the objective of restoring sites suffering from adverse impacts. These initiatives are encompassed in the Environment Agency Water Resources Strategy. The Agency is undertaking the review of consents required under the Habitats Directive. The Agency is also drawing information on sites perceived to be at risk from abstraction through the national Restoring Sustainable Abstraction Programme (RSAP) in preparation of the review of all licences in 2012. A further initiative is the Catchment Abstraction Management Strategy (CAMS) which develops a sound strategy for determining new licences. All these will contribute to achieve the necessary ecological status required under the Council Directive 2000/60/EC, the "Water Framework Directive".

The River Dart Catchment Abstraction Management Strategy (CAMS) is due to be published in 2006. This strategy will set river flow objectives (RFO) for defined stretches of river and will become a tool for planning future water availability and for determining new abstraction licences. The RFOs are based on the ecological sensitivity of a river to flow reduction related to abstraction. The sensitivity is determined using data relating to fish population, aquatic macrophyte and invertebrate assemblages and natural river morphology.

Current abstraction licences in the Dart catchment are being reviewed by 2004 as part of the Habitats Directives process to determine impact on Atlantic salmon. Those shown to have an impact on salmon populations will be reviewed.

2.2 Water quality

Water quality is managed by setting targets called River Quality Objectives (RQOs). RQOs are intended to protect current water quality and future use. They are used as a basis for setting consents for new discharges and planning future water quality improvements. RQOs are allocated to 30 classified river stretches in the Dart catchment comprising a total of 212.4 km of river.

All of the stretches have an RQO of "good" or "very good" quality defined by the River Ecosystem (RE) classification scheme (i.e. suitable for all fish species). Further information on the RE classification scheme is contained in the River Dart Local Environment Agency Plan (LEAP) – Consultation Report (Environment Agency, 1997).
During 2001 five stretches failed to meet their long term RQOs, as a result of elevated levels of either Biochemical Oxygen Demand (BOD) or elevated ammonia, or a combination of both. These failures can be attributed to diffuse agricultural

pollution, sewage treatment works discharges, storm sewer overflow operations or combinations of these. Stretches affected include the Bidwell Brook, the Am Brook, the Harbourne and the Wash; investigations and improvements are on going. Some stretches in the north of the catchment fail to meet their RQO as a result of low pH values. The low pH of the water is a natural phenomenon that is caused by the underlying granite rocks of Dartmoor and could be exacerbated by factors such as afforestation. Investigations on the acidity of the River Dart are on going.

Investigations are also taking place on the main River Dart, at Kilbury Sewage Treatment Works (STW) regarding the operation of storm overflows and the discharge of pesticides. Improvements are being carried out at Totnes STW under AMP3 (Asset Management Programme stage 3).

Extensive reaches of the main river and of the principal tributaries are designated as Salmonid Fisheries under the EC Freshwater Fish Directive – 78/659/ECC. (Figure 1).

PART 3 DESCRIPTION OF THE FISHERIES

The River Dart supports rod and net fisheries for both salmon and sea trout. The net fishery operates in the estuary of the River Dart.

The rod fishery:

The salmon rod fishery is regulated by a series of byelaws, some long standing, some recently introduced and some time-limited. The current regulations are as follows:

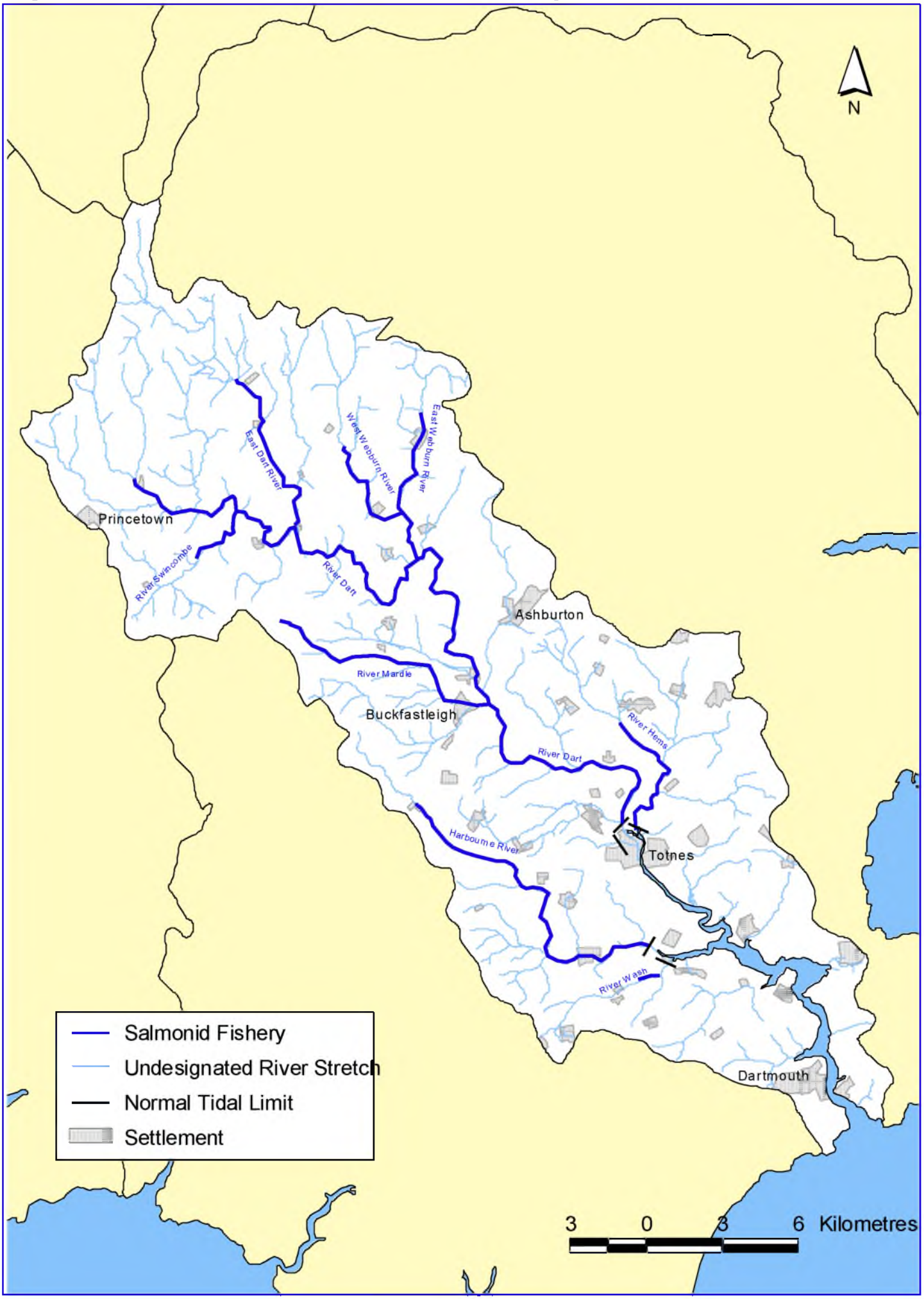
- Fishing season from 1 February to 30 September inclusive (for migratory trout from 15 March to 30 September).
- Use of worm or maggot is prohibited.
- Use of spinners* is prohibited at all times except below Holne bridge.
- No shrimp or prawn except below Staverton Bridge.
- No salmon to be retained before the 16 June **.
- Fly and spin only before 16 June **.

  * Artificial baits which spin: When fishing for salmon or trout use of any artificial bait which spins is restricted to those with only a single, double or treble hook. The width of the hook must not be greater than the spread of the vanes of the bait.
  ** National byelaw which expires on 31 December 2008.

Many angling associations have implemented their own fishing regulations (see Appendix 1).

Figure 1 EC Freshwater Fish Directive Designated Fisheries

Figure 1 - EC Freshwater Fish Directive Designated Fisheries



The net fishery:

The net fishery is regulated by a Net Limitation Order (NLO) and byelaws, some of which are long standing, some recently introduced and some time-limited. The current regulations are as follows:

- The number of nets is limited to fifteen under the current NLO, which was renewed in 2000 for three years and expires on 25 February 2003.
- Licensed netting for salmon and migratory trout takes place in the Dart estuary.
- Fishing is solely by means of seine nets.
- The netting season for salmon runs from 1 June* to 16 August inclusive.
- Nets may currently operate from 15 March to catch sea trout, but any salmon caught before 1 June must be released.
- The weekly close time for netting is between 06.00 on Saturday morning and 06.00 the following Monday morning.
- In the Dart estuary, netting for migratory salmonids is prohibited upstream of the boundary of the Parish of Berry Pomeroy where it crosses the river at the lower end of Fleet Mill Reach.

*National byelaw expires 31 December 2008

3.1 Catches and catch effort

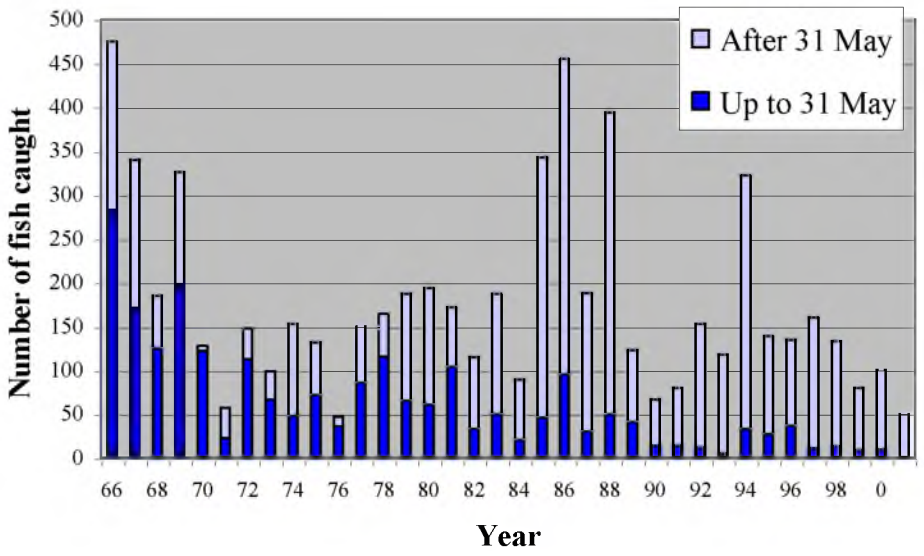
3.1.1 Rod catches

Declared annual rod catches for the period 1966 to 2001 are presented in Figure 2. Catches are split into numbers caught before and after 1 June. Fish caught before 1 June represent the 'spring salmon' component of the stock comprising multi-sea winter (MSW) fish, whereas fish caught later in the season are a mixture of MSW salmon and 'grilse' (one sea winter fish).

The salmon catches have been highly variable with no significant trend. Rod catches peaked at 475 salmon in 1960 and dropped to 50 in 2001.

Spring salmon catches have been declining significantly from about 200 fish per season in the late 1960s to fewer than 20 per season at present. The proportion of spring salmon in the total catch has fallen from 60 % to 10 % in recent years. Since the introduction in 1999 of national byelaw which requires the release of all rod caught salmon prior to 16 June, catches have remained at very low levels.

Figure 2. Salmon catches - River Dart Rods



3.1.2 Rod effort

The total numbers of days fished for salmon and sea trout combined have been recorded on statutory catch returns since 1993. This shows that fishing effort has reduced from over 6000 days per year in 1993 to just over 1500 days per year in 2001. The reduction in effort from 1999 onwards is probably related to the introduction of the national salmon byelaws. However catch per licence day for salmon has remained low, i.e., below 0.1 varying from 0.033 to 0.068 salmon per day over the period.

The national byelaw which prohibits the retention of any salmon before 16 June was introduced in 1999. In addition to the national byelaw, anglers have operated a voluntary catch and release scheme. In both 2000 and 2001, over 50% of the salmon caught were returned to the river, with more than 80 % of these fish being released after 16 June.

A summary of rod catch data is given in Table 1 below.

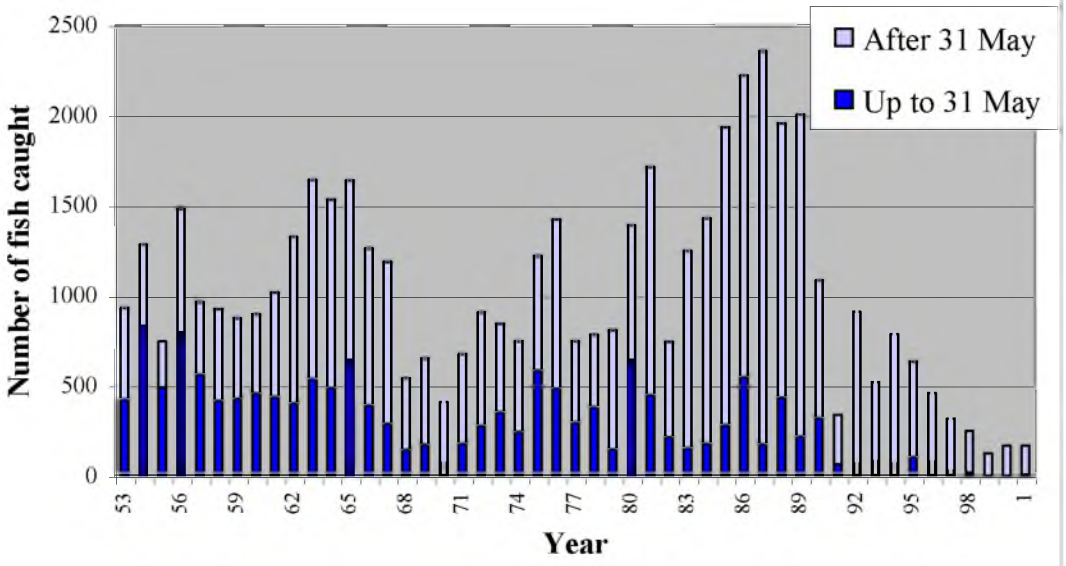
3.1.3 Net catches

Annual net catches for the period 1953 to 2001 are presented in Figure 3. Catches are split into numbers caught before and after 1 June. Fish caught before 1 June represent the 'spring salmon' component of the stock comprising multi-sea winter (MSW) fish, whereas fish caught later in the season are a mixture of MSW salmon and 'grilse' (one sea winter fish).

The salmon catches peaked in 1987 at over 2300 fish per season and have declined to below 170 fish per season in the last three years. Catches in late 1960s dropped from over 1000 fish per season before 1967 to around 500 fish per season in early 1970s.

This decline could be related to an Ulcerative Dermal Necrosis (UDN) outbreak which was widespread at the time.
Catches of spring salmon have significantly declined from over 800 fish per season in the 1950s to fewer than 30 fish per season from 1997 to date.

Figure 3. Salmon catches - River Dart Nets



3.1.4 Net effort

The number of nets operating remained at 18 for most of the period 1951 to 1994. Since 1994 the take-up of licences has reduced to 16 in 1995, 13 in 1996, 15 in 1997, 14 in 1998 and 13 in 1999. Since the NLO was renewed in 2000 at a reduced level of 15, the take up has been 11 in 2000 and 2001, and 13 in 2002.

A national byelaw which prohibited netting for salmon before 1 June was introduced in 1999. An exemption for the River Dart allowed netsmen to continue to fish for sea trout prior to 1 June, but to return any salmon caught.

Information on netting effort has been collected since 1997. Total annual netting effort reduced from an average of over 750 days per year in 1997 and 1998 to less than 500 days per year from 2000 (Broad, 2002). Catch per licence day for salmon has remained high over the period in comparison with the rod catch per unit effort.

The lowest netting station is situated at Anchor stone, just below Dittisham and the most upstream one is at Ham reach, 3.5 km below Totnes. 27 netting stations were in operation in the 1950s. These were reduced to 17 as a result of siltation and now only 7 are used regularly.

A summary of net catch data is given in Table 2 below.

Table 1 - Rod Catch Summary.

	PRE - 1 JUNE CATCH		POST-1 JUNE CATCH		ANNUAL CATCH		CATCH PER LICENCE DAY	
	2001	5yr mean 1997-2001	2001	5yr mean 1997-2001	2001	5yr mean 1997-2001	2001	5yr mean 1997-2001
Rods	1	9	49	96	50	105	0.034	0.044

Table 2 - Net Catch Summary.

	PRE - 1 JUNE CATCH		POST-1 JUNE CATCH		ANNUAL CATCH		CATCH PER LICENCE DAY	
	2001	5yr mean 1997-2001	2001	5yr mean 1997-2001	2001	5yr mean 1997-2001	2001	5yr mean 1997-2001
Nets	11	12	158	193	169	206	0.35	0.43

3.1.5 Sea trout

The annual declared sea trout rod catches are represented in Figure 4. Sea trout catches have been increasing significantly from the 1970s to date. The catches remain at their highest level, as in the late 1960s, at around 800 fish per season.

Early season catches (up to the end of May) have increased slowly from 1966 to date but are very variable.

Annual sea trout net catches are shown in Figure 5. Catches have been quite variable and have decreased slowly since the 1980s when they peaked at over 900 fish per season. Catches in late 1960s and early 1970s dropped suddenly from over 500 fish per season to below 100 fish per season. This decline could be related to an Ulcerative Dermal Necrosis (UDN) outbreak affecting salmon and sea trout at about this time.

There has been no significant trend in numbers of early season sea trout caught from the 1950s to date. From the late 1970s the proportion of sea trout caught before 1 June has been quite variable,-sometimes representing over fifty percent of the total catch.

Figure 4. Sea Trout catches - River Dart Rods

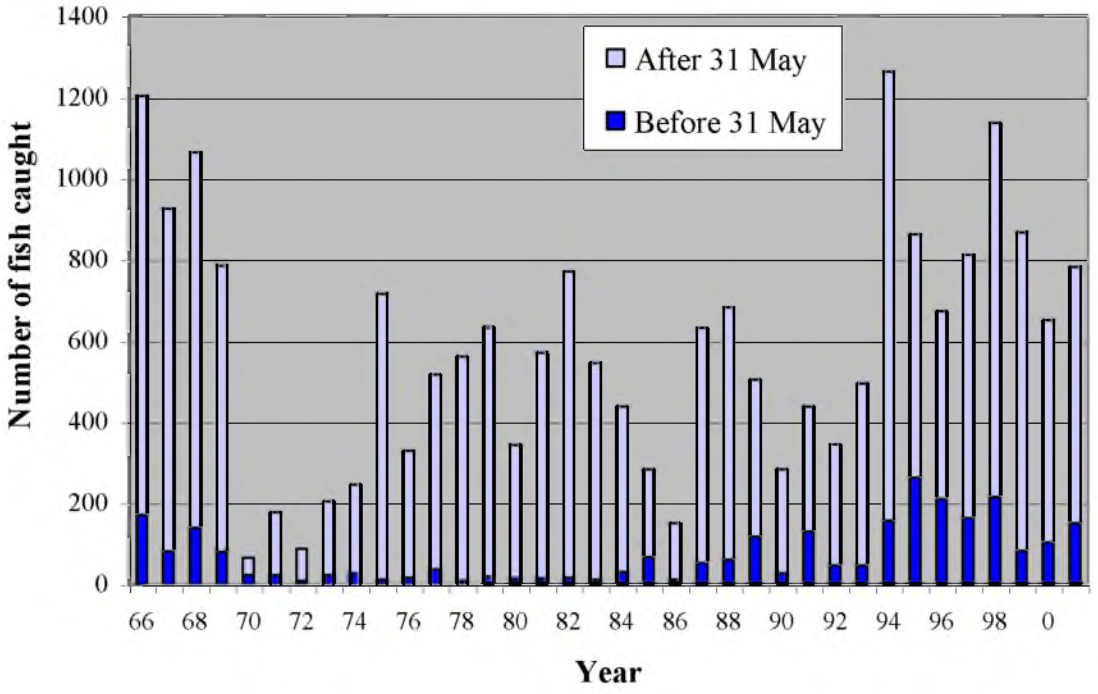
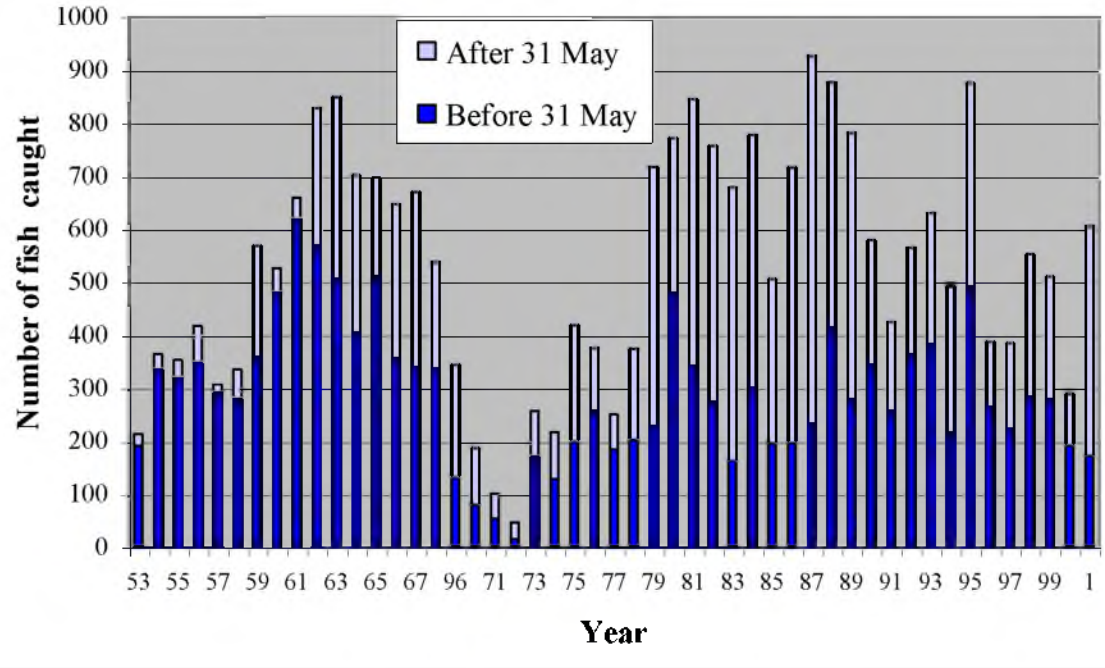


Figure 5. Sea Trout catches - River Dart Nets



PART 4 DESCRIPTION OF STOCKS, CURRENT STATUS AND RELEVANT TRENDS

4.1 Stock Monitoring

Comprehensive stock monitoring is a fundamental requirement for effective stock management. This is particularly important at a time of low stock levels if limiting factors are to be identified and, where possible, eased. We aim to monitor stocks by targeting life stages, times and conditions for which data of satisfactory precision can be obtained within the constraints of finance and physical river conditions.

4.1.1 Adults

Reported rod and net catches are useful indicators of salmon run size in a given year and are used for comparative purposes. More reliable estimates of run size may be obtained using direct counting of adults entering the river, typically by means of a fish counter. However, at present the River Dart does not have the benefit of a fish counter, so run size estimates have to be based on catch returns. This involves the estimation of exploitation rates, which is difficult without counter data or mark-recapture studies.

4.1.2 Spawners

Annual assessments of the number of spawners are made using reported rod and net catches in conjunction with estimated exploitation rates, to calculate spawning escapement.

4.1.3 Juveniles

Extensive monitoring of juvenile salmonids using electric fishing techniques has been undertaken on the River Dart on a regular basis since 1965. Between 1993 and 1999 the monitoring programme included a survey of the River Dart in a three year rolling programme. Since 2002 the monitoring programme has been modified to reduce the number of sites sampled by a third. A small proportion of the sites are now surveyed annually and the rest every five years. Semi-quantitative and quantitative surveys at sites throughout the catchment provide density estimates for salmon fry and parr. At the larger main river sites only timed, semi-quantitative surveys are possible, indicating presence or absence of juvenile salmon only.

As part of the monitoring programme, river habitat assessment using the HABSCORE technique will be carried out every five years at electric fishing sites. This technique is used to predict the potential juvenile salmonid production at a site, based on physical habitat features. When compared with the juvenile survey results, the data can be used to highlight fish production problems at a given site.

4.2 Juvenile Abundance

The results of the 1999 survey are summarised in Table 3 using the national Fisheries Classification Scheme (FCS). This system provides a standard approach for

presenting quantitative fish survey data and allows comparison of sites throughout England and Wales. The distributions of 0+ and >0+ juvenile salmon recorded in the 1999 survey are shown in Figures 6 and 7.

Table 3 - Juvenile salmon abundance in 1999 (66 sites)

% Sites in each juvenile abundance class (Number of sites)						
Age Class	**A**	**B**	**C**	**D**	**E**	**F**
0+	4.5 (3)	3.0 (2)	4.5 (3)	3.0 (2)	16.7 (11)	68.2 (45)
>0+	9.1 (6)	12.1 (8)	16.7 (11)	3.0 (2)	12.1 (8)	47.0 (31)
Combined	6.1 (4)	4.5 (3)	12.1 (8)	15.2 (10)	15.2 (10)	47.0 (31)

Densities in the lower catchment tributaries are low (the majority of the sites are classified as E and F), generally as a result of poor chemical quality (see part 2), degraded physical habitat and the presence of partial barriers restricting utilisation of the river habitat (Figure 8). Densities in the higher catchment tributaries are the highest.

Salmon parr are present in more sites than fry which suggests these older fish are more mobile than fry and colonise reaches other than those where they spent their first summer.

Historical data show that the densities in 1987 reached a peak, probably as a result of good salmon spawning in 1986 and 1985. This suggests that juvenile production in 1993, in 1996 and 1999 was below carrying capacity (Peress 1999) and ties in with the assessment that egg deposition in the whole catchment has fallen below the conservation limit in recent years (see Part 5).

Brown trout were caught at all surveyed sites. Eel, bullhead, minnow, stone loach and lamprey were also found in the River Dart catchment.

The timed, semi-quantitative surveys since 1993 have demonstrated that salmon fry and parr are distributed throughout the main river Dart, in the West Dart, and in the East Dart. They also indicate a steady improvement in salmon fry populations over the period 1993 to 1999 (by comparing number of fish caught per minute and per area) suggesting that spawning success, spawning activity or survival after hatching has increased in the main river in recent years (Broad 2002). However, salmon parr populations in the main river have remained stable over the same period.

Figure 6 – Distribution of Salmon Fry in the Dart Catchment 1999

Figure 6 - Distribution of Salmon Fry in the Dart Catchment 1999

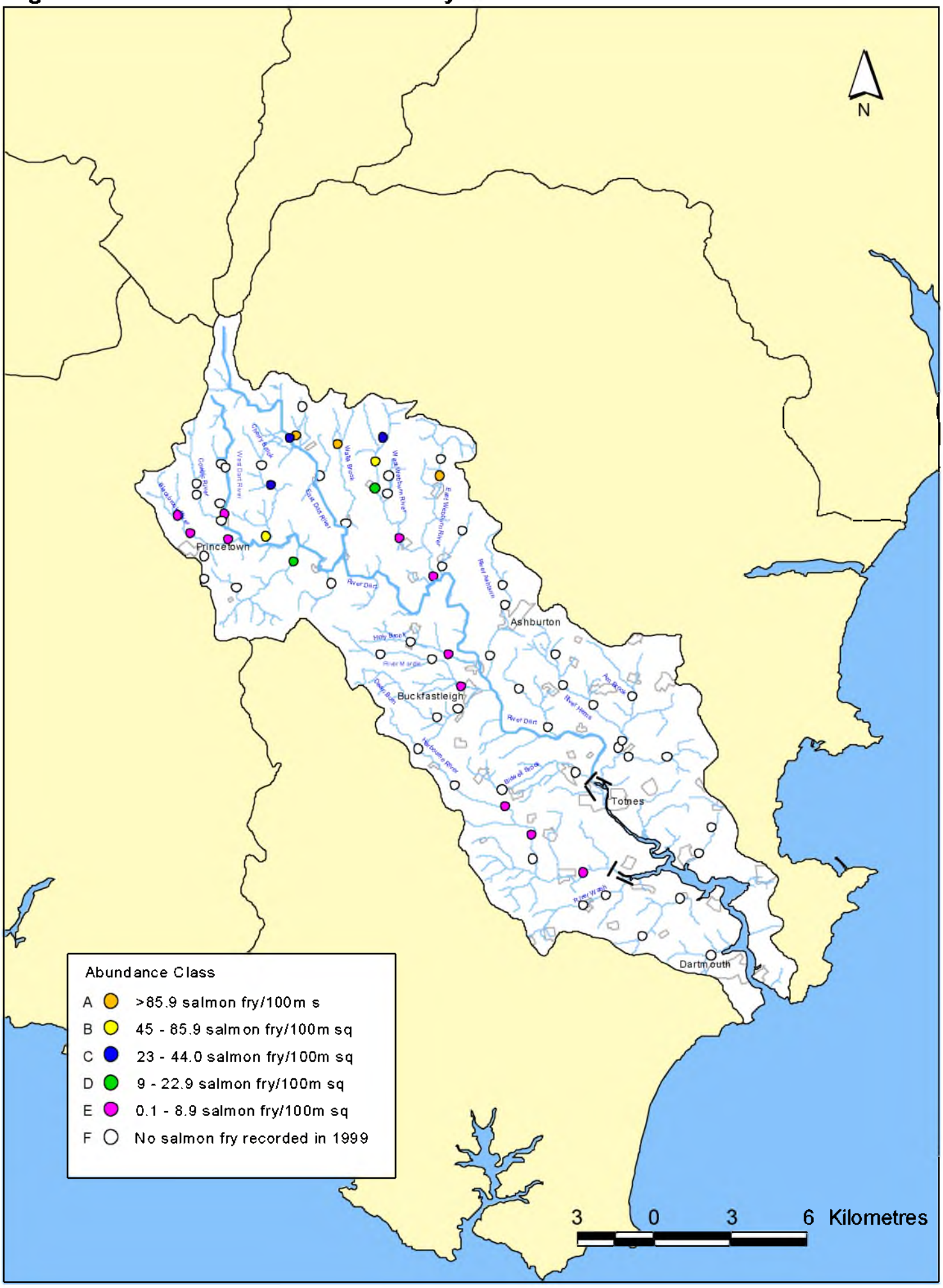
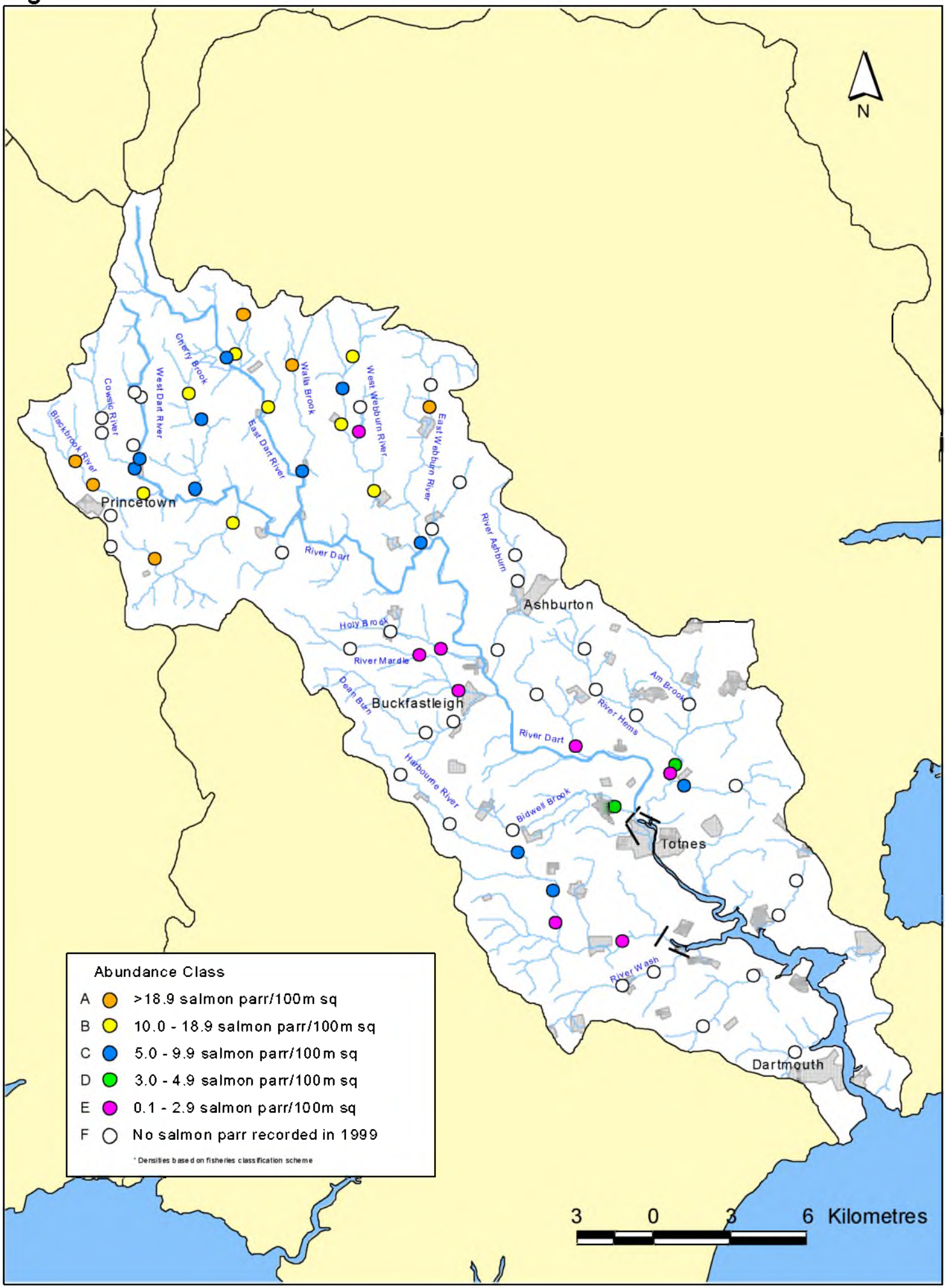


Figure 7 – Distribution of Salmon Parr in the Dart Catchment 1999

Figure 7 - Distribution of Salmon Parr in the Dart Catchment 1999



4.3 Distribution of spawning habitat and utilisation of the catchment

Figure 8 shows the barriers to salmon migration and the areas where salmon spawning activity has been observed.

Many manmade historical barriers to salmon migration now have fish passes installed and are passable at most flows. The most recent fish passes were installed on the River Mardle at Strode Road (2000) and at Merryfield (2001). Weirs and fish passes are regularly checked to ensure that they remain passable.

Venford reservoir on the Venford Brook is a complete barrier to migration. The A38 crossings on the Dean Burn and on the River Harbourne are complete barriers to migration as are some of the River Ashburn check weirs and the Dartington Mill weir on Bidwell Brook. Sections of the Dean Burn above the A38 obstacle are good nursery and spawning habitat and should be made accessible to migratory fish.

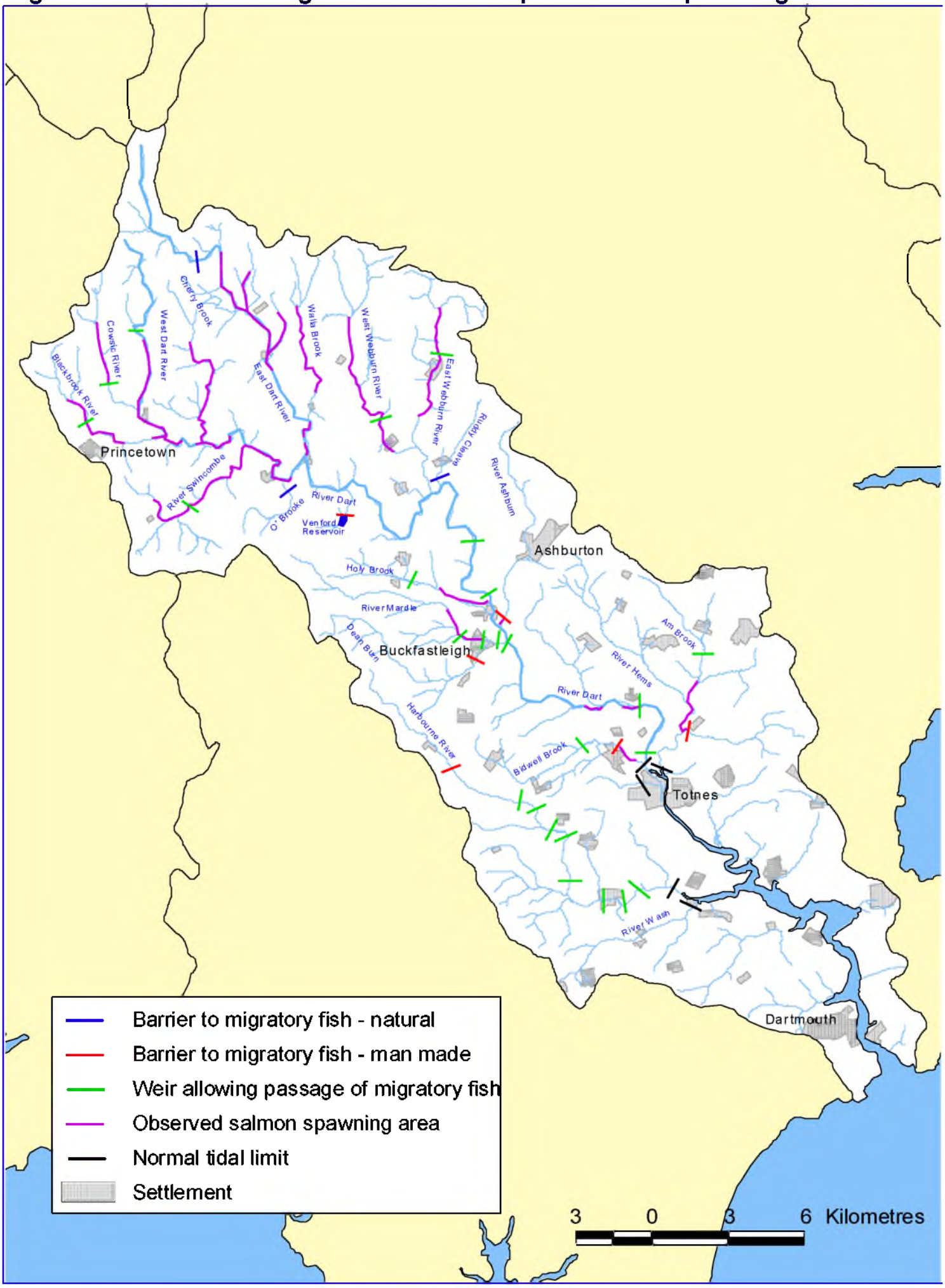
Natural falls on the Ruddycleave, O'brook and East Dart are also barriers to salmon migration. Salmon have never been recorded upstream of these locations.

Most of the spawning activity in the catchment has been observed in the upper catchment, upstream of Holne bridge. Some spawning activity has been observed on the main river Dart and on small stretches of lower catchment tributaries. The nursery areas for juvenile salmon coincide largely with the spawning areas.

Many of the salmon spawning areas are also utilised by sea trout and to a lesser extent, brown trout. Under favourable flows, sea trout will penetrate further upstream than salmon, reducing competition for spawning territory between the species. The effect of any interactions between salmon and trout and the implications for salmon stocks are unknown and cannot be assessed with any confidence. Possible interactions that may affect salmon include competition for food, spawning space and juvenile habitat territory.

