

## **Fish inclusion system**

### **Assessed by middle of november**

For line-fish to be included in this study, there has to be a somewhat link to kelp forests either geographically, and/or in their diets. Although not all these relationships are strong, weaker relationships will be excluded for the basis of lack of evidence. Despite a small relationship, it cannot be quantified to explain how their relationship occurs or the extent to which kelp is required by the line-fish to survive. Furthermore, there will be three main categories for which fish will be grouped based on their relationship to kelp forests and if it can be measured.

#### *1. Definite relationship with kelp forests*

Line-fish that have data and studies indicating a direct relationship with kelp forests. These could be either consuming kelp (dietary requirements), or establishing within kelp forests (habitat provisioning).

#### *2. Probable relationship with kelp forests*

Although studies might not suggest a direct relationship with kelp forests, there appears to be a relationship present. This can include fish that occur within temperate reefs that migrate to other ecosystems during different stages of their life. There is also a consumption of kelp-associated organisms such as sea urchins, and crustaceans. Although studies may not specify which species line-fish consume, there is a possibility that their diet does encompass kelp-associated organisms. Distributions of fish will also be checked in comparison to studies on fish locations or boundaries, to determine if there is a possible occurrence of fish in kelp-forests. If there is this overlap it might indicate a possible relationship.

#### *3. Weak (currently non-measurable) and no relationship*

There are no studies indicating a probable relationship of line-fish in kelp forests. Studies also suggest that line-fish are pelagic, indicating that they are found further away from the coastline. This further illustrates that these fish might not require kelp, or if so then their requirements are quite low. Line-fish that are typically carnivorous such as big sharks will also be excluded due to their dietary preferences, and miscellaneous congestion of kelp from grazing/hunting for fish. Although they may consume kelp indirectly there would be no quantifiable method on determining the extent of dependence as of yet. Line-fish that also have little to no studies will be included in this category as no relationship can be established.

### Line-fish under cat 1:

- *Boopsoidea inornata*
  - *Mesodopsis major* is a common mysid in kelp forests, feed on this mysid
- *Carcharodon carcharias*
  - This study examines how variations in *Ecklonia maxima* densities may alter the spatial utilization patterns of large juvenile to adult *Carcharodon carcharias*. the results suggest that high *E. maxima* densities have the ability to significantly modify large *C. carcharias* fine-scale spatial distributions. But, the results are not consistent with our original hypothesis, as *C. carcharias* were routinely detected in mid-kelp densities. This finding illustrates that *C. carcharias* can utilize ecosystems with moderately spaced kelp and that increasing kelp density may be a characteristic influencing and/or limiting *C. carcharias* movements(O'Connell et al 2019)
- *Dichistius capensis*
  - Also found in the surf zone along sandy beaches and in **kelpbeds** (Attwood and Bennett 1999)
- *Pachymetopon blochii*
  - Gut content analysis shows the hottentot to be an omnivore, consuming a wide variety of algae and invertebrate prey associated with kelp (*Ecklonia maxima* Osbeck) beds. The hottentot fish, *P. blochii* was identified as an important carnivore in the kelp bed community (Velimirov et al 1977). The prevalence of rhodophytes is not unexpected for a species grazing in the understory of kelp beds where, due to the shading effect of *Laminaria* and/or *Ecklonia*, this algal group is prolific. Analysis of the diet of *P. blochii* shows that the species is largely an omnivorous benthic feeder, exhibiting a varied preference for a high diversity of organisms occurring in the understory of kelp beds, and on subtidal reefs.
  - Adults live in rocky reefs and kelp beds to depths of 55m (Pulfrich 1987, Heemstra and Heemstra 2004). Junveniles live in shallow water in kelpbeds (Pulfrich 1987). (Mann et al 2013) The hottentot fish, *Pachymetopon blochii* (Val.) is a sparid endemic to southern Africa. It occurs commonly in and around kelp (*Ecklonia maxima* Osbeck) beds and on subtidal reefs, from Luderitz to the mouth of the Breede River (van der Elst 1981), and forms a major component of the western Cape commercial handline catch.(Pulfrinch & Griffiths 1998)
- *Poroderma africanum*
  - They predate on *Eckloniaichthys scylliorhiniceps* (weedsucker) which is an important part of the subtidal kelp forest ecosystem as it provides a link in the trophic food web between crustacean meiofauna and higher-level predators (Smith 1943)
  - They were present within low, moderate and high kelp densities for 20, 21, and 15 trials, respectively (O'Connell et al 2019). Can be found among inshore kelp beds. Catsharks are abundant in kelpbeds (Prochazka 1994; Lechanteur in

press) and are likely to be very important predators in that environment (Dainty 2002).

- *Poroderma pantherium*
  - Similar to above
- *Pterogymnus laniarius*
  - P. laniarius feed on species associated with kelp forests (sea urchins and brittle stars respectively). The increased abundance of their respective dietary constituents as a result of the kelp forests is likely the reason that they are able to successfully co-exist with the schools of T. trachurus in the area (Dando 2020).
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- *Triakis megalopterus*
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- *Notorynchus cepedianus*
  - Pictures of this shark swimming within kelp forest, Millers Point?. Chondrichthyans form the most abundant prey item in the stomachs of this shark, with the most abundant being *Poroderma africanum* and *P. pantherium*. These catsharks use kelp forests as habitats and nurseries ground indicating a dependence of kelp. There is also an overlap in the distribution of this shark and kelp

### **Line-fish under cat 2:**

- *Argyrozona argyrozona*
  - Distribution overlaps with kelp boundary (distribution map). Mentioned in a study that they occur along the entirety from Cape Agulhas to Port Alfred
- *Argyrosomus inodorus*
  - Overlap in the distribution, they are abundant in cooler waters along the west coast
- *Argyrosomus japonicus*
  - Overlap in distribution with kelp. Depth profile matches with kelp, mainly nearshore
- *Atractoscion aequidens*
  - Overlap with kelp boundary. High catch yields in kelp ecosystem, suggesting possible occurrence
- *Callorhinus capensis*
  - Feeds on kelp-associated organisms (sea urchins), mainly feeds on invertebrates. Often in sheltered bays, soft substrates. Depth profile matches with kelp depth. Overlap in boundary
- *Carcharhinus brachyurus*
  - Pregnant sharks in Mauritius and St. Francis Bay. Consumption of seaweed indicates feeding close to the seabed. Overlap in distribution with kelp forests
- *Carcharhinus limbatus*
  - Overlap with kelp boundary, uses shallow waters for nursery grounds

- *Carcharhinus obscurus*
  - Catch data suggest high abundance in kelp boundary. Strangely occurs in warmer waters. However consume a possible kelp-associated line-fish *A. japonicus*
- *Carcharhius taurus*
  - Overlap in distribution with kelp forests, consumes organisms associated with sandy and rocky substrates. Nursery grounds in shallow waters, around gullies and caves near reefs
- *Cheimerius nufar*
  - Slight overlap with kelp forests, migrate between reefs
- *Chelidonichthys capensis*
  - Overlap distribution
- *Chrysoblephus cristiceps*
  - Apparent occurrence in rocky reefs in water 5-30m deep. Caught in areas where kelp occurs
- *Chrysoblephus gibbiceps*
  - Feeds on kelp-associated organisms i.e., sea urchins. Catch landings is high along kelp distribution (i.e. overlap in distribution)
- *Chrysoblephus laticeps*
  - Overlap in boundaries
- *Cymatoceps nasutus*
  - Juveniles occur in rocky reefs, inshore reefs, tidal pools, shallow subtidal pools. Adults occur in inshore and offshore reefs, mainly in offshore and deeper high-profile inshore and offshore reefs. Overlap and catch landings along kelp boundaries
- *Dasyatis chrysonota*
  - Overlap in distribution with kelp. Occurs nearshore in sandy beach ecosystems, as well as in sandy substrates mainly 1) surf-zone (swash zone), 2) nearshore zone, and 3) offshore
- *Diplodus capensis* (old name - *Diplodus sargus capensis*)
  - Feeds on *Parenchinus angulosus*, sea urchin, that occurs in kelp forests. Mainly found in their stomachs. Juveniles were noted to feed on species in nursery grounds, including rock pools. There is a prominent relationship between sea urchins and abundance of fish. Frequent rocky and sandy areas, along with turbulent seas and rocky shores. Depth matches with that of kelp, and overlaps with kelp distribution
- *Diplodus hottentotus* (old name - *Diplodus cervinus hottentotus*)
  - There is an overlap in distribution with kelp. Found living in association with seaweeds on rocky shores. Frequents rocky inshore reefs. Feeds on sea urchins. Depth matches with that of kelp forests
- *Epinephelus andersoni*
  - Distribution outside of the kelp boundary. However, noted that they are recorded as far south as De Hoop and some found in Bettys Bay
- *Epinephelus marginatus* (new name - *Mycteroperca andersoni*)

- There is an overlap and catch landings in kelp boundary. The east coast rock lobster is an important prey item in their diet. Prefers to frequent rocky bottoms, shallow waters. Juveniles occur in tidal pools. Rocky intertidal zones and surf-zones act as nursery grounds
- *Galeichthys ater*
  - Overlap in distribution. Juveniles are strictly marine, occurring in intertidal pools. Adults occur in offshore reefs.
- *Galeichthys feliceps*
  - Overlap in distribution with kelp. It is estuarine dependent
- *Galeorhinus galeus*
  - Overlap in distribution with kelp forests. Catch yieldings within kelp boundaries. Feeds on kelp associated fish - *Pachymetopon blochii*
- *Gymnocrotaphus curvidens*
  - Overlap in distribution with kelp forests. It is endemic to SA, found in False Bay and Port Alfred, and St. Johns
- *Gymnura natalensis*
  - Overlap in distribution with kelp forests. They inhabit shallow sandy areas, surf-zones and occasionally enter estuaries. Pupping occurs off shallow sandy beaches and bays
- *Isurus oxyrinchus*
  - Feeds on *Carcharius obscurus* - feeds on kelp associated organisms. They are a pelagic oceanic species, occasionally close inshore where the continental shelf is narrow. There is also an overlap in the distribution with kelp forests
- *Katsuwonus pelamis*
  - There is an overlap in the distribution with kelp forests. There are also catch yields of this fish in areas near kelp forests. They are pelagic but do occur close to the coast within 8 km in Mossel Bay
- *Lichia amia*
  - There is an overlap in the distribution of the fish with kelp forests. They use estuaries as nursery grounds along with surf-zones in Port Elizabeth. They migrate
- *Lithognathus lithognathus*
  - There is an overlap in the distribution with kelp forests with catch landings of the fish within kelp boundaries. They feed on kelp associated organisms such as *Parechinus angulosus*. They are found in De Hoop and False Bay. They consume rock-associated prey items, which accounted for over 90% of all food consumed. They are however, estuarine dependent
- *Lithognathus mormyrus*
  - There is an overlap in the distribution with kelp forests. Surf-zones are used as a nursery zone
- *Liza richardsonii*
  - There is an overlap in distribution with kelp forests. Juveniles occur nearshore, surface zone, estuaries, and in the lower reaches of river systems

- *Liza tricuspidens*
  - There is an overlap in the distribution with kelp. They are often found in surf-zones near rocky areas. They are noted to feed on algae, not specific
- *Merluccius capensis*
  - Occurs in a wide variety of habitats from rough rocky bottom to sandy substrates. It is associated with the Benguela system characterized by upwelling of cold water. It is most abundant on the West Coast, with 70% of landings on the Agulhas Bank in shallow waters from Cape Town to East London. There is an overlap in distribution with kelp forests
- *Mugil cephalus*
  - It is a cosmopolitan species, with juveniles occurring in estuaries. They are found in clear and turbid waters. They can tolerate temperatures from 13-33°C. There is an overlap in distribution with kelp forests
- *Mustelus mustelus*
  - It is an epipelagic shark, but is abundant in shallow enclosed bays with sandy bottoms. It is found and caught near rocky reefs. There is an overlap in distribution. It was mentioned that they are found in False Bay
- *Myliobatis aquila*
  - It is a semi-pelagic ray found in inshore and offshore reefs. There is a preference for inshore reefs. These species are more common along Western Cape and Eastern Cape coasts than KZN. There is also an overlap in the distribution of the ray with kelp forest distribution
- *Neoscorpis lithophilus*
  - This species mainly feeds on red algae and green algae. It is noted that they also consume invertebrates associated with algae without mentioning what type of algae. They are found mainly in turbulent coastal environments, noted as an inshore species. There is an overlap in distributions
- *Oplegnathus conway*
  - There is not much information about this species, however, there is an image of this fish in kelp forests. There is also an overlap in distributions
- *Pachymetopon aeneum*
  - They occur within shallower reefs, living in high-profile inshore and offshore reefs. Juveniles occur in shallow subtidal reefs. They are found over reefs between False Bay to Durban. There is also an overlap in the distribution of this fish and kelp
- *Pachymetopon grande*
  - Primarily herbivorous, feeding on algae (not noted which type of algae). They are found inshore on rocky shores. They also occur in areas dominated with algae (doesn't say type). They use subtidal weed beds as nursery grounds
- *Petrus rupestris*
  - Images within kelp forests, and there is an overlap in distribution

- *Polysteganus undulosus*
  - There is an overlap in distribution with kelp forests. They frequent deep offshore reefs and offshore banks. Juveniles occupy offshore reefs deeper than 20m in the Eastern Cape and Western Cape. They also migrate from the Eastern Cape to KZN
- *Pomadasys commersonni*
  - There is an overlap in distribution. Estuaries act as nursery grounds. Juveniles stay for a year then leave to the sea. Adults frequent sandy beaches and tidal estuaries. They are estuarine dependent
- *Pomadasys olivaceus*
  - There is an overlap in distribution with kelp forests. They appear to be estuarine dependent. Juveniles occur in shoals around shallow water reefs, occasionally in estuaries, surf-zones and soft substrate banks. Spawn in marine environments. Adults occur in offshore reefs. Noted to occur in False Bay
- *Pomatomus saltatrix*
  - There is an overlap in distribution and catch landings suggesting occurrence in kelp boundaries. They occur in large marine bays on the south coast of the Eastern Cape, which serves as a nursery ground. Adults live in soft and rocky substrata. Juveniles prefer shallow subtidal embayments less than 20m deep along the south eastern and south western cape coast
- *Rhabdosargus globiceps*
  - There is an overlap in distribution with kelp forests. Juveniles occur in estuaries along the western cape. Adults are found to a lesser extent in estuaries. Juveniles occur in bays, surf-zones, with larger fish inhabiting marine environments in False Bay, Saldanha, They occur from Cape Agulhas to Port Alfred. There is also a picture of this fish in a kelp forest
- *Rhabdosargus holubi*
  - Overlap in distribution with kelp. Picture in kelp forest. They are a non-reef associated species, primarily marine, shallow coastal water. Inshore species, in sandy areas and shallow reefs
- *Rhinobatus annulatus*
  - There is an overlap in distribution with kelp. They frequent estuaries and surf-zones of sandy beaches. Late summer, breeding season, shallow waters (surf-zone) act as nurseries. Females predominate surf-zone in early summer
- *Sardinops sagax*
  - Overlap in distribution with kelp. They are a filter feeder, play an important role in the pelagic food-web and are a dominant prey item in the Benguela and Agulhas system. They ingest phytoplankton and zooplankton. Habitat encompasses both coastal and shelf waters in the cold Benguela Current upwelling ecosystem. Recruitment occurs in inshore waters in all regions. Food environments, dominated by small particles, will favour sardine occurrence. They are a cold water species, found living in association with upwelling areas

- *Sarpa salpa*
  - Herbivorous species within False Bay. Juveniles are plankton feeders, some seaweed found in stomachs. They are confined to the surf-zone, continually on the move and stopping to feed on algae. Adults frequent subtidal reefs. Juveniles utilise tidal pools, estuaries, and sandy beach surf-zones as nursery grounds. There is an overlap in distribution with kelp forests
- *Scomber japonicus*
  - There is an overlap and catch landings within kelps distribution. Adults are coastal pelagic species, to a lesser extent epipelagic to mesopelagic over the continental shelf slope. Juveniles live inshore, moving into deeper waters upon reaching maturity. Noted as a temperate water species, most abundant in the northern Benguela Current region. Spawning in upwelling areas of SW Cape
- *Seriola lalandi*
  - Overlap and catch landings within kelps distribution. It is a generalist feeder, with pelagic fish being their main prey item. Most prey item is the sardine - a highly important species in False Bay. Occurs in shore reefs from Cape Point to False Bay. Rockybank mouth to False Bay. Adults and juveniles are epipelagic
- *Sparodon durbanensis*
  - There is an overlap in distribution. Sea urchins were found in their stomachs - possible kelp-associated organism. Occur in tidal pools along the Cape, uses both intertidal and shallow subtidal zones of rocky shores as nursery areas. Seeks shelter beneath rocks
- *Sphyrna zygaena*
  - Overlap in distribution. They consume fish that may have a relationship with kelp listed in cat 2. Coastal and semi-oceanic pelagic shark found in warm temperate and tropical waters. Uncommon catch from the shore. Occurrence in large offshore areas, over reefs about 100m deep near the edge of continental shelf. Nursery grounds in Eastern Cape
- *Spondyllosoma emarginatum*
  - There is an overlap in the distribution with kelp forests, along with catch landings. They are omnivorous species, with algal grazing taking place. Noted as small benthic invertebrate predators. Shift in their diet with size, with larger fish being carnivorous. Juveniles benefit from zooplankton. Large shoals are associated with coastal reefs. Intolerant of low salinity, can be found in estuaries. Sandy substrata, langebaan lagoon, cool nutrient-rich upwelling waters. Reef associated fish, nesting in sheltered bays. Nesting population in subtidal rocky granite reef characteristic in False Bay
- *Thyrsites atun*
  - There is an overlap in distribution with kelp forests, along with catch landings. Important predator of sardine - possible kelp associated fish. Occur in a variety of depths, and habitats. Colonised oceanic islands, west coast upwelling and subtropical convergence. They occur in inshore and offshore waters



- *Thunnus alalunga*
  - It is an opportunistic fish, and specialist with small fishes. Feed on micronekton and zooplankton, taking advantage of ephemeral aggregations of crustaceans, fish, and molluscs. Feed on sardines - possible kelp associated fish. Can occur inshore, offshore, and in high seas. Caught at surface temperatures of 15-28°C, with the greatest abundance at 17-19°C. There is an overlap in distribution with kelp forests, along with catch landings within these distributions
- *Thunnus albacore*
  - There is an overlap in distribution with kelp forests, along with catch landings. Occur in SA east coast and off Cape in summer. They are epipelagic, prefer water temperatures. Cosmopolitan species in tropical and subtropical open waters
- *Trachurus capensis*
  - There is an overlap in distribution with kelp forests. Diet consists entirely of zooplankton. They are semi-pelagic, small recruits occurring in shoals inshore, shift in depth to semi-pelagic, move offshore. Prefers cool coastal waters found on the west and south coasts. West coast serves as nursery ground
- *Umbrina robinsoni*
  - There is an overlap in the distribution with kelp forests. Present in inshore waters. False Bay is colder than De Hoop, fish tend to live longer and grow faster in the former. Most commonly associated with high-profile limestone reefs or mixed rock and sand habitats. Dominated by extensive shallow water, they occur in broken limestone reefs with sheltered sandy pockets beaches in the West. Inhabits the surf-zone and shallow subtidal reefs

### **Line-fish under cat 3:**

- *Acanthocybium solandri*
  - Although distribution map indicates an overlap in kelp distribution, it occurs predominantly in the open ocean (further away from kelp occurrence)
- *Acanthopagrus vagus*
  - Distribution lies outside of kelp boundary, occurs predominantly in estuaries, rarely leaving. Migrate from lakes/ivers to the mouths during different life stages but remains in the estuaries
- *Argyrops spinifer*
  - Outside of kelp boundary
- *Caranx sexfasciatus*
  - Prefers warmer waters, sensitive to changes in salinity and water turbidity. Corals reefs and outside of boundaries
- *Carcharhinus leucas*
  - Outside of kelp boundaries, mainly temperate and estuarine environments. One species in St. Francis bay
- *Coryphaena hippurus*

- Adults are epipelagic, close to the surface but occur in the open ocean. Juveniles are pelagic. Mostly in warmer waters 21-30 °C. Not in the Benguela system. Slight overlap in distribution but occurs further away from the shore
- *Dichistius multifasciatus*
  - Frequents the surf zone of rocky coasts, where they live in turbulent conditions. Adults occur in turbulent surf-zone areas along with rocky shore. Juveniles frequent shallow reefs and tidal pools. Occur outside the distribution of kelp
- *Dinoperca petersi*
  - Outside of kelp distribution
- *Elops machnata*
  - May be found in turbid water, however, distribution is outside of kelp boundaries
- *Epinephelus rivulatus*
  - Not enough information to make a distinction. Outside of kelp boundary
- *Istiophorus platypterus*
  - No SA papers on fish. It is epipelagic. Noted that it is located as far as False Bay. There is an overlap with a high yielding
- *Makaira nigricans*
  - It is an epipelagic fish that prefers warm waters from 24-30°C. Juveniles are pelagic, no juveniles/larvae have been identified off the coast of SA. Migration however, has been recorded as far as Cape Town. There is also an overlap in distribution, however, they occur further from the coast and are mainly pelagic
- *Pagellus natalensis*
  - They are distributed outside of kelp
- *Platycephalus indicus*
  - They are distributed outside of kelp
- *Polysteganus praeorbitalis*
  - They are noted as reef predators, inhabiting coastal reefs and shallow waters over reefs. There is no map indicating their distribution, but they are mainly in KZN and occur within the Agulhas system
- *Porcastoma dentata*
  - Outside of boundary
- *Prionace glauca*
  - Oceanic species, epipelagic, and occurs in inshore waters where the continental shelf is narrow. Although there is an overlap, they are mainly oceanic
- *Rachycentron canadum*
  - No overlap in distribution. Occurs along the eastern coast of SA
- *Sarda sarda*
  - There is an overlap. Noted to be pelagic, however, no south african papers to make a clear distinction to the extent of their relationship with kelp
- *Sebastes capensis*
  - There is an overlap. No SA papers, can't determine extent
- *Scomberomous commerson*
  - Outside of kelp distribution. Pelagic fish, widely distributed in warm waters. Feeds mainly on open water pelagic fish. Noted to range from Mossel Bay to the

Transkei to Mozambique. Occurs in slightly deeper waters over the continental shelf in the Natal, but can occur inshore

- *Seriola rivoliana*
  - Outside boundary
- *Sphyræna jello*
  - Outside boundary
  
- *Thunnus obesus*
  - There is an overlap in distribution with kelp forests. They are opportunistic feeders. Prefers warmer waters, which are the main habitat for juveniles. Adults and subadults have a greater variety, occurring in deeper colder waters. They are epipelagic and mesopelagic
- *Trachinotus africanus*
  - Lies outside distribution of kelp
- *Xiphias gladius*
  - There is an overlap in the distribution with kelp forests. They are oceanic, and pelagic fish. Display tropical spawning, and prefer temperate feeding grounds, with temperatures of 18-22°C