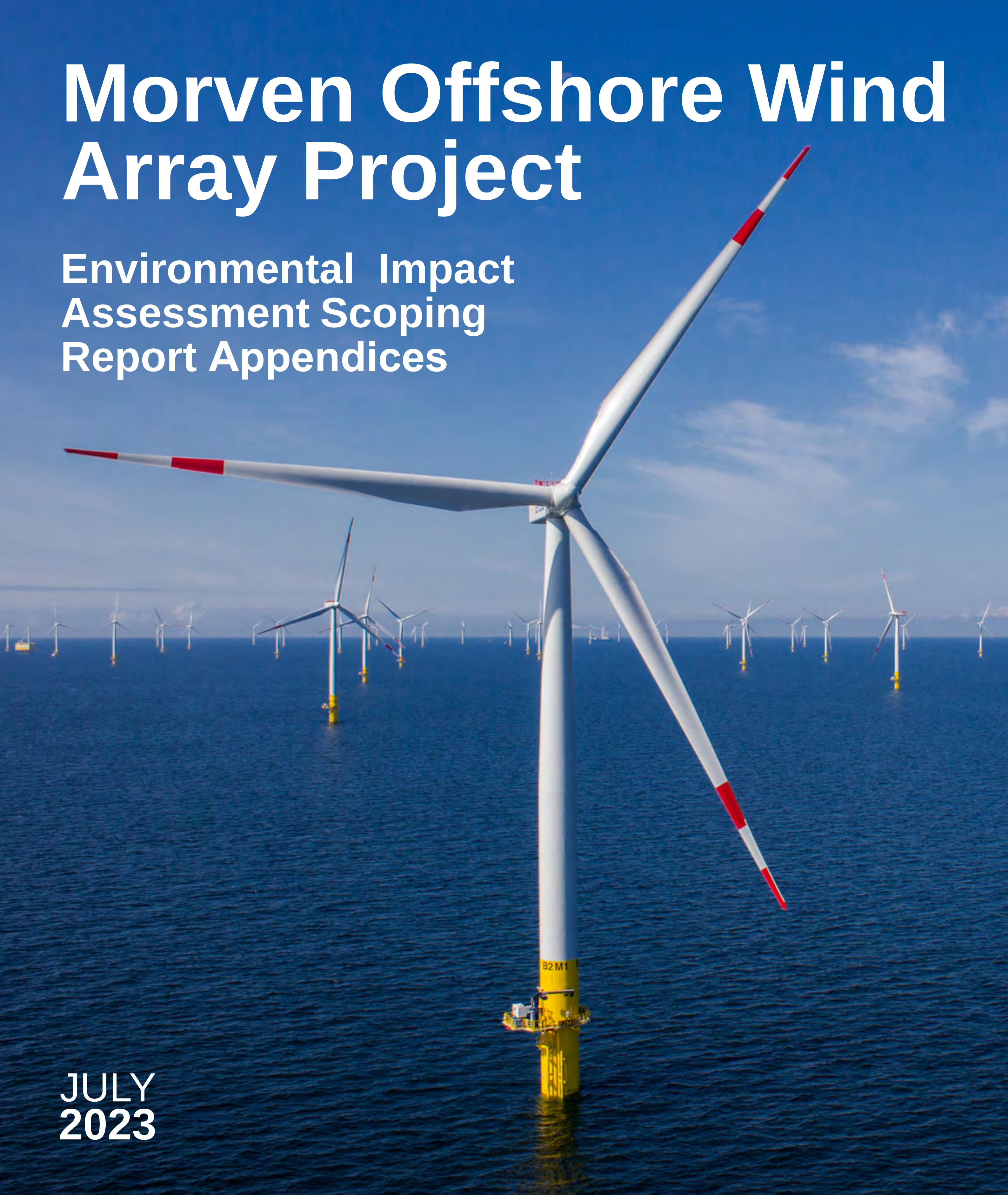
Morven Offshore Wind Array Project

Environmental Impact Assessment Scoping Report Appendices

JULY
2023



A TETRA TECH COMPANY

Partners in UK offshore wind

Approval for Issue		
	[Redacted]	
Alexander Schneeweiß		17 July 2023

Prepared by:	RPS	
Approved by:	Lizy Gardner	[Redacted]
Prepared for:	**Morven Offshore Wind Limited**	
Checked by:	Rhona Fairgrieve	[Redacted]
Accepted by:	Victoria Ridyard	[Redacted]
Approved by:	Alexander Schneeweiß	[Redacted]

Table of contents

Table of tables

Table of figures

Glossary

Term	Meaning
Allision	The act or process of a moving object striking a stationary object.
Appropriate Assessment	An assessment to determine the implications of a plan or project on a European site in view of that site's conservation objectives. An Appropriate Assessment forms part of the Habitats Regulations Appraisal (HRA) and is required when a plan or project (either alone or in combination with other plans or projects) is likely to have a significant effect on a European site.
Ancillary	Providing necessary support to the primary activities or operation of an organization or system.
Annex I habitats	A natural habitat type of community interest, defined in Annex I of the Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora (Habitats Directive). The designation of Special Areas of Conservation (SAC) is required in the UK to ensure the conservation of these habitats. The protection afforded to sites designated prior to EU Exit persists in UK law.
Annex I species	Birds that are the subject of special conservation measures concerning their habitat in order to ensure their survival and reproduction in their area of distribution. As appropriate, Special Protection Areas to be established to assist conservation measures.
Annex II species	Animal or plant species of community interest, defined in Annex II of the Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora (Habitats Directive). The designation of Special Areas of Conservation (SAC) is required in the UK to ensure the conservation of these species. The protection afforded to sites designated prior to EU Exit persists in UK law.
Array Project Scoping Boundary (hereafter, "Scoping Boundary")	The Scoping Report red line boundary within which the wind turbines, Offshore Substation Platforms and associated foundations, inter-array cables, interconnector cables and associated infrastructure (the 'Array Project Assets') will be located.
Array Project Environmental Impact Assessment Scoping Opinion (hereafter, "Scoping Opinion")	Scoping Opinion identifies the scope of impacts to be addressed and the method of assessment to be used in the Environmental Impact Assessment Report ("EIA Report") for the Proposed Development.
Array Project Scoping Report (hereafter, "Scoping Report")	Report that presents the findings of the scoping process undertaken for the Array Project.
Array Project Scoping Workshop (hereafter, "Scoping Workshop")	A series of sessions preceding the finalisation of the Array Project Scoping Report to provide an opportunity for the Applicant to consult on the draft scope and for stakeholders to request additional information on key issues.
Attenuation	Gradual loss of acoustic energy.
Barrier Effects	Where a (wind farm) creates an obstacle to regular movements of animals (e.g. breeding bird colonies or migration)
Baseline Environment	The existing conditions as represented by the latest available survey and other data, which is used as a benchmark for making comparisons to assess the impact of the Proposed Development.
Bathymetry	The measurement of water depth in oceans, seas and lakes.

Term	Meaning
Birds of Conservation Concern List	A list that reviews the extinction risk of all bird species for Great Britain using International Union for Conservation of Nature (IUCN) criteria and protocols.
Cetaceans	Aquatic mammals constituting the infraorder Cetacea (whales, dolphins, porpoises).
Climate Change	A long-term change in the average weather patterns that have come to define Earth's local, regional and global climates.
Coastal Character Types	Seascape assessments which were defined as part of NatureScot's Commissioned Report No. 103: An Assessment of the Sensitivity and Capacity of the Scottish Seascape in Relation to Windfarms (Scottish Natural Heritage, 2005):
Colonisation	The action by a plant or animal of establishing itself in an area
Collision Risk Modelling	A multistage calculation that results in a predicted number of birds killed per month and per year by a proposed wind farm.
Competent Authority	The term derives from the Habitats Regulations and relates to the exercise of the functions and duties under those Regulations. Competent authorities are defined in the Habitat Regulations as including "any Minister, government department, public or statutory undertaker, public body of any description or person holding a public office". In the context of a plan or project, the competent authority is the authority with the power or duty to determine whether or not the proposal can proceed.
Compressional wave	Vibration wave where direction of particle motion is parallel to direction of propagation.
Conservation Objectives	The specification of the overall target for the species and/or habitat types for which a site is designated in order for it to contribute to maintaining or reaching favourable conservation status of the habitats and species concerned.
Continuous sound	As defined in the National Physical Laboratory (NPL) 2014 guidelines (NPL, 2014), continuous sounds are sounds where the acoustic energy is spread over a significant time, typically many seconds, minutes or even hours. The amplitude of the sound may vary throughout the duration, but the amplitude does not fall to zero for any significant time. The sound may contain broadband noise and tonal (narrowband) noise at specific frequencies. Examples of continuous sound include ship noise, operational noise from machinery including marine renewable energy devices, and noise from drilling.
Cumulative Effect Assessment (CEA)	Assessment of likely significant effects as a result of the incremental change caused by other projects and plans together with the Array Project.
Cumulative effects	The effect of the Morven Offshore Wind Array Project taken together with similar effects from one or more different projects and plans, on the same receptor/resource.
Decibel (dB)	Expression of the ratio of one value of a power quantity to another (reference value) on a logarithmic scale. The reference value should be stated.
Decidecade	One tenth of a decade. A decade is a logarithmic frequency interval whose upper bound is ten times larger than its lower bound. Also referred to as one-third octave.
Deposition	The laying down of sediment carried by wind, flowing water, the sea or ice.

Term	Meaning
Designed in measures	For the purposes of the EIA process and in line with Institute of Environmental Management and Assessment (IEMA) (2016) guidance, designed in measures include Primary and Tertiary measures, which refer to measures developed as part of the Project design, or measures implemented to comply with standard industry practices or those required by law.
Dose-response approach	Derived from Graham et al. (2019) for cetaceans and Whyte et al. (2020) for pinnipeds for piling only. These describe the magnitude of the response of an organism as a function of exposure to a stimulus or stressor.
eDNA	Environmental DNA (eDNA) is nuclear or mitochondrial DNA that is released from an organism into the environment. Sources of eDNA include secreted faeces, mucous, and gametes; shed skin and hair; and carcasses. eDNA can be detected in cellular or extracellular (dissolved DNA) form.
Electromagnetic Field (EMF)	An electric and magnetic force field that surrounds a moving electrical charge.
Ensonified	Filled with sound.
Environmental Management Plan (EMP)	An action plan or system which addresses the how, when, who, where and what of integrating environmental mitigation and monitoring measures throughout an existing or proposed operation or activity.
European Economic Area (EEA)	Consists of Member States who entered an agreement on the EEA, which seeks to seeks to strengthen trade and economic relations between the contracting parties.
Exclusive Economic Zone (EEZ)	An area up to 200 nautical miles from the coast over which a sovereign state has rights regarding marine resources.
FeAST	The Feature Activity Sensitivity Tool is a web-based application which allows users to investigate the sensitivity of marine features.
Geoacoustic	Relating to the acoustic properties of the seabed.
Greenhouse gas	Gases created by human activity which are trapping heat in the atmosphere, raising the temperature and causing global warming or climate change.
Gross Value Added (GVA)	In economics, gross value added is the measure of the value of goods and services produced in an area, industry or sector of an economy.
Habitats Regulations Appraisal (HRA)	A process required by the Habitats Regulations of identifying likely significant effects of a plan or project on a European site and (where Likely Significant Effects are predicted or cannot be discounted) carrying out an appropriate assessment to ascertain whether the plan or project will adversely affect the integrity of the European site. If adverse effects on integrity cannot be ruled out, the latter stages of the process require consideration of the derogation provisions in the Habitats Regulations.
High Voltage Direct Current (HVDC)	High voltage direct current is the bulk transmission of electricity by direct current (DC), whereby the flow of electric charge is in one direction.
Impact	A change caused by an action that occurs during a project’s lifetime.
Impulsive sound	Sound which is typically transient and brief, with rapid rise time and rapid decay.
Invasive Non-Native Species (INNS)	An introduced organism that becomes overpopulated and negatively alters its new environment.

