

# The Bot River Estuary

## The Bot River Estuary - Should we interfere?

By Rod Bally and George Branch

(**Article Source:** African Wildlife, Volume 40, No. 6)

Of all the ecosystems in southern Africa, none is more threatened than our estuaries. They are small in extent, extensively utilised by man, influenced by events that occur anywhere in their catchments and depend vitally on a regular supply of fresh water and contact with the sea.

In recent years, the Bot river estuary (also known as the "Botrivierlei") has been the subject of a research programme focusing on the question of how the estuary should be managed. The "Bot" is one of the largest estuaries in the Cape Province and lies only 100 kilometres from Cape Town. Nowadays, it is used mostly for recreation (fishing, sailing, windsurfing and bird-watching) but in the past it was also used for commercial fishing and even as a landing site for military flying boats during the Second World War. It is normally a closed estuary, having a sandbar that blocks and dams its mouth. Each year the water level in the estuary rises when the winter rains descend and flooding of the banks occurs frequently. Low-lying structures, such as the cottages near the mouth and the Yacht Club's boathouse, are threatened almost annually. In addition, the rains dilute the estuary, slowly lowering its salinity until, at times, it becomes so low that massive mortalities of fish occur. Because of this, the mouth has been bulldozed open every few years to allow the fresh water to escape and to replenish the seawater content and fish stocks.

Traditionally the mouth has been opened at Sonesta (the present "Meerensee" resort) because the dunes there are narrow and made of soft, loose sand. The outflowing flood of water carves a deep, wide mouth, allowing maximal loss of fresh water and accumulated sediments and substantial penetration of sea-water into the estuary. Consequently, the mouth remains open for a relatively long period.

Unfortunately, the act of opening the mouth results in a rapid drop in the water level of the vlei and a sudden change in salinity, killing the extensive weed-beds and leaving unsightly and foul-smelling mudflats covered by dying weeds and invertebrates which rot in the sun. Within a matter of months, the mouth closes again but it takes a few years before the estuary is completely full once more.

## Heated Debate

In the late 1970s there was considerable and often heated debate about whether or not the Bot river estuary should be artificially opened. Some felt that this was unnecessary manipulation of a natural system and



Landscape at the mouth of Bot River. **Photo:** Gerald Cubitt

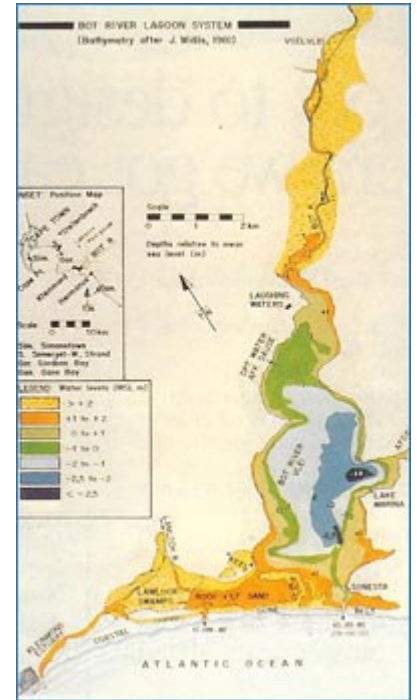


**Bot River Estuary:** the site of an intensive research programme into the effects of artificial breachings of the mouth. **Photo:** G.M. Branch

disapproved of the destruction that followed. Others argued that artificial opening was essential to keep the estuary the way it was and that if it were not opened, the fish would eventually die out. There are so many different parties interested in the estuary, with so many conflicting interests, that it is impossible to design a management policy that will satisfy everyone. But whatever policy is adopted, it should take into account both the needs of the people using the estuary and the importance of conserving the estuary in an ecologically healthy state.

The one fact that emerged early was the almost complete absence of scientific information on the Bot river estuary. Because of this, the South African National Committee for Oceanographic Research agreed to fund a six-year research programme. The purpose of this was two-fold. Firstly, to investigate the estuary as a system with a view to developing a sound management strategy and secondly, to gain some insight into the dynamics of closed estuaries in general, since these are quite common in South Africa.

