10

THE FISHES of THE EXE ESTUARY

THE FISHES OF THE EXE ESTUARY

10.1 Introduction

The Exe estuary is situated in south east Devon. It is largely rural although there are centres of population sited at each end, at Exeter and Exmouth. The estuary is approximately 10 km long and between 1 and 2 km wide at high water. The area covered at high tide is over 1,370 ha., at low tide this is reduced to 400 ha. The channel which remains at low tide is less than 500 m. wide. This restricted flow causes rapid currents through it. The estuary is sheltered and has a double spit across the estuary mouth which is both low and unstable. The mean tidal range is 3.8 m. at spring tides and 1.5 m. for neap tides, The salinity is reduced throughout the estuary (Devon County Council, 1975; Dixon, 1985; Davidson *et al.*, 1991)

The areas between Exmouth and Straight Point have been designated an Area of Outstanding Natural Beauty (AONB), the area west of the estuary is within a Coastal Preservation Area and an area of 429 ha. is designated to a wild bird sanctuary (Devon County Council, 1975). The whole estuary is considered an SSSI and of primary marine biological interest for its wide range of habitats (Davies *et al.*, 1990). The estuary is of international importance for its wintering populations of waders and wildfowl, with a special study having been carried out on oystercatchers (Dixon, 1985).

10.2 Estuarine Habitats

Predominant substrata is mud at the estuary head and clean sand/gravels at the mouth with areas of mixed deposits in between. Sediments have been derived from marine and riverine inputs. There are areas of fine sand with various mixtures of mud, which have been deposited to form sand banks and mud flats. (Holme, 1949) There are rocky intertidal areas and the channel bed is current swept sands. *Zostera* beds have been reduced since the survey of Allen & Todd, 1902. Fishes have been recorded in areas of mud, sand and gravel. (Allen & Todd, 1902; Dixon, 1985).

10.3 Fish lists

The most comprehensive fish list from the Exe Estuary is given in Allen & Todd (1902). Other, more recent records are mainly on abundant and commercial species. (Dixon, 1986; Driver, pers. comm. 1992; Davies, pers. comm. 1992; Friend, pers. comm. 1993). The number of fish species recorded from the Exe Estuary is 39 (see Table 10.1)

10.4 Fish and fisheries

Fishing used to take place all year round using deep water seines, but there is little commercial fishing within the estuary apart from netting for salmon, trout and eels (Devon County Council, 1975; Dixon, 1985, Friend, pers. comm. 1993)).

Salmon (*Salmo salar*) and sea trout (*Salmo trutta*) were commercially fished using seines. The sport fishery is mainly contained in the upper estuary. Catches of salmon and sea trout since 1969 have been adversely affected by ulcerative dermal necrosis (UDN) (Allen &Todd, 1902; Devon County Council, 1975).

There is a small fishery for eels (*Anguilla anguilla*) (Dixon, 1985).

The Exe Estuary is a nursery for bass (*Dicentrarchus labrax*) which are predominant in the lower reaches. (Kelley, 1988; Davies, pers. comm. 1992).

Flounder (*Platichthys flesus*) are common in the estuary and are regularly angled (Davies, pers. comm. 1992).

Plaice (*Pleuronectes platessa*) were very common in the Salthouse Lake area and along the shore above the mouth of the Lake at low water (Allen & Todd, 1902). They now appear to be restricted to the lower area around the Warren and Exmouth front (Davies, pers. comm. 1992). The Exe is a plaice nursery (Driver, pers. comm. 1992).

Thick-lipped grey mullet (*Chelon labrosus*) feeds in the estuary at all states of the tide and is found mainly in summer between May and August (Driver, pers. comm. 1992).

The sand goby (*Pomatoschistus minutus*) is by far the most common goby in the estuary and was present in almost every haul of the mosquito net (Allen & Todd, 1902).

Pollack (*Pollachius pollachius*), saithe (*Pollachius virens*), conger eel (*Conger conger*), and mackerel (*Scomber scombrus*) are regularly caught in the commercial harbour and pier area (Davies, pers. comm. 1992).

The allis shad (*Alosa alosa*) and twaite shad (*Alosa fallax*) are very infrequently caught in nets and may possibly spawn in the Exe (Driver, pers. comm. 1992).

10.5 Impacts

Exmouth has a **dock** and provides mooring for commercial and recreational craft. Although, relatively few ships use the estuary for commercial purposes as many are restricted by shallowness of the estuary. The cargoes handled at Exeter and Exmouth include coal, timber, grain, feedstuffs, fertilizer and cement. Several small boat building businesses operate from Exmouth, Starcross, and Topsham (Devon County Council, 1975; Dixon, 1985).

Commercial fishing is restricted to a small fleet of boats from the Exe Estuary, from Exmouth, Topsham and Lympstone. The main fishing grounds are outside the estuary. There are processing works associated with the fishing industry, two wholesalers and two processing shellfish. (Dixon, 1985).

A **shellfish fishery** exists for mussels and winkles, but current use of the Exe Estuary mussel stocks is minor, although some are caged and grown on. The old scallop fishery outside the estuary is much reduced (Dixon, 1985).