Term	Meaning
Landscape Character Assessment (LCA)	The process of identifying and describing variation in character of the landscape
Landscape Character Types (LCT)	A list of landscape character types as classified by NatureScot's Landscape Character Assessment (Scottish Natural Heritage, 2019)
Low-flying operation	Military fixed wing aircraft are assessed to be low flying when operating below 2,000 feet Above Ground Level (AGL); helicopters and light propeller-driven aircraft are assessed to be low flying when below 500 feet AGL.
Marine Protected Area (MPA)	Clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values
Marine Licence	A Marine Licence permits the undertaking of different activities in the marine environment, including construction, the deposition or removal of substances or objects, and dredging. The Marine and Coastal Access Act 2009 requires a Marine Licence to be obtained for licensable marine activities within the Scottish offshore region (12nm – 200Nm). The Marine (Scotland) Act 2010 requires Marine Licences for licensable activities taking place within Scottish Territorial Waters (MHWS to 12Nm).
Microwave links	A communications system that uses a beam of radio waves in the microwave frequency range to transmit video, audio, or data between two locations,
Natura 2000	A network of core breeding and resting sites for rare and threatened species and habitat.
Non-impulsive sound source	A source of sound that does not carry a sudden sharp sound or bang (no characteristics of impulsive sound) and which usually occurs over a longer duration. For example, from vessels or vibratory pile driving.
Offshore Substation Platforms (OSP)	OSPs comprise the support structure, topside and electrical components used for collecting and/or converting the electricity generated by the wind turbine generators for the passage or transmission between OSPs and to offshore export cables.
Population Viability Analysis (PVA)	Modelling method to predict impacts of the wind farm on seabird populations
Precautionary approach	This approach enables decision-makers to adopt precautionary measures when scientific evidence is uncertain.
Primary (type of designed in mitigation measure)	Measures included as part of the Project design. Includes modifications to location or design, integrated into the application for consent. These measures are implemented through the consent itself.
Permanent Threshold Shift (PTS)	An irreversible loss of hearing sensitivity.
Pinnipeds	Infraorder of marine mammals including true and eared seals, sealions and walrus.
Ramsar Site	Wetlands that have been designated under the Convention of Wetlands of International Importance, signed in Ramsar, Iran, in 1971.
Receptor	A component of the natural or man-made environment that is potentially affected by an impact.

Term	Meaning
Report to inform Appropriate Assessment (RIAA)	A report that examines the impact on a site's qualifying features.
Root-Mean-Square Sound Pressure (RMSS)	Square root of the integral over a specified time interval of squared sound pressure, divided by the duration of the time interval, for a specified frequency range.
Schedule 1 of the Wildlife and Countryside Act	The Act makes it an offence (with exceptions to species listed in Schedule 2) to intentionally kill, injure or take any wild bird or their eggs or nests
Scotland's net zero target	Legislated target that requires the Scottish Government to reduce the Scotland's net emissions of greenhouse gases by 100%, relative to 1990 levels, by 2045.
Screening	A procedure used to determine whether a proposed project is likely to have significant effects on the environment.
SeabORD	A tool to estimate the fate of birds displaced by offshore renewable development.
Secondary (type of designed in mitigation measure)	Foreseeable mitigation that requires further activity, identified through the EIA process. Industry standard measures committed to by the Applicant might include a commitment to implementing post-consent management plans to reduce the significance or likelihood of adverse environmental effects. These measures are also implemented through the consent itself.
Sessile	The inability to move actively or spontaneously or of pertaining to being permanently attached to the substrate or base, hence, not freely moving.
Shear wave	Vibration wave where the direction of particle motion is perpendicular to the direction of propagation.
Sirenians	Order of marine mammals including manatees and dugongs.
Site of Special Scientific Interest (SSSI)	Areas of land designated for features of special interest such as wildlife, geology or landforms, which require management.
Sound Exposure	Time integral of squared sound pressure over a stated time interval in a stated frequency band.
Sound Exposure Level (SEL)	Ten times the logarithm to the base 10 of the ratio of sound exposure to the specified reference value in decibels. The reference value in underwater acoustics is 1 µPa2s.
Sound Pressure (SP)	The contribution to total pressure caused by the action of sound.
Sound Pressure Level (SPL)	20 times the logarithm to the base 10 of the ratio of rms sound pressure to the specified reference value in decibels. The reference value in underwater acoustics is 1 µPa.
Special Areas of Conservation (SAC)	A site designation specified in the Habitats Directive (Council Directive 92/43/EEC). Each site is designated for one or more of the habitats and species listed in the Directive. The Directive requires that a management plan be prepared and implemented for each SAC to ensure the favourable conservation status of the habitats or species for which it was designated. In combination with SPAs, these sites contribute to the 'Natura 2000' or 'European' Sites network (in the UK – National Sites Network).
Special Protection Area (SPA)	Special Protection Areas (SPAs) are sites that are designated to protect rare or vulnerable birds (as listed on Annex I of the Directive 2009/147/EC on

Term	Meaning
	the conservation of wild birds), as well as regularly occurring migratory species.
Spring tidal excursion	The net horizontal distance over which a water particle moves during one (spring) tidal cycle of flood and ebb.
Steaming distances/times	The shortest distance/time between two ports, which a ship traverses while sailing from one port to another
Strategic collaboration	Collaboration between organisations to promote more efficient future offshore wind deployment
Study Area	For each environmental topic, the baseline environment will be characterised and the potential environmental impacts will be described within a topic-specific study area. Specific study areas are defined for each topic and are based on the maximum spatial extent across which potential impacts of the Array Project may be experienced by the relevant receptors (i.e. Zone of Influence).
Subsea cables	Cables that are laid on the ocean floor and used to transmit data rapidly from one point to another.
Suspended Sediment Concentrations (SSC)	The concentration of fine inorganic particles, fine sand and particulate organic matter suspended in the water column.
Temporary Threshold Shift (TTS)	A temporary reduction in hearing sensitivity.
Tertiary (type of designed in mitigation measure)	Inexorable mitigation, which will be implemented regardless of the design process and the EIA (i.e. actions that would occur with or without input from the EIA feeding into the design process), e.g. contractor's standard industry practices that manage potential nuisance activities or compliance with statutory requirements.
The 'Aarhus' Convention	A convention that guarantees access to information, public participation in decision-making and access to justice in environmental matters.
The 'Bern' Convention	The convention, adopted at Bern on 19 September 1979, aims to promote cooperation between the signatory countries in order to conserve wild flora and fauna and their natural habitats and to protect endangered migratory species.
The 'Bonn' Convention	The Convention on the Conservation of Migratory Species of Wild Animals, also known as the Convention on Migratory Species or the 'Bonn Convention', is an international agreement that aims to conserve migratory species throughout their ranges.
The 'Espoo' Convention	A convention that provides guidance on the assessment of transboundary impacts to promote "environmentally sound and sustainable development" and enhance international co-operation in assessing a project's environmental impact.
The 'Ramsar' Convention	The Convention on Wetlands of International Importance especially as Waterfowl Habitat ('Ramsar Convention' or 'Wetlands Convention') was adopted in Ramsar, Iran in February 1971 and came into force in December 1975. It provides the only international mechanism for protecting sites of global importance and is, thus, of key conservation significance.
Transboundary effects	Factor that arises when the impacts from a project within one State affects the environment of another State(s).
Unexploded Ordinance (UXO)	Explosive weapons that did not explode when they were deployed or disposed of and still pose a risk of detonation.

Term	Meaning
UK Continental Shelf	The region of waters surrounding the United Kingdom in which the country has mineral rights. This includes part of the North Sea, the North Atlantic, the Irish Sea and the English Channel.
Valued Ornithological Receptor (VOR)	VORs are species populations and assemblages of high ecological value, present within the zone of influence of the project, and in numbers that could mean that any effect associated with a project could be considered significant.
Zone of Influence (ZoI)	The maximum spatial extent across which potential impacts of the Array Project may be experienced by the relevant receptors.

Abbreviations

Acronym	Meaning
ADD	Acoustic Deterrent Device
ADR	Air Defence Radar
AIDU	Aeronautical Information Documents Unit
ASA	Acoustical Society of America
AWI	Ancient Woodland Inventory
BDMPS	Biologically Defined Minimum Population Scales
BTO	British Trust for Ornithology
CaP	Cable Plan
CCA	Coastal Character Assessment
CCT	Coastal Character Type
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CGNS	Celtic and Greater North Seas MU
CIEEM	Institute of Ecology and Environmental Management
CRM	Collision Risk Management
dB	Decibel
DEFRA	Department for Environment Food and Rural Affairs
EC	European Commission
ECOMMAS	East Coast Marine Mammal Acoustic Study
EcIA	Ecological Impact Assessment
eDNA	Environmental DNA
EEA	European Economic Area
EEC	European Economic Community
EIA	Environmental Impact Assessment
EMF	Electromagnetic Fields
EMP	Environmental Management Plan
ETZ	Energy Transition Zone
EU	European Union
FD	Finite Difference
FeAST	Marine Features Sensitivity Analysis
FLOWW	Fishing Liaison with Offshore Wind and Wet Renewables Group
FSA	Formal Safety Assessment
GDEM	Generalised Digital Environmental Model
GES	Good Environmental Status
GHG	Greenhouse Gas

Acronym	Meaning
GIS	Geographical Information System
GVA	Gross Value Added
HF	High-Frequency
HPAI	Highly Pathogenic Avian Influenza
HRA	Habitats Regulations Appraisal
HVDC	High Voltage Direct Current
IAMMWG	Inter-Agency Marine Mammal Working Group
ICPC	International Cable Protection Committee
IEMA	Institute of Environmental Management and Assessment
IMO	International Maritime Organization
INNS	Invasive Non-Native Species
iPCoD	Interim Population Consequences of Disturbance Model
IPIECA	International Petroleum Industry Environmental Conservation Association
JNCC	Joint Nature Conservation Committee
LCA	Landscape Character Assessment
LCT	Landscape Character Type
LF	Low-Frequency
LSE	Likely Significant Effects
MarESA	Marine Evidence based Sensitivity Assessment
MCA	Maritime and Coastguard Agency
MCZ	Marine Conservation Zone
MDS	Maximum Design Scenarios
MD-LOT	Marine Directorate Licensing Operations Team
MEDIN	Marine Environmental Data Information Network
MHWS	Mean High Water Springs
MoD	Ministry of Defence
MPA	Marine Protected Area
MRSea	Marine Renewables Strategic environmental assessment
MSFD	Marine Strategy Framework Directive
MSS	Marine Scotland Science
MU	Management Unit
MZ	Mitigation Zone
NATS	National Air Traffic Services
NC	Nature Conservation
NECRIFG	North and East Coast Regional Inshore Fisheries Group
NLB	Northern Lighthouse Board

Acronym	Meaning
nm	Nautical miles
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
OWF	Offshore Wind Farm
O&M	Operations and Maintenance
P	Primary mitigation
PAM	Passive Acoustic Monitoring
PCW	Phocid Carnivores in Water
PDE	Project Design Envelope
PE	Parabolic Equation
PK	Peak Pressure Level
PSR	Primary Surveillance Radar
PTS	Permanent Threshold Shift
PVA	Population Viability Analysis
QA	Quality Assurance
RIAA	Report to Inform the Appropriate Assessment
RMS	Root-mean-square
RRH	Remote Radar Head
RSPB	Royal Society for the Protection of Birds
S	Secondary mitigation
SAC	Special Area of Conservation
SAR	Search and Rescue
SEL	Sound Exposure Level
SELcum	Cumulative Sound Exposure Level
SFF	Scottish Fishermen’s Federation
SLA	Special Landscape Area
SLVIA	Seascape, Landscape and Visual Impact Assessment
SMRU	Sea Mammal Research Unit
SMU	Seal Management Unit
SNCB	Statutory Nature Conservation Body
SPA	Special Protection Areas
SPL	Sound Pressure Level
SPLpk	Peak Sound Pressure Level
SSC	Suspended Sediment Concentrations
SWFPA	Scottish White Fish Producers Association
T	Tertiary mitigation

Acronym	Meaning
TTS	Temporary Threshold Shift
UNECE	United Nations Economic Commission for Europe
UK	United Kingdom
UKFEN	UK Fisheries Economics Network
UKHO	UK Hydrographic Office
UXO	Unexploded ordnance
VHF	Very High-Frequency
VOR	Valued Ornithological Receptor
WWT	Wildlife and Wetlands Trust
ZoI	Zone of Influence
ZTV	Zone of Theoretical Visibility

1 Appendix 1 – Transboundary Screening

1.1 Introduction

1.1.1.1 This appendix identifies the potential transboundary receptors that may be affected by the construction, Operations and Maintenance (O&M) and decommissioning phases of the Morven Offshore Wind Array Project (hereafter, 'Array Project'), and assesses the potential impacts.