This research was completed in 1985 and most of the findings have already been published in the scientific literature (a few are listed in the section "Further Readings"). Such literature may, however, be difficult to get hold of and is laborious to interpret. This article is intended to communicate the research findings to the general public. It is being produced partly in gratitude to all those who expressed interest and concern and gave support to the research; partly as a source of information; partly to inform anyone interested in the Bot river estuary and especially in the hope of enlisting the help and co-operation of parties interested in the future management of the estuary.



The Bot River Estuary and its neighbour, the Kleinmond Estuary. The coloured areas are normally submerged when the estuary is full. The mouth is usually breached at Sonesta but was once experimentally opened at Rooisand.

## General Background

The Bot river estuary lies at the bottom of the broad and fertile Bot river valley. Its catchment basin includes the towns of Caledon, Botrivier, Kleinmond and Hawston. The estuary itself measures about six by two kilometres and is quite shallow, having an average depth of 1.5 metres. It is fed by two rivers, the Bot river itself and the Afdaks river. A barrier of sand dunes separates the estuary from the sea, effectively damming it. Lying immediately behind this barrier to the west of the estuary and joined by a narrow connection called "Die Keel", is a shallow extension known as Rooisand. Aerial photographs taken in the 1930s show that this has appeared only within the last 50 years, developing on the site of a former dune-field which has seemingly been blown away. The importance of Rooisand is that it forms a connection between the Bot river and Kleinmond estuaries. As we will describe below, this is of vital importance to the manner in which the Bot river estuary functions.

These two estuaries together form an estuarine system, since water can flow from one estuary to the other (in either direction), depending on the water levels and rainfall patterns in the catchment basin. The Kleinmond Estuary is fed mostly by the Lamloch River.

## How the Bot River Estuary Functions as a Physical System

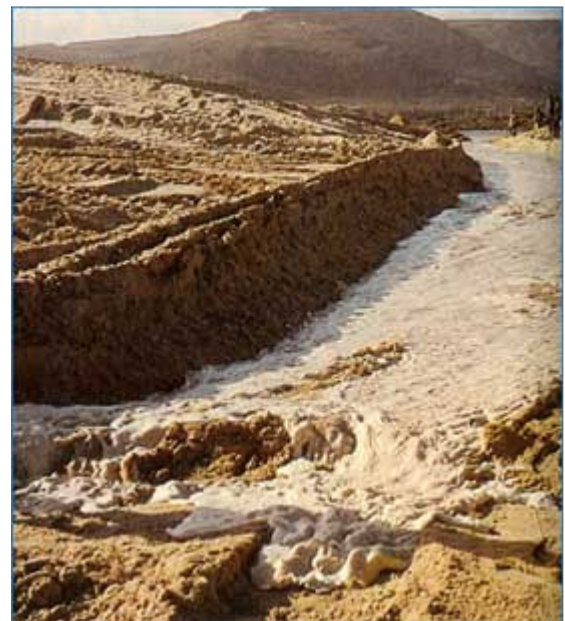
The key to understanding how the estuary functions are to look at the way water levels and salinities

change with time after an artificial opening. The estuary is usually opened towards the end of winter (the rainy season) when the water level is high. A massive drop in the level of the water occurs immediately the mouth is opened. However, the artificially created mouth only stays open for about six weeks because the net outflow from the estuary is insufficient to wash away the sand deposited in the mouth by the sea. While the mouth is open, the estuary is tidal; seawater penetrates the estuary each high tide, increasing the salinity to a level of about 35 parts per thousand, roughly the same as that of the sea.

During the summer months, very little fresh water enters the estuary but evaporation is considerable and salinities may rise to 40 parts per thousand, while the water level in the estuary continues to drop. With the onset of the winter rains in June, water levels begin to rise and the water in the estuary is gradually diluted with rain and river water. The estuary continues to fill throughout the winter but once it reaches a height of 1.7 metres above sea level, it begins to overflow into the neighbouring Kleinmond Estuary through the Rooisand connection. This overflow is not very efficient and water levels in the Bot may rise as high as 2.8 metres above sea level in a wet winter but the overflow does reduce the water level by about ten centimetres a week once the rain stops. The Rooisand connection thus serves to limit the height to which the water can rise in the Bot. It also allows water to be flushed through the Bot and out to the sea via the Kleinmond estuary.