Sewage and storm drains flow into the Exe from the Culm and lower Exe catchments. It receives all the treated effluent from seven population centres in the region via the Rivers Exe, Clyst and Kenn, plus settlements discharging directly into it. A treatment works at Countess Weir digests sludge, which is dumped in Lyme Bay. At Exmouth a primary treatment plant discharges effluent from an outfall near Maer Rocks, but only on ebb tides. During the summer months there is considerable discharge of waste and raw sewage from recreational craft (Devon County Council, 1975).

Industrial effluents. There are no industrial activities bordering the estuary producing aqueous effluents. Harbours, sailing clubs, and boat repair yards release chronic low levels inputs of oil, petroleum, and anti fouling paints, although current levels of TBT are below the detection limit (Dixon, 1985).

Agricultural catchment industries include dairy farmers, market gardens, and mixed farming (Dixon, 1985).

Recreational activities. The estuary is a major recreational area, with over 30 organisations having a direct interest in the use of the estuary and its shores. Activities include sailing, motor boating, fishing, water skiing, power boat racing, canoeing, wind surfing, SCUBA diving and swimming. Potential threats include proposals to build marina facilities in the estuary. Some activities are believed to affect the operation of the commercial migratory fishery these are sailing, boating and water skiing. (Devon County Council, 1975; Dixon, 1985).

Angling for sea fish is popular both in and outside the estuary, many anglers are visitors in summer (Dixon, 1985).

Bait digging for fishing in the estuary is for polychaetes and 'peeler' crabs. Sandeels (*Ammodytes sp.*) are trawled for bait (Dixon, 1985).

Educational activities include fieldwork for local schools and colleges. Exeter University, Rolle College and other educational establishments use the estuary for recreational activities (Devon County Council, 1975; Dixon, 1985).

Heavy metals levels are given in Burt *et al.* (1992).

10.6 Water quality

Migratory fish returning to the Exe system, may be influenced by adverse water quality, and thereby affect the commercial and sport fishing, but it is felt that this is unlikely following improvements to the water quality (Devon County Council, 1975)

In recent years following improvement in the treatment of sewage there have been improvements in water quality, although it is still only graded "fair" in the region of Exeter (NRA, 1991)(see Figure 10.1).

Recent surveys of a number of variables and pollutants indicated that rather few data were available before 1990. (Edmondson & Watts, 1992).

10.7 Summary

The Exe Estuary is of considerable nature conservation importance for its wintering population of waders and wildfowl. A number of commercial fisheries exist and angling is a popular sport. Typical estuarine species are found and the estuary provides important feeding and nursery grounds for a number of species. Recent improvements in the way effluent discharges are treated will contribute to the improvement of the water environment.

10.8 Recommendations

It is recommended that:

1. rigorous efforts are maintained to improve water quality and especially relating to the discharges in the Exeter area.

2. a detailed survey of the distribution of commercial and non commercial fishes be carried out.

10. 9 References

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Kelley, D. 1988. The importance of estuaries for sea-bass *Dicentrarchus labrax* (L.). *Journal of Fish Biology*, **33** (Supplement A), 25-33.

Table 10.1 The Fishes of the Exe Estuary

Lamprey
Petromyzon marinus
Anguilla anguilla
Conger conger
Alosa alosa
Alosa fallax
Clupea harengus
Sprattus sprattus
Salmo salar
Salmo trutta
Pollachius pollachius
Pollachius virens
Belone belone
Atherina presbyter
Gasterosteus aculeatus
Spinachia spinachia
Syngnathus acus
Syngnathus rostellatus
Eutrigla gurnardus
Myoxocephalus scorpius
Taurulus bubalis
Agonus cataphractus
Dicentrarchus labrax
Chelon labrosus
Crenilabrus melops
Labrus bergylta
Echiichthys vipera
Lipophrys pholis
Ammodytes tobianus
Callionymus lyra
Gobiusculus flavescens
Pomatoschistus microps
Pomatoschistus minutus
Scomber scombrus
Psetta maxima
Scophthalmus rhombus
Limanda limanda
Platichthys flesus
Pleuronectes platessa
Solea solea