1.1.2 Background

1.1.2.1 Transboundary effects arise from impacts caused by a project within one European Economic Area (EEA) State affecting the environment of another EEA State(s).

1.1.2.2 The Applicant has completed a transboundary screening impact assessment or potential transboundary effects from the construction, O&M and decommissioning phases of the Array Project. The results of the transboundary screening assessment are set out in sections 1.3 and 1.4. Section 1.3 also states when no potential transboundary impacts have been identified during the transboundary screening process. The Marine Scotland Consenting and Licensing Guidance for Offshore Wind, Wave and Tidal Energy Applications (Scottish Government, 2018[1]) states that the transboundary impacts most likely to relate to offshore renewable energy projects in Scotland are:

- projects that could have an impact on mobile species;
- projects close to a national boundary or area governed by another relevant authority.

1.1.2.3 The guidance also states "MS-LOT [now the Marine Directorate Licensing Operations Team (MD-LOT)] would expect to see consideration of potential transboundary and cross border effects throughout the Environmental Impact Assessment (EIA) from the scoping phase" (Scottish Government, 2018).

Legislative context

1.1.2.4 The United Nations Economic Commission for Europe (UNECE) Convention on EIA in a Transboundary Context (the Espoo Convention) (as amended) provides guidance on the assessment of Transboundary impacts to promote 'environmentally sound and sustainable development' and enhance international co-operation in assessing a project's environmental impact.

1.1.2.5 When an activity occurring in one country may have a significant impact on another country, the Espoo Convention (named after the Finnish city of Espoo where it was adopted) requires that EIAs consider potential impacts across national borders. The United Kingdom (UK) is also a signatory to the Convention on Access to Information, Public Participation in Decision Making, and Access to Justice in Environmental Matters (the 'Aarhus Convention') and its Protocol, which guarantees access to information, public participation in decision-making and access to justice in environmental matters.

1.1.2.6 In European Union (EU) member States, Directive 85/337/EEC (as amended) (the EIA Directive) implements both the Espoo and Aarhus Conventions. EIA Regulations were adopted to transpose this Directive into UK law and the UK remains a signatory even after exiting the EU.

<u>Environmental Impact Assessment</u>

1.1.2.7 Under the EIA Regulations (see chapter 4: EIA Methodology of the Scoping Report), Scottish Ministers are required to determine whether proposed developments are likely to have significant effects on the environment of another EEA State (a transboundary impact). Regulation 29(1)(a) and 29(2) of the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017, for example, states that when it comes to the attention of the Scottish Ministers that works proposed to be carried

[1] An update to this guidance is expected in 2023, following consultation on the Marine Scotland Marine Consenting Manual consultation document which closed on 21 April 2023.

out in Scotland are the subject of an EIA application and are likely to have significant effects on the environment in an EEA State other than the United Kingdom Scottish Ministers must:

- send certain particulars (e.g. description of development and available information on its possible significant effect on the environment in that state and how a decision on the application may be taken) to the EEA State, as soon as possible and no later than the date of publication of the relevant notice in The Edinburgh Gazette;
- publish the information in a notice placed in The Edinburgh Gazette, indicating the address where further information is available;
- allow the EEA State a reasonable time period in which to indicate whether it wishes to participate in the procedure for which these Regulations provide.

Habitats Regulations Appraisal

1.1.2.8 As relevant to the Array Project, the Habitats Directive has been transposed into UK law through:

- the Conservation of Habitats and Species Regulations 2017 (which apply to certain specific consent applications including Section 36 applications);
- the Conservation of Offshore Marine Habitats and Species Regulations 2017 (which apply to marine licences and Section 36 applications within the Scottish Offshore region).

1.1.2.9 The guidance states "Where Scottish Ministers are required to undertake an appropriate assessment of cumulative impacts in relation to Natura interests, including transboundary and cross border effects, the developer's HRA will need to provide the required information" (Scottish Government, 2018).

1.2 Consultation

1.2.1.1 Once an EEA State has confirmed that it wishes to participate in discussions on the potential transboundary effects of a project, that EEA State must be consulted by the Scottish Ministers. Based on geographical proximity, it is proposed that the following States should be consulted on whether they intend to participate:

- Norway;
- Denmark;
- Germany;
- The Netherlands.

1.3 Screening of Transboundary Impacts

1.3.1.1 Appendix Figure 1.1 illustrates the proximity of the Array Project to other EEA States. The distance from the Array Project to other EEA States with which there may be transboundary impacts has been considered within this assessment.

Figure 1.1: Proximity of the Array Project in relation to other EEA States

1.3.2 Physical and Biological Environment

1.3.2.1 The Applicant has carried out a transboundary screening assessment for all potential physical and biological receptors. The conclusion of the assessment undertaken for each topic is presented within the following sections. Where it has been proposed that receptor groups be screened out of the Scoping Report, these receptor groups (i.e. airborne sound, air quality) have not been considered within this transboundary screening assessment on the basis that no significant effects to the environment are predicted and, therefore, no significant effects will occur to another EEA State.

1.3.2.2 The HRA process will consider the potential for the Array Project to impact benthic, fish and shellfish, marine mammal or offshore ornithology features of nature conservation designations in other EEA States.

Physical Processes

1.3.2.3 The Physical Processes Study Area has been defined as the extent of one spring tidal excursion from the Array Site. The Physical Processes Study Area is, therefore, entirely outwith any other EEA State and no potential transboundary impacts are predicted for this topic. Physical processes have, therefore, been screened out of further assessment for transboundary impacts in the EIA.

Underwater Sound

1.3.2.4 Potential impacts on underwater sound include:

- increased underwater sound from pile driving activity;
- increased underwater sound from unexploded ordnance (UXO) clearance;
- increased underwater sound from non-impulsive sound sources.

1.3.2.5 These impacts may affect receptors within the following topics:

- fish and shellfish ecology;
- marine mammals;
- commercial fisheries.

1.3.2.6 Transboundary impacts for underwater sound will, therefore, be considered within those receptor groups assessments and, consequently, underwater sound has been screened out of further assessment for transboundary impacts in the EIA.

Offshore Water Quality

1.3.2.7 Potential impacts on offshore water quality include:

- increased suspended sediment concentrations (SSC) and associated deposition;
- increased risk of introduction and spread of invasive non-native species (INNS).

1.3.2.8 These impacts will occur within the Offshore Water Quality Study Area, which is entirely outwith any other EEA States. However, impacts to water quality may have direct impacts on receptors groups including benthic ecology, fish and shellfish ecology and marine mammals, and directly impacts on receptor groups including benthic ecology, fish and shellfish ecology and offshore ornithology through impacts on prey availability. Transboundary impacts for offshore water quality will, therefore, be considered within those receptor groups assessments and, consequently, offshore water quality has been screened out of further assessment for transboundary impacts in the EIA.

Benthic Subtidal Ecology

1.3.2.9 Potential impacts on benthic subtidal ecology receptors include:

- temporary habitat loss/disturbance;
- long-term habitat loss;
- increased suspended sediment concentrations (SSC) and associated deposition;
- increased risk of introduction and spread of INNS;
- colonisation of hard structures;
- changes in physical processes.

1.3.2.10 Potential impacts on benthic ecology receptors will be largely focused within the Array Project Scoping Boundary. Therefore, considering the location of the Array Project, the sessile nature of benthic ecology receptors and the adherence to an Environmental Management Plan (EMP) to minimise the spread of INNS, no potential transboundary impacts are predicted for this receptor group. Benthic subtidal ecology has, therefore, been screened out of further assessment for transboundary impacts in the EIA.

Fish and Shellfish Ecology

1.3.2.11 Potential impacts on fish and shellfish ecology receptors include:

- temporary habitat loss/ disturbance;
- long-term habitat loss;
- increased SSC and associated sediment deposition;
- colonisation of hard structures;
- underwater sound;
- electromagnetic fields (EMF).

1.3.2.12 Impacts associated with indirect effects on fish and shellfish habitats, including habitat loss and suspended sediments are expected to be localised to within the Fish and Shellfish Study Area, which is entirely outwith other EEA States. However, fish species, including Annex II migratory fish species and fish of commercial importance for fishing fleets of other EEA States may transit through the Array Project Scoping Boundary. Therefore, these impacts have been scoped into the EIA transboundary assessment for this receptor group.

1.3.2.13 Increased underwater sound during the construction phase of the Array Project has the potential to injure and/or disturb fish receptors, including Annex II migratory fish species and fish that have commercial value. A direct impact may result from, for example, piling during construction of foundations, and an indirect impact may result from, for example, changes in prey availability during construction. Therefore, there is potential for transboundary impacts associated with the construction phase of the Array Project for this receptor group. Fish and shellfish ecology has been screened in for transboundary impacts and will be further considered in the EIA Report.

Marine Mammals

1.3.2.14 Potential impacts on marine mammal receptors include:

- injury and disturbance from underwater sound generated from piling;
- injury and disturbance from underwater sound generated from unexploded ordnance (UXO) clearance;
- injury and disturbance from vessel use and other (non-piling) sound producing construction activities;

- injury due to collision with vessels;
- changes in prey availability;
- disturbance from pre-construction site investigation surveys.

1.3.2.15 It is acknowledged that some marine mammals can travel large distances to forage and, consequently, the Regional Marine Mammal Study Area extends beyond the Scottish and UK territorial water limits and into the waters of neighbouring EEA States. Therefore, there is the potential for transboundary impacts associated with the Array Project to directly affect Annex II marine mammal species. Consequently, marine mammals as a receptor group has been screened in for transboundary impacts for the above potential impacts and will be further considered in the EIA Report.

Offshore Ornithology

1.3.2.16 Potential impacts on offshore ornithology receptors include:

- permanent habitat loss associated with the wind turbines;
- direct and indirect temporary habitat loss/disturbance due to vessel, construction and O&M activities;
- collision with turbines;
- displacement due to the presence of wind turbines and other ancillary structures;
- barrier effects due to the presence of wind turbines;
- accidental pollution associated with maintenance or supply/service vessels;
- attraction of lit structures by migrating birds;
- changes in prey availability.

1.3.2.17 There is potential for seabird populations located outside of UK territorial waters, including those that are qualifying features of designated sites, to be impacted by the Array Project. Such impacts could occur during the construction, O&M or decommissioning phases. Consequently, offshore ornithology has been screened in for transboundary impacts for the above potential impacts and will be further considered in the EIA Report.

1.3.2.18 Existing published information on seabird foraging behaviour (e.g. Woodward *et al.*, 2019) will be used to determine transboundary connectivity in the breeding season. In the non-breeding season, it is possible that birds from non-UK seabird colonies may occur within the Scoping Boundary and, therefore, there may be impacts on birds originating from non-UK colonies. A wide variety of published material will be used to determine transboundary connectivity for migratory species, including Wright *et al.* (2012); WWT Consulting and MacArthur Green (2014); Furness (2015); and species-specific tracking information.

1.3.3 Human Environment

1.3.3.1 The Applicant has carried out a transboundary screening for all potential human environment receptors. The conclusion of the assessment undertaken for each receptor group is presented within the following sections. Where it has been proposed that receptor groups be screened out of the Scoping Report, these receptor groups (i.e. seascape, landscape and visual impact (SLVIA) and onshore heritage assets, and marine archaeology) have not been considered within this transboundary screening assessment, on the basis that no significant effects to the environment are predicted and, therefore, no significant effects will occur to another EEA State.