Figure 8 – Barriers to Migration and Principle Salmon Spawning Areas

Figure 8 - Barriers to Migration and Principle Salmon Spawning Areas



PART 5. ASSESSMENT OF STOCK AND FISHERY PERFORMANCE

5.1 Conservation Limits

The first objective of the Salmon Management Strategy is that:

"Individual salmon stocks and the environment in which they live should be managed to optimise recruitment to home water fisheries."

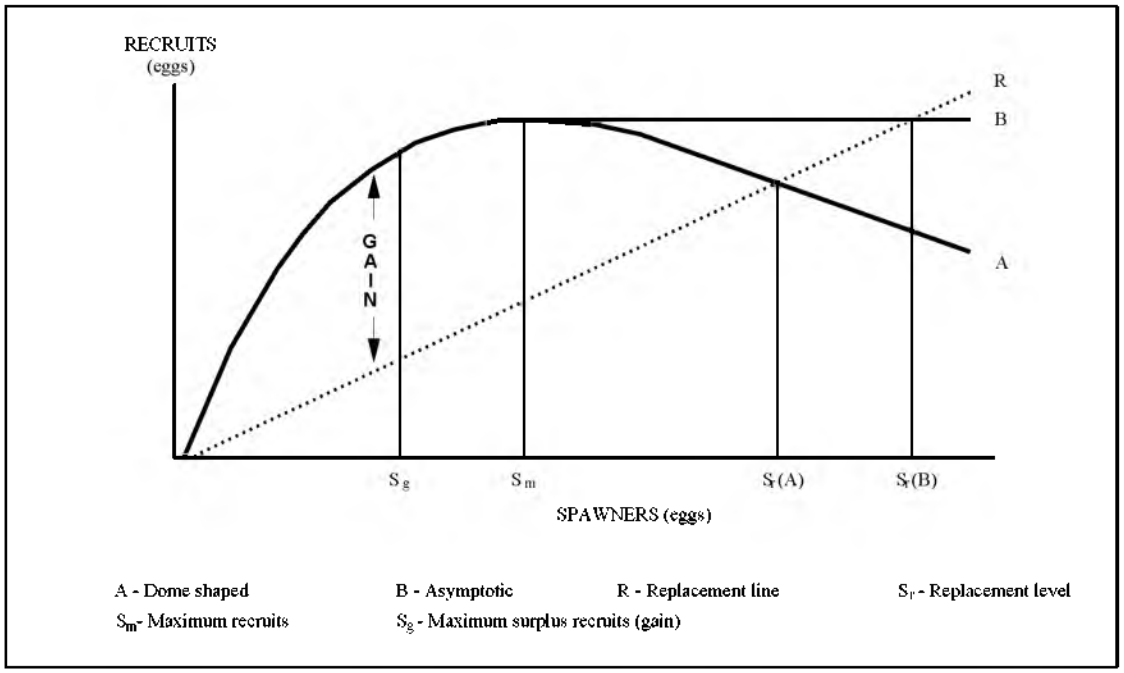
This objective needs to be expressed in terms of biological targets. To do this nationally requires a common approach across the Agency's regions to the setting of targets and the assessment of compliance (Environment Agency, 1996).

Although several types of target can be set for the management of salmon, the International Council for the Exploration of the Seas (ICES) has recently recommended (ICES, 1995) that spawning stock at maximum gain should be the standard target defining the Minimum Biologically Acceptable Level (MBAL) or Conservation Limit for the maintenance of a given salmon stock (see Appendix 2).

The Conservation Limit (CL) has been adopted by the Environment Agency as being consistent with the objectives of the Salmon Management Strategy.

The relationship between spawners and the number of recruits produced can be summarised as a stock-recruitment (S-R) curve (Figure 9). The replacement line represents the relationship between the recruits and spawners and the difference between this line and the S-R curve is referred to as 'gain'. These are the surplus fish (recruits) potentially returning to the system above the level required to replace the spawning stock that generated them. Maximum Gain occurs at a mathematically definable point (Sg) on the curve.

Figure 9 - Diagrammatic stock recruitment curve



A Conservation Limit has been definitively calculated for only one river in the UK - the River Bush in Northern Ireland – where a stock-recruitment curve and replacement line have been estimated from several years of monitoring data for salmon smolts and adults. Values from the Bush S-R curve are 'transported' to rivers in England and Wales using the methodology described in the Agency's Salmon Action Plan Guidelines (Environment Agency, 1996). This procedure uses the Bush S-R values along with river-specific estimates of juvenile production and other information (e.g. marine survival estimates) to derive an S-R curve and replacement line for SAP rivers. In turn, these two relationships are used to define the Conservation limit.

5.1.1 Conservation Limit of the Catchment

The Conservation Limit for the River Dart is 294 eggs per $100m^2$ of total accessible area for salmon, which equates to a total of 4.0 million eggs (Peress 2000 and 2002). This is equivalent to 1417 spawning adults. The parameters used to derive the CL value and annual egg deposition figures are given in Table 4.

Table 4 - Summary of conservation limit value and compliance estimates

TARGET	VALUE
Conservation limit	$294/100m^2$ or 4.0 million eggs
Spawners equivalent to CL value	1417

Parameters used to calculate above:
Total accessible area = 1.37 million m^2
Marine survival: grilse = 25% , MSW = 15%
Fecundity: grilse = 4128, MSW = 6273 (from 1960s scale reading River Dart net catches investigation)
Proportion of females: grilse = 53.2%, MSW = 68.7%
Proportion of grilse = 70.2%
In-river mortality = 9%
Extant rod exploitation rate =30%, 39%, 26%, 17%, 17.5%, 14%, 14%, 8%, 6%, 3% respectively from 1992 to 2001 (Peress, 2002).
Rod catch declaration = 91% (from 1994 to date) , 53% (1992-93)

5.1.2 Historic egg deposition and compliance assessment

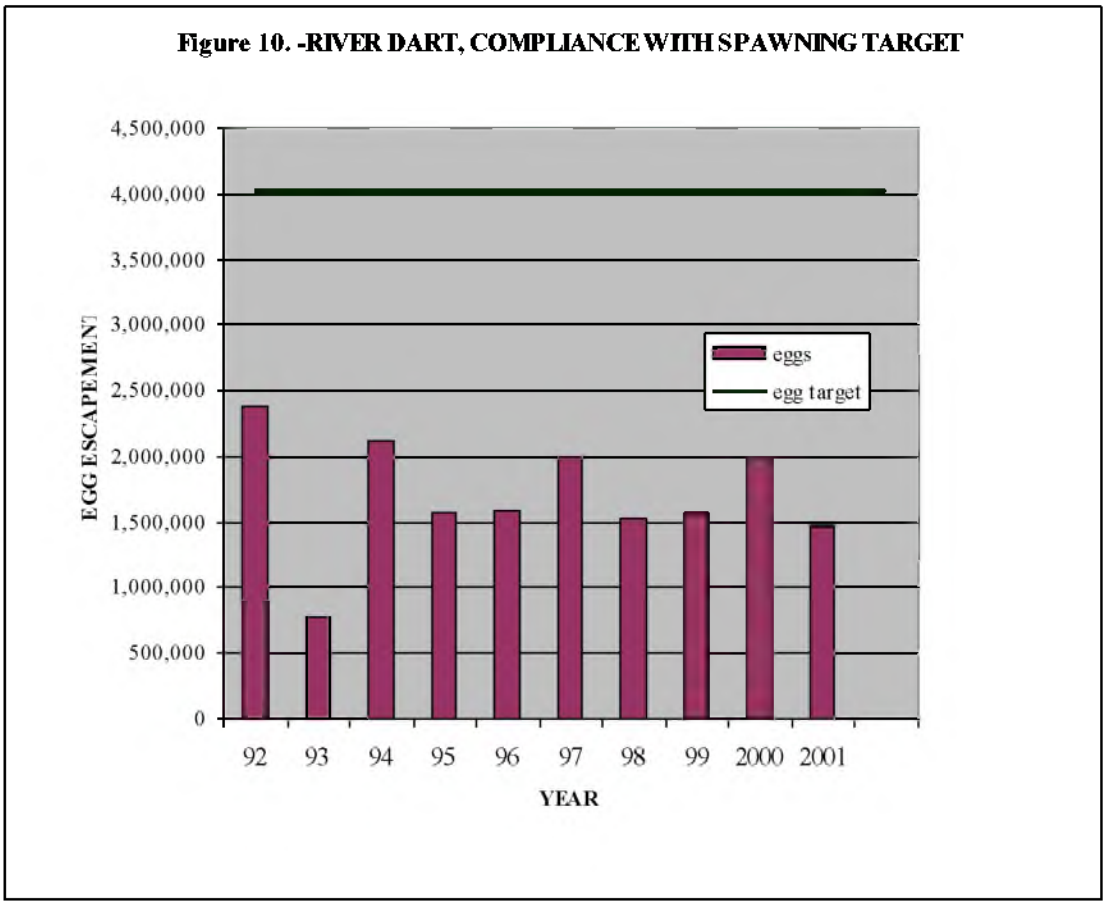
Annual egg deposition estimates have been calculated for the period 1992 to 2001 according to the National protocol, which bases estimates of stock on rod catch returns.

Compliance is assessed using the national protocol, which is based on the identification of failure "episodes." Failure occurs if an episode (below target) lasts for more than two years without a clear gap of at least two years

Historic egg deposition levels are shown in Figure 10 and periods of non-compliance with the spawning target are highlighted.

Egg deposition has failed to reach spawning target level during the last 10-year period. Compliance assessment indicates continuous failure to meet the spawning target from 1992 to date.

Figure 10 - River Dart Salmon egg deposition and compliance with spawning target, 1992- 2001.



The current position with respect to egg deposition against the spawning target level is summarised in Table 5.