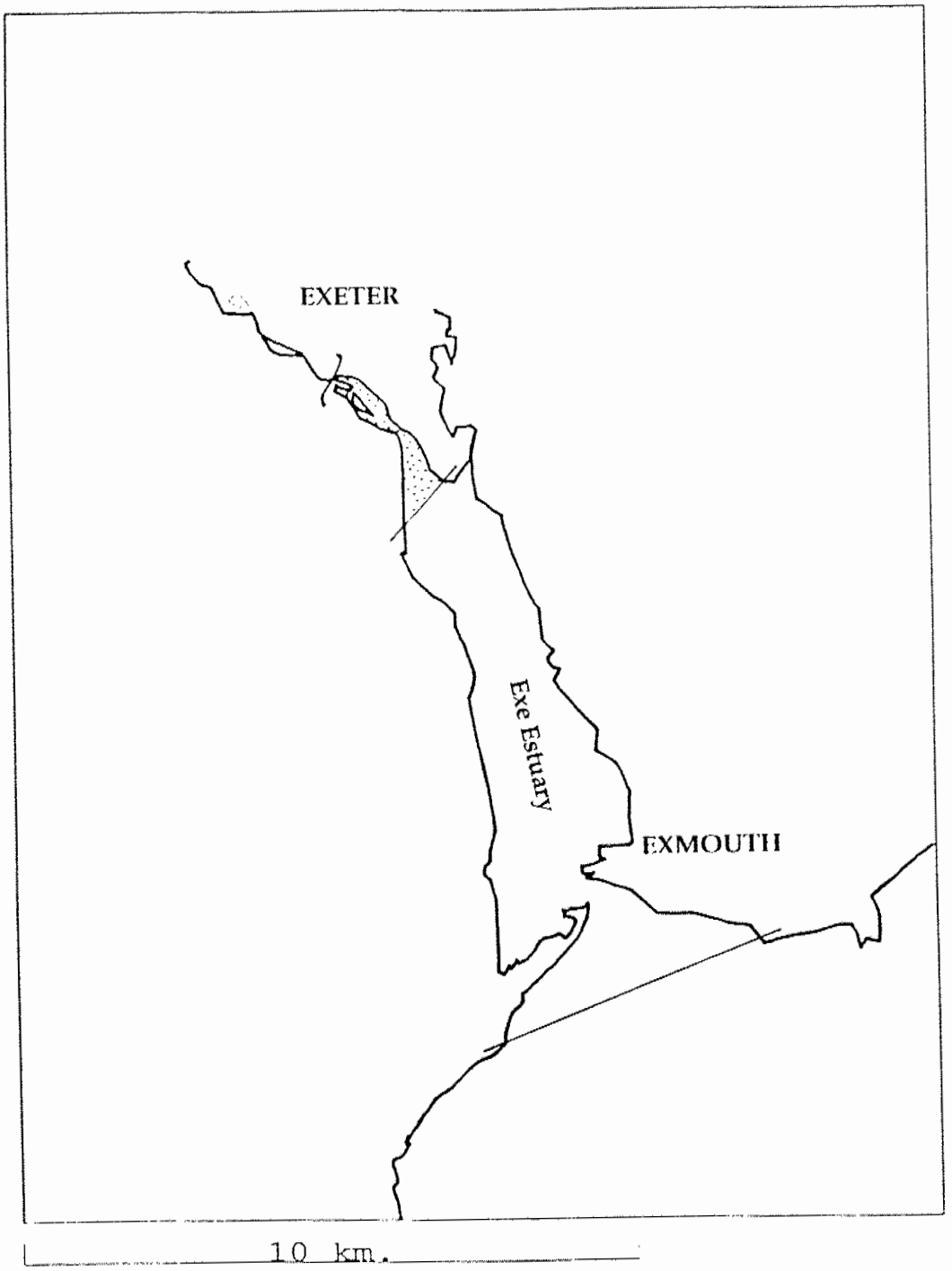

Figure 10.1 Map of the Exe Estuary showing the upper and lower extent of the estuary, the upper tidal limits, and the water quality according to the 1991 NRA Survey. Water quality is characterised as "good" [unmarked], "fair" [medium stipple], "poor" [dense stipple], and "bad" [solid infill].

11

THE FISHES
of
THE SALCOMBE AND KINGSBRIDGE ESTUARIES

THE FISHES OF THE SALCOMBE & KINGSBRIDGE ESTUARIES

11.1 Introduction

The Salcombe and Kingsbridge Estuaries provide a classical ria or drowned river valley occupying an area of 674 ha. and with a tidal channel of 8.3 km. The estuaries drain from attractive rural countryside and is an SSSI of scientific importance. The intertidal sediments contain a variety of burrowing organisms and the rich diversity of habitats and species make the estuary of high conservation value (Marine Biological Association, 1957). The estuary has a historic tradition of fishing with some small trading vessels operating to the head of the estuary at Kingsbridge. However, commercial use of the estuary is much reduced, being taken over by the development of marinas and water leisure activities. (Hiscock, 1986; Davidson *et al.*, 1991).

11.2 Estuarine habitats

Salcombe and Kingsbridge Estuaries have a rich marine fauna and flora which has been studied since the early 19th century (Allen & Todd, 1900). The areas has been systemically studied by the Marine Biological Association over many years and provides the primary source of information. The diversity of habitat types makes the area of considerable marine importance and while relatively little has been done on the fishes of the area, a rich fauna could be expected. Shore sediments contain a variety of burrowing organisms. In 1948 Wilson describes the decline of the *Zostera* beds with the associated faunas.

11.3 Fish lists

The most comprehensive species list is given by Allen & Todd (1900). The NRA regulate commercially important species (Driver, pers. comm. 1992), while records from anglers on more recent catches have added to the list (Davies, pers. comm. 1992). The number of fish species recorded from Salcombe and Kingsbridge Estuaries is 46 (see Table 11.1)

11.4 Fish and fisheries

Salcombe and Kingsbridge Estuaries have been designated bass (*Dicentrarchus labrax*) nursery areas and consequently very little commercial fishing is carried out. Netting for mullet (*Mugil sp.*) has virtually stopped, but seining for sandeel is carried out on a small scale for bait. Anglers are numerous and are after blonde and thornback rays, plaice, flounder, dab, bass, and mullet (Hiscock, 1986; Little, 1987; Friend, pers. comm. 1993).

Ballan wrasse (*Labrus bergylta*) are found associated with subtidal rocks and muddy sand. The two spot goby (*Gobiusculus flavescens*) is common over sand covered rocks and muddy sand, as is the pollack (*Pollachius pollachius*) (Allen & Todd, 1900).