LIST OF FISH SPECIES FOUND IN THE BOT RIVER ESTUARY			
Common name	Scientific name	Abundance	Breeding area
Estuarine round herring	<i>Gilchristella aestuarius</i>	****	E
Krystna sand goby	<i>Psammogobius krystnaensis</i>	***	E
Prison goby	<i>Caffrogobius multifasciatus</i>	**	E
Bot River klipvis	<i>Clinus spatulatus</i>	**	E
Cape silverside	<i>Hepsetia breviceps</i>	****	E & S
Longnose pipefish	<i>Syngnathus acus</i>	**	E & S
Blackhand sole	<i>Solea bleekeri</i>	*	E & S
Krystna halfbeak	<i>Hyporhamphus capensis</i>	*	E & S
White steenbras	<i>Lithognathus lithognathus</i>	**	S
Flathead mullet	<i>Mugil cephalus</i>	**	S
Leervis	<i>Lichia amia</i>	**	S
Cape stumpnose	<i>Rhabdosargus holubi</i>	*	S
Cape moony	<i>Mondactylus falciformis</i>	*	S
Southern mullet	<i>Liza richardsoni</i>	****	S
Sea catfish	<i>Galeichthys feliceps</i>	****	S
Elf	<i>Pomatomus saltatrix</i>	**	S
White stumpnose	<i>Rhabdosargus globiceps</i>	**	S
Striped mullet	<i>Liza tricuspidens</i>	*	S
Sand snake eel	<i>Ophisurus serpens</i>	**	S
Kob	<i>Argyrosomus hololepidotus</i>	*	S
Gurnard	<i>Trigla capensis</i>	*	S
Maasbanker	<i>Trachurus capensis</i>	*	S
Streple	<i>Sarpa salpa</i>	*	S
Piggy	<i>Pomadasys olivaceum</i>	*	S
Zebra	<i>Diplodus cervinus</i>	*	S
Sandshark	<i>Rhinobatus annulatus</i>	*	S
Blacktail	<i>Diplodus sargus</i>	*	S
Anchovy	<i>Engraulis capensis</i>	*	S
Mackerel	<i>Scomber japonicus</i>	*	S
Carp	<i>Cyprinus carpio</i>	*	FW
Kurper	<i>Oreochromis mossambicus</i>	*	FW
Largemouth bass	<i>Micropterus salmoides</i>	*	FW

E = Estuaries    E & S = Estuaries and Sea    S = Sea    FW = Fresh Water



While the Bot River Estuary used to be opened by people using spades, nowadays a bulldozer is used to dig a channel. **Photo:** National Research Institute of Oceanology



This has two very important consequences for the estuary. The first is that the saline water in the estuary is gradually flushed out of the system. Thus, over a period of four or five years, the salinity in the estuary becomes lower and lower, although there are seasonal variations due to dilution by rainwater and concentration by evaporation that lie superimposed on this general decline. We estimate that after an artificial opening, it will take between three and five years for the Bot river estuary to turn into a freshwater coastal lake, unless the mouth is opened again.

The second consequence is that because the high water-levels are drained off via the overflow, there is little chance that the water in the Bot will reach a level that is high enough to spill naturally over the dunes and break open the mouth. Against all odds there are, however, rare occasions when this does happen. As we were writing this article flash floods filled the estuary, raising the water level by an astonishing 1.2 metres in about 24 hours and bursting open the mouth. Only three such natural breachings of the mouth have occurred in the last 60 years.

We estimate that it will normally take between 3 and 5 years after an artificial opening for the Bot river estuary to turn into a freshwater coastal lake, unless a natural opening occurs under the exceptional circumstances outlined above. It should be remembered, however, that only three such openings have occurred in the last 60 years.

### The Fauna and Flora and their Ecology

The ecology of the Bot river estuary reflects the physical conditions outlined earlier. All the aquatic species are tolerant of salt or brackish water, except for three species of freshwater fish (carp, *Cyprinus carpio*, kurper, *Oreochromis mossambicus* and largemouth bass, *Micropterus salmoides*) which only venture into the estuary when salinities are very low. Because the physical conditions are so variable and unpredictable, the species diversity in the estuary is low, since relatively few species can tolerate such a wide range of conditions.

Four aquatic plant species dominate the plant life. These are *Ruppia maritime* and *Potamogeton pectinatus*, both water weeds, and *Phragmites australis* and *Scirpus linoralis*, both reeds. Of these, *Ruppia* is by far the most important and it is the beds of this species that form the main habitat for most of the invertebrate fauna and many of the fish species. It



Bot River Estuary: an aerial view showing the coastline dune-barrier, the Lamloch Swamps (front and left) and the experimental mouth breached from Rooisand (centre). **Photo:** Zeida Wahl



Artificial breaching starts as a small trickle of water, but soon develops into a spectacular raging torrent with standing waves up to two meters, as some 60 percent of the volume

is on this species that most of the organisms in the Bot river estuary ultimately depend.

Of the 32 invertebrate species recorded from the estuary, only six are ever present in consistently large numbers. The sand prawn, *Callinassa kraussi*, is present in great densities in the lower reaches of the estuary, although it should be noted that it cannot breed once salinities drop below 12 parts per thousand, a fairly regular occurrence in this estuary. A small mussel, *Arcuatula capensis*, which lives nestled among the roots of *Ruppia* is also common. The remaining important species are all crustaceans: the shrimp-like tanaid, *Apseudes digitalis*; the amphipod, *Melita zeylanica* and the isopods, *Cyathura estuaria* and *Exosphaeroma hylcoetes*. The latter looks rather like an aquatic wood louse but is an herbivore capable of digesting the bacteria growing on weeds.

The fish fauna with 32 species is, by contrast, quite diverse. (Refer to the list of fish species.) These can be divided into four categories based on where they breed. Firstly, there are those that breed only in estuaries, including one newly discovered species of klipvis, *Clinus spatulatus*, which is endemic to the Bot river estuary. Secondly, there are species that breed both in estuaries and in the sea, such as silversides, which are an important source of food for many angling species.

A third group includes species that can breed only at sea, while a fourth group breeds in fresh water. The third category forms the largest group and these species mostly make use of the estuary as a nursery area. The young fish move into the estuary while the mouth is open and remain there until the onset of sexual maturity. The reason for this is that they are relatively safe from predators in estuaries and having access to abundant food, are able to grow faster than at sea. They must, however, return to the sea to breed, thereby completing their life cycle. It is these fish (leervis, steenbras and elf) which are the popular angling and table fish.

With the exception of the freshwater fish (all alien species such as carp and bass), the angling fish in the Bot river estuary die if the salinity drops too low (less than five parts per thousand). On several occasions there have been massive mortalities of fish with thousands of putrefying steenbras, leervis and stumponose washing up on the shore.

The birdlife is also varied and over 50 species have been reported from the estuary. The marshes at the head of the Kleinmond Estuary are particularly species-rich. At certain times the Bot river estuary supports over 36,000 redknobbed coots, representing about 28 per cent of the total coastal coot population in South Africa. Other important species include ducks, greater and lesser flamingos and cormorants.

Of the total amount of weed that grows in the estuary, about ten per cent is eaten by coots and probably a further ten per cent by herbivorous invertebrates. The fish eat very little weed themselves, although they do

of the estuary pours out within a few hours. **Photo:** R.Bally and H.P. de Decker



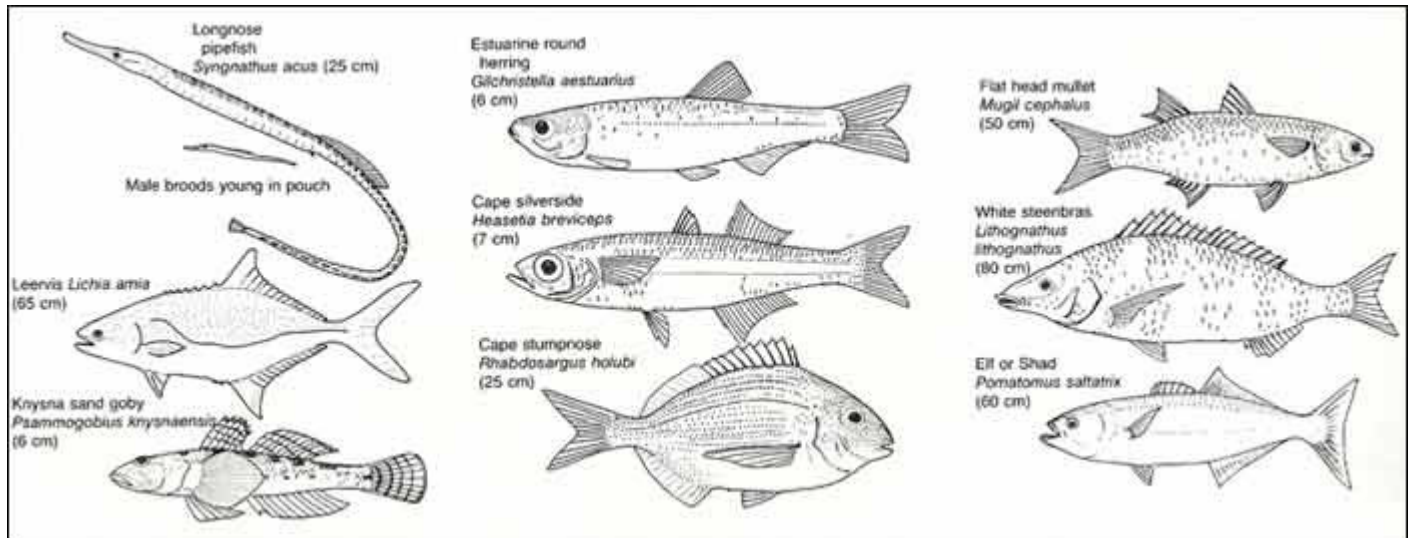
Up to 36 000 red-knobbed coots occur on the Bot River Estuary where they are important herbivores on the weeds. They all move elsewhere once the estuary is opened and the weed-beds are left stranded. **Photo:** B. Rauch



Once salinities in the estuary decline below a critical level, many fish species begin to die. This large cob and the smaller stumponose, were such victims.

**Photo:** National Research Institute of Oceanology

feed on both herbivorous invertebrates and other fish. Filter feeders such as the clam, *Arcuatula* and the sand prawn, *Callinassa* feed on bacteria-rich detritus produced by the breakdown of weeds by bacteria. Indeed, bacteria are responsible for most of the consumption of weed in the Bot river estuary.

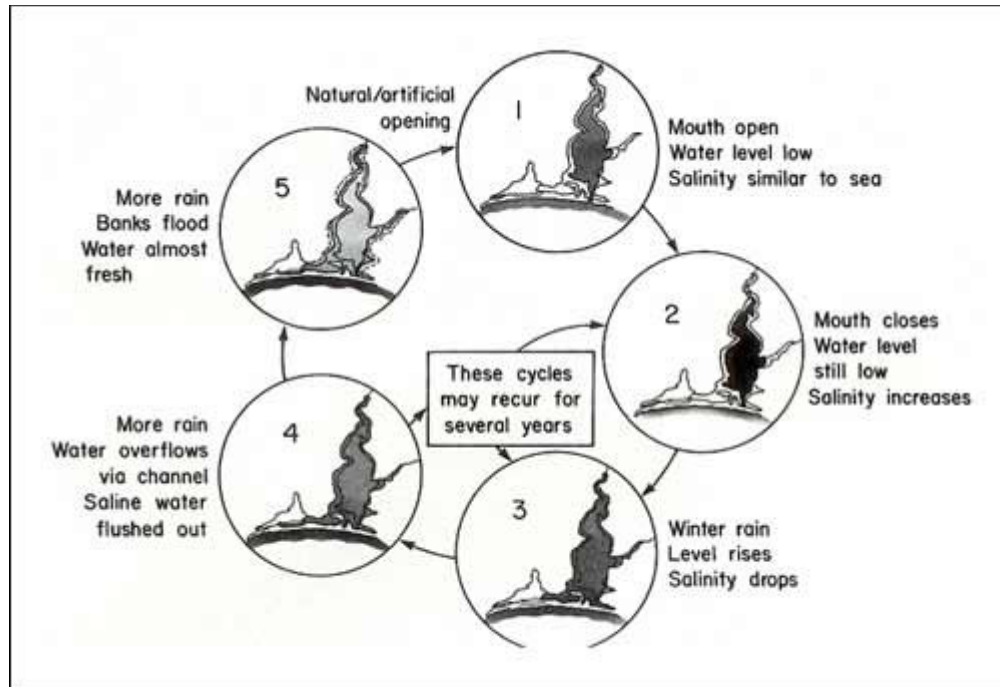


## Artificial Breaching

The effects of artificially opening the estuary are dramatic. When a bulldozer breaches the dune-barrier, usually, a channel 200 metres wide forms within a few hours. Millions of litres of water are swept out to sea in a broad river that smashes its way through the surf zone and heads straight out to sea for well over a kilometre. In the estuary itself, water levels drop from about 2,8 metres above sea level to 20 centimetres above sea level within a matter of hours.

The loss of all this water means that the surface area of the estuary is reduced just as quickly and the estuary shrinks to about 60 per cent of its former size. Biologically speaking this is a disaster. Waterweeds such as *Ruppia* can only grow where they receive enough light. In the muddy, turbid waters of the Bot they are limited to the shallow areas around the edge. So when the water level suddenly drops by over two metres, nearly all the *Ruppia* is left stranded and eventually dies. With it die most of the communities associated with the weed-beds, or about 54 per cent by weight of all the invertebrates in the estuary. The huge flocks of coots leave the estuary almost overnight, since they feed only on the weeds. Where they go, we do not know.

Virtually the only groups that benefit from all this are the estuarine fish and those fish that use the estuary as a nursery area. For the former, estuarine conditions are re-established, enabling these species to continue to survive (despite the fact that thousands of individuals die, trapped in the stranded weed-beds). For the latter, the fish are swept out to sea where they can breed at last, while juveniles rush into the sanctuary of the estuary, where they will remain, trapped until the next time the mouth is opened.



*Cycle of events in the Bot River Estuary.*

## Human use of the Estuary

The fertile valley of the Bot river has been inhabited since time immemorial. Stone tools dating back some 500,000 years have been found both in and around the estuary. Within the first few years of their arrival in the Cape, the Dutch were trading with the Hottentots in the area for butter and other animal products. Indeed, the name "Bot" is a corruption of "boter" (butter) and a direct translation of the Hottentot name for the river which was "Gougakamma", meaning 'fat river'. The Bot river Valley was also the home of the blue antelope, the first of Africa's large mammals to be exterminated in modern times.

The first use of the estuary itself seems to have been for fishing and this remains its prime use to this day. Table 1 lists the three most important groups of users (in terms of numbers) and the kinds of activity they carry out at the estuary, as identified in a survey undertaken in 1982.

Fishing is clearly the most important activity to all except Yacht Club members who, nevertheless, rate it second in importance. Table 2 shows that Kleinmond residents and Yacht Club members fish almost exclusively for recreational purposes. Hawston residents, on the other hand, fish almost exclusively for food, probably chiefly for economic reasons. This fact raises the debate on the management of the Bot River estuary from a largely academic issue to a much more crucial and sensitive level.

## How should we use the Bot River Estuary in the Future?

There are four major ways that we could manage the estuary in the future. These are:

**1. To discontinue artificial opening.** This will result in the estuary becoming a freshwater lake, except for the rare occasions when it breaches naturally. There have even been suggestions that a weir be built across the mouth and across Die Keel, to guarantee that breaching never occurs. These

possibilities can be dismissed because they are expensive and will achieve little. Both actions would intensify flooding and any reduction in the flow of water from the Bot to the Kleinmond would lengthen the periods the Kleinmond Estuary remained closed.

**2. Continue opening the mouth at Meerensee** on an ad hoc basis whenever water levels rise and someone feels it should be done.