Table 5- Egg Deposition

Current egg deposition	Target egg deposition	Failure within last 3 years?
1.5 million	4.0 million	Yes

Stock assessment analysis of the River Dart salmon population (Peress 2002) suggests that levels of exploitation of salmon stock both by net and rod fisheries have decreased significantly over the past 10 years (net exploitation decreased from 45 % to 9 % and rod exploitation from 39% to 3%) and therefore low adult marine survival (from smolt to adult) and/or low juvenile freshwater survival could explain why egg deposition has not achieved the conservation limit. Degraded freshwater habitats in the lower part of the catchment, poor conditions at sea and in the estuary and high seas fisheries are the main factors currently limiting salmon population production.

In order to allow egg deposition to achieve the conservation limit in future years, exploitation rates both for net and rod fisheries should not increase above the 2001 level. Levels of catch and release of fish should be maintained or increased. Fishing effort should not be increased, or should even be reduced, from current levels. Accurate records of fishing effort, in terms of days fished, should be kept.

5.2 Freshwater production

Freshwater production is reduced by factors limiting freshwater density independent survival, mainly occurring in the lower part of the Dart catchment (see Part 4).
River habitat improvement works have been carried out annually on nursery and spawning habitat on sections of tributaries running off Dartmoor and on the River Mardle. Such works typically include gravel cleaning and bank restoration to prevent silt production and accumulation in the river bed.

Salmon smolt production remains unknown as no smolt monitoring has been carried out to assess the overall juvenile production of the River Dart. Occasionally, smolts will run down leats and die (at Jordan and Buckfast Abbey hydropower plants). Adult scale readings indicate that the majority of smolts migrate to sea at 2 years old, with the remainder migrating at 3 years old.

5.3 Diversity and Fitness

The MSW and spring fish components of the River Dart stock have declined over the long term (since the 1960s). A weight frequency distribution analysis of net catches has been carried out from 1973 to date to determine the sea age composition of the salmon stock (Peress 1998). This showed that MSW components of the River Dart stock have declined since the 1980s. This trend has been observed in many rivers in the United Kingdom and the National Spring Salmon byelaw in place since 1999, aims to contribute to reduce this decline. MSW fish are particularly valuable to the stock as a whole in terms of their fecundity and because the proportion of females is greater than for grilse.

The grilse catch component has been increasing in proportion but not in numbers.

Transfer of salmon stocks between different catchments and the River Dart is prohibited in order to maintain genetic integrity of the Dart salmon stock.

PART 6 LIMITING FACTORS

Factors which could currently or potentially be limiting salmon stocks and/or the salmon fishery of the Dart are listed below:

6.1 Environmental Limiting Factors

The environment of salmon may be limited by impacts on both the physical habitat and chemical habitat.

6.1.1 Impacts on physical habitat

Impact of unscreened intakes on smolts and kelts.
Impact of low flows on adult, kelt and smolt migration.
Impact of low flows on juvenile survival and production.
Impact of low flows on adult survival.
Impact of sedimentation on spawning gravels.
Impact of obstructions to adult and smolt migration.
Impact of overgrazing leading to loss of riparian vegetation, bankside erosion and channel instability.
Other impacts on channel morphology and physical features, particularly for juveniles.
Impact of ocean currents and sea temperatures on marine survival of smolts and adults.
Impact of global warming.

6.1.2 Impacts on chemical habitat

Impact of eutrophication
Impact of pesticides
Impact of endocrine disruptors
Impact of other determinands (BOD/ammonia, metals.)
Impact of pH related events

6.2 Biological Limiting Factors

Competition for habitat from trout
Food source competition in river
Food source competition at sea
Impact of avian predation
Impact of predation by other fish
Impact of stocking with farmed brown trout
Impact of mammalian predation
Impact of diseases
Impact of parasites
Impact of adverse genetic change

6.3 Fishery limiting factors

Legal high seas fisheries (including bycatch of smolts)

Legal Irish fishery
Legal fishing in the Dart estuary
Licensed rod fishing
Illegal high seas fisheries
Illegal Irish fishery
Illegal fishing in the Dart estuary
Illegal fishing in coastal waters
Illegal fishing in river

6.4 Most significant limiting factors

All of the above factors influence the salmon stock of the River Dart. The factors, which are considered to be most significant in limiting the population at present, are listed below:

- Reduced marine survival
- Exploitation in the high seas and Irish fisheries
- Siltation of spawning gravel
- Agricultural pollution
- Low flows due to abstractions
- Exploitation by the net fishery in the Dart estuary
- Illegal fishing in coastal waters
- Illegal fishing in the Dart estuary
- Illegal fishing in river

6.5 Management information issues

In addition to the above factors which directly influence Dart salmon stocks, there are also shortfalls in the quality and quantity of information available to the Agency upon which to make decisions regarding future management of the fishery. These include:

Limited understanding of factors and mechanisms determining stock abundance (need for further research).

Need for better assessment of adult, smolt and juvenile life stages.

Need for better assessment of freshwater physical habitat and carrying capacity.

Need for better information on marine mortality and exploitation rates.

Need for better estimation of rod exploitation rates.

Need for better estimation of net exploitation rates.

PART 7 ISSUES AND ACTIONS

7.1 Issues related to the marine phase

Limiting factors in the marine phase are discussed further in Appendix 3. These relate to natural and fishing mortality reducing the number of salmon returning to homewaters. Clearly, these are national and international issues which are largely out of the control of the Agency, particularly at a local level. However, we are working with other agencies to influence governments to reduce marine exploitation rates where appropriate.

7.2 National issues

Some of the limiting factors which have been identified are national issues affecting salmon stocks. Siltation of spawning gravels is a good example where measures taken locally are unlikely to go far enough to adequately address the problem. To have any measurable and beneficial long term effect will require changes in current land use practice, which is ultimately driven by the European Union's Common Agricultural Policy and the types of grant awarded by the DEFRA to the farming community. The consistent occurrence of siltation as a problem in the salmon rivers in England and Wales presents the Agency with a good opportunity of raising awareness of the issue at a national level.

Other issues which are of national or international significance include low flows (eg caused by drought) and avian predation on smolts.

Research and development needs to support better provision of management information are also applicable nationally.

7.3 Local issues

Many of the limiting factors and information needs which have been identified, may be regarded as local issues or as a local threat to the salmon population.

Initiatives to investigate and/or address some of local issues on the River Dart are identified in Table 6. Actions are aimed to conserve salmon populations and salmon habitat from future developments and from new threats, as well as to resolve present issues. These actions should be carried out in an integrated manner taking into account wider ecological impact.

7.4 What we are doing now

Ongoing fishery management activities on the Dart are detailed in Table 7. As previously discussed, many factors which have a major influence on salmon stocks are beyond the control of the Agency.

Table 6- Issues and Actions

Issue 1	Limiting Factors	Actions	Partners (lead in bold)	Priority	Comments
Physical deterioration of spawning and juvenile habitat	Reduction in egg to smolt survival.	Reduce production and accumulation of silt in the river while considering the river's natural processes and the ecology of water course's corridor. This needs be done through: Protecting river bank by fencing to limit livestock access to the river and to encourage the growth of bankside vegetation. Programme on going part of Action for Wildlife on Dartmoor. Identifying other sections of river that are suffering from silt accumulation and that would benefit from habitat protection especially lower part of the catchment. Carrying out spawning and nursery rehabilitation annually and identify where else it is required	**EA** **EA** DNPA DFA DAA Duchy **EA** DFA **EA** DFA		£5 000 per year Actions led by EA Environment Management team in consultation with EA Biodiversity team and carried out in partnership with landowners.

Issue 2	Limiting Factors	Actions	Partners (lead in bold)	Priority	Comments
Diffuse pollution	Pollution from agricultural practices and from roads reduces available salmon habitat and could cause fish kill and long term impact on salmon population production.	Identify sections of rivers that are suffering from pollution run offs. Promote good farming practice. Encourage the implementation of EA Best Farming Practices recommendations. Identify who will give advice to farmers and take example from the River Axe enhancement project. Protect identified river sections by creating a buffer zone along the river bank to absorb any run off.	**EA** **Farmers** **EA** DNPA DEFRA **EA**	HIGH	

Issue 3	Limiting Factors	Actions	Partners (lead in bold)	Priority	Comments
Point source pollution	Acute and chronic pollution from sewage treatment works and from agricultural pollution incidents reduces available salmon habitat and could cause fish kill and long term impact on salmon population production	Implement the legislation for the treatment of sewage and negotiate with South West Water Ltd improvements under AMP3 and AMP4. Improvement on going: Totnes STW and its storm overflow capacity, new STW at Dartmouth, improvement at Ipplepen STW and on the Da rtington to Totnes combined sewer overflow (CSO)on the Bidwell brook. Contribute to the review of discharge consents under the Habitat Regulations for Dartmoor cSAC. Liaise with SWW over planned improvements for Harbertonford STW and at Buckfastleigh investigate operation of (CSO). Include improvements under AMP4, if need identified. Issuing new discharge consents without impacting RQO compliance Education of farming community to minimise risks of pollution incidents.	**EA** SWW **SWW** EA **EA** EN **EA** SWW **EA** **EA** NFU Farmers	HIGH HIGH HIGH HIGH HIGH	

Issue 4	Limiting Factors	Actions	Partners (lead in bold)	Priority	Comments
Obstruction to fish passage	Area of accessible stretches of river is reduced due to impassable man made obstacles. The negotiation of weirs causes exhaustion and fatigue and occasionally physical damage to the salmon population.	Improve fish passage during migration period by installing fish pass on the Dean Burn (A38 stopper) Assess the feasibility of improving fish passage on the Ashburn (A 38 check weir), on the Bidwell brook (Dartington mill) and on the Holy brook. Evaluate the need to improve the weirs on a regular basis and other obstruction such as trash dams after fully considering the wider ecological impact. Maintain all fish passes in the Dart catchment. Continue programme of "tripper dam" removal. Work with DNPA to educate the public and limit their creation.	**Highways Agency** EA **EA** Highways Agency DNPA Buckfast Abbey **EA** DFA **EA** **EA** DNPA		£ 50 000 Design has been carried out by the EA £ 1000 Feasibility study cost are part of ongoing work costs. Routine work to be carried out by the EA Environment Management Team

Issue 5	Limiting Factors	Actions	Partners (lead in bold)	Priority	Comments
Abstractions	Flow reduction at abstraction point is hindering fish passage especially during low flow periods.	Develop ecological and flow monitoring to quantify impact under RSAP for potential unsustainable abstractions, part of the review of all licences. Assess potential impact from abstractions suspected to act as bottle neck for fish passage on the main river. Observations indicated that abstractions at Buckfast Abbey, River Dart Country Park, Jordan, Belsford, Beenleigh and Hatchlands fish farm are affecting fish passage and are reducing amount of water flowing downstream of the abstraction point during summer months.	**EA** Abstractors	High	
	Abstractions are reducing the wetted area especially during the summer contributing to the reduction in juvenile production	Contribute the appropriate assessment that the Agency must undertake as part of stage 3 of the review of consents under Habitats Directive for Dartmoor cSAC. If an abstraction is proved to have a negative impact on Salmon, licence conditions should be modified.	**EA** EN	High	
	Smolt and kelts migrating to sea have been drawn into abstractions through unscreened leats	Assess and implement on existing licences the prescribed minimum flow required based on R&D outcomes.	**EA**	High	
		Ensure adequate levels of protection for the river when granting new licences. Influence the River Dart CAMS due to be started in 2004 and in particular the definition of RFOs	**EA** Abstractors	Medium	

Issue 5	Limiting Factors	Actions	Partners (lead in bold)	Priority	Comments
Abstractions		Ensure adequate screening arrangements are in place to allow migrating fish to bypass abstraction points, of even more importance when water quantity abstracted is greater. Need identified at Buckfast Abbey , River Dart Country Park, Swimcombe intake, Jordan and Beenleigh Manor. Continue inspection visits. Carry out feasibility study for each abstraction, subsequent design and installation. Feasibility is ongoing for Buckfast Abbey.	**EA** Abstractors	High	£1000 for feasibility study per abstraction

Issue 6	Limiting Factors	Actions	Partners (lead in bold)	Priority	Comments
Illegal Exploitation in freshwater, estuary and coastal waters.	Problems of illegal exploitation occur at most times of the year.	Continue current level of enforcement Publicise successful poaching offence prosecution. Raise awareness through magistrate training seminars.	**EA** DFA Netsmen Police	High	

Issue 7	Limiting Factors	Actions	Partners (lead in bold)	Priority	Comments
Insufficient monitoring of fish population and modelling	No adult fish counter results in a high level of uncertainly in the calculation of egg deposition figures. Estimates of rod exploitation and out of season run have to be made	Seek funds to modify Totnes Weir fish pass to accommodate a fish counter. Seek funds to run such a counter.	**EA** DFA	Medium	£50k plus for modification and installation. £25k annual running costs.
	Insufficient information relating to freshwater production	Implement new monitoring programme in accordance with national guidelines. Consider need for additional monitoring.	**EA**	High	
	Lack of River Dart and tributaries freshwater habitat assessment and mapping	Assess the feasibility of overall freshwater habitat assessment in order to estimate carrying capacity	**EA**	Medium	
		Carry out HABSCORE surveys and run HABSCORE model as recommended by the national monitoring programme	**EA**	High	

Issue 8	Limiting Factors	Actions	Partners (lead in bold)	Priority	Comments
Netting exploitation	Exploitation of salmon at current low stock level	Reduce net exploitation rates by reducing fishing effort.	**EA** Net fishery association	High	
		Renew NLO to a reduced level of 13 nets from 2003 for three years and review NLO by 2006	**EA** DFA Netsmen DEFRA	High	
		Review need for further measures to protect salmon stock.	**EA**	High	
		Review effect of 1999 national salmon byelaw on spring and MSW fish component in 2003	**EA**	High	

Issue 9	Limiting Factors	Actions	Partners (lead in bold)	Priority	Comments
Angling exploitation	Exploitation of salmon at current low stock level	Maintain exploitation at or below current level by maintaining fishing effort and proportion of killed salmon at or below current levels. Continue or tighten voluntary measures through the angling association regulations. Review need for further measures to protect salmon stock. Review effect of 1999 national salmon byelaw on spring and MSW fish component in 2003	EA **Angling and riparian owners** **EA** **EA**	High High High	

Table 7 - Fishery Management Activities

ACTIVITY	WORK INVOLVED
Enforcement	Rod and Net licence checks Anti-poaching activities in river, estuary and coastal waters Prosecution of offenders Dealer/Hotel checks Section 14 SFFA – screening of abstractions Section 30 SFFA – stocking consents
Monitoring	Catch statistics Electric fishing juvenile survey Redd counting, targeting specific areas
Habitat Improvement	Gravel Rehabilitation Trash Dam removal River bankside fencing projects River bankside coppicing/planting schemes
Regulation	Controlling the activities of others (new developments, planning applications, abstractions, discharges)
Control of exploitation	Net Limitation Order and byelaws to control exploitation. Promotion of catch and release and other voluntary measures. Marine fisheries.
Emergency	Fish rescues Fish mortality assessments

PART 8 REFERENCES

Broad K. J. (2002). River Dart Net Limitation Order review. FRCN/02/03. Environment Agency.

Environment Agency (1996). Salmon Action Plan Guidelines. Version 1

Environment Agency (1997). River Dart LEAP – Consultation Report.

ICES (1995) Report of the ICES working Group on North Atlantic Salmon, 3-12 April 1995. ICES CM 1995/Assess:14

National Rivers Authority (1996). A strategy for the management of salmon in England and Wales.

Peress J. (1998). River Dart salmon spawning target and compliance assessment. Fisheries Technical Report FRCN/98/05, Environment Agency South West Region.

Peress J. (1999). Stock assessment review on the River Dart. Fisheries Technical Report FRCN/99/07, Environment Agency South West Region.

Peress J. (2002). Amendments to River Dart conservation measures to protect salmon stock. FRCN/2002/02. Environment Agency.

Reddin, D and Friedland, K. (1996) Declines in Scottish spring salmon and thermal habitat in the Northwest Atlantic: How are they related?

PART 9 GLOSSARY OF TERMS

Alevin	Salmon or trout immediately after hatching. At this stage the fish is not free-swimming and is dependant on its yolk sac for sustenance
Accessible habitat	the total area of the catchment accessible to adult salmon.
AMP3	Asset Management Plan 3 – The third Asset Management Plan produced by the Water Companies for the Office of Water Services (OFWAT). It sets out the water investment programme for the period 2006-2010.
BOD	Biochemical Oxygen Demand – A standard test which measures over 5 days the amount of oxygen taken up by aerobic bacteria in the oxidation of organic (and some inorganic) matter.
CL	Conservation Limit – see Appendix 2 for an explanation.
cumecs	cubic metres per second. Measurement of discharge or rate of flow.
Exploitation	removal of stock through legal/illegal fishing.
EC/EU	European Community/ European Union. As members of the EC/EU we are obliged to act upon European law, issued in the form of Directives.
Escapement	the stock remaining after exploitation.
Extant rod exploitation	Extant rates express the rod catch as a proportion of the total run.
FCS	Fisheries Classification Scheme – a nationally standardised format employed by the Agency, a means by which populations of juvenile salmon can be compared using an abundance scoring system.
Fecundity	the total number of eggs produced by one mature female.
Fry	juvenile life stage between alevin and parr, where the alevin becomes free-swimming and actively hunts for food.
GIS	a computerised mapping facility (or Geographic Information System) which can be used to measure catchment features e.g. river lengths.

ICES	International Council for the Exploration of the Seas, the mission of which is to collate, research and report data on the international status of salmon stocks.
CEFAS	the Centre for Environment, Fisheries and Aquatic Science, formally known as the Directorate of Fisheries Research (DFR) section of MAFF. Involved with salmon research and data collation at national and international levels.
HABSCORE	a system for measuring and evaluating stream salmonid habitat features, giving theoretical predictions for optimum fish densities in a given section of river.
MBAL	Minimum Biologically Acceptable Level. Defines, from a stock- recruitment curve, that level of spawning which maximises the sustainable catch (total catch, comprising all marine and freshwater fisheries).
Microtag	a coded wire tag of 1.5mm long and 0.25mm diameter, inserted into the nasal cartilage (snout) of fish. Detectable in live fish, but only readable after removal.
MSW	Multi Sea Water Salmon, salmon that has spent more than one winter at sea.
Q95	the flow that on average is equalled or exceeded for 95 % of the time.
Q5	the flow that on average is equalled or exceeded for 5 % of the time.
Parr	juvenile life stage following fry, where the fish exhibit characteristic parr marks/bars as dark vertical stripes upon their flanks.
Post-rod mortality	mortality that takes place after the end of the angling season but before spawning. In the absence of local information, a default value of 9% (from radio-tracking studies) is assumed for this mortality when estimating egg deposition.
RE1	The targets for managing water quality are known as River Quality Objectives (RQOs); these are based on the River Ecosystem (RE) classification scheme. RE1 is described as water of very good quality suitable for all fish species, and RE2 is water of good quality suitable for all fish species.
Redd	salmon nest in river bed. Dug out of gravel/stony bed by spawning adults, with eggs deposited in displaced material.
RFO	River Flow Objective

RQO	River Quality Objective
Run	the number of adult salmon ascending, or smolts descending, a given river in a given year.
Salmonid	a fish of the salmon family; salmon, sea trout, brown trout.
SFFA	Salmon and Freshwater Fisheries Act, 1975.
Siltation	deposition of waterborne suspended solids in/on the river bed. Siltation blocks gaps between substrate particles, preventing the through passage of water necessary for egg survival.
Smolt	life stage between freshwater parr and seawater adult phase, where parr undergo a process of pre-adaptation to a saltwater environment. As a part of this process, smolts acquire a characteristic silver appearance - similar to adult salmon - prior to migration down river and out to sea.
Substrate	the composition of the river bed.
The Agency	the Environment Agency, successors to the National Rivers Authority (NRA).
Year class:	the population of salmon, of all life stages, resulting from one year's spawning.
0+	notation to describe the age of a fish – fish in its first year of life.

PART 10 APPENDICES

Appendix 1.

Fishing Regulations of the Dart Fisheries Association.

DART FISHERIES ASSOCIATION

FISHING REGULATIONS FOR 2002

In addition to the National Byelaws, which require all salmon caught before June 16th to be returned, the DFA strongly recommends that:

- **All salmon over 10lbs [approx. 32ins long], or which are coloured or which have been tagged, to be returned.**
- **All salmon caught in September to be returned.**
- **Not more than one salmon in any one day and not more than three salmon in the period from June 16th to August 31st may be kept.**
- **For salmon – single or double barbless hooks no larger than size 6 to be used.**
- **Not more than two seatrout per night to be kept.**

In order to give the Committee the information they need to manage the river it would be most helpful if riparian owners could send a note of their own catches, and their guests/tenants catches, of both salmon and seatrout to the Hon. Secretary at the end of the season.

Appendix 2

Conservation Limits

* Description of methodology

Within the individual river SAPs, the assessment of the current status of salmon stocks is partly based upon assessment of compliance against spawning targets or Conservation Limits.

The principal of Conservation Limits is now used by the Agency as a means of determining appropriate exploitation levels. The policy follows the recommendations made by the North Atlantic Salmon Conservation Organisation (NASCO) during 1995 and draws upon an extensive body of experience in the use of targets for salmon management in North America since 1977. The basic rationale behind this approach is outlined below.

The main reason for using Conservation Limits in salmon management is to provide an objective standard against which to assess the status of a river's salmon stock. The standard is selected to ensure the long-term sustainability of the stock and the fishery it supports. The principle is simple. The numbers of salmon a river can produce (and consequently the catches that result) are a function of the quality and quantity of accessible spawning and rearing area. This is why, in general, big rivers have larger catches and have correspondingly bigger total spawning requirements than small rivers. Thus, for any given size of river there should be a preferred or optimum level of stock that the Conservation Limit seeks to define.

There are three stages in the use of Conservation Limits: setting the limit, estimating actual egg deposition and assessing compliance against the limit. The procedures used are described in detail elsewhere (Environment Agency, 1996).

The Agency defines Conservation Limits in terms of optimum spawning levels, expressed as egg deposition (eggs laid down per $100m^2$ or the total number of eggs per river). This is because spawning level is considered the primary factor controlling the number of smolts likely to be produced by a river section. On average, more eggs deposited means more smolts being produced, up to a point beyond which output levels off or may even decrease. This occurs because young salmon are strongly territorial and there is a finite number that a river section can support. This level of production is often referred to as the carrying capacity. If data are available, for a given river a curve can be plotted showing the change in smolt production (or adults 'recruiting' back to fisheries) accompanying increasing spawning stock level. This is known as a "stock recruitment" (S-R) curve. A characteristic feature of such curves, even when numbers are accurately and precisely measured, is the wide variation in recruitment which occurs at any one stock level: this is mainly due to the effects of random factors influencing survival.

The Conservation Limit chosen for SAPs is derived from one recommended by NASCO which defines, from a S-R curve, that level of spawning which maximises the sustainable catch (total catch, comprising all marine and freshwater fisheries), and it is termed the **M**inimal **B**iologically **A**cceptable **L**evel (MBAL). If exploitation rate

increases above the sustainable catch level then, although the catch may temporarily increase, the stock will eventually reduce. Thus, MBAL is a threshold spawning level below which it is inadvisable to go. Indeed, in order to give some leeway on the estimate it is preferable to establish a long term spawning level rather higher than MBAL to ensure against the effects of unforeseen exceptional events leading to low survival.

A buffer is incorporated into the statistical compliance procedure adopted by SAPs, but it may be felt that more insurance is desirable. This should be a local management decision and depends on circumstances. For example, particular uncertainty over the deposition estimates may lead a manager to set a higher Conservation Limit to reduce risk of the potentially damaging effect of over fishing.

Because S-R curves are not available for most rivers the procedures used here are taken from the River Bush in Northern Ireland, where long-term studies have given a working model of the relationship between spawners and recruits. The shape of the S-R curves is controlled by the productivity of the freshwater habitat and the survival rate. Therefore, correcting for these features allows the Bush model to be transported to other rivers. This gives an improved approximation of a river-specific Conservation Limit.

*** Management application of Conservation Limits**

It is important to recognise why Conservation Limits are valuable: they provide objective reference points to guide managers in local stock assessment and a standard framework to report stock status nationally. Moreover, although Conservation Limits (or spawning targets) have been accepted internationally as a good working practice for some years, there is still a need for improvements in understanding and methodology.

Failure to meet the Conservation Limit can be due to one or more of the following reasons: decreased freshwater survival, decreased marine survival or over-exploitation. If the failure to meet the Conservation Limit is due to poor freshwater or marine survival, then reducing exploitation, whilst possibly producing a rise in egg deposition, may not provide a long-term solution i.e. egg deposition may not rise to Conservation Limit levels. The factors affecting survival would need to be addressed also. In some instances, such as the possible changes in marine survival due to climate change, solutions may not be easy or even practicable.

Therefore, before deciding upon management action, it is important that the reasons for a failure to comply with a Conservation Limit are as thoroughly understood as possible. It is also important that the possible benefits of any management actions taken to address compliance failures are assessed honestly and realistically.

Numerous factors could lead to misinterpretation of a Conservation Limit set for a whole river. A particular problem is the possibility of stock structuring on large rivers, which in theory might require Limits to be set for different stock components originating from different parts of the catchment and having different age, run and exploitation characteristics. Currently, such tight sub-catchment management is impracticable, although special measures to protect or enhance run components,

particularly spring-running fish, must be brought in when they are shown necessary. It may be possible, for some rivers, to define objectively separate Conservation Limits for grilse and multi sea-winter fish, and this is the subject of continuing research.

It is important to emphasise that nominal "passing" or "failing" of Conservation Limits *in isolation* does not guarantee a correct management decision. Professional scientific and fishery management judgement, taking into consideration the full range of other factors acting on a fishery, is essential to come to the correct conclusions.

The methodology for determining Conservation Limits and estimating egg deposition continues to develop. It is important to note therefore that both Conservation Limits and egg deposition estimates already produced may alter as the methodology improves.

Appendix 3

Limiting factors in the marine phase of the salmon life cycle

Natural mortality: Advice to NASCO suggests that in general there is an overall decreasing trend in survival during the marine phase over the last 5 –10 years. Fewer smolts are therefore surviving to become salmon. The abundance at sea of salmon which would return as multi-sea-winter fish is related to the availability of ocean at temperatures preferred by salmon (6-8 deg. C). The amount of such thermal habitat has been lower in the 1980s and 1990s than in the 1970s (Reddin and Friedland 1996).

Greenland fishery: There has been a net fishery on the west coast of Greenland since the 1960s. Catches peaked in 1971 at 2689 tonnes. Since 1976, only Greenlandic vessels fish it and the catch has usually been limited by a quota agreed at NASCO. Since 1993 the quota has been related to estimates of the pre-fishery abundance of salmon which have been declining. The fishery exploits only salmon that would have returned to Europe or North America as multi-sea-winter (MSW) fish. Prior to recent negotiated reductions in the quota for this fishery, the exploitation rate on the MSW component of English and Welsh stocks was estimated to be in the region of 10 –20 per cent. In 1998, only a subsistence quota was allowed, amounting to 11 tonnes of which 2-3 tonnes were probably of European origin, mostly from the UK and Ireland. Current levels of exploitation of English and Welsh MSW salmon by this fishery are therefore at very low levels.

Faroes fishery: Also developed in the 1960s, this fishery uses long lines. The catch peaked at 1027 tonnes in 1981 but exploits salmon of mainly northern European origin. Since 1991, the Faroes quota, agreed at NASCO, has been bought out by the North Atlantic Salmon Fund.
Prior to these buyouts, tag recoveries indicated that exploitation of salmon of English or Welsh origin were very low, perhaps 1 per cent. Since the buy outs began only a small research fishery has operated, in some years. Currently, exploitation is therefore negligible.

Ireland: The reported catch of salmon in Ireland increased from about 700 tonnes in the 1960s to a peak of over 2000 tonnes in the mid-1970s. This coincided with the expansion of a coastal drift net fishery. Of the Irish salmon catch, some 600 tonnes in 1998, probably more than half is taken by the drift nets. In 1997, new regulations were introduced restricting fishing to daylight within 6 miles of the coast and delaying the start of drift netting until 1 June. Tagging studies indicate that prior to these regulations, the Irish drift nets took a significant though variable proportion of the stock destined for English and Welsh rivers. Exploitation rates were low (~1%) for stocks in the north east of England, higher (around 5%) for rivers in the north west and highest (perhaps 10-20 percent) for rivers on the south coast of England and Wales. The effects of the new regulations on the level of exploitation have not been assessed.

International fishery: An unregulated high seas fishery has operated in international waters by ships flagged to countries which are not signatories to the NASCO convention. In 1995, annual catches were thought to have been 25 to 100 tonnes, comprising predominantly European stocks. Diplomatic efforts by NASCO have been made to restrict landings of these catches. There is no evidence that this fishery still operates, although surveillance has been limited.

Impact of fisheries for other species:

The potential catch of salmon post-smolts in marine fisheries continues to be a matter of concern. The fishery with the greatest potential for such a by-catch is probably the mackerel fishery near the Faroes and in the international area of the Norwegian Sea. There is very little evidence that post-smolts are caught but the problem is difficult to assess.

The British Government has proposed measures to ban sandeel fishing along the east coast of England and Scotland. This would principally be to protect certain bird species but it might also benefit stocks of salmon and sea trout.