Plaice (*Pleuronectes platessa*), (*Callionymus lyra*), sandeels (*Ammodytes sp.*) the sand goby (*Pomatoschistus minutus*) are found associated with the mobile sandy substrates and on the sand bar at the mouth of the estuary (Allen & Todd, 1900).

Conger eels (*Conger conger*) occur in crevices near the seaward end of the estuary (Allen & Todd, 1900).

The black goby (*Gobius niger*) is found over hard rocky and muddy substrates, in the estuary but not in the creek, while the sand goby (*P. minutus*), and dragonet (*C. lyra*) occupy sandy mud in the south pool creek area. The presence of the black goby may be indicative of estuarine water quality (Allen & Todd, 1900).

The leopard-spotted goby (*Thorogobius ephippiatus*), is commonly associated with silted crevices at the mouth of the estuary.

A group of giltheads (*Sparus aurata*) have regularly visited the estuary with both British records (shore and boat) coming from here (Davies, pers. comm 1992).

Triggerfish (*Balistes carolinensis*) are regularly caught in the estuary and has shown signs of an increase in numbers in recent years (Davies, pers. comm 1992).

A record of the amberjack (*Seriola dumerili*) angled on sand eel bait at the mouth of the Salcombe Estuary is given in the Plymouth Marine Fauna (Marine Biological Association, 1957).

A long finned tuna (*Thunnus alalunga*) was caught by rod and line in Salcombe Harbour (Davies, pers. comm 1992).

11.5 Impacts

Shellfish are taken commercially and include winkles, cockles, mussels and oysters are cultivated (Hiscock, 1986; Little, 1987).

Details of **sewage** discharges are given in Hiscock (1986).

Industrial effluents and pollution are at low levels, but waste dumping damages underwater communities and therefore reduces food available for fishes (Little, 1987)

Education field courses and collection for **research** purposes results in selective sampling and digging which can damage areas of conservation value (Hiscock, 1986; Little, 1987).

Concern has been expressed about **bait digging** (Hiscock, 1986).

Port and harbour facilities are mainly for recreational use with moorings and pontoons and marinas. **Recreational activities** include sailing and diving, but pose no real threat (Hiscock, 1986)

Sand extraction was once a problem, but has now stoppped (Wilson, 1948)

11.6 Water quality

The water quality of the Salcombe and Kingsbridge Estuaries are generally "good" (NRA, 1991)(see Figure 11.1). However, the increases in the urban and tourist populations coupled with low freshwater volumes draining into the estuary mean that sewage related pollution can occur in the upper reaches of the estuary. The marinas have in the past resulted in high concentrations of TBTs which have damaged marine life.

Studies on a variety of water quality determinants are given by Edmondson & Watts (1992) and metal contamination by Burt *et al.* (1992).

11.7 Summary

The Salcombe and Kingsbridge Estuaries contain a diverse range of marine and estuarine habitats and are likely to contain correspondingly rich fish populations. They are recognised as important nursery areas for bass. The marine conservation value is high.

11.8 Recommendations

It is recommended that:

1. a detailed survey is carried out on the fishes of the Kingsbridge and Salcombe estuaries to compare with the major previous study of Allen and Todd (1900) and to provide a baseline for future work.

2. conservation measures to safeguard some benthic communities will improve the fish resource of the estuary.

11.9 References

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Table 11.1 The Fishes of Salcombe and Kingsbridge Estuaries

Raja brachyura
Raja clavata
Anguilla anguilla
Conger conger
Sprattus sprattus
Salmo salar
Salmo trutta
Osmerus eperlanus
Pollachius pollachius
Pollachius virens
Trisopterus sp.
Trisopterus luscus
Atherina presbyter
Zeus faber
Spinachia spinachia
Entelurus aequoreus
Syngnathus acus
Syngnathus sp.
Taurulus bubalis
Dicentrarchus labrax
Seriola dumerili
Sparus aurata
Mullus surmuletus
Mugil sp.
Centrolabrus exoletus
Crenilabrus melops
Ctenolabrus rupestris
Labrus bergylta
Pholis gunnellus
Ammodytes sp.
Ammodytes tobianus
Callionymus lyra
Aphia minuta
Gobius niger
Gobius paganellus
Gobiusculus flavescens
Pomatoschistus sp.
Pomatoschistus minutus
Pomatoschistus pictus
Thorogobius ephippiatus
Thunnus alalunga
Tetrapturus albidus
Psetta maxima
Limanda limanda
Platichthys flesus
Pleuronectes platessa
Pleuronectes sp.
Solea solea
Balistes carolinensis

Potts & Swaby (1993)

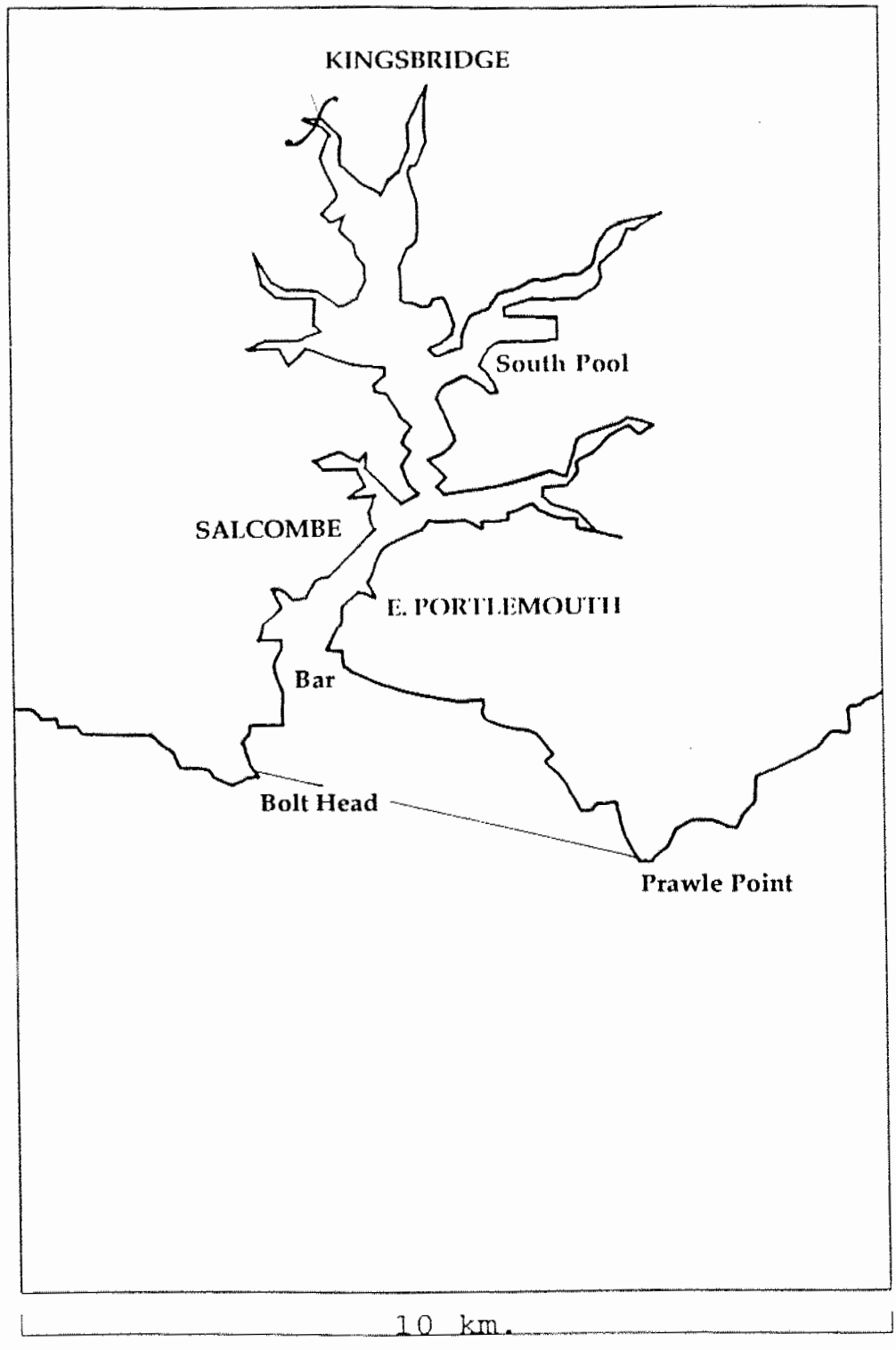

Figure 11.1 Map of the Salcombe and Kingsbridge Estuaries showing the upper and lower extent of the estuary, the upper tidal limits, and the water quality according to the 1991 NRA Survey. Water quality is characterised as "good" [unmarked], "fair" [medium stipple], "poor" [dense stipple], and "bad" [solid infill].

12

THE FISHES
of
THE TAMAR ESTUARY AND PLYMOUTH SOUND

THE FISHES OF THE TAMAR ESTUARY AND PLYMOUTH SOUND

12.1 Introduction

The Tamar Estuary is tidal for about 30 km and is joined by the Rivers Tavy and Lynher. The Tamar Estuary empties into Plymouth Sound. Tidal range at Plymouth is between 0.8 and 5.5 m. on spring tides and 2.2 and 4.4 on neaps. The freshwater input is seasonally, highly variable and records show a steady near surface salinity of 35 parts per thousand at the Breakwater and Drakes Island dropping to 27 parts per thousand following heavy rain. Plymouth is an important commercial harbour with the Devonport Naval Dockyard situated in the Lower Tamar Estuary. There is a deep channel that provides access from the Breakwater to the Tamar (Marine Biological Association, 1957; Hiscock & Moore, 1986).

The Lynher Estuary and St Johns Lake are SSSIs of marine biological importance for their *Zostera* beds (Davies *et al.*, 1990).

12.2 Estuarine habitats

The Tamar Estuary and Plymouth have been the subject of numerous studies from the Marine Biological Association, and which are mostly published in the Journal of the Marine Biological Association. A detailed marine fauna is published in the Plymouth Marine Fauna (1957), which also contains habitat descriptions. Further papers on the ecology of the Tamar Estuary are published in the Journal and cover a number of accounts of the macrofauna (see Spooner & Moore, 1940; Milne, 1940; Smith, 1956; and others).

The area covering the Tamar Estuary and Plymouth Sound show a wide diversity of habitats from fully freshwater to fully marine. Intertidal shores are almost entirely bedrock with a few small shingle beaches. Subtidal substrates include fine sand, muddy sand, coarse sand, gravel and shells, rock, mud, dry shells, and mud and small stones. Plymouth Sound and its associated estuaries have a very rich marine fauna and flora with a high habitat diversity from rock to soft sediments (Marine Biological Association, 1957; Hiscock & Moore, 1986).

12.3 Fish lists

The fish list for this area has been compiled from references, databases and personal communications, including Percival (1929), Hartley (1939), Marine Biological Association (1957), the database of the Cornish Biological Records Unit Turk & French, pers. comm. 1992; Driver, pers. comm. 1992; Potts, pers. comm. 1992 and data extracted from the "Fishing Grounds around Plymouth" derived from the charts and personal notes of Mr F.E. Hutchings, retired skipper of R.V. Sepia, Marine Biological Association. The number of fish species recorded from the Tamar Estuary and Plymouth Sound is 80 (see Table 12.1). It should be noted that there are 179 fishes in the 1957 Plymouth Marine Fauna from the western approaches to the English Channel.

It is likely Plymouth Sound has a significant fish fauna to be recorded. A list of species from the Tamar Estuary alone yielded 51 species, a number which was increased to 80 when Plymouth Sound was included.

12.4 Fish and fisheries

The number of fishermen working regularly decreased in the late 1930's and very little commercial fishing now goes on in the Sound and Lower Tamar Estuary for navigational and naval reasons. (Hartley, 1939; Hiscock & Moore, 1986).

The Devon Sea Fisheries Committee only permits NRA licenced nets to take salmon, sea trout and eels in the Tamar Estuary (Friend, pers. comm. 1993).

The most comprehensive review of the fishes of the River Tamar are given by Hartley (1939) and the following information comes from this source unless otherwise indicated.

Salmon (*Salmo salar*) pass through the estuaries on their way to freshwater of the Tamar and Lynher. The "run" begins at the end of February. Salmon (*Salmo salar*) are caught in the Tamar Estuary by set nets and seines. Sea trout (*Salmo trutta*) are occasionally caught on their way to the sea (Hiscock & Moore, 1986).

The flounder (*Platichthys flesus*) is a catadromous species that is caught from October until March and is considered a valuable catch. It is not possible to catch flounders in the summer months, and the distribution varies within a year. It remains in freshwater until sexually mature, when they begin a migration to the sea. In the Tamar Estuary and the Lynher Estuary the gonads begin to develop in November until most ripening fish leaving in January and all are gone before the end of February. Fish remain in the sea to feed and grow before they return to the estuarine spawning grounds. Stomach contents have been analysed showing crustaceans form the bulk of the food. Age growth rates and changes in condition are given in Hartley (1939). Fishing for flounder is most successful at dusk.

Dab (*Limanda limanda*) are found on the fishing grounds nearest the sea. Its growth age and feeding habits identify that it is in direct competition with other carnivorous species, but in its second year it relies on food organisms (marine worms) not usually taken by other fish.

The plaice (*Pleuronectes platessa*) uses the Tamar and its associated estuaries as a nursery ground and young plaice are found high up the river. It is believed to have a similar life history to dab (*L. limanda*) with two years in the estuary before descending to the sea. It feeds mainly on polychaetes and crustaceans and takes more molluscs than most fish on the same grounds .

Immature soles (*Solea solea*) are sometimes caught, and in the past have been caught in salmon nets in summer. Sand sole (*Solea lascaris*) has been caught and stomach contents identified.

Herring (*Clupea harengus*) are sometimes caught in the winter months. The majority of herring caught being 0-group which at times are very numerous, but appearance of schools are irregular. The estuaries are a nursery ground for herring. There is a drfit net fishery for herring in the river mouth from mid September until mid November. Herring in estuaries feed almost entirely on crustaceans.

Cucumber smelt (*Osmerus eperlanus*) has been caught by beam trawl in the Tamar Estuary but only following high rainfall and when the salinity is low (Hutchings, pers. comm. 1992).

Eels (*Anguilla anguilla*) are sometimes taken, and many small eels have been found living under stones at Neal Point, Hern Point and higher up the estuary.

Adult sea bass (*Dicentrarchus labrax*) are usually found close inshore on rocky coasts and off harbour bars. Fish are netted in the estuaries and sandy bays and in the Tamar Estuary numbers of immature bass were taken in tuck nets during winter. The Tamar Estuary has been used as a study ground for the spawning and nursery areas of bass (Dando & Demir, 1985; Kelley, 1988).

Mackerel (*Scomber scombrus*) are caught in large numbers in the autumn of some years. As many as 300 have been caught in one shot of a tuck net. The fishermen believe a good sprat (*S. sprattus*) year is a good mackerel year as they follow and feed on schools of sprat.

Sprats (*Sprattus sprattus*) once caught in large seines, have since declined and now catches are irregular. The sprat is in direct competition for food with herring (*C. harengus*). Pilchard (*Sardina pilchardus*) are never common in the estuaries.

Grey mullet (*Chelon labrosus* and *Liza aurata*) are common in the Tamar Estuary and Lynher Estuary, but are difficult to catch. In warm summer months schools of mullet swim in the shallows along the edge of mudflats (Hartley, 1939; Hutchings, pers. comm. 1992).

Small brill (*Scophthalmus rhombus*) have been caught. Its chief food is the sand goby *(Gobius minutus)* and other small teleosts.

The smelt (*Atherina presbyter*) was numerous, but are now only very occasionally caught in sprat seines.

Five gadoids are found in the estuaries. Whiting (*Merlangius merlangus*) is usually most numerous. Bib (*Trisopterus luscus*) appears irregularly.

Dragonet (*Callionymus lyra*) are numerous. It has a varied diet and is very common on sandy trawling grounds. The brackish and muddy conditions of the estuaries may not be suitable for them.

The pipefish (*Syngnathus acus*) are occasionally netted.

Five gobies are to be found in the estuary: *Gobius microps, Gobius minutus, Gobius niger, Gobius paganellus,* and *Aphia minuta.* The feeding habits are summarised by Hartley (1939).

The pogge (*Agonus cataphractus*) are found on all estuarine fishing grounds. They feed almost entirely on crustaceans.

Small horse mackerel (*Trachurus trachurus*) are caught in late summer and early autumn.

An allis shad (*Alosa alosa*) was recorded from the Tamar Estuary on 24th February, 1936 (Marine Biological Association, 1957)

"Lampreys" have been recorded in the estuary, but not identified to species (Driver pers. comm. 1992)

By including Plymouth Sound in the assessment area, a number of clearly fully marine speices have been included such as, basking shark (*Cetorhinus maximus*), porbeagle (*Lamna nasus*) and the sunfish (*Mola mola*).

12.5 Impacts

The Tamar Estuary contains a number of sewage outfalls which drain into the river and which can cause a health hazard in the upper reaches in summer months. Plymouth Sound has 35 untreated sewage outflows which are reported to be a contributory factor to inshore eutrophication during the summer months. A consequence is the presence of summer phytoplankton blooms (*Gyrodinium sp.*) which may adversely affect fish populations.

The Royal Naval Dockyard is responsible for significant discharge of industrial effluents including oil and petroleum products. The **naval** ships are exempt from the ban on the use of TBT, which results in damage to marine invertebrates and other species in the area. Since the ban of TBTs in 1988 other areas of Plymouth Sound are showing a recovery in the invertebrate faunas.

Dredging occurs to keep the main navigational channels clear.

Occasional **agriculture spillages** have resulted in fish kills in the upper estuary.

Plymouth Sound and the Tamar Estuary have long been sites of **education and research**.

SCUBA diving, as part of the training programme at Bovisand Underwater Centre, takes place, as does recreational diving.

Recreational activities also include canoeing, dingy racing, angling, wind surfing, yachting, marinas with a variety of servicing facilities.

Bait digging takes place in the Tamar Estuary and soft crab traps are found in most parts of the estuary (Friend, pers. comm. 1993)

12.6 Water quality

Water quality in the lower reaches of the Tamar at the Royal Naval Dockyard and in the Plymouth Sound is generally of "good" (NRA, 1991) quality, although discharges will have some influence on the passage of fishes into the upper Tamar (see Figure 12.1).

The pollution from sewage at Saltash has stopped shellfish collecting (Friend, pers. comm. 1993).

Details of the heavy metal contamination has been examined by the Marine Biological Association and are in part summarised by Burt *et al.* (1992).

The Plymouth Sound and Tamar were subjected to a survey by Edmonson & Watts (1992).

12.7 Summary

The Tamar Estuary is a well studied stretch of water ranging from fully saline at the seaward end to almost freshwater at Calstock. While species specific studies have been carried out, as yet no attempt has been made to examine the total fish fauna, its abundance or distribution. The Tamar is an area of outstanding natural beauty and of conservation importance. Plymouth Sound is a marine inlet which is reflected in its fish fauna which is almost purely marine. The range of habitats makes the area of considerable biological importance. Plymouth Sound has strong estuarine features with the freshwater influences of the Tamar and the Plym which drain into it.

12.8 Recommendations

It is recommended that:

1. The Tamar Estuary and Plymouth Sound are independently subjected to detailed studies on the fish distribution and abundance. This work should link well with existing studies in benthic invertebrates and marine sediments.

2. Pressure should be maintained to improve water quality and in particular sewage treatment in the upper estuary and into Plymouth Sound.

3. A review on the impact of recreational activities needs to be carried out.

4. The industrial effluent associated with the Naval Dockyard needs to be monitored.

12.9 References

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Table 12.1 The Fishes of the Tamar Estuary and Plymouth Sound

Petromyzon marinus
Lamna nasus
Cetorhinus maximus
Scyliorhinus canicula
Torpedo nobiliana
Raja clavata
Raja montagui
Dasyatis pastinaca
Anguilla anguilla
Conger conger
Alosa alosa
Clupea harengus
Sardina pilchardus
Sprattus sprattus
Salmo salar
Salmo trutta
Osmerus eperlanus
Lepadogaster lepadogaster
Lophius piscatorius
Ciliata mustela
Ciliata septentrionalis
Pollachius pollachius
Trisopterus luscus
Trisopterus minutus
Belone belone
Atherina presbyter
Zeus faber
Gasterosteus aculeatus
Spinachia spinachia
Entelurus aequoreus
Hippocampus ramulosus
Nerophis lumbriciformis
Nerophis ophidion
Syngnathus acus
Syngnathus typhle
Aspitrigla cuculus
Eutrigla gurnardus
Trigla lucerna
Taurulus bubalis
Agonus cataphractus
Cyclopterus lumpus
Liparis liparis
Dicentrarchus labrax
Trachurus trachurus
Spondyliosoma cantharus
Mullus surmuletus
Chelon labrosus
Liza aurata
Mugil sp.
Centrolabrus exoletus
Crenilabrus melops
Ctenolabrus rupestris
Labrus bergylta
Labrus mixtus
Echiichthys vipera
Lipophrys pholis
Parablennius gattorugine
Pholis gunnellus
Ammodytes tobianus
Ammodytes sp.
Hyperoplus immaculatus
Hyperoplus lanceolatus
Callionymus lyra
Callionymus sp.
Aphia minuta
Gobius niger
Gobius paganellus
Gobiusculus flavescens
Pomatoschistus microps
Pomatoschistus minutus
Pomatoschistus pictus
Pomatoschistus sp.
Thorogobius ephippiatus
Scomber scombrus
Psetta maxima
Scophthalmus rhombus
Zeugopterus punctatus
Limanda limanda
Platichthys flesus
Pleuronectes platessa
Solea lascaris
Solea solea
Balistes carolinensis
Mola mola

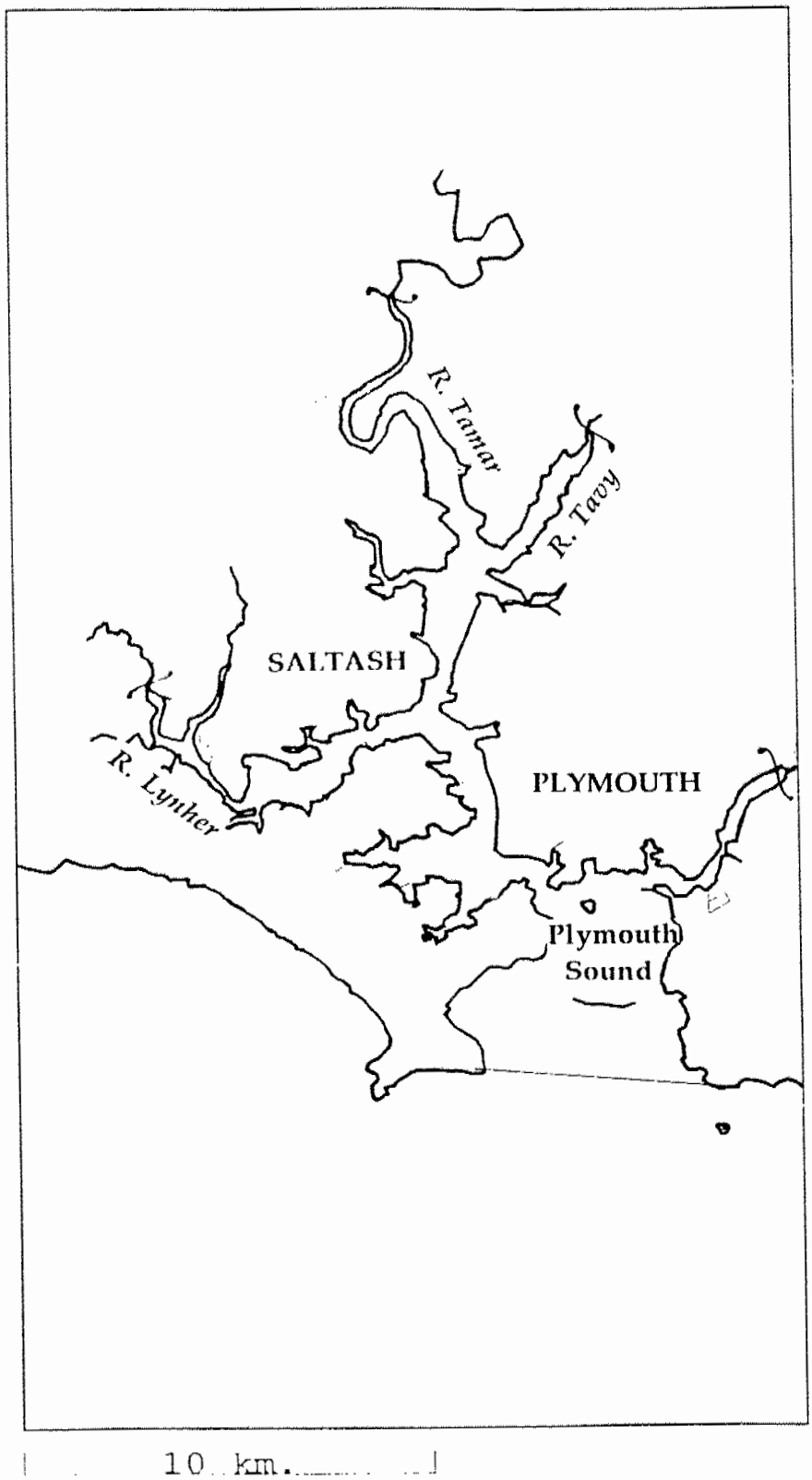

Figure 12.1 Map of the Tamar Estuary and Plymouth Sound showing the upper and lower extent of the estuary, the upper tidal limits, and the water quality according to the 1991 NRA Survey. Water quality is characterised as "good" [unmarked], "fair" [medium stipple], "poor" [dense stipple], and "bad" [solid infill].