**3. Close the overflow to the Kleinmond estuary** (at Die Keel) to encourage natural opening.

**4. Open the estuary on a planned basis.** Suggestions (2), (3) and (4) will lead to estuarine conditions similar to those existing at present. Options (2) and (3) can be dismissed. These are the ad hoc opening and closure of the overflow at Die Keel. The first of these is the option being followed at present and is clearly unsatisfactory from nearly everyone's point-of-view. Flooding still occurs almost annually, water levels fluctuate wildly, rotting weed-beds are left stranded and the estuary does not have time to "settle down" between one opening and the next. This, therefore, leaves two options, namely to discontinue artificial openings and simply allow nature to take its course, or else to open the estuary on a planned basis. Which of these two options should be followed? This is the critical question and its answer depends very much on what function we feel the Bot river estuary should have. At present, the estuary fills both a recreational and a nutritional role for the people who use it. These uses of the estuary have developed both in spite of, and because of, over a century of human interference with the estuary. Why not cease all such interference then and see what happens?

TABLE 1			
Human activities (expressed as percentages) carried out at the Bot River Estuary by Yacht Club members and residents of Kleinmond and Hawston. As people may participate in several activities, percentages total more than 100.			
Activity	Yacht Club %	Kleinmond %	Hawston %
Fishing	45	42	96
Boating	73	14	5
Bathing	15	9	7
Bird-watching	25	28	—
Sight-seeing	18	33	—

TABLE 2			
Types of fishing carried out on the Bot River Estuary by Yacht Club members and residents of Kleinmond and Hawston.			
Type of fishing	Yacht Club %	Kleinmond %	Hawston %
Recreational	100	87	—
Commercial	—	—	2
For food	—	13	98

## Man is Part of the Environment

The answer to this question is that it is too late to try to turn the Bot river estuary into a wholly natural system. We are already part of the environment of the estuary, whether we like it or not. Apart from damming rivers in the catchment area and removing water for irrigation, we humans have also had a much more insidious effect on the estuary's natural behaviour. This has been the introduction of plants which have stabilised the dunes; plants that are now so well established that it will be almost impossible to eradicate them. Their effect has been to eliminate a once large dune-field

and to widen the sand dune barrier, preventing the estuary from breaking through to the sea easily. The development of the Rooisand arm of the estuary and the overflow channel between the Bot and Kleinmond estuaries are believed to be a direct consequence of this unwitting interference.

### **What Should be Done?**

In the sense of conservation of an undisturbed ecosystem, therefore, it does not matter what we do to the Bot river estuary, because it is not undisturbed. What we should do instead, is take a long and hard look at the conservation requirements in the whole south-western Cape before deciding to change the present situation. After all; we know that with a little help from man, the Bot does function, after a fashion, as a closed estuary. It acts as an important nursery area for commercially important fish species such as white steenbras and it supports the only known population of the Bot river klipvis.

If we were to turn the estuary into a freshwater coastal lake, its nursery function would disappear as would, in all probability, the Bot river klipvis. Instead, the estuary would become a "promised land" for all kinds of introduced plant and fish species.

If we are to open the estuary on a planned basis, two last decisions remain to be made. How often should it be done and where should it be opened? On an ecological basis it makes no sense to open the mouth simply because water levels are high but rather to wait until the salinity drops to a point where it becomes a threat to the fish. We would suggest that the mouth be breached either when the salinity drops to six parts per thousand, or every four years (whichever occurs first). This will ensure that the fish have long enough in the estuary to grow and mature, while still allowing them to escape to breed in the sea.

Where should it be opened? Although the mouth is usually breached at Meerensee (creating a deep mouth), the mouth was experimentally opened at Rooisand in 1981. This was an attempt to get the best of both worlds. Because Rooisand is shallow and has a hard bottom, it resists erosion. Any mouth created in this area will be shallow. Consequently a breaching at Rooisand allows the level to drop but does not result in the usual massive outflow of water that occurs when the mouth is cut at Meerensee. But the experiment failed; the shallowness of the Rooisand mouth prevented seawater from penetrating into the estuary and salinities dropped lower and lower, until fish began dying. Clearly, if the function of breaching the mouth is to maintain estuarine conditions, then Meerensee is the only suitable site.

We reiterate that there are many parties with conflicting interests when it comes to managing the estuary; not everyone will be satisfied with these proposals. Nevertheless, they remain the best compromise possible, taking into account the needs of the people who use the estuary and the desirability of maintaining estuarine conditions.



Both greater and lesser flamingoes grace the Bot River Estuary where they feed in the shallows. **Photo:** G.M. Branch

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**Article Source:** African Wildlife, Volume 40, No. 6