GUIDANCE DOCUMENT:
IDENTIFICATION AND PROTECTION OF JUVENILE ANGELSHARK (SQUATINA SQUATINA) HABITAT IN THE CANARY ISLANDS
Angelsharks (Squatina squatina) are flattened sharks that use their broad pectoral fins to bury themselves in soft sediment, from where they ambush unsuspecting fish. Angelsharks were once widespread throughout the Eastern Atlantic and Mediterranean Sea but populations have declined by over 80% in the last 50 years. They are particularly susceptible to incidental capture in fisheries and habitat loss due to their coastal preference and biology (slow growth rates and low fecundity). The Canary Islands have been identified as a unique stronghold for the species and provides an important opportunity to complete much-needed research into Angelshark ecology to inform conservation initiatives in the archipelago and range wide.

Angelshark research is in its infancy, in part due to the difficulty of studying a rare, cryptic species, thus little is known about their distribution, location of critical habitats and population structure.

This work contributes to five priority Objectives of the Angelshark Action Plan for the Canary Islands.

• **Objective 2.1:** Critical Angelshark Areas are mapped together with the location of known potential threats
• **Objective 2.2:** Ensure that new infrastructure does not detrimentally impact Critical Angelshark Areas
• **Objective 3.2:** The impact of beach users in Critical Angelshark Areas is assessed and minimised by 2022
• **Objective 5.1:** Understand Angelshark abundance and distribution in the Canary Islands
• **Objective 5.3:** Understand Angelshark movement in the Canary Islands and connectivity across the wider Angelshark range

Why survey at night?

All our juvenile Angelshark survey work is completed at night as Angelsharks are more active and their eyes reflect torch-light, making it easier to identify each shark.


Angelsharks were once widespread throughout the Eastern Atlantic and Mediterranean Sea but populations have declined by over 80% in the last 50 years.

Legislative measures for Angelshark in the Canary Islands:

- Scheduled to be listed as “En Peligro” under El Catálogo Español de Especies Amenazadas in 2019.
- Prohibited species under the EU Common Fisheries Policy Council Regulation (EC) 43/2009.

Cited as Critically Endangered on the IUCN Red List of Threatened Species.
Identification and protection of juvenile Angelshark habitat is vital to safeguard the future of this species, as population growth is strongly influenced by juvenile survival \(^{15,16,17}\). It is important to use clear definitions of what a nursery area is to ensure clarity between all stakeholders and make sure the most important habitats are protected.

**NA CRITERIA 1:**
Juvenile Angelsharks are more commonly encountered in the area than other areas.

**NA CRITERIA 2:**
Individual juvenile Angelsharks have a tendency to remain or return for extended periods.

**NA CRITERIA 3:**
The area or habitat is repeatedly used by juvenile Angelsharks across years.

ASP:CI is committed to continue NA research at key sites, specifically focused on testing the NA Criteria. At time of writing, sites that fulfil three NA Criteria are categorised as “Confirmed NAs”; two NA Criteria are categorised as “Potential NAs” and 1 NA Criteria are categorised as “Juveniles Observed”.

ASP:CI classifies juvenile Angelsharks as those under 60cm total length, with a subcategory of “newborn” for those less than 39cm total length. These size classes were identified following research on Angelshark growth rates at Playa de Las Teresitas, Tenerife \(^{14}\).

How do you study juvenile Angelsharks?

ASP:CI have spent five years developing and conducting methods to identify and study juvenile Angelsharks around the Canary Islands.

A five-step approach to juvenile Angelshark research has been created:

- **Identification of beaches using satellite imagery and citizen science sightings.**
- **Scoping assessments** to verify presence of juvenile Angelsharks and identify whether beach conditions are suitable for survey work.
- **Seasonal timed surveys** of juvenile Angelsharks completed at night to understand density, seasonality and environmental conditions needed for NA’s.
- **Focused mark-recapture study** at survey sites with a higher density of Angelsharks to understand abundance, growth rates and residency.
- **Genetic analysis** of tissue samples to understand connectivity, philopatry and mating systems.
**Key Results**

**Playa de Las Teresitas Study**

Playa de Las Teresitas is the first confirmed Angelshark NA in the Canary Islands\(^7\),\(^14\),\(^18\), fulfilling the three NA Criteria.

**NA Criteria 1:** Juvenile Angelsharks have been encountered at Playa de Las Teresitas more commonly than in any other area so far investigated by ASP:CI. Since 2014, we have been monitoring this beach by tagging juvenile Angelsharks, taking measurements and genetic samples. So far, we have caught 511 juvenile Angelsharks in Playa de Las Teresitas and tagged 424 individuals with visual ID Tags\(^14\).

**NA Criteria 2:** Data from 87 recaptured Angelsharks (20.5% recapture rate) indicates that juvenile Angelsharks have a tendency to remain in Playa de Las Teresitas up to 15 months until they reach a total length of approximately 50cm and leave this NA\(^14\).

**NA Criteria 3:** Our results confirm that Playa de Las Teresitas is repeatedly used by juvenile Angelsharks across years. However, in 2018 almost 50% fewer individuals have been recorded compared to previous years\(^14\).

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**Identification of NAs**

Shark NAs are shown to have at least one of the following characteristics:

- Lower rates of predation than in other areas
- Greater abundance or density of prey than in other areas
- Environmental conditions to allow juvenile sharks to grow quicker than in other areas

Shark species born at relatively small body sizes and slow growth rates, like the Angelshark, tend to use protected shallow coastal habitats as NAs primarily to avoid predation\(^15\). To identify Angelshark NAs in the Canary Islands, we used the following techniques:

1. **Citizen science data:** 110 newborn Angelshark sightings were submitted to the Angel Shark Sightings Map, ePoseidon and RedPromar between January 2014 and December 2018. 83% of sightings occurred in coastal habitats shallower than 10m depth.

2. **Satellite telemetry:** Satellite imagery from across the Canary Islands were used to identify sheltered beaches which could provide the conditions needed for Angelshark NAs. 191 priority beaches were identified for study: 21 with 1 side protected by a breakwater; 32 with 2 sides protected by a breakwater; 22 with 3 or more sides protected by a breakwater; and 116 naturally sheltered beaches.

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**Location of Citizen Science Sightings of Newborn Angelsharks**

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**Tagged Recaptured**

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<th>Year</th>
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*From Meyers et al. in prep*
Timed snorkel surveys, completed at night at least three times a year, were completed at 15 beaches identified as highest priority using citizen science data and satellite telemetry (6 in GC; 3 in TN; 6 in FV). Any juvenile Angelsharks identified were tagged with a visual ID tag. The results were highly variable:

- 29 juvenile Angelsharks were identified across nine of the study beaches and were categorised as Juveniles Observed.

- On nine occasions, surveys were abandoned due to storms, which caused poor underwater visibility or pollution events. This highlights the difficulty of surveying in spring or autumn, and these data gaps impacted our analyses.

- None of the tagged juvenile Angelsharks were resighted, possibly due to mortality or movement outside of the ASP:CI survey area, so we were unable to test NA Criteria 2 yet.

- Surveys were initially completed across one year at each study beach, so NA Criteria 3 could not be tested by survey data alone.

Environmental Factors

Habitat analysis

The Confirmed NAs and Potential NAs are located at a variety of beaches across the Canary Islands. Some are highly modified, for example Playa de Las Vistas in Tenerife, created following breakwater development in 1995. Others remain completely unmodified, for example Playa del Cabrón in Gran Canaria.

Annex 2 provides habitat maps of all Confirmed NAs or Potential NAs and highlight the following features:

- Sand composition identified through sediment sampling.
- Habitat structure identified through visual observations prior to ASP:CI survey work.
- Identification of potential threats, including outfalls, possible pollution sources, beach nourishment programmes and human disturbance.
- Habitat notes focusing on breakwater development, proximity to harbours, identification as an EU Bathing Water or located in a Special Area of Conservation.

Prey species

During each seasonal timed survey, three 500m² belt prey transect surveys were conducted to identify the diversity and number of prey species at each site. The majority of fish observed were juvenile specimens and there was no significant difference in the Diversity Index score between Confirmed NAs, Potential NAs and Juveniles Observed. Sand smelt (*Atherina presbyter*) was the most abundant species in 13 of the 15 sites and four species of sea bream (*Sparidae*) were part of the eight most abundant species.
Together with partners, genetic analyses have been completed on tissue samples taken from tagged juvenile Angelsharks. The results will be published at the end of 2019, exploring relatedness between juveniles at each beach and philopatry (whether female Angelsharks return to the same beaches to give birth). In addition, ASP:CI survey work enabled the first eDNA study on Angelsharks and confirmed this technique is suitable to identify whether Angelsharks are present at the different beaches (but it does not differentiate between juveniles or adult sharks).

- Juvenile Angelsharks are likely present in a large number of sheltered beaches across the Canary Islands, more than those presented in this Guidance Document. Further exploratory research is needed to fully assess juvenile Angelshark distribution and relative importance of each site.

- Playa de Las Teresitas has a unique density and abundance of juvenile Angelsharks and is of principle importance to safeguard the future of Angelsharks in the Canary Islands. It also provides a vital opportunity to complete detailed, multidisciplinary research into juvenile Angelshark ecology, which benefits conservation measures across their natural range.

- Citizen Science sightings data have been vital to complement focused survey work to better understand location of Potential NAs and Confirmed NAs. This dual approach to species research should be continued, with ASP:CI survey work focused on better understanding Potential NAs and Confirmed NAs, as well as identifying new beaches important for juvenile Angelshark.

**Conclusion**

- Juvenile Angelsharks are likely present in a large number of sheltered beaches across the Canary Islands, more than those presented in this Guidance Document. Further exploratory research is needed to fully assess juvenile Angelshark distribution and relative importance of each site.

- Playa de Las Teresitas has a unique density and abundance of juvenile Angelsharks and is of principle importance to safeguard the future of Angelsharks in the Canary Islands. It also provides a vital opportunity to complete detailed, multidisciplinary research into juvenile Angelshark ecology, which benefits conservation measures across their natural range.

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**Acknowledgements**

We thank the Gobierno de Canarias and Ministerio de Agricultura, Pesca y Alimentación for facilitation of permits to conduct this research. We also thank everyone who submitted an Angelshark sighting to the Angel Shark Sightings Map, RedPromar or ePoseidon, Kevin Feldheim for leading the genetic analyses and all the dive centres, volunteers and students for assisting fieldwork.
RECOMMENDATIONS TO GOVERNMENT:

INCLUSION IN COASTAL & MARINE PLANS

Coastal and marine spatial planning strategies must consider juvenile Angelshark presence in sheltered beaches across the Canary Islands. We strongly recommend that a precautionary approach is adopted to reduce changes of any negative impact from development. Initially, this should be prioritised in the Confirmed NAs and Potential NAs. We recommend that Playa de Las Teresitas and Playa del Castillo should be considered for designation as marine protected areas.

MITIGATION OF BEACH NOURISHMENT

33% of the Confirmed NAs and Potential NAs occur in artificial beaches where sand is added through beach nourishment. Beach nourishment programmes could prevent pregnant female Angelsharks giving birth in favourable habitat or affect the sediment structure needed for juvenile Angelsharks to camouflage. Beach nourishment programmes in Confirmed NAs and Potential NAs, need to develop clear mitigation measures for Angelsharks, including no beach nourishment activity during the Angelshark breeding period (April to October) (Meyers et al. 2017).

ANGLING ASSESSMENT

Seven of the Confirmed NAs and Potential NAs are also popular angling locations and interaction between anglers and juvenile Angelsharks needs immediate assessment. Location of Confirmed NAs and Potential NAs need to be included in updates to fisheries legislation.

REMOVE OUTFALLS

70% of Confirmed NAs and Potential NAs have one or more outfall within 1km of the beach entrance, which are likely to negatively impact water quality at these sites. This includes 18 non-authorised outfalls, which should be prioritised for removal.

INFORMATION PANELS

80% of Confirmed NAs and Potential NAs are located in EU Bathing Waters. These beaches are used by a large number of people, increasing likelihood of interaction between bathers and Angelsharks. Information panels should be installed to let people know about the presence of Angelsharks, how to reduce chances of interaction, and information about their biology, status and ecological importance.

SAC MANAGEMENT PLANS

Eight of the Confirmed NAs and Potential NAs are located in a Special Area of Conservation and Angelsharks should be considered as a species of interest when SAC management plans are developed for each site, with specific mitigation measures identified to reduce threats.

BEST PRACTICE GUIDANCE

Develop best practice guides for recreational diving and snorkelling activities, to comply with minimum disturbance and distance to the animals and reporting in citizen science databases.

SUPPORT RESEARCH

Continued Government support of long-term juvenile Angelshark research is fundamental to inform conservation and management measures into the future.

ASP:CI NEXT STEPS:

ASP:CI are committed to complete the following research on Angelshark NAs over the next three years, funded by Shark Conservation Fund and Disney Conservation Fund:

• NA survey programme completed at 15 beaches across three years, including seasonal timed surveys, collecting environmental data, prey analysis and predator assessments.
• Habitat surrounding 15 beaches assessed through dive surveys to identify pregnant adult Angelsharks, possible predators and other suitable juvenile habitat.
• Spatial management and protection options identified through workshop with Government Officials, planners and developers.
• Genetic analysis of tissue samples used to determine relationship between juvenile Angelsharks, number of adult females using each site and connectivity between beaches.
• Relative importance of 15 beaches assessed through analysis of survey results and comparison with this Guidance Document to update key parameters for NAs.

References:
### Annex 1:

**Juvenile Angelshark Data Gathered by Citizen Science Sightings or ASP:CI Survey Work Used to Identify Confirmed NAs and Potential NAs in the Canary Islands**

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**PLAYA DEL CASTILLO (FV)**

**Confirmed NA**
- 3 juvenile Angelsharks in ASP:CI Surveys; 15 citizen science sightings

**Potential Threats:**
- 1 authorised & 2 non authorised outfalls within 1km
- Beach nourishment (last deposition 2017)

**Pollution:**
- from recreational harbour
- from nearby industry

**Run-off:**
- from urban area
- from agricultural area

**Disturbance:**
- Popular for recreational angling
- Large number of bathers
- Popular diving site

**Habitat Notes:**
- Imported grey-golden sand
- 1 breakwater constructed before 2000
- Recreational harbour in site (potential impact from anchors/moorings)
- Identified as EU Bathing Water

**Playa del Castillo habitat map**

**Composition of sediment samples**
- Sand: 4%
- Gravel: 92%
- Mud: 3%

---

**PLAYA DEL JABLITO (FV)**

**Confirmed NA**
- 10 juvenile Angelsharks in ASP:CI Surveys; 5 citizen science sightings

**Potential Threats:**
- 2 authorised & 2 unauthorised outfalls within 1km
- Beach nourishment (1973 = 270,000 tons, 1999, 2004)

**Pollution:**
- from recreational harbour
- from nearby industry
- Oil rigs & port

**Run-off:**
- from urban area
- from agricultural area

**Disturbance:**
- Popular for recreational angling
- Large number of bathers
- Popular diving site

**Habitat Notes:**
- Natural grey-golden sand
- Harbour in site (potential impact from anchors/moorings)
- Within SAC No. 69_TF= Sebadal de San Andrés

**Playa del Jablito habitat map**

**Composition of sediment samples**
- Sand: 6%
- Gravel: 12%
- Mud: 92%

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**PLAYA DE LAS TERESITAS (TN)**

**Confirmed NA**
- 511 juvenile Angelsharks in ASP:CI Surveys; 9 citizen science sightings

**Potential Threats:**
- 2 outfalls in process within 1km
- Beach nourishment (1973 = 270,000 tons, 1999, 2004)

**Pollution:**
- from recreational harbour
- from nearby industry

**Run-off:**
- from urban area
- from agricultural area

**Disturbance:**
- Popular for recreational angling
- Large number of bathers
- Popular diving site

**Habitat Notes:**
- Imported grey-golden sand
- 3 breakwaters constructed in 1973
- Harbour in site (potential impact from anchors/moorings) and close to industrial harbour
- Identified as EU Bathing Water
- Within SAC No. 16_FV = Playas de sotavento de Jandía

**Playa de Las Teresitas habitat map**

**Composition of sediment samples**
- Sand: 99%
- Gravel: 1%

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**PLAYA DEL PUERTITO (FV)**

**Confirmed NA**
- 0 juvenile Angelsharks in ASP:CI Surveys; 7 citizen science sightings

**Potential Threats:**
- from recreational harbour
- from nearby industry

**Run-off:**
- from urban area
- from agricultural area

**Disturbance:**
- Popular for recreational angling
- Large number of bathers
- Popular diving site

**Habitat Notes:**
- Natural black-brown sand
- Within SAC No. 16_FV = Playas de sotavento de Jandía

**Playa del Puertito habitat map**

**Composition of sediment samples**
- Sand: 99%
- Gravel: 1%
- Mud: 0%
**Playa de la Concha (FV)**

**Potential Threats:**
- Pollution: from recreational harbour, from nearby industry
- Run-off: from urban area, from agricultural area
- Disturbance: Popular for recreational angling, Large number of bathers, Popular diving site

**Habitat Notes:**
- Natural white-golden sand
- Identified as EU Bathing Water

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**Playa del Cabrón (GC)**

**Potential Threats:**
- Pollution: from recreational harbour, from nearby industry
- Run-off: from urban area, from agricultural area
- Disturbance: Popular for recreational angling, Large number of bathers, Popular diving site

**Habitat Notes:**
- Natural grey-golden sand
- Harbour in site (potential impact from anchors/moorings)
- Within SAC No. 34_GC = Playa del Cabrón

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**Playa del Muellito (FV)**

**Potential NA**

- 8 juvenile Angelsharks in ASP:CI Surveys; 1 citizen science sightings

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**Playa de Melenara (GC)**

**Potential NA**

- 0 juvenile Angelsharks in ASP:CI Surveys; 4 citizen science sightings

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**Playa de la Concha (FV)**

**Potential NA**

- 0% juvenile Angelsharks in ASP:CI Surveys; 1 citizen science sightings

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**Playa del Cabrón (GC)**

**Potential NA**

- 3 juvenile Angelsharks in ASP:CI Surveys; 4 citizen science sightings

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**Playa del Muellito (FV)**

**Potential NA**

- 0 juvenile Angelsharks in ASP:CI Surveys; 4 citizen science sightings

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**Playa de Melenara (GC)**

**Potential NA**

- 3 juvenile Angelsharks in ASP:CI Surveys; 0 citizen science sightings
Potential NA
5 juvenile Angelsharks in ASP:CI Surveys; 0 citizen science sightings

Playa Mogán (GC) Playa de Sardina del Norte (GC)

Potential Threats:
1 authorised & 3 non-authorised outfalls within 1km
Beach nourishment
Pollution:
- from recreational harbour
- from nearby industry
Run-off:
- from urban area
- from agricultural area
Disturbance:
- Popular for recreational angling
- Large number of bathers
- Popular diving site

Habitat Notes:
- Imported grey-golden sand
- 3 breakwaters constructed <2000
- Close to two harbours
- Identified as EU Bathing Water

Potential NA
5 juvenile Angelsharks in ASP:CI Surveys; 0 citizen science sightings

Playa del Muelle (GC) Playa Chica (LN)

Potential Threats:
1 non authorised outfall within 1km
Pollution:
- from recreational harbour
- from nearby industry
Run-off:
- from urban area
- from agricultural area
Disturbance:
- Popular for recreational angling
- Large number of bathers
- Popular diving site

Habitat Notes:
- Natural black-brown sand
- 2 breakwaters constructed before 2000
- Close to recreational harbour
- Identified as EU Bathing Water
- Within SAC No. 61_GC = Costa de Sardina del Norte

Potential NA
5 juvenile Angelsharks in ASP:CI Surveys; 2 citizen science sightings

Playa Mogán (GC) Playa de Sardina del Norte (GC)

Potential Threats:
1 non authorised outfall within 1km
Pollution:
- from recreational harbour
- from nearby industry
Run-off:
- from urban area
- from agricultural area
Disturbance:
- Popular for recreational angling
- Large number of bathers
- Popular diving site

Habitat Notes:
- Natural black-brown sand
- 1 breakwater constructed before 2000
- Identified as EU Bathing Water
- Within SAC No. 61_GC = Costa de Sardina del Norte

Potential NA
5 juvenile Angelsharks in ASP:CI Surveys; 2 citizen science sightings

Playa del Muelle (GC) Playa Chica (LN)

Potential Threats:
2 outfalls in process & 5 non-authorised outfalls within 1km
Pollution:
- from recreational harbour
- from nearby industry
Run-off:
- from urban area
- from agricultural area
Disturbance:
- Popular for recreational angling
- Large number of bathers
- Popular diving site

Habitat Notes:
- Natural grey-golden sand
- 2 breakwaters constructed before 2000
- Close to recreational harbour
- Identified as EU Bathing Water
- Within SAC No.1_LZ = Cagafrecho
### Playa Flamingo (LN)

**Potential Threats:**
- 1 authorised outfall within 1km
- Beach nourishment

**Pollution:**
- from recreational harbour
- from nearby industry

**Run-off:**
- from urban area
- from agricultural area

**Disturbance:**
- Popular for recreational angling
- Large number of bathers
- Popular diving site

**Habitat Notes:**
- Imported white-golden sand
- 2 breakwaters constructed before 2000
- Identified as EU Bathing Water

### Playa de Las Vistas (TN)

**Potential Threats:**
- 2 authorised & 2 non-authorised outfalls within 1km
- Beach nourishment

**Pollution:**
- from recreational harbour
- from nearby industry

**Run-off:**
- from urban area
- from agricultural area

**Disturbance:**
- Popular for recreational angling
- Large number of bathers
- Popular diving site

**Habitat Notes:**
- Imported grey-golden sand
- 2 breakwaters constructed in 1995
- Close to recreational harbour
- Identified as EU Bathing Water
- Within SAC No. 103_TF = Franja marina Teno - Rasca

### Playa Honda (LN)

**Potential Threats:**
- 1 authorised outfall, 2 outfalls in process & 2 non-authorised outfalls within 1km

**Pollution:**
- from recreational harbour
- from nearby industry
  (airport)

**Run-off:**
- from urban area
- from agricultural area

**Disturbance:**
- Popular for recreational angling
- Large number of bathers
- Popular diving site

**Habitat Notes:**
- Natural grey-golden sand
- Identified as EU Bathing Water
- Within SAC No. 2_LZ = Sebadales de Guasimeta

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**Sediment Composition:**

- **Sand:** 99%
- **Gravel:** 1%

**Habitat Structure:**
- 6 juvenile Angelsharks in ASP:CI Surveys; 5 citizen science sightings
- 3 juvenile Angelsharks in ASP:CI Surveys; 4 citizen science sightings
- 0 juvenile Angelsharks in ASP:CI Surveys; 5 citizen science sightings
These projects were supported by: