

# A Research Plan for the Japanese Dugong Sub-Population<sup>1</sup>

*Prepared by an expert workshop held at Toba Aquarium 24-26<sup>th</sup> September 2019*

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<sup>1</sup> This Plan should be cited as:

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## Introduction

In March 2019, a 2.9m female dugong died on the west coast of Okinawa, Japan stabbed by a ray barb (Ministry of the Environment Okinawa Amami Natural Environment Office 2019 pers comm.), presumably while bottom feeding. This animal is the last known dugong in the waters of Okinawa, one of the Nansei Islands that occur in Japanese waters between Kyushu and Taiwan.

This Japanese Dugong Sub-Population is the northern most dugong sub-population in the world. This sub-population is geographically distinct and demographic or genetic exchange with other sub-populations is unlikely (Brownell et al. 2019). The sub-population has been considered to be under serious threat of local extinction for decades (Uchida 1994; Kasuya and Brownell 2001). A scientifically-valid estimate of its size is not available, but numbers are certainly very low (Shirakihara et al. 2007). The dugong must be of grave risk of becoming the eighth mammal recorded as extinct on the Japanese Red List of Threatened Species.

In recent years, studies of this sub-population have largely been restricted to the waters of Okinawa Island. Nonetheless, dugongs were widely distributed in the Nansei Islands Region, probably in the low hundreds during the late 19th century, but at that time and in the early years of the 20th century they were exploited at an unsustainable rate. For example, Uni (2003) conducted a detailed analysis of old statistical references related to dugong hunting and concluded that a least 327 dugongs were killed between 1894 and 1916.

Advice from the Japanese Ministry of Environment indicates that three different laws prohibit the intentional catch of dugongs in Japan and that the major cause of dugong mortality is now incidental catches in fishing operations. It is also illegal to move, trade, import and/or export dugongs. Habitat loss and degradation are becoming greater concerns, especially the loss of seagrass associated with construction of the US military base in dugong habitat near Henoko on Okinawa Island.

In August 2019, the IUCN SSC Sirenia Specialist Group lodged a listing assessment for this sub-population with IUCN (Brownell et al. 2019), proposing that it be listed as Critically Endangered. This evaluation is consistent with the 2007 listing of the Japanese Ministry of Environment. The dugong is also listed on the Japanese list of Natural Monuments (Walsh 2010).

In response to international concerns about the status of the Japanese Dugong Sub-Population, the IUCN SSC Sirenia Specialist Group held a small expert workshop in September 2019. The workshop, which was hosted by Toba Aquarium and funded by the US Marine Mammal Commission, was attended by 10 people (see Appendix 1), plus Toba Aquarium staff. Attendees included a representative of the Wildlife Division of the Japanese Ministry of Environment (as an observer), two representatives of Japanese NGOs, and Japanese and international dugong and seagrass experts. One of representatives of the Japanese NGOs spoke to a slide presentation outlining the dugong protection measures developed by the Okinawa Prefecture on behalf of the Nature Conservation Section of the Okinawa Prefectural Environment Department

Workshop attendees agreed to develop a Research Plan for the Japanese Dugong Sub-Population to guide the research and monitoring conducted by the Japanese Government, the Okinawan Prefecture and NGOs. This Research Plan outlines our highest priority: **multiple approaches to determine if any dugongs remain in Japanese waters because the numbers are so low that any single approach is unlikely to be sufficient.** The Plan also outlines initiatives to improve knowledge of the status of seagrass in the Nansei Islands Region and to raise public awareness. If dugongs are detected in the Nansei Islands Region, a second workshop will be held with the key stakeholders to design conservation initiatives. The projects in the Plan are summarised in Table 1.

Table 1: Summary of projects suggested in this Research Plan

Objective (s)	Project #	Project Name	Recommended Commencement Date
To identify locations where dugongs might still be present in the Nansei Islands Region using the expert knowledge of local fishermen. <b>(Highest Priority)</b>	1	Seeking information from fishermen to determine the distribution and relative abundance of dugongs in the Nansei Islands Region	As soon as possible
	2	A smartphone App to encourage citizens to record and report sightings of dugongs and dugong feeding trails in the Nansei Islands Region	As soon as possible
To contribute to a multiple lines of evidence approach to confirm the presence of dugongs in candidate habitats where other data e.g., public sightings, reports from fishers, sounds, feeding trails) suggest that one or more dugongs may currently occur in the Nansei Islands Regio. <b>(Very high priority)</b>	3	Using eDNA to confirm the presence of dugongs in the Nansei Islands Region	Preliminary work: as soon as possible Application: when other data <b>suggest</b> where one of more dugongs may currently occur in the Nansei Islands Region.
	4	Drone surveys for dugongs, dugong feeding trails and seagrass in the Nansei Islands Region	
	5	Passive acoustic observations of dugongs in Nansei Islands Region	
To provide insights into the behaviour of dugongs e.g., time and amount of feeding, vocal hotspots, socializing behaviour if dugongs are confirmed to still exist in the Nansei Islands Region. <b>(Low priority)</b>	4	Drone surveys for dugongs, dugong feeding trails and seagrass in the Nansei Islands Region	Preliminary work: as soon as possible Application: when other data <b>confirm</b> dugongs still exist in the Nansei Islands Region.
	5	Passive acoustic observations of dugongs in Nansei Islands Region	
<p>1.To document the spatial extent, connectivity, community composition, ecosystem functions and ecosystem services of seagrass beds in Okinawa as critical component of the effective conservation and management of the Japanese Dugong Sub-Population.</p> <p>2.To document the threats to seagrass communities in the Nansei region as the basis of a spatial risk</p>	6	Current status of seagrass beds in the Nansei Islands Region	As soon as possible

assessment to be used as a basis for conservation response. <b>(Medium priority)</b>			
<p>1.To raise public awareness of the significance of the dugong in the Nansei Islands Region and the importance of dugong conservation by disseminating information on the dugong.</p> <p>2. To encourage the public/local communities to participate in generating information about the dugong in the Nansei Islands Region.</p> <p>3.To assist the Japanese Ministry of Environment and the government of Okinawa Prefecture and to be more effective in disseminating and sharing information about the dugong with a view to increasing public awareness as a pre-requisite for better conservation efforts that will aid the fishing and eco-tour industry. <b>(Very High priority)</b></p>	7	Mapping dugongs: raising public awareness of the dugong in the Nansei Islands Region	As soon as possible

# Project 1: Seeking information from fishermen to determine the distribution and relative abundance of dugongs in the Nansei Islands Region

## Background

- Recent information about the Japanese Dugong Sub-Population has largely been restricted to the waters of Okinawa Island but information is required for the entire Nansei Islands Region. Given the current very low abundance of dugongs in this Region, a comprehensive scientific survey of the dugong's former range would be logistically challenging and expensive, especially as much of the region is remote and difficult to access and most techniques provide only snapshot information. In contrast, fishermen are out on the water most days providing them with unparalleled opportunity to interact with dugongs.
- Shirakihara et al. (1992) used a questionnaire survey to obtain information on the distribution of the finless porpoise in Japanese waters. He sent out a questionnaire to 2053 fisheries cooperative unions together with a stamped self-addressed envelope obtained information from 1382 (67%) of them. The resultant presence/absence information was in reasonable agreement with known records of the species distribution confirming the robustness of this approach.
- Pilcher et al. (2017) developed a flexible and cost-effective tool to document the spatial distribution and population trends for dugongs and other marine megafauna in the form of an interview questionnaire supported by a structured data upload sheet and a comprehensive project manual. This questionnaire has already been deployed in 18 countries across the Indo-Pacific region at average of USD 5,000 per country and has obtained large data sets on dugong distribution, trends, catch and bycatch, and threat overlaps <https://www.cms.int/dugong/en/publication/revise-dugong-questionnaire-upload-file-and-new-short-questionnaire> <https://www.cms.int/dugong/en/publication/revise-dugong-questionnaire-upload-file-and-new-short-questionnaire>. There are several aspects of this approach that are likely to be relevant to a project seeking information from fishermen in the Nansei Islands Region.
- The Japanese Ministry of Environment is also underwriting a project to obtain additional information on dugongs in the Nansei Islands Region from fishermen.
- We suggest a method to extend the scale of that program by seeking information from a broader selection of fishermen from throughout the Nansei Islands including those on small islands around Okinawa Island and in the Yaemama and Miyako Islands.

## Objective

- To identify locations where dugongs might still be present in the Nansei Islands Region using the expert knowledge of local fishermen.

## Brief Description

- The project could involve the following steps:
  1. Consult with the relevant prefectural fisheries agencies about the proposed surveys.
  2. Obtain the required Human Ethics approval so that the survey results can be published.
  3. Hire consultants that will be trusted by the fishermen to design and conduct the surveys, such as NGOs and/or universities.

4. Send a letter to each fishery cooperative union in the Nansei Islands Region explaining the objectives of and need for the survey and asking them to request information from knowledgeable fishers.
5. Provide a short survey form that each fishery cooperative union can distribute to knowledgeable fishers. The form should preferably: (1) be developed with input from a social scientist with expertise in survey design; (2) include pictures of a dugong as seen from a boat; (3) ask fishermen to provide information on the location and approximate dates of dugong sightings; and (4) also ask them to provide their name and contact details.
6. Consider including the option to enter the names of respondents into a draw for a cash prize to incentivise participation in the survey.
7. Ask each fisheries cooperative to return completed forms by providing them with stamped self-addressed envelopes.
8. Conduct semi-structured interviews (via telephone or face-to-face as preferred by the respondent) with each fisherman who reports a dugong sighting.
9. Use the results to design other research activities to detect the presence of dugongs at the locations of reported sightings e.g., e-DNA, drone surveys for dugongs and feeding trails, acoustic monitoring.

#### **Duration**

Preliminary work several months. The project would need to be ongoing for at least two years, depending on results.

#### **Output format**

Written report of result for donor, prefectures, Ministry of Environment, fishery cooperative unions and local communities. Contribution to the dugong database held by Okinawa Prefecture and other dedicated websites (see Project 7) as the foundation of the multiple lines of evidence approach to determine whether dugongs are still present in the Nansei Islands Region.

#### **Priority**

**Highest.** This project is envisaged as the foundation of all subsequent research on dugong distribution and abundance in the Nansei Islands Region.

## **Project 2: A smartphone App to encourage citizens to record and report sightings of dugongs and dugong feeding trails in the Nansei Islands Region**

#### **Background**

- Several Apps have been developed to encourage members of the public to record the sightings of marine mammals on their phones as part of citizen science initiatives. Examples include Seafari <http://www.seafariapp.org> Wild About Whales: <https://www.wildaboutwhales.com.au/app> , a good example of a multispecies APP; Hector's Dolphin Sightings <https://play.google.com/store/apps/details?id=com.thundermaps.dolphin&hl=en> or

<https://apps.apple.com/nz/app/hectors-dolphin-sightings/id1095179294>, a good example of a focused single species app.

### **Objectives**

1. To contribute to a multiple lines of evidence approach to confirm the presence of dugongs in the Nansei Islands Region by developing a smartphone App that features dugongs, dugong feeding trails and seagrasses.
2. To make local citizens and tourists throughout the Nansei Islands Region more aware of the Japanese sub-population of dugongs.

### **Brief description**

- This project is envisaged as a citizen science project underwritten by a Japanese mobile phone manufacturer.
- Advice on the scope of the APP should be sought from a PR expert . A generic marine mammal App that includes dugongs, dugong feeding trails and seagrasses may be more popular and likely to be downloaded than a specialist dugong/seagrass App..
- The project could involve the following steps:
  1. Obtain advice on the scope of the APP from a PR expert
  2. Employ an App developer to either: (a) develop an appropriate App *or* (b) modify an existing marine mammal App (See URLs for examples above) for application throughout the Nansei Islands Region.
  3. Link the App to an agreed, appropriate database maintained by the Okinawa Prefecture and any other appropriate databases (see Project 7).
  4. Promote the conservation value of the App and the resultant georeferenced recording and photography of marine mammals and their habitats, with particular reference to dugongs, dugong feeding trails and seagrasses.
  5. Make the APP freely available via an App Store for Apple and Android devices
  6. Advertise the APP widely by promoting it in schools, dive shops, kite surfing operators, fishermen's cooperatives, dugong release training programs and general public drone users
  7. Ensure that the uploaded information is reviewed by experts in a timely manner
  8. Provide subsequent advice to the citizens who report information.

### **Duration and funding:**

- The use of the App would be ongoing after preliminary work by App developer.
- Funding required for: (1) initial development/modification of the APP and: (2) ongoing data validation, upgrades and links to website etc.

### **Output format**

Written report of result for donor, prefectures, Ministry of Environment, and local communities.

Contribution to the dugong database held by Okinawa Prefecture and other dedicated websites (see

Project 7) as part of the multiple lines of evidence approach to determine whether dugongs are still present in the Nansei Islands Region.

**Priority**

**Very high.**

## **Project 3: Using eDNA to confirm the presence of dugongs in the Nansei Islands Region**

**Background**

- eDNA is increasingly being used to detect the presence of cryptic species in aquatic habitats. The method has been successfully used for sharks (Bakker et al. 2017); sawfish (Simpfendorfer et al. 2016), Florida manatees (Hunter et al. 2018, killer whales (Baker et al. (2018); and dugongs in the Arabian Gulf (Helene Marsh pers comm.)

**Objective**

- To contribute to a multiple lines of evidence approach to confirm the presence of dugongs in candidate habitats where other data e.g., public sightings, reports from fishers, sounds, feeding trails) suggest that one or more dugongs may currently occur in the Nansei Islands Region.

**Brief description**

- This project is envisaged as joint research between scientists in Japan and Australia.
- The project involves the following steps:
  1. Develop appropriate dugong primer (dugong primers are well represented in GenBank®)
  2. Test primer using water from: (1) dugong holding tank in aquarium; (2) known dugong habitat in Australia obtained using and eDNA Field Pump e.g. <http://www.oninnovation.com.au/en/ON-teams/ON-Tribe/ON-Accelerate4-Teams/Grover-Scientific>
  3. Optimise the sampling protocol at a known dugong habitat in Australia (suggest starting with sample at 4-5 sites separated at intervals of approx 1 km along transect; at each site take 5 x 5L samples using eDNA Field Pump, approx. 1 hour per site with sample processing)
  4. Store filters in [longmire buffer](#) until further processing.
  5. Perform an appropriate number of replicates on the DNA elution for each sample within site.
  6. Use at candidate dugong habitats in Okinawa.

**Duration**

Preliminary work several months. Fieldwork ongoing on an opportunity basis.

## Output format

Published papers preferably in open access journals, technical reports, contributions to Okinawan Prefecture dugong database and any other appropriate databases and websites (see Project 7).

## Priority

Priority for the required preliminary work is **Very High**. Priority for applying the methodology depends on identification of current candidate dugong habitats in Nansei Islands Region using other techniques. Once a candidate habitat has been identified the priority for applying the method would be **Very High**.

# Project 4: Drone surveys for dugongs, dugong feeding trails and seagrass in the Nansei Islands Region

## Background

- Drones are increasingly replacing manned aircraft for surveying marine mammals including dugongs (Hodgson and Koh 2013; Hodgson et al. 2013, 2017 and in prep).
- There are several options for survey methods depending on the drones available.
- Regardless of the drone, the survey would need to be designed to census rather than sample the target areas because of the low number of dugongs in the Nansei Islands Region.
- Large-scale surveys e.g. a survey of the coastal waters of all the islands in the Nansei Islands Region, require long-range and high endurance drones. Such drones may be difficult to obtain, are expensive, and require a licence to operate. Use of such drones is dependent on the local regulations governing drone use, especially in areas used by military forces. For these drones to be effective, it would be necessary to fly at high altitudes (e.g. above 500 ft) and beyond the visual line of sight (BVLOS). This approach can cover large areas and with higher frequency than smaller (less capable) drones.
- Several types of drones are suitable for local scale surveys:
  - Medium-scale drones (e.g. hybrid drones that can take off and land vertically but fly as a fixed wing) that can fly high and beyond the visual line of sight.
  - Small off the shelf drones (e.g. Phantom), which cover only a limited area in a short time, but allow small areas (e.g. locations of recent sightings) to be censused.
- Aerial images collected during these surveys can be used to detect high density seagrass communities that are visible from the air (see also Project 6) . Rasheed et al. (2017) remotely detected dugong feeding trails in intertidal areas in Australia and made some progress with image analysis software. Dugongs produce feeding trails only when feeding on particular species of seagrass in soft sediments.
- It is important to note that there are likely to be restrictions in areas where there are military operations and training exercises. It would be necessary to explore whether permission could be sought to fly in those areas and the restrictions on times, range (e.g., distance you can fly from the boat) and altitudes.

## Objectives

1. To confirm the presence of dugongs in candidate habitats where other data e.g., public sightings, reports from fishers, eDNA, sounds, feeding trails) suggest that one or more dugongs may currently occur in the Nansei Islands Region.
2. To obtain a minimum count of the current Japanese Dugong Sub-Population.

## Brief Description

- This project could be developed in collaboration with drone companies in Japan, which are keen to demonstrate the capabilities of their vehicles and might invest some in kind support.
- If it is appropriate to use large drones, large-scale (100s-1000s km<sup>2</sup>) surveys should be designed for complete coverage of broad areas around the most recent sightings using line transect surveys at above 400 ft and beyond visual line of sight.
- Small/local-scale surveys (10s km<sup>2</sup>) should be designed for complete coverage of the immediate area around the most recent sightings on multiple occasions during the year. If small cheap accessible drones (e.g. Phantom) are available use grid sampling.
- Both methods involve collecting still images continuously while flying along a set path.
- A combination of automated dugong detection (using software being developed by AMRU) and manual sampling should be used to process the images to detect:
  - (a) dugongs
  - (b) potential seagrass
  - (c) feeding trails.

## Duration

Survey candidate areas as intensely as possible over a one-year period.

## Output

- Maps of dugong detections and images of the sightings.
- Maps of potential seagrass habitat and feeding trails.
- Published papers preferably in open access journals, technical reports, contributions to Okinawan Prefecture dugong database and any other appropriate databases and websites (see Project 7).

## Priority

Priority depends on identification of current candidate dugong habitats in the Nansei Islands Region using other techniques. Once a candidate habitat has been identified the priority for applying this method is **Very High** and so the preparatory work should be done as soon as possible.

## Project 5: Passive acoustic observations of dugongs in Nansei Islands Region

### Background

- Dugongs use underwater sound for communication producing narrow-band sequential calls that consist of several chirps followed by a trill (Ichikawa et al., 2009). Masticating dugongs produce broadband low frequency sounds and such sounds are an appropriate indicator of dugong feeding events (Tsutsumi et al., 2006; Hodgson et al. 2007).
- Passive acoustic recorders can be used to:
  - a. detect the presence of vocalizing dugongs within about 200 m of the recorder depending on water depth and sediment type. Thus the likelihood of false negatives is high, although

the use of call-back recordings may increase the likelihood of detection (Ichikawa et al., 2009).

- b. study dugong behaviour, especially at night time. There are areas within dugong habitats in Thailand where dugongs are vocally active (vocal hotspots) which are stable for years (Ichikawa et al., 2009). Dugong feeding sounds can also be used to monitor foraging (Tsutsumi et al., 2006; Hodgson et al. 2007).
- The Okinawa Defense Bureau has been conducting passive acoustic monitoring around Okinawa for several years to detect the presence of dugongs and obtain basic information on their habitat use. Their program includes: daily boat-based monitoring in Oura Bay by towed acoustic hydrophones and five autonomous recorders deployed in each of four selected locations along the northern coast of Okinawa Island: Kayo, Ada, Cape Hedo, and Kouri Island. The autonomous recorders have recorded nearly 200 calls from dugongs in the monitored area. Each call was verified by an expert. The results have provided information on dugong behaviour in the western and eastern coasts of Okinawa Island. We understand that this monitoring will continue throughout the construction of the US military base near Henoko on Okinawa Island

### **Objectives**

1. To use passive acoustic monitoring to contribute to a multiple lines of evidence approach to confirm the presence of dugongs in candidate habitats in the Nansei Islands Region where other data e.g., public sightings, reports from fishers, feeding trails, eDNA, drone surveys) suggest that one of more dugongs may currently occur.
2. To provide insights into the behaviour of dugongs e.g., time and amount of feeding, vocal hotspots, socializing behaviour if dugongs are confirmed to still exist in the Nansei Islands Region.

### **Brief descriptions**

- The two sub-projects outlined below should be developed in collaboration with academic experts in the passive acoustic monitoring of marine mammals.
- The two sub-projects should be carried out sequentially if appropriate conditions arise as described below. Each sub-project is considered separately below.
  - 5.1 Acoustic recordings could be used as one of multiple lines of evidence to confirm the presence of dugongs in candidate habitats in the Nansei Islands Region where other data e.g., public sightings, reports from fishers, feeding trails, eDNA, drone surveys suggest that one of more dugongs may currently occur.
  - 5.2 If several dugongs are confirmed in the Nansei Islands Region, passive acoustic receivers could be deployed at their habitat(s). Multiple recording stations around the site(s) could be used to: (a) monitor the movements of dugongs in the area and along the coast and (b) provide insights into the behaviour of dugongs e.g. time and amount of feeding, vocal hotspots, socializing behaviour.

### **Duration**

At least three years

## Output

- Scientific papers in open-access journals, with links through open web pages (see Project 7)
- Summary of results and guiding take-home messages from the research output (see Project 7)
- Summary for policy makers in conjugation with other projects that contribute to the multiple lines of evidence approach to confirming dugongs in the Nansei Islands Region.

## Priority

- The priority of Sub-project 5.1 depends on identification of current candidate dugong habitats in the Nansei Islands Region using other techniques. Once a candidate habitat has been identified, the priority for sub-project 5.1 is **Very High** as one of the lines of evidence for dugong presence. Sub-project 5.2 has **Low** priority unless a habitat is detected which supports several dugongs.

# Project 6: Current status of seagrass beds in the Nansei Islands Region

## Background

- Dugongs are seagrass community specialists (Marsh et al. 2011).
- Seagrass beds are declining globally (Waycott et al. 2009; Unsworth et al. 2018) due to multiple human-induced factors including land development, water quality deterioration, destructive fishing and climate-change related environmental changes.
- The status of seagrass beds affects the status of dugong sub-populations. Seagrass dieback affects dugong mortality, fecundity, habitat use and movements (Marsh et al. 2018).
- Human use of seagrass beds, especially fishing also affects dugong survival directly through bycatch and vessel strike (Marsh and Sobotzick 2015).
- Seagrass communities provide valuable ecosystem services including provisioning, regulating and cultural services (Nordlund et al. 2016).
- Thus, understanding the status of seagrass beds throughout the Nansei Region in terms of their extent, biomass, biodiversity and functions, and the use of their multiple ecosystem services by multiple stakeholders is essential to the effective conservation and management of dugongs.

## Objectives

- To document:
  1. The spatial extent, connectivity, community composition, ecosystem functions and ecosystem services of seagrass beds in Okinawa as critical component of the effective conservation and management of the Japanese Dugong Sub-Population.
  2. The threats to seagrass communities in the Nansei region as the basis of a spatial risk assessment to be used as a basis for conservation response.

## Brief description

- The three sub-projects outlined below should be carried out in a coordinated manner throughout the Nansei Islands. The methodology should be refined and standardized on the basis of pilot studies in Okinawa and after liaison with the IKI project co-ordinated by the Dugong MOU secretariat and an appropriate Japanese seagrass expert.
  - Each of the three sub-projects is considered separately below.
- 6.1 Use an integrated approach of in-situ fieldwork and remote sensing to study the structure of seagrass communities.
- 6.1.1 Undertake in-situ surveys of seagrass beds using standard field census techniques (e.g. SeagrassNet <http://www.seagrassnet.org/>, Seagrass Watch [http://www.seagrasswatch.org/home\\_noG.html](http://www.seagrasswatch.org/home_noG.html)) along with: invertebrate surveys (core sampling), fish swims (use experts who can identify species, or develop a fish detector that uses artificial intelligence), water quality and sediment surveys.
  - 6.1.2 Explore the potential of mapping the range of seagrass communities using drones and Remote Underwater Vehicles at fine-scale resolution (link to Project 4). Compare the data obtained by these remote sensing devices with the field census data from 6.1.1 to estimate their potential for seagrass detection and ongoing use.
  - 6.1.3 If appropriate, use the data obtained from 6.1.2 to extrapolate the data obtained in 6.1.1 to produce GIS-based seagrass maps which include species composition and biomass information.
- 6.2 Evaluate the threats to seagrass communities in the Nansei region as the basis of a spatial risk assessment.
- 6.2.1 Map the threats to seagrasses in the Nansei region using spatial information on fishing, aquaculture, water quality, tourism, industrial and military uses including information obtained through Sub-project 6.1 above.
  - 6.2.2 Conduct drone surveys to map the position of fishnet/aquaculture plots in each seagrass beds and monitor their temporal changes in this infrastructure (link to Project 4) and the adjacent seagrass beds using appropriate techniques.
  - 6.2.3 Conduct a risk assessment to evaluate the likelihood and consequences of each threat at an agreed spatial scale.
- 6.3 Evaluate the relative importance of the multiple ecosystem services of seagrass communities, focusing on trade-offs between fisheries/aquaculture uses and dugong activities but also including regulating services like water quality alteration, blue carbon sequestration and erosion prevention.
- 6.3.1 At each site, conduct a social survey of the major stakeholders using the seagrass beds, e.g. fishers, aquaculture farmers, leisure use (local gleaning, swimming/bathing, marine sports, etc), educational use.
  - 6.3.2 Obtain statistics by prefecture (or central government) on fisheries and tourism use and compare with social survey (see 6.2 above).
  - 6.3.3 Analyze and evaluate the different ecosystem services of seagrass beds using data obtained above, e.g., provisioning services can be estimated from the fish swim data (6.1.1 above) as “potential amount of services”, and by fish

catch data (see 6.2 and 6.3.1. and 6.3.2 above) as “actual amount of services”. The regulating services of seagrass beds can be estimated by the product of spatial extent and aboveground/belowground biomass as the basis for estimating the capacity of each meadow for water quality regulation, blue carbon stock, and erosion regulation. Cultural services can be estimated by social surveys or statistics on leisure use/educational uses (see 6.3.1 above).

**Duration:**

- A minimum of three years. The monitoring of seagrass biodiversity and functions should be carried out four times a year to capture seasonal variation. Monitoring should be continued as long as possible, but for at least three years to understand inter-annual variability in response to different climate conditions (e.g. El Nino/La Nina).
- The social surveys could be carried out on the following timetable:
  - a. 1<sup>st</sup> year: Preliminary interviews of key stakeholders (leaders in fishers, officials in local government)
  - b. 2<sup>nd</sup> year: Social survey of seagrass bed direct/indirect users
  - c. 3<sup>rd</sup> year: Follow-up survey of information gaps and uncertainty based on results of 1<sup>st</sup>/2<sup>nd</sup> years

**Outputs**

- Scientific papers in open-access journals, with links through open web pages (see Project 7)
- Summary of results and guiding take-home messages from the research output (see Project 7)
- Summary for policy makers in conjugation with other projects

**Priority**

**Medium**

## **Project 7: Mapping dugongs: raising public awareness of the dugong in the Nansei Islands Region**

**Background:**

- The dugong has attracted considerable attention from the local public in Okinawa in the context of the controversy concerning the construction of a US military base in Henoko-Oura Bay in northern Okinawa Island. As a result, the dugong is typically viewed as a symbol of the anti-base construction movement or as an animal that is destined to be extinct in the near future. The significance of the dugong as a critically endangered marine mammal that is at high risk of being the eighth mammalian taxon recorded as ‘extinct’ on the Japanese Red List of Threatened Species, a Japanese Natural Monument, and Okinawa’s cultural icon, has not been appreciated.
- To date, the attempts to raise the public awareness of the importance of a comprehensive approach to dugong conservation in the Nansei Islands Region have been unsuccessful. There is a lack of understanding of the global significance of the Japanese Dugong Sub-Population, both in Okinawa and throughout the remainder of Japan.

- Given the critically endangered status of the dugong in the Nansei Islands Region, this situation needs to be changed as a matter of urgency.

### **Objectives**

1. To raise public awareness of the significance of the dugong in the Nansei Islands Region and the importance of dugong conservation by disseminating information on the dugong.
2. To encourage the public/local communities to participate in generating information about the dugong in the Nansei Islands Region.
3. To assist the Japanese Ministry of Environment and the government of Okinawa Prefecture to be more effective in disseminating and sharing information about the dugong with a view to increasing public awareness as a pre-requisite for better conservation efforts that will aid the fishing and eco-tour industry.

### **Brief Description**

- This project is envisaged as a possible collaboration between the Japanese Ministry of the Environment and Okinawa Prefecture with philanthropic funding and financial support from the business sector.
- The project could involve the following steps:
  1. Seek philanthropic funding and financial support from the business sector.
  2. Explore the potential for collaboration with the Dugong MOU/IKI project with regard to website development as part of a network of dugong seagrass partnerships.
  3. Involve professionals with PR marketing experience to advise how to remessage the Japanese dugong (including the title of this project) asking the Dugong MOU secretariat for contacts.
  4. Commission a professional web developer to enable the Okinawa Prefecture Government, in collaboration with the Ministry of the Environment, to establish a website system where:
    - a. The existing information on the dugong (from the Okinawa prefectural government, Ministry of the Environment, and Ministry of Defense, IUCN and others) is easily accessible to the general public so that they can appreciate the significance of the dugong in the Nansei Islands Region in relation to dugongs in other parts of the species' global range).
    - b. People can upload information about and photographs of their sightings of dugongs and dugong feeding trails in the Nansei Island Region (via websites, smartphone App (See Project 2), phone calls) and have them validated by experts using an agreed Quality Assurance process.
    - c. Dugong sightings and feeding trails are shown and updated as often as possible, synthesising the existing government information and publically-generated information.
    - d. The Okinawa prefectural government/ NGOs/ Tourism agencies conduct Public Relations (PR) campaigns for this project (including workshopping its names) via the website plus PR magazines, and social media networks.
  5. Encourage relevant organisations e.g. Toba aquarium, Churaumi aquarium in Okinawa to display information on the dugong to inform the public about the Japanese Dugong Sub-Population and the potential for public involvement in their conservation.

#### 4. Duration

Two-stage process:

- (1) An awareness raising campaign for 6 months to one year.
- (2) An on-going project (website etc).

#### Output format

Maps and up-to-date information on a dedicated website.

#### Priority

**Very High.** Making the information about the dugong held by the government of Okinawa Prefecture, the Ministry of the Environment, and the Ministry of Defense more readily and easily accessible is an essential pre-requisite to public awareness of the dugong as a critically endangered marine mammal, a Japanese Natural Monument, and Okinawa's cultural icon.

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### References cited in this Research Plan

- Baker SC, Steel D, Nieu Kirk S, Klinck H. 2018 Environmental DNA (eDNA). 2018. From the wake of the whales: Droplet digital PCR for detection and species identification. *Frontiers of Marine Science* 19 April 2018. <https://doi.org/10.3389/fmars.2018.00133>
- Bakker J, Wangensteen OS, Chapman DD, Boussarie G, Buddo D, Guttridge TL, Hertler H, Mouillot D, Vigliola L, Mariani S. 2017 Environmental DNA reveals tropical shark diversity in contrasting levels of anthropogenic impact. *Scientific Reports*: 7: 16886
- Brownell, RL, Kasuya T, Marsh, H. 2019. An IUCN Red List assessment of the status of the Japanese Dugong Sub-Population. Submitted to IUCN in August 2019.
- Hodgson JC, Koh LP. 2016. Best practice for minimising unmanned aerial vehicle disturbance to wildlife in biological field research. *Current Biology* 26(10): R404-R405.
- Hodgson AJ, Marsh H, Delean S, Marcus L. 2007. Is attempting to change marine mammal behaviour a generic solution to the bycatch problem? A dugong case study. *Animal Conservation*. 10: 263-273.
- Hodgson AJ, Kelly N, Peel D. 2013. Unmanned Aerial Vehicles (UAVs) for surveying marine fauna: a dugong case study. *PLoS ONE* 8(11): e79556.
- Hodgson A, Peel D, Kelly N. 2017. Unmanned aerial vehicles for surveying marine fauna: assessing detection probability. *Ecological Applications* 27(4): 1253-1267.
- Hodgson, AJ, Kelly N, Peel D, (in prep). Unmanned aerial vehicles produce superior data over human observers during large-scale aerial surveys of marine wildlife.

- Hunter ME, Meigs-Friend G, Ferrante JA, Kamla AT, Dorazio RM, Keith Diagne L, Luna F, Lanyon JM, Reid JP 2018. Surveys of environmental DNA (eDNA): A new approach to estimate occurrence in Vulnerable manatee populations. *Endangered Species Research* 35: 101-111 DOI: 10.3354/esr00880
- Ichikawa K, Akamatsu T, Shinke T, Sasamoir K, Miyauchi Y, Abe Y, Adulyanukosol K, Arai N. 2009 Detection probability of vocalizing dugongs during playback of conspecific calls. *Journal of Acoustical Society of America* 126( 4):1954-1959.
- Kasuya T, Brownell RL. 2001. Conservation status and future prospects of dugongs in Japanese waters. Unpublished report
- Marsh H, Sobotzick S. 2015. *Dugong dugon*. The IUCN Red List of Threatened Species 2015:e.T6909A43792211. <http://dx.doi.org/10.2305/IUCN.UK.2015-4.RLTS.T6909A43792211.en>
- Marsh H, O'Shea TJ, Reynolds, JE III. 2011. The ecology and conservation of Sirenia: Dugongs and manatees. Cambridge University Press. 521pp.
- Marsh H, Grech A, McMahon K. 2018. Dugongs: Seagrass Community Specialists. In: Larkum A, Kendrick G, Ralph P. (Eds) *Seagrasses of Australia*. Springer, Cham DOI [https://doi.org/10.1007/978-3-319-71354-0\\_19](https://doi.org/10.1007/978-3-319-71354-0_19)
- Nordlund LM, Koch EW, Barbier EB, Creed JC. 2016. Seagrass ecosystem services and their variability across genera and geographical regions *PLoS One* [10.1371/journal.pone.0163091](https://doi.org/10.1371/journal.pone.0163091).
- Pilcher NJ, Adulyanukosol K, Das H, Davis P, Hines E, Kwan D, Marsh H, Ponnampalam L, Reynolds J. 2017. A low-cost solution for documenting distribution and abundance of endangered marine fauna and impacts from fisheries. *PLoS ONE* 12(12):e0190021.
- Rasheed M., O'Grady D, Scott E, York PH, Carter AB. 2017. Dugong feeding ecology and habitat use on intertidal banks of Port Curtis and Rodds Bay – Final Report. Report produced for the Ecosystem Research and Monitoring Program Advisory Panel as part of Gladstone Ports Corporation's Ecosystem Research and Monitoring Program. Centre for Tropical Water and Aquatic Ecosystem Research (TropWATER) Publication 16/14, James Cook University, Cairns, 68 pp.
- Shirakihara K, Yoshida H, Shirakihara M, Takemura A. 1992. A questionnaire survey on the distribution of the finless porpoise, *Neophocaena phocaenoides*, in Japanese waters. *Marine Mammal Sci.* 8(2): 160-164.
- Shirakihara M, Yoshida H, Yokochi ., Ogawa H, Hosokawa T, Higashi N, Kasuya T. 2007. Current status and conservation needs of dugongs in southern Japan. *Marine Mammal Science.* 23:694–706.
- Simpfendorfer CA, Kyne PM, Noble TH, Goldsbury J, Basiita RK, Lindsay R, Shields A, Perry C, Jerry DR. 2016. Environmental DNA detects Critically Endangered largetooth sawfish in the wild. *Endangered Species Research* 30: 109–116, 2016 doi: 10.3354/esr00731
- Tsutsumi C, Ichikawa K, Arai N, Akamatsu T, Shinke T, Hara T, Adulyanukosol, K. 2006. Feeding behavior of wild dugongs monitored by a passive acoustical method using an underwater recording system. *Journal of Acoustical Society of America* 120(3):1356-1360. DOI:<http://dx.doi.org/10.1121/1.2221529>
- Uchida S. 1994. The dugong. In *Base Data of Japanese Rare Wild Aquatic Organisms*, edited by S. Odate, pp. 569-583. Fisheries Agency and Japanese Association for Conservation of Aquatic Resources, Tokyo.
- Uni, K. (in Japanese) 2003. Harvest report of Dugong (*Dugong dugon*) in Okinawa Prefecture. *Bulletin of Nago Museum* 11: 1–14.
- Unsworth RKF, Ambo-Rappe R, Jones BL, La Nafie YA, Irawan A, Hernawan UE, Moore AM, Cullen-Unsworth LC. 2018. Indonesia's globally significant seagrass meadows are under widespread threat. *Science of the Total Environment* 634:279-286. doi: 10.1016

Waycott M, Duarte CM, Carruthers TJB, Orth RJ, Dennison WC, Olyarnik S, Calladine A, Fourqurean JW, Heck KL, Hughes AR, Kendrick GA, Kenworthy WJ, Short FT, Williams SL. 2009. Accelerating loss of seagrasses across the globe threatens coastal ecosystems. *Proceedings of the National Academy of Sciences* 106: 12377-12381. [10.1073/pnas.0905620106](https://doi.org/10.1073/pnas.0905620106)

Welch D., Rokkum,A, Jefferson TA, Higa N, McNeill JR. 2010. An anthropological study of the significance of the Dugong in Okinawa culture. Unpublished report prepared for US Marine Corps, Washington, D.C., USA.

## Appendix 1

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## Appendix 2

### Supplementary References in Japanese

#### 1. List of Okinawa Defense Bureau's Reports on the Status of Dugongs and Seagrass beds in Northern Part of Okinawa Island (Henoko-Oura Bay, Kayo, Kori Island, and others)

Okinawa Defense Bureau (September, 2019)

*Heisei 30 nendo futenmahikojyo daitaishisetsu kensetsujigyo ni kakaru jigochosa houkokusho Reiwa gan nen 9 gatsu* [Japanese Fiscal Year Heisei 30 Report on Post [start of construction] Surveys

Regarding the Construction Project of the Futenma Air Base Replacement Facility, Reiwa 1 September] in Japanese.

<https://www.mod.go.jp/rdb/okinawa/07oshirase/chotatsu/jigochousa30/Jigochousa30.html>

Okinawa Defense Bureau (September, 2018)

*Heisei 29 nendo futenmahikojyo daitaishisetsu kensetsujigyo ni kakaru jigochosa houkokusho Heisei 30 nen 9 gatsu* [Japanese Fiscal Year Heisei 29, Report on Post [start of construction] Surveys Regarding the Construction Project of the Futenma Air Base Replacement Facility, Heisei 30 September] in Japanese.

<https://www.mod.go.jp/rdb/okinawa/07oshirase/chotatsu/jigochousa29/Jigochousa29.html>

Okinawa Defense Bureau (September, 2017)

*Heisei 28 nendo futenmahikojyo daitaishisetsu kensetsujigyo ni kakaru jigochosa houkokusho Heisei 29 nen 9 gatsu* [Japanese Fiscal Year Heisei 28, Report on Post [start of construction] Surveys Regarding the Construction Project of the Futenma Air Base Replacement Facility, Heisei 29 September] in Japanese.

<https://www.mod.go.jp/rdb/okinawa/07oshirase/chotatsu/jigochousa28/Jigochousa28.html>

Okinawa Defense Bureau (September, 2017)

*Heisei 26, 27 nendo futenmahikojyo daitaishisetsu kensetsujigyo ni kakaru jigochosa houkokusho Heisei 29 nen 9 gatsu* [Japanese Fiscal Year Heisei 26 and 27, Report on Post [start of construction] Surveys Regarding the Construction Project of the Futenma Air Base Replacement Facility, Heisei 29 September] in Japanese.

<https://www.mod.go.jp/rdb/okinawa/07oshirase/chotatsu/jigochousa26et27/Jigochousa26et27.html>

Okinawa Defense Bureau and IDEA Consultant, Inc. (March, 2015)

*Schwab (H25) Suiiki seibutu to chosa houkokusho heisei 27 nen 3 gatsu* [Schwab (H25) Report on Surveys regarding Aquatic Organisms in the Schwab Waters Area, Heisei 27 March] in Japanese.

<https://www.mod.go.jp/rdb/okinawa/07oshirase/chotatsu/280318syuwabu25suiikiseibutu/280318syuwabu25suiikiseibutu.html>

## **2. List of Okinawa Prefectural Government's Reports on its Dugong Conservation Efforts in Okinawa**

Okinawa Prefectural Government (Environmental Department, Nature Conservation Division) (March 2019)

*Heisei 30 nendo jyugon hogo taisaku jigyo houkokusho* [Report on Dugong Protection Project in Japanese Fiscal Year Heisei 29] in Japanese.

[https://www.pref.okinawa.jp/site/kankyo/shizen/documents/h30\\_honpen.pdf](https://www.pref.okinawa.jp/site/kankyo/shizen/documents/h30_honpen.pdf)

Okinawa Prefectural Government (Environmental Department, Nature Conservation Division) (March 2018)

*Heisei 29 nendo jyugon hogo taisaku jigyo houkokusho* [Report on Dugong Protection Project in Japanese Fiscal Year Heisei 29] in Japanese.

[https://www.pref.okinawa.jp/site/kankyo/shizen/documents/h29houkokusyo\\_1.pdf](https://www.pref.okinawa.jp/site/kankyo/shizen/documents/h29houkokusyo_1.pdf)

[https://www.pref.okinawa.jp/site/kankyo/shizen/documents/h29houkokusyo\\_2.pdf](https://www.pref.okinawa.jp/site/kankyo/shizen/documents/h29houkokusyo_2.pdf)

Okinawa Prefectural Government (Environmental Department, Nature Conservation Division) (March 2017)

*Heisei 28 nendo jyugon hogo taisaku jigyo houkokusho* [Report on Dugong Protection Project in Japanese Fiscal Year Heisei 28] in Japanese.

<https://www.pref.okinawa.jp/site/kankyo/shizen/documents/gaiyou.pdf>

### 3. List of Ministry of the Environment's Reports on Dugong Conservation Projects in Okinawa

Japanese Ministry of the Environment (2019)

*Jyugon to chiikishakai tono kyosei suishin no torikumi Heisei 30 nendo kekka gaiyo* [Project for Promoting Coexistence between Dugongs and Local Communities: A Summary of the Project Results in Japanese Fiscal Year Heisei 30 (2018)] in Japanese.

[https://www.env.go.jp/nature/H30\\_MOE\\_%20dugong\\_report.pdf](https://www.env.go.jp/nature/H30_MOE_%20dugong_report.pdf)

Japanese Ministry of the Environment (2018)

*Jyugon to chiikishakai tono kyosei suishin no torikumi Heisei 29 nendo kekka gaiyo* [Project for Promoting Coexistence between Dugongs and Local Communities: A Summary of the Project Results in Japanese Fiscal Year Heisei 29 (2017)] in Japanese.

[https://www.env.go.jp/nature/H29\\_MOE\\_%20dugong\\_report.pdf](https://www.env.go.jp/nature/H29_MOE_%20dugong_report.pdf)

Japanese Ministry of the Environment (2017)

*Jyugon to chiikishakai tono kyosei suishin no torikumi Heisei 28 nendo kekka gaiyo* [Project for Promoting Coexistence between Dugongs and Local Communities: A Summary of the Project Results in Japanese Fiscal Year Heisei 28 (2016)] in Japanese.

[https://www.env.go.jp/nature/H28\\_MOE\\_%20dugong\\_report.pdf](https://www.env.go.jp/nature/H28_MOE_%20dugong_report.pdf)

Japanese Ministry of the Environment (2016)

*Jyugon to chiikishakai tono kyosei suishin no torikumi Heisei 18 nen ~ 27 nendo kekka gaiyo* [Projects for Promoting Coexistence between Dugongs and Local Communities: A Summary of the Project Results between Japanese Fiscal Year Heisei 18 (2006) and 27 (2015)] in Japanese.

[https://www.env.go.jp/nature/kisho/research/jugon-tiiki-torikumi\\_P1.pdf](https://www.env.go.jp/nature/kisho/research/jugon-tiiki-torikumi_P1.pdf)

#### 4. NGO Reports

NGO reports on Dugong sightings and feeding trails in Okinawa

Two organizations, Nature Conservation Society of Japan (NACS-J) and Team Zan (Research Team of the Association to Protect Northernmost Dugong), along with other groups, have been working together to conduct survey on dugong feeding trails in Henoko-Oura Bay and Kayo (north of Henoko-Oura Bay). Taro Hosokawa is a key figure in this collaboration.

Here is a list of survey reports produced in the last 5 years by the two organizations.

NACS-J's report discusses not only dugong feeding trails but also corals, newly discovered species, and the impacts of base construction on the environment of Henoko-Oura Bay.

Team Zan's reports present the findings of dugong feeding trails in various parts of Henoko-Oura Bay and Kayo. On April 15, 2015, the team found 35 dugong feeding trails at the seabottom 19.5 meter below the water surface near the Chiribushi blue coral colony in Oura Bay. Team Zan has been conducting survey on dugong feeding trails mostly in the northern part of Okinawa Island, mostly in Henoko-Oura Bay and Kayo since 2007.

Nature Conservation Society of Japan (July, 2014)

*Henoko/ kankyo asesu go ni hanmeishita aratana jujitsu wo hattpyo shimasu* [Announcement of Facts regarding Henoko found after Environmental Impact Assessment]

[https://www.nacsj.or.jp/archive/files/katsudo/henoko/pdf/20140709\\_henoko\\_release.pdf](https://www.nacsj.or.jp/archive/files/katsudo/henoko/pdf/20140709_henoko_release.pdf)

Team Zan (Research Team of the Association to Protect Northernmost Dugong) (September, 2018)

"2018 Shokusei chousa" [2018 Survey on Dugong Feeding Behavior/habitat] in Japanese.

<https://teamzan.ti-da.net/e10729945.html>

Team Zan (Research Team of the Association to Protect Northernmost Dugong) (August, 2016)

"2016 Shokusei chousa" [2016 Survey on Dugong Feeding Behavior/habitat] in Japanese.

<https://teamzan.ti-da.net/e8875989.html>

Team Zan (Research Team of the Association to Protect Northernmost Dugong) (May, 2015)

"5 gatsu 9 nichi Oura wan haniato chousa" [May 9<sup>th</sup> Feeding Trail Survey] in Japanese.

<https://teamzan.ti-da.net/e7555044.html>

Team Zan (Research Team of the Association to Protect Northernmost Dugong) (April, 2015)

"Oura wan chiribishi aosango gunshu oki de tasu no hamiato" [Many feeding trains found near the Chiribishi Blue coral colony in Oura Bay] in Japanese.

<https://teamzan.ti-da.net/e7478092.html>

Team Zan (Research Team of the Association to Protect Northernmost Dugong) (July, 2014)

"7/14 Umino yousu" [Seabottom on July 14] in Japanese.

<https://teamzan.ti-da.net/e6536265.html>