Other Sea Users, Marine Infrastructure and Communications

1.3.3.2 Potential impacts associated with the Array Project identified for other sea users and marine infrastructure receptors include:

- displacement of recreational activities (e.g. sailing, cruising, fishing);
- interference with offshore microwave fixed communication links.

1.3.3.3 Since no potential receptors associated with other EEA States have been identified for this receptor group, the Array Project is not expected to have any transboundary impacts for this topic. Other sea users and marine infrastructure as a receptor group has, therefore, been screened out of further assessment for transboundary impacts in the EIA.

Socio-economics

1.3.3.4 Potential impacts associated with the Array Project identified for socio-economics receptors include:

- impacts to employment and Gross Value Added (GVA);
- demographic changes and demand for housing and other services;
- changes to visitor behaviour;
- changes to commercial fisheries;
- changes to shipping and marine recreation.

1.3.3.5 If commercial fishing vessels or shipping and navigation receptors associated with other EEA States are affected, there is the potential for transboundary impacts. However, these have been considered within their respective receptor groups and will, therefore, not be considered further within the socio-economic transboundary screening.

1.3.3.6 Transboundary socio-economic impacts could arise through the purchase of Array Project components, equipment, and the sourcing of labour from companies based outside the UK. As a result, socio-economics will be further considered for transboundary impacts in the EIA.

Shipping and Navigation

1.3.3.7 Potential impacts on shipping and navigation receptors include:

- increased vessel to vessel collision risk resulting from displacement (third party to third party);
- increased vessel to vessel collision risk resulting from displacement (third party to Array Project vessel);
- vessel allision risk;
- reduced access to local ports and harbours;
- anchor and fishing gear interactions with subsea cables;
- interference with navigation, communications, and position-fixing equipment;
- reduction of Search and Rescue (SAR) capability.

1.3.3.8 Transits to/from other countries, as well as shipping routes to/from other EEA State ports, are considered to have potential transboundary impacts. Therefore, shipping and navigation will be further considered for transboundary impacts in the EIA.

Climate Change

1.3.3.9 Potential impacts on climate change and greenhouse gas (GHG) receptors include:

- GHG emissions arising from land-use change (seabed);

- GHG emissions arising from the manufacturing and installation of the Array Project;
- GHG emissions arising from the consumption of materials and activities required to facilitate the O&M phase and the impact of estimated abatement of UK Grid emissions during the O&M phase;
- GHG emissions arising from decommissioning works (e.g. plant, fuel and vessel use) and the recovery (or disposal) of materials;
- vulnerability of the Array Project to climate change during the O&M phase.

1.3.3.10 All developments that emit GHGs may impact the atmospheric mass of GHGs as a receptor, resulting in a transboundary impact on climate change. Therefore, climate change and GHG will be further considered for transboundary impacts in the EIA Report. The Array Project's transboundary impacts are assessed by defining the atmospheric mass of GHGs as a high sensitivity receptor. Each country has its own carbon and climate change policy and targets that are designed to limit GHG emissions within its defined budget and international commitments. However, for the purposes of this assessment, reference will be made to the UK Carbon Budgets and climate-related policy and objectives in the transboundary assessment for climate change and greenhouse gas in the EIA.

Commercial Fisheries

1.3.3.11 As the Scoping Boundary is located beyond the 12nm limit, where European Union (EU) member states are currently permitted to fish, there is potential for transboundary impacts upon commercial fisheries during the construction, O&M and decommissioning phases of the Array Project. These include:

- temporary loss or restricted access to fishing grounds;
- permanent loss or restricted access to fishing grounds;
- displacement of fishing activity into other areas;
- interference with fishing activity;
- increased steaming distances and times;
- snagging risk resulting in loss or damage to fishing gear;
- impacts on commercially exploited species.

1.3.3.12 Commercial fisheries will be further considered for transboundary impacts in the EIA. Within the Commercial Fisheries Study Area, non-UK fleets with significant fishing activity, and permission to fish in the area, will be included as receptors throughout the impact assessment.

Aviation (Military and Civil)

1.3.3.13 Potential impacts associated with the Array Project identified for aviation and radar receptors include:

- interference with low flying operation;
- interference with airborne SAR operations;
- interference with Buchan (Remote Radar Head (RRH)) Air Defence Radar (ADR), Brizlee Wood (RRH) ADR, Allanshill (NATS) Primary Surveillance Radar (PSR) and Perwinnes (NATS) PSR.

1.3.3.14 As there are no oil and gas installations in the Aviation Study Area, low flying operations associated with other EEA States (where oil and gas platforms are serviced from non-EEA States) will not be affected. All the radars identified are UK based and, considering the location of the Array Project and the identified receptors, no transboundary impacts associated with aviation and radar are predicted. As a result, aviation and radar has been screened out of further assessment on transboundary impacts in the EIA.

Major Accidents and Disasters

1.3.3.15 Potential impacts considered with respect to the Array Project's vulnerability to existing hazards include:

- collision risk from existing shipping and navigation and aviation;
- collision risk – aviation (military and civil);
- snagging risk from existing commercial fisheries activities;
- risk of accident due to the presence of the Eastern Link 2 High Voltage Direct Current (HVDC) cable within the Scoping Boundary;
- risk of accident – oil and gas infrastructure;
- temperature changes, precipitation changes and sea revel rise;
- pollution of the marine environment (structures);
- risk of accident in extreme weather (e.g. storm surges) during all phases;
- sabotage events.

1.3.3.16 Potential impacts considered with respect to the Array Project's potential to cause accidents and disasters include:

- physical impacts (collision, allision);
- UXO;
- pollution of the marine environment (vessels);
- fire at wind turbine/offshore substation platforms (OSP);
- snagging risk to subsea cables from commercial fishing operations;
- collision risk – aviation (military and civil).

1.3.3.17 Activities associated with the Array Project may have transboundary impacts on shipping and navigation and commercial fisheries receptors. Transboundary impacts for major accidents and disasters will, therefore, be considered within those receptor groups. Other potential major accidents (e.g. third party HVDC infrastructure within the Array Project and accidents occurring as a result of extreme weather events) are localised to within the Scoping Boundary. Consequently, major accidents and disasters as a receptor group has been screened out of further assessment in the EIA.

Human Health

1.3.3.18 The Human Health Study Area is located entirely outside of other EEA states and no potential transboundary impacts, such that could cause population level impacts, are predicted for this receptor group. Human health has, therefore, been screened out of further assessment on transboundary impacts in the EIA.

1.4 Conclusions

1.4.1.1 This transboundary screening has been carried out considering the location of the Array Project and the current Project Description Chapter (chapter 3: Project Description of the Scoping Report). A receptor group that either has a defined study area that crosses into another EEA State and/or has receptors associated with the study area that belong to, or are under the protection of another EEA State, has been screened in. The exception to this is where receptors are covered within another receptor group.

1.4.1.2 There is the potential for transboundary impacts associated with the Array Project for the following receptor groups:

- fish and shellfish ecology;
- marine mammals;
- offshore ornithology;
- shipping and navigation;
- climate change;
- commercial fisheries.

1.4.1.3 These receptor groups will be considered further for transboundary impacts in the EIA Report.

2 Appendix 2 - Designed in Measures and Mitigation Log

2.1 Introduction

2.1.1.1 This appendix provides a summary of the designed in measures and mitigation measures which have been committed to by the Applicant and considered in the Array Project Scoping Report (hereafter, 'Scoping Report'). These are detailed in each technical chapter and summarised in Appendix Table 2.1.

2.1.1.2 Therefore, the Environmental Impact Assessment (EIA) can be undertaken assuming these measures will be implemented in the associated plan. As a result, potential effects that might arise prior to the implementation of designed in measures do not need to be identified as potential effects as there is no potential for them to arise (Institute of Environmental Management and Assessment (IEMA), 2016).

2.1.1.3 It is expected that the Array Project Scoping Opinion (hereafter, 'Scoping Opinion') and future stakeholder engagement will inform the development of mitigation measures. Therefore, the designed in measures and mitigation log will be updated throughout the EIA process.

Table 2.1: Array Project designed in measures and mitigation log

Reference	Phase of Array Project	Mitigation and monitoring commitment	Justification (specific)	Outline plan commitment	Topics of relevance															Means of implementation	Mitigation category
					Physical processes	Underwater sound	Offshore water quality	Benthic subtidal ecology	Fish and shellfish ecology	Marine mammals	Offshore ornithology	Other sea users, etc.	Socio-economics	Shipping and navigation	Climate change	Commercial fisheries	Aviation (military & civil)	Major accidents & disasters	Marine archaeology		
MM-1	Operation and Maintenance (O&M).	Scour protection will be used around offshore structures as set out in chapter 3: Project Description of the Scoping Report.	There is the potential for scouring of seabed sediments to occur due to interactions between Metocean regime (wave, sand and currents) and foundations or other seabed structures. This scouring can develop into depressions around the structure. The use of scour protection around offshore structures and foundations will be employed, as described in detail in chapter 3: Project Description of the Scoping Report. The scour protection has been included in the modelled scenarios used within the assessment of effects to protect foundations from the effects of scour.	Cable Plan and Construction Method Statement.	✓			✓						✓		✓				Secured in the Section 36 Consent and Marine Licence, via the requirement for Cable Plan.	P
MM-2	Construction.	Development and adherence to a Cable Plan.	There is a potential for cable exposure to occur due to interactions between Metocean regime (wave, sand and currents). Sediment transportation can lead to exposure of cables and infrastructure, although the use of a target cable burial depth alongside the cable installation strategy should provide sufficient depth to avoid exposure. The Cable Plan will outline the technical specifications of the cables used in the Array Project and describe the installation methodology; also includes cable protection to be installed.	Cable Plan	✓		✓	✓						✓		✓				Secured in the Section 36 Consent and Marine Licence, via the requirement for a Cable Plan.	P
MM-3	O&M.	Any additional cable protection involving rock protection will be evaluated in line with the Operation & Maintenance Plan (OMP) and follow industry standard guidelines in terms of slope angle and rock grading. Secured through the (OMP).	Cables to be reburied to where possible; cable protection to be reinstated as necessary and provide information on the cable reinstallation process and how specific activities will be controlled.	OMP.												✓				Secured in the Section 36 Consent and Marine Licence, via the requirement for an OMP.	T
MM-4	Construction.	Development of, and adherence, to a Construction Method Statement (CMS).	Provided as a means of controlling specific health and safety risks that have been identified and to ensure the health and safety aspects of the development are secured.	CMS.			✓	✓	✓											Secured in the Section 36 Consent and Marine Licence, via the requirement for a CMS.	T

Reference	Phase of Array Project	Mitigation and monitoring commitment	Justification (specific)	Outline plan commitment	Topics of relevance															Means of implementation	Mitigation category
					Physical processes	Underwater sound	Offshore water quality	Benthic subtidal ecology	Fish and shellfish ecology	Marine mammals	Offshore ornithology	Other sea users, etc.	Socio-economics	Shipping and navigation	Climate change	Commercial fisheries	Aviation (military & civil)	Major accidents & disasters	Marine archaeology		
MM-5	Construction, O&M, and decommissioning.	Development of, and adherence to, an Environmental Management Plan (EMP), including actions to minimise invasive non-native species (INNS), Marine Mammal Mitigation Protocol (MMMP) and a Marine Pollution Contingency Plan (MPCP), which will include planning for accidental spills, address all potential contaminant releases and include key emergency details.	Provides a means to ensure the efficient management and communication of commitments made for the management of the potential environmental impacts. The MMMP may include using marine mammal observers and Passive Acoustic Monitoring (PAM) to monitor the mitigation zone (MZ, as determined by the underwater sound modelling) to ensure that animals are not observed within the MZ during piling. Acoustic Deterrent Devices (ADD) may be used if required to deter animals from the MZ. For offshore water quality, measures will be adopted to ensure that the potential for release of pollutants from construction, and operations and maintenance, is minimised. In this manner, the accidental release of contaminants from rigs and supply/ service vessels will be strictly controlled, thus providing protection for birds and their prey species across all phases of the development. For benthic subtidal ecology, an MPCP will include planning for accidental spills, addressing all potential contaminant releases and include key emergency details. The INNSMP will include measures for controlling INNS and their impact on fish and shellfish ecology receptors.	EMP		✓	✓	✓	✓	✓	✓			✓	✓					Secured in the Marine Licence via the requirement for an EMP, including a MPCP, MMMP and INNS Management Plan	T
MM-6	Construction, O&M and decommissioning.	Relevant Health, Safety and Environment (HSE) procedures will be followed for all activities during construction, O&M and decommissioning periods.	When using consumables that are potentially hazardous, or refuelling offshore, relevant HSE procedures will be followed, with the objective of mitigating any risk of pollution incidents.								✓									Required in accordance with relevant Health and Safety legislation	T

Reference	Phase of Array Project	Mitigation and monitoring commitment	Justification (specific)	Outline plan commitment	Topics of relevance															Means of implementation	Mitigation category
					Physical processes	Underwater sound	Offshore water quality	Benthic subtidal ecology	Fish and shellfish ecology	Marine mammals	Offshore ornithology	Other sea users, etc.	Socio-economics	Shipping and navigation	Climate change	Commercial fisheries	Aviation (military & civil)	Major accidents & disasters	Marine archaeology		
MM-7	Construction, O&M and decommissioning.	A Navigation Safety and Vessel Management Plan will be developed, which will determine vessel routing to and from construction areas and ports to avoid areas of high risk.	The Navigation Safety and Vessel Management Plan will confirm the types and numbers of vessels engaged in the Array Project and consider vessel coordination, including indicative transit route planning. The plan will minimise disturbance of seabird species by avoiding bird populations and/or migratory routes, and allow the identification of standard routes.	Navigation Safety Plan (NSP) and Vessel Management Plan (VMP).							✓			✓		✓				Secured in the Section 36 Consent and Marine Licence via the requirement for a VMP.	T
MM-8	Construction, O&M and decommissioning.	Development of, and adherence to, a Navigation Safety and Vessel Management Plan.	The Navigation Safety and Vessel Management Plan will describe measures put in place by the Applicant related to navigational safety, including information on Safety Zones, charting, construction buoyage, temporary lighting and marking and means of notification of Array Project activity to other sea users (e.g. via Notices to Mariners).	Navigation Safety and VMP.										✓						Secured in the Section 36 Consent and Marine Licence via the requirement for a Navigational Safety Plan (NSP).	T
MM-9	Construction, O&M and decommissioning.	The Array Project operator will issue, as necessary, requests to the UK Aeronautical Information Service to submit Notification to Aviation Missions (NOTAM) in the event of any failure of aviation lighting.	To minimise the risks of temporary hazards.	Lighting and Marking Plan.													✓			Secured in the Section 36 Consent and Marine Licence via the requirement for Lighting and Marking Plan (LMP).	T
MM-10	Construction.	The Defence Infrastructure Organisation (DIO) will be informed of the construction start and end dates, the maximum height of construction equipment and locations of substations.	To maximise awareness of temporary hazards.														✓			Secured in the Section 36 Consent and Marine Licence.	T
MM-11	Construction, O&M and decommissioning.	Promulgation of information as required (e.g., Notices to Mariners, Kingfisher Bulletin).	To maximise awareness of the Array Project, allowing other sea users and marine infrastructure receptors to plan in advance to ensure project vessels are suitably managed to minimise the likelihood of involvement in incidents and maximise the ability to assist in the event of a third-party incident.									✓		✓		✓				Secured in the Section 36 Consent and Marine Licence.	T

Reference	Phase of Array Project	Mitigation and monitoring commitment	Justification (specific)	Outline plan commitment	Topics of relevance															Means of implementation	Mitigation category
					Physical processes	Underwater sound	Offshore water quality	Benthic subtidal ecology	Fish and shellfish ecology	Marine mammals	Offshore ornithology	Other sea users, etc.	Socio-economics	Shipping and navigation	Climate change	Commercial fisheries	Aviation (military & civil)	Major accidents & disasters	Marine archaeology		
MM-12	Construction, O&M and decommissioning	Consultation with oil and gas operators and other energy infrastructure operators, as required.	To promote and maximise cooperation between parties and minimise spatial and temporal interactions between conflicting activities.									✓								Secured in the Section 36 Consent and Marine Licence.	P
MM-13	Construction, O&M and decommissioning.	Supply Chain Development Statement (SCDS) (bp/EnBW, 2022).	To analyse the commitments underpinning the SCDS and support economic growth with a commitment to approximately £1.2bn of spend in Scotland and £2.3bn to the UK, subject to market assumptions. Includes enhanced supply chain commitments as a Scottish Champion and investment in two Scottish ports – Port of Leith and Port of Aberdeen. These commitments will be updated over time, in agreement with Crown Estate Scotland.	Supply Chain Development Statement (SCDS).									✓							Secured via the Crown Estate leasing process.	S
MM-14	Construction, O&M and decommissioning.	Compliance with Marine Guidance Note (MGN) 654 (Maritime and Coastguard Agency (MCA), 2021) and its annexes, where applicable.	To ensure the final array layout is suitable for SAR operations and that reductions in under keel clearance are acceptable.											✓						Secured via the Section 36 Consent and Marine Licence.	T
MM-15	Construction, O&M and decommissioning.	Development of, and adherence to, a Development Specification and Layout Plan (DSLP). The DSLP will ultimately confirm the layout and design parameters of the Array Project.	To ensure the final array layout is suitable for both surface and air based (for SAR purposes) navigation and to ensure accurate mapping for navigation.	Development Specification and Layout Plan (DSLP).										✓						Secured via the Section 36 Consent and Marine Licence via the requirement for a DSLP.	T
MM-16	Construction, O&M and decommissioning.	Marine coordination and communication to manage Array Project vessel movements through the Navigation Safety and Vessel Management Plan.	To ensure project vessels are suitably managed to minimise the likelihood of involvement in incidents and maximise the ability to assist in the event of a third-party incident.	Navigation Safety and Vessel Management Plan.										✓						Secured in the Section 36 Consent and Marine Licence via the requirement for a VMP.	T
MM-17	Construction, O&M and decommissioning.	Compliance of Array Project vessels with international marine regulations as adopted by the Flag State, including the International Regulations for Preventing Collisions at Sea (COLREGs) (International Maritime	To minimises the risk introduced due to the presence of project vessels.	Navigation Safety and VMP.										✓						Secured in the Section 36 Consent and Marine Licence via the requirement for a VMP.	T

Reference	Phase of Array Project	Mitigation and monitoring commitment	Justification (specific)	Outline plan commitment	Topics of relevance															Means of implementation	Mitigation category
					Physical processes	Underwater sound	Offshore water quality	Benthic subtidal ecology	Fish and shellfish ecology	Marine mammals	Offshore ornithology	Other sea users, etc.	Socio-economics	Shipping and navigation	Climate change	Commercial fisheries	Aviation (military & civil)	Major accidents & disasters	Marine archaeology		
		Organization (IMO), 1972/77) and the International Convention for the Safety of Life at Sea (SOLAS) (IMO, 1974) through the Navigation Safety and VMP.																			
MM-18	Construction, O&M and decommissioning.	Development of a Fisheries Management and Mitigation Strategy (FMMS). The FMMS will include details on the measures which are proposed to be implemented to minimise impacts on commercial fishing.	To detail the Applicant's proposed approach to fisheries liaison and facilitate co-existence.	FMMS.												✓				Secured in the Section 36 Consent and Marine Licence via the requirement for a FMMS.	T
MM-19	Construction, O&M and decommissioning.	Ongoing consultation with the fishing industry and appointment of a Fisheries Liaison Officer (FLO).	To provide a point of contact to liaise and engage with the fishing industry.													✓				Secured in the Section 36 Consent and Marine Licence via the requirement for a FMMS.	T
MM-20	Construction, O&M and decommissioning.	Adherence to good practice guidance with regards to fisheries liaison (e.g. FLOWW, 2014; 2015).	To facilitate productive relationships with fisheries stakeholders and the implementation of an evidence-based approach to mitigation.													✓				Secured in the Section 36 Consent and Marine Licence via the requirement for a FMMS.	P
MM-21	Construction, O&M and decommissioning.	Participation in the Forth and Tay Commercial Fisheries Working Group (FTCFWG) and liaison with Fisheries Industry Representatives (FIRs), as appropriate.	To provide a forum for information sharing and discussion of key issues with fisheries stakeholders and other developers in the region.													✓				Secured in the Section 36 Consent and Marine Licence via the requirement for a FMMS.	P
MM-22	Construction, O&M and decommissioning.	Consideration of the principle of cooperation agreements in instances where static gears may be required to be temporarily relocated.	To minimise potential adverse interactions between the Array Project and fishing activities.													✓				Secured in the Section 36 Consent and Marine Licence via the requirement for a FMMS.	P

Reference	Phase of Array Project	Mitigation and monitoring commitment	Justification (specific)	Outline plan commitment	Topics of relevance															Means of implementation	Mitigation category
					Physical processes	Underwater sound	Offshore water quality	Benthic subtidal ecology	Fish and shellfish ecology	Marine mammals	Offshore ornithology	Other sea users, etc.	Socio-economics	Shipping and navigation	Climate change	Commercial fisheries	Aviation (military & civil)	Major accidents & disasters	Marine archaeology		
MM-23	Construction, O&M and decommissioning.	Procedures for helicopter hoist operations will be established in accordance with CAP 437.	To minimise the likelihood of incidents.														✓			Secured in the Section 36 Consent and Marine Licence via the requirement for an ERCoP.	T
MM-24	Construction, O&M and decommissioning.	Development of, and adherence to, an Emergency Response and Cooperation Plan (ERCoP), including consideration of helicopters.	To formulate robust emergency response plans and site safety.	ERCoP.													✓			Secured in the Section 36 Consent and Marine Licence via the requirement for an ERCoP.	T
MM-25	Construction, O&M and decommissioning.	The implementation of Archaeological Exclusion Zones (AEZs) around sites identified as having a known important archaeological potential.	AEZs will ensure offshore infrastructure avoids any known wrecks. The size of the AEZ will be evidence based and established using the precautionary principle to ensure that it is of sufficient size to protect the site from the nature of impact (Wessex Archaeology, 2007; Wessex Archaeology for The Crown Estate, 2021).																✓	Secured in the Section 36 Consent and Marine Licence.	P
MM-26	Pre-construction.	Archaeological input into survey specifications for, and data analysis of, future preconstruction geophysical surveys, geotechnical surveys, preconstruction Remotely Operated Vehicle (ROV) or diver surveys and preconstruction site preparation activities.	This might include the presence of a geoarchaeologist on board the survey vessel and a provision for advice on methodology including sampling, analysis and reporting of recovered cores. The results of all geoarchaeological investigations are to be compiled in a final report that includes a sediment deposit model. If appropriate, to carry out watching briefs of such work. All anomalies of unconfirmed archaeological potential to be considered during pre-construction activities and final design. If they are likely to be impacted, these anomalies would undergo further archaeological investigation. Should these anomalies prove to be of archaeological importance then future AEZs may be implemented following consultation with Heritage Environment Scotland (HES).	Written Scheme of Investigation (WSI) and Protocol for Archaeological Discoveries (PAD)															✓	Secured in the Section 36 Consent and Marine Licence via the requirement for a WSI.	P
MM-27	Pre-construction	All anomalies of unconfirmed archaeological	All anomalies of unconfirmed archaeological potential to be considered	WSI and PAD.															✓	Secured in the Section 36 Consent and Marine	S

Reference	Phase of Array Project	Mitigation and monitoring commitment	Justification (specific)	Outline plan commitment	Topics of relevance															Means of implementation	Mitigation category
					Physical processes	Underwater sound	Offshore water quality	Benthic subtidal ecology	Fish and shellfish ecology	Marine mammals	Offshore ornithology	Other sea users, etc.	Socio-economics	Shipping and navigation	Climate change	Commercial fisheries	Aviation (military & civil)	Major accidents & disasters	Marine archaeology		
		potential to be considered during pre-construction activities and final design. If they are likely to be impacted, these anomalies would undergo further archaeological investigation. Should these anomalies prove to be of archaeological importance then future AEZs may be implemented following consultation with HES.	during pre-construction activities and final design. If they are likely to be impacted, these anomalies would undergo further archaeological investigation. Should these anomalies prove to be of archaeological importance then future AEZs may be implemented following consultation with HES.																	Licence via the requirement for a WSI.	
MM-28	Pre-construction	Archaeologists to be consulted in advance of preconstruction site preparation activities and, if appropriate, to carry out watching briefs of such work.	To prevent damage occurring to unidentified archaeological finds.	WSI and PAD.															✓	Secured in the Section 36 Consent and Marine Licence via the requirement for a WSI.	T
MM-29	Construction, O&M and decommissioning.	Micro-siting of wind turbine foundation anchors and mooring lines to avoid known wrecks if practicable.	Micro-siting to avoid known marine archaeology features such as wrecks.	WSI and PAD.															✓	Secured in the Section 36 Consent and Marine Licence via the requirement for a WSI.	T
MM-30	Pre-construction and construction.	Mitigation of unavoidable direct impacts on known sites of archaeological importance during pre-construction and construction activities. Options include i) preservation by record, ii) stabilisation and iii) detailed analysis and safeguarding of otherwise comparable sites elsewhere.	Options include preservation by record; stabilisation; and detailed analysis and safeguarding of otherwise comparable sites elsewhere.	WSI and PAD.															✓	Secured in the Section 36 Consent and Marine Licence via the requirement for a WSI.	P

Reference	Phase of Array Project	Mitigation and monitoring commitment	Justification (specific)	Outline plan commitment	Topics of relevance															Means of implementation	Mitigation category
					Physical processes	Underwater sound	Offshore water quality	Benthic subtidal ecology	Fish and shellfish ecology	Marine mammals	Offshore ornithology	Other sea users, etc.	Socio-economics	Shipping and navigation	Climate change	Commercial fisheries	Aviation (military & civil)	Major accidents & disasters	Marine archaeology		
MM-31	Construction, O&M and decommissioning.	Development and adherence to a WSI and PAD.	The WSI will include proposed Archaeological Exclusion Zones (AEZs) for marine archaeology receptors identified within the geophysical survey data to prevent direct damage to maritime archaeology receptors. The PAD will allow for the recording, preservation and protection of any unexpected archaeological discoveries that may occur due to sediment disturbance and deposition during the Array Project.	WSI and PAD.															✓	Secured in the Section 36 Consent and Marine Licence via the requirement for a WSI and PAD.	T
MM-32	Pre-construction.	Use of drilling fluids regulated by the UK REACH Regulations, secured through the Environmental Management Plan (EMP).	To limit potential environmental damage from small quantities of drill fluids may be released.	EMP.			✓													Secured in the Marine Licence via the requirement for an EMP, including a MPCP, MMMP and INNS Management Plan.	P
MM-33	Construction, O&M and decommissioning.	Application for safety zones of up to 500m during construction and periods of major maintenance.	To protect third-party vessels from project vessels involved in construction and major maintenance activities, which may be Restricted in their Ability to Manoeuvre (RAM).											✓						Secured via an application for safety zone prior to construction commencing.	T
MM-34	O&M.	Appropriate lighting and marking of wind turbines and offshore substation platforms will be established in accordance with Civil Aviation Authority (CAA) regulations and guidance (CAP 393, The ANO) and in accordance with the CAA and the Defence Infrastructure Organisation (DIO), which is responsible for the safeguarding of Ministry of Defence (MOD) assets. Secured through the development of, and adherence to, a Lighting and Marking Plan (LMP).	Up to date guidance on turbine lighting will be followed when producing the LMP to address aviation, shipping and ornithological requirements	LMP.							✓			✓			✓			Secured in the Section 36 Consent and Marine Licence via the requirement for LMP.	T

Reference	Phase of Array Project	Mitigation and monitoring commitment	Justification (specific)	Outline plan commitment	Topics of relevance															Means of implementation	Mitigation category
					Physical processes	Underwater sound	Offshore water quality	Benthic subtidal ecology	Fish and shellfish ecology	Marine mammals	Offshore ornithology	Other sea users, etc.	Socio-economics	Shipping and navigation	Climate change	Commercial fisheries	Aviation (military & civil)	Major accidents & disasters	Marine archaeology		
MM-35	Construction, O&M and decommissioning.	Marking and lighting of the site in agreement with the Northern Lighthouse Board (NLB) and in line with International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) Recommendation O-139 (IALA, 2021 (a)) and Guidance G1162 (IALA, 2021 (b)) through Navigation safety and Vessel Management Plan.	Maximises awareness of the Array Project in both day and night conditions, including in restricted visibility and assists with SAR operations.	Navigation safety and Vessel Management Plan.										✓						Secured in the Section 36 Consent and Marine Licence via the requirement for a Navigation Safety Management Plan.	T
MM-36	Construction, O&M and decommissioning.	Prior to the start of construction, the MoD Aeronautical Information Documents Unit (AIDU) and UK Hydrographic Office (UKHO) will be informed of the locations, heights, and lighting status of the OSP, including estimated and actual dates of construction and operation activities, and the maximum height of any equipment to be used, to allow inclusion on aviation charts.	To allow inclusion on aviation charts.														✓			Secured in the Section 36 Consent and Marine Licence	T
MM-37	Construction, O&M and decommissioning.	Appropriate marking on UKHO Admiralty charts.	To maximise awareness of the Array Project, allowing other vessels, sea users and marine infrastructure receptors to plan their activities in advance.	Navigation Safety and Vessel Management Plan.								✓		✓		✓				Secured in the Section 36 Consent and Marine Licence via the requirement for a VMP.	T
MM-38	Construction.	Buoyed construction area in agreement with NLB and described within the LMP, Navigation Safety and VMP.	To protect third-party vessels from project vessels involved in construction and major maintenance activities which may be Restricted in their Ability to Manoeuvre (RAM).	LMP, Navigation Safety and VMP.										✓						Secured via the Section 36 Consent and Marine Licence via the requirement for the LMP, Navigation Safety and VMP.	P

Reference	Phase of Array Project	Mitigation and monitoring commitment	Justification (specific)	Outline plan commitment	Topics of relevance															Means of implementation	Mitigation category
					Physical processes	Underwater sound	Offshore water quality	Benthic subtidal ecology	Fish and shellfish ecology	Marine mammals	Offshore ornithology	Other sea users, etc.	Socio-economics	Shipping and navigation	Climate change	Commercial fisheries	Aviation (military & civil)	Major accidents & disasters	Marine archaeology		
MM-39	Construction, O&M and decommissioning.	Use of guard vessels and Offshore Fisheries Liaison Officers (OFLOs), as appropriate.	To facilitate engagement with fisheries stakeholders during work and minimise potential conflict between the Array Project and fishing activities.											✓		✓				Secured in the Section 36 Consent and Marine Licence via the requirement for FMMS.	P
MM-40	Construction.	A soft-start procedure (including low hammer initiation and ramp up) be implemented for pile driving to allow additional time for animals to leave the area before full power piling begins. Soft-start procedure to be outlined in the Construction Method Statement (CMS).	Soft-start will allow time for animals to leave the area prior to full power piling beginning.	Construction Method Statement.		✓			✓	✓										Secured in the Section 36 Consent and Marine Licence via the requirement for a CMS.	P
MM-41	Construction.	Sufficient spacing between wind turbines (at least 1,000m).	Sufficient spacing between wind turbines to mitigate wake effects and changes to the wave field.		✓															Secured in the Section 36 Consent and Marine Licence.	P
MM-42	Construction.	A minimum spacing of 500m shall be maintained between blade tip to blade tip of all surface infrastructure (for OSPs, this shall be taken as the outermost point of the infrastructure).	To facilitate access by SAR helicopters operating under instrument meteorological conditions (IMC) flight rules, in line with MCA guidance.														✓			Secured in the Section 36 Consent and Marine Licence.	P
MM-43	Construction, O&M and decommissioning.	A minimum blade tip height of 30 m (LAT) will be used for the Array Project, accounting for pitch and roll as per MGN 654.	This minimum blade tip height clearance is considered appropriately conservative so as to minimise risk.								✓			✓						Secured via the Section 36 Consent and Marine Licence.	P
MM-44	O&M.	Undertaking of post-lay and cable burial inspection surveys and monitoring. Secured through the Cable Plan, as part of the OMP.	To minimise the risks of interactions with cable protection, anchor or fishing gear interaction with subsea cables.	Cable Plan and OMP.												✓				Secured in the Section 36 Consent and Marine Licence via the requirement for Cable Plan.	P

Reference	Phase of Array Project	Mitigation and monitoring commitment	Justification (specific)	Outline plan commitment	Topics of relevance															Means of implementation	Mitigation category
					Physical processes	Underwater sound	Offshore water quality	Benthic subtidal ecology	Fish and shellfish ecology	Marine mammals	Offshore ornithology	Other sea users, etc.	Socio-economics	Shipping and navigation	Climate change	Commercial fisheries	Aviation (military & civil)	Major accidents & disasters	Marine archaeology		
MM-45	O&M.	Implementation, management and monitoring of cable protection (via burial or external protection where adequate burial depth, as identified via risk assessment, is not feasible) with any damage, destruction or decay of cables notified to MCA, NLB, Kingfisher and UKHO no later than 24 hours after discovered. Secured through the Navigation Safety and Vessel Management Plan.	Cable protection may be necessary in some locations where sufficient cable burial depth cannot be achieved or where cables become exposed during the lifetime of the Array Project. To ensure that the Cable Plan has been successfully implemented, monitoring will be undertaken as part of wider Array Project pre- and post-construction geophysical surveys and are likely to involve a combination of multibeam echosounder or high-resolution side-scan sonar. This minimises the risks of underwater allision with cable protection, anchor or fishing gear interaction with subsea cables and interference with magnetic position fixing equipment.	OMP.	✓			✓						✓						Secured via the Section 36 Consent and Marine Licence via the requirement for the Cable Plan and Navigation Safety and Vessel Management Plan.	P

3 Appendix 3 - Morven Array Project Scoping Workshop

3.1 Introduction

3.1.1.1 This appendix provides a summary of the pre-application Scoping Workshop undertaken for the Array Project, held on the 18 and 19 April 2023. The Scoping Workshop was an opportunity for the Applicant to consult on the draft scope of the Array Project, and for stakeholders to request additional information on key issues to be addressed in the Array Project Scoping Report (hereafter, 'Scoping Report). The following appendix outlines the topics discussed at the Scoping Workshop, including the agenda (section 3.2; Appendix Table 3.1) and topic-related questions (section 3.3; Appendix Table 3.2).

3.2 Scoping Workshop Agenda

3.2.1.1 The Scoping Workshop agenda was determined by the Applicant, based on pre-application (and pre-Scoping Workshop) Stakeholder consultation and discussion. Stakeholders invited to the Scoping Workshop were identified with the support of the Marine Directorate Licensing and Operation Team (MD-LOT) and the Applicant sought to include all relevant stakeholders for each of the Scoping Workshop topic sessions.

3.2.1.2 The key topics presented at the Scoping Workshop, along with the agenda items and a list of Stakeholders invited to each topic session (and those that gave their apologies), are presented in Appendix Table 3.1. Appendix Table 3.1 also gives details of the materials used to support this engagement, which were issued to stakeholders on 28 March 2023, three weeks prior to the Scoping Workshop.

3.2.1.3 Following the Scoping Workshop, stakeholders were invited to provide feedback to the questions asked per topic and on the Methodology Statements, where provided (see Appendix Table 3.1). Written feedback was received electronically from NatureScot on 15 May 2023. The key aspects of this advice, and the Applicant's responses are detailed in the consultation sections of the relevant chapters of this Scoping Report. The minutes of the Scoping Workshop sessions were circulated to stakeholders for comment between 12 May 2023 and 26 May 2023. Finalised minutes were issued to stakeholders on 19 June 2023. As the minutes have yet to be agreed by MD-LOT at the time of submission, the minutes of the sessions have not been appended but any written feedback has been incorporated into the relevant scoping chapters.

3.3 Scoping Workshop Questions

3.3.1.1 The Scoping Workshop addressed areas for discussion relevant to key topics to be presented in the Scoping Report. For each of these key topics, aspects such as study areas, availability of further guidance or baseline data, assessment methodology and impacts to be scoped in and out of the assessment were raised with the stakeholders. These were discussed and, where possible, an agreement was reached on how these topics would be approached in the Environmental Impact Assessment (EIA). Topic-specific questions discussed with stakeholders in the Scoping Workshop are presented in Appendix Table 3.2. A summary of stakeholder responses to these questions, and how the Applicant responded or proposes to address stakeholder responses through the EIA process, is presented in the consultation section of each chapter of this Scoping Report.

Table 3.1: Agenda and supporting information for Scoping Workshop sessions (April 2023)

Session	Agenda topic	Start time	End time	Stakeholders	Supporting materials	Agenda notes
18 April morning session	**Physical Processes and ecology (benthic, fish and shellfish) session**					
	Introduction	09:00	09:15	Marine Directorate, MD-LOT, NatureScot, Marine Scotland Science.	Slide pack	Short introduction to the Array Project.
	Physical Processes	09:15	10:05		Slide pack	Seek to agree impact assessment methodology. Overview of expected impact pathways for topic.
	Benthic Subtidal Ecology	10:05	10:55		Slide pack	Presentation of high-level overview of baseline. Seek agreement on the impact assessment methodology. Overview of expected impact pathways for topic. Presentation of the Marine Protected Area (MPA) Screening.
	Fish and Shellfish Ecology	10:55	11:45		Slide pack	Presentation of high-level overview of baseline. Seek agreement on the impact assessment methodology. Overview of expected impact pathways for topic. Use of eDNA results in assessment.
	Habitats Regulations Appraisal (HRA) approach	11:45	12:00			Approach to HRA.

Session	Agenda topic	Start time	End time	Stakeholders	Supporting materials	Agenda notes
	Shipping and Navigation session					
	Introduction	09:00	09:15	Marine Directorate, MD-LOT, Maritime Coastguard Agency (MCA), Northern Lighthouse Board (NLB), Chamber of Shipping, Royal Yachting Association (Scotland), Montrose Port.	Slide pack.	Short introduction to the Array Project.
	Shipping and Navigation	09:15	11:00		Slide pack.	Presentation of high-level overview of baseline, including 2022 winter vessel traffic survey data. Seek agreement on the impact assessment methodology. Overview of expected impact pathways for topic.
18 April afternoon session.	**Marine Mammals and Underwater Sound session**					
	Introduction	13:00	13:15	MD-LOT, NatureScot, Marine Scotland Science, JASCO.	Slide pack.	Short introduction to the Array Project.
	Marine Mammals	13:15	14:15		Slide pack. Technical Annex: Marine Mammals Methodology Statement.	Presentation of high-level overview of baseline. Seek agreement on the impact assessment methodology. Overview of expected impact pathways for topic. High level overview of Year 1 survey data. Discussion on presenting connectivity of Special Areas of Conservation (SACs).
	Underwater Sound	14:15	14:45		Slide pack. Technical Appendix: Underwater Sound Methodology Statement.	Presentation of modelling methodology.

Session	Agenda topic	Start time	End time	Stakeholders	Supporting materials	Agenda notes
	HRA approach	14:45	15:00			Presentation of high-level approach to be followed in identification of SACs to be screened in.
	Commercial Fisheries session					
	Introduction	13:00	13:15	MD-LOT, Marine Scotland Science; Scottish Fishermen's Federation; Scottish Pelagic Fishermen's Association; North and East Coast Regional Inshore Fisheries Group; and Scottish White Fish Producers Association.		Short introduction to the Array Project.
	Commercial Fisheries	13:15	15:00		Slide pack. Technical Appendix: Commercial Fisheries Methodology.	Summary of best practice guidance to be referenced including: FLOWW guidance and Marine Scotland guidance (ABPmer, 2022; Blyth-Skyrme 2010; FLOWW, 2014; 2015; ICPC, 2009; UKFEN, 2012; and Xodus Group, 2022). Data and information sources to be used to inform the baseline. Summary of stakeholder consultation to be undertaken. Overview of expected impact pathways for topic. Relationships with other aspects.
	SLVIA and Onshore Historic Environment session					
	Introduction	13:00	13:15	Aberdeen City Council Apologies from MD-LOT, Historic Environment	Slide pack	Short introduction to the Array Project.
	Seascape, Landscape and Visual Impact	13:15	14:00		Slide pack	Presentation of high-level overview of baseline, including Zone of Theoretical Visibility

Session	Agenda topic	Start time	End time	Stakeholders	Supporting materials	Agenda notes
	Assessment (SLVIA).			Scotland , Angus Council and Aberdeenshire Council .	Technical Appendix: Wirelines and Zones of Theoretical Influence.	(ZTV) and wirelines. Discussion on scoping out of topics.
	Onshore Historic Environment.	14:00	14:30		Slide pack.	
19 April afternoon session.	**Offshore Ornithology session**					
	Introduction	13:00	13:15	MD-LOT, NatureScot, Marine Scotland Science, Royal Society for the Protection of Birds (RSPB).	Slide pack.	Short introduction to the Array Project.
	Offshore Ornithology	13:15	14:15		Slide pack. Technical Appendix: Offshore Ornithology Yield 1 Results Data Analysis. Technical Appendix: Offshore Ornithology Methodology.	Presentation of overview of baseline including Year 1 survey data results. Presentation of impact assessment methodology. Overview of expected impact pathways for topic. Discussion on the value in presenting connectivity of Special Protection Areas (SPAs).
	HRA Approach	14:15	15:00			Presentation of high-level approach to be followed in identification of SPAs to be screened in.
	Close of Workshop	15:00	15:30			Wrap up and next steps.
	Socio-economics session					
	Introduction	13:00	13:15	MD-LOT, Scottish Government's Marine	Slide pack	Short introduction to the Array Project.

Session	Agenda topic	Start time	End time	Stakeholders	Supporting materials	Agenda notes
	Socio-economics	13:15	14:30	Analytical Unit, Aberdeenshire Council, City of Edinburgh Council, Aberdeen City Council, Forth Ports, Scottish Enterprise, Energy Transition Zone (ETZ Ltd.). Apologies from Angus Council.	Slide pack	Summary of guidance to be referenced. Summary of Study Areas. Discussion around consultation and engagement. Overview of economic and social impacts.
	Close of Workshop	14:30	15:00			Wrap up and next steps.

Table 3.2: Scoping Workshop Questions per topic, used to guide the Scoping Workshop

Topic	Question	Further clarification
Seascape Landscape and Visual Impact Assessment (SLVIA) and Onshore Historic Environment session		
Impacts scoped out	Are consultees content to scope out the SLVIA of the offshore elements within the Scoping Boundary based on the viewpoint wirelines and Zone of Theoretical Visibility (ZTV)?	Justification: Due to large intervening distance beyond 62km distance (out with an "accepted" 50km SLVIA Study Area from the Scoping Boundary) and limited visibility of the Array Project (low to negligible magnitude), there would be no significant effects on the seascape, landscape and visual receptors. Therefore, it is proposed to scope out the SLVIA of the EIA.
	Are consultees content to scope out the onshore heritage assets of the offshore elements within the Scoping Boundary?	At the meeting there were a few additional viewpoints identified as of importance to SILVIA including: • Baron's Cairn- the presence of visible modern elements close to the asset and setting includes clear visibility of marine activity; • Torry Battery- setting includes clear visibility of marine activity; • Broad Hill Summit- setting includes clear visibility of marine activity. However, it was determined that the visibility from onshore heritage assets would be limited due to landscape and distance. Stakeholders agreed to this approach.
Offshore Ornithology section		
Impact pathways	Do you agree with the impacts that have been scoped in and out of the assessments?	Impacts scoped in: • direct temporary habitat loss/disturbance; • indirect temporary habitat loss/disturbance (including indirect effects on prey species); • collision; • displacement; • barrier effects; • attraction to light. Impacts scoped out: • permanent habitat loss: area affected is negligible;

Topic	Question	Further clarification
		• accidental pollution: implementation of designed in mitigation measures.
Displacement	The displacement and mortality rates provided in NatureScot's guidance will be presented in assessments. Can the evidence base associated with these rates be provided?	Assessment methodology (displacement analysis): • species for consideration in displacement analysis will be those Valued Ornithological Receptors (VORs) that are vulnerable to displacement, based on Wade *et al.* (2016); • displacement analysis will follow JNCC *et al*. (2022) guidance and NatureScot (2020) guidance; • where applicable, SeabORD will also be used; • a range of displacement and mortality rates will be presented with assessments based on those recommended by NatureScot (2020) and other relevant evidence.
Population modelling	What is the basis for the use of a 0.02 percentage point increase in survival rate to identify when Population Viability Analysis (PVA) is required?	Population modelling: • Population modelling will be undertaken using the Natural England PVA tool (Searle *et al.,* 2019); • PVA will be undertaken based on the proportion of baseline mortality for a population represented by an impact; • threshold to be identified following impact estimation based on Marine Scotland Science advice on PVA thresholds.
	What is NatureScot's position on thresholds to identify when PVA is required when considering the advice from Marine Scotland Science relating to the use of a 0.05 percentage point increase?	
	Should different thresholds be applied to different colonies to account for feature conditions (e.g. favourable, unfavourable)?	
Cumulative	What are the other agreed approaches when considering cumulative impacts in the non-breeding season?	Cumulative assessment: • cumulative assessment will include all offshore wind farm projects within the appropriate geographic area for each species; • projects will be tiered based on the development stage and data confidence; • in the breeding season, this will be based on the foraging range • in the non-breeding season, this will be based on the geographic area associated with seasonal Biologically Defined Minimum Population Scales (BDMPS);

Topic	Question	Further clarification
		• impact estimates will be sourced from publicly available project-specific information.
Publications	When will the following be published: • Guidance Note 10 (advice on marine renewables development- marine ornithology); • FeAST (marine features sensitivity analysis); • Ozsanlev-Harris paper (recommended bird survey methods to inform impact assessment of onshore windfarms); • mCRM (advice note 7 on marine renewables development- marine ornithology); • updated migratory Collision Risk Management (CRM) paper.	None.
Approach to HRA Screening	Do you agree with the proposed approaches to screening for each bird category? Is there any further guidance or are there other approaches that could inform the refinement of the long list from Likely Significant Effects (LSE) screening, especially for breeding seabirds in the non-breeding season? What is your position on the updating of cumulative and in-combination estimates to account for changes to project designs that occur post-application (i.e. for as-built scenarios)?	Approach to HRA Screening: Screening will be undertaken for the following bird categories, for connectivity and for the determination of LSE: • breeding seabirds in the breeding season; • breeding birds in the non-breeding season; • non-breeding seabirds; • migrating seabirds (little gull, tern species, petrel species, shearwater species, skua species); and • migrating waterbirds and terrestrial birds.
HRA strategy questions	Plan-level HRA for ScotWind: • Can you provide any update on the timeline for the conclusion of the Iterative Plan Review now that the INTOG results have been released? • Can you provide any early indication of the likely outcome of the Iterative Plan Review?	None.

Topic	Question	Further clarification
	Compensation: • Do you agree that if Berwick Bank OWF goes ahead, with compensation measures to offset effects on SPAs and associated features, Berwick Bank will not be required to be included within the Array Project in-combination ornithology assessment for those SPAs where compensation will be delivered?	
Socio-economics session		
Guidance	Is any other guidance relevant for the socio-economic assessment? When is the Scottish Government’s Marine Analytical Unit guidance due to be published?	Existing guidance: • Scottish Government (2022a), Defining 'Local Area' for assessing the impact of offshore renewable and other marine developments; • Scottish Government (2022b), General Advice for Socio-Economic Impact Assessment Marine Analytical Unit, Marine Directorate. Guidance principles: • Glasson *et al*. (2018), Guidance on assessing the socio-economic impacts of Offshore Wind Farms; and • UK Government (2022), The Green Book: Appraisal and Evaluation in Central Government. UK Government (2020), UK Offshore Wind Sector Deal: • UK Government (2020), UK Offshore Wind Sector Deal. Expected guidance: • Scottish Government (Marine Analytical Unit, Marine Directorate) guidance on the assessment of the socio-economic impacts of offshore wind energy projects.
Study areas	Are there other study areas that are relevant to the socio-economic assessment?	For socio-economics, the relevant study areas are onshore (even for offshore elements).

Topic	Question	Further clarification
Consultation and engagement	How should national stakeholders be engaged?	The purpose of the engagement was to: • identify impacts; • understand the nature and degree of impacts; • understand perceptions of and attitudes to impacts; • identify opportunities for mitigation and enhancement.
	Is there an expectation that they will have the resources available to engage with all ScotWind projects?	
	Are there any other national or local stakeholders who should be engaged?	
Economic impacts	How might commitment and ambition scenarios be assessed in the context of EIA requirements for the 'worst case'?	The factors to consider when assessing the magnitude of impacts include: • scale of the economy; • diversity of sectors in the economy; • level of economic activity; • level of skills and education; • level of economic potential from utilising capital (e.g. natural, human, social and economic).
	What approach can be taken to consider the potential impacts of transmission and grid elements when locations are unknown?	
	Is there anything else that should be considered when assessing the 'sensitivity' of the study area economies?	
	Do the definitions of magnitude seem reasonable?	
Social impacts	Are there social impacts that are particularly important to consider informing the consenting process?	In most cases, the effects of these social impacts will depend on the wider social and economic impacts of the Array Project – and on the market and government response.
	What assumptions should be made on market and government responses to social impacts related to economic impacts?	
Marine Mammals session		
Study area and baseline data	Do you agree with the Regional Marine Mammal Study Area?	Regional Marine Mammal Study Area – extends over the North Sea geographic region. Used in screening area of cumulative impact assessment.
	Baseline data – are there any additional data sources to consider?	Are there any other relevant data sources or planned publications?
Scoping in/out topics	Do you agree with the impacts to be scoped in / scoped out?	Impacts scoped in: • injury and disturbance from underwater sound generated from piling; • injury and disturbance from underwater sound generated from unexploded ordnance (UXO) clearance; • disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities;

Topic	Question	Further clarification
		• injury to marine mammals due to collision with vessels; • effects on marine mammals due to changes in prey availability; • disturbance to marine mammals from pre-construction surveys. Impacts scoped out: • accidental pollution during all phases; • increased suspended sediment concentrations (SSC) and associated sediment deposition during all phases; • impact of electromagnetic fields (EMF) (from surface-laid or buried cables) during the O&M phase; • disturbance to marine mammals from operational sound from wind turbine operation during the O&M phase.
Underwater sound impact threshold criteria	Do you agree with the dual metric approach for the assessment of injury?	The dual metric approach is based on both Peak Sound Pressure Levels (PK) (i.e. un-weighted) and hearing-weighted cumulative sound exposure level (SEL) as per the latest guidance from Southall *et al.* (2019). The dose-response approach (for piling): • Pile driving is unlikely to lead to 100% avoidance of all individuals exposed and there will be a proportional decrease in avoidance at greater distances from the pile-driving source. • Dose-response curve derived from Graham *et al.* (2019) for cetaceans and Whyte *et al.* (2020) for pinnipeds for piling only.
	Do you agree with adopting either peak sound pressure level (SPLpk) or cumulative sound exposure level (SELcum) for Permanent Threshold Shift (PTS) to underpin mitigation?	
	Do you agree with the application of dose response for all species?	
	Do you agree with the National Marine Fisheries Service (NMFS) criteria of non-trivial (strong) disturbance (160dBrms) for impulsive sound sources?	
Approach to UXO	Do you agree with the approach to UXO?	The approach to UXO: • modelling a range from low-order to high-order clearance; • Temporary Threshold Shift (TTS) used as a proxy for behavioural effects for UXO only.
Physical Processes		
Baseline environment	Do you agree that the existing data available to describe the physical processes baseline remains sufficient to describe the physical	Physical processes encompass the following elements: • bathymetry;

Topic	Question	Further clarification
	environment in relation to the Proposed Development? Are there any other data sources that you would recommend?	• wind and waves; • tidal currents and elevation; • seabed substrate and geology; • suspended sediments; • sediment transport.
Impacts	Do you agree that all impacts have been identified for physical processes?	None.
Designed in measures	Do you agree that the designed in measures described provide a suitable means for managing and mitigating the potential effects of the Array Project on the physical processes' receptors?	Designed in measures: • scour protection around offshore structures and foundations; • sufficient spacing between wind turbines; • adherence to a Cable Plan; • suitable implementation of cable protection around offshore cables; • monitoring of cable protection through the O&M phase.
Impacts scoped in	Do you agree with the impacts that are proposed to be scoped into the Array Project EIA?	Impacts scoped in (no impacts scoped out of the EIA): • increased suspended sediment concentrations; • impacts on the wave climate; • impacts on the tidal regime; • impacts on the sediment transport and sediment transport pathways.
Methodology	Do you agree with the proposed methodology?	For assessment, numerical modelling will be undertaken to provide an overview of the potential impacts on physical processes and receptors.
Benthic Subtidal Ecology		
Study area and baseline environment	Do you agree that the Regional Study Area is appropriate and sufficient?	Regional Study Area: Encompasses the wider subtidal North Sea habitats, neighbouring consented and developing OWFs and designated sites.
	Are there any additional desktop datasets we should consider?	None.

Topic	Question	Further clarification
Methodology	Do you agree with the proposed methodology for undertaking the benthic ecology assessment?	The impact assessment methodology follows the CIEEM (2018) guidelines for Ecological Impact Assessment (EcIA) in the UK and Ireland.
	Do you agree that the assessment of sensitivity should be primarily informed by Marine Evidence based Sensitivity Assessment (MarESA) and Feature Activity Sensitivity Tool (FeAST) tools and supplemented with any more recent relevant evidence?	None.
Impacts scoped in/scoped out	Do you agree with the impacts proposed to be scoped in?	Scoped in: • temporary habitat loss/disturbance; • increased suspended sediment concentrations and associated sediment deposition; • long-term habitat loss; • colonisation of hard structures; • increased risk of introduction and spread of invasive non-native species (INNS); • removal of hard substrates; • changes in physical processes. Scoped out: • accidental pollution; • release of sediment-bound contaminants; • impacts on benthic invertebrates due to EMF; • impacts on benthic invertebrates due to heat from subsea electrical cables.
	Do you agree with the impacts proposed to be scoped out? To ensure the assessment aligns with the proportionate EIA approach, are there any additional impact pathways you would agree could be scoped out (e.g. removal of hard substrates)?	
Surveys	On the basis that no Annex I habitats or other sensitive habitats were recorded during the baseline surveys; do you agree that pre-construction Annex I surveys will not be required?	None.
Cumulative Assessment	Do you agree that any impacts that are assessed as negligible for the project alone assessment can be scoped out of the benthic cumulative assessment?	None.

Topic	Question	Further clarification
MPA Assessment		
Guidance	Is the guidance and approach detailed in the MPA Handbook still applicable and should it be applied to the Array Project?	Marine Scotland Planning Scotland's Seas Nature Conservation Marine Protected Areas: Draft Management Handbook (undated).
Screening	Do you agree with the preliminary screening criteria outlined for each receptor?	Screening conclusions (main assessment): • Firth of Forth Banks Complex MPA - subtidal sands and gravels and ocean quahog. Screening conclusions (sites to be screened out): • Turbot Bank nature conservation MPA (sandeel); • Southern Trench nature conservation MPA (minke whale); • Berwick to St Mary's Marine Conservation Zone (MCZ) (common eider).
	Do you agree in principle with the preliminary screening conclusions to be taken forward for main assessment?	
	Do you agree in principle with the preliminary screening conclusions for sites proposed to be screened out of the main assessment?	
Physical processes and ecology session (fish and shellfish ecology)		
Study area and baseline	Do you agree that the Regional Study Area is appropriate and sufficient?	The Regional Fish and Shellfish Ecology Study Area: • comprises the proposed development area and extends out to the boundary of the Northern North Sea; • enables the context required for the population and species information collected and identified within the Fish and Shellfish Ecology Study Area.
	Are there any additional desktop datasets we should consider?	
Receptors	Do you agree with ocean quahog and horse mussel being considered Benthic receptors and therefore, not included within the Fish and Shellfish Ecology topic?	These receptors are considered in the benthic assessment.
Assessment	Do you agree with the proposed methodology for undertaking the Fish and Shellfish Ecology assessment?	Methods: • site specific survey; • habitat suitability; • spawning and nursery grounds; • designated sites; • CIEEM (2018) guidelines;
	Are there any specific requirements you would like to discuss surrounding the assessment of Underwater Sound on Fish and Shellfish?	

Topic	Question	Further clarification
		• underwater sound: assessment criteria for injury and behavioural effects on different groups of fish based on Acoustical Society of America (ASA) guidelines (Popper *et al.,* 2014).
Impacts scoped in/ scoped out	Do you agree with the impacts proposed to be scoped in?	Scoped in: • temporary habitat loss and disturbance of habitats; • underwater sound impacting fish and shellfish receptors; • increased SSCs and associated sediment deposition; • long-term habitat loss; • colonisation of hard structures; • EMF from subsea electrical cabling. Scoped out: • accidental release of pollutants; • release of sediment-bound contaminants; • underwater sound from wind turbine operations; • underwater sound from vessels; • thermal emissions.
	Do you agree with the impacts proposed to be scoped out? To ensure the assessment aligns with the proportionate EIA approach, are there any additional impact pathways you would agree could be scoped out?	
Cumulative Effect Assessment	Do you agree that any impacts that are assessed as negligible for the project alone assessment can be scoped out of the cumulative assessment?	
HRA approach: LSE Screening questions	For Annex I habitats, do you agree that the 20km buffer used for screening sites, which could be impacted by SSC and associated deposition, is sufficiently precautionary to enable screening for this impact in the absence of a site specific modelled tidal excursion?	A 20km buffer has been applied, which is sufficiently precautionary to capture all European sites within the Zone of Influence (ZoI) for indirect effects of SSC. There are no European sites with Annex I habitat qualifying features within 20km of the Array Project. Therefore, no European sites designated for Annex I habitats have been screened for LSE assessment. Taken forward in Report to Inform the Appropriate Assessment (RIAA): European sites designated for Annex II species: • River Dee SAC;
	Do you agree that no sites designated for Annex I habitats are required to be taken forward for LSE determination?	
	Do you agree with the initial list of five European sites designated for Annex II diadromous fish/freshwater pearl mussels?	

Topic	Question	Further clarification
	Do you agree with the two species identified as relevant species for inclusion in the LSE screening and the two species excluded from LSE screening?	• River South Esk SAC; • River Tweed SAC; • River Tay SAC; • River Teith SAC.
	Do you agree with the impacts and the project phases they apply to, screened in for further assessment within the RIAA?	• underwater sound impacting fish and shellfish (construction and decommissioning); • EMF from subsea electrical cabling O&M.
	Do you agree with the two species and five sites which are proposed to be taken forward for further assessment in the RIAA?	Sites as listed above. Species: • Atlantic salmon (*Salmo salar);* • Freshwater pearl mussel (*Margaritifera margartitifera).*
Shipping and Navigation session		
Study area	Are there any other study areas that are relevant to the assessment?	
Datasets	Are there any additional datasets the Applicant should consider?	Included: • baseline navigational features; • winter 2022 vessel traffic survey data; • summer 2023 vessel traffic survey data.
Assessment methodology	Do you have any suggestions in respect of the proposed impact assessment methodology?	An assessment of effects will be carried out in line with the International Maritime Organisation (IMO) Formal Safety Assessment (FSA) and relevant EIA guidance.
Impacts scoped in/scoped out	Are the impacts that have been scoped in and out of the assessment appropriate?	Cumulative: All impacts considered for the alone assessment will be scoped into the cumulative assessment, where a pathway is identified.

4 Appendix 4 - Array Project Stakeholder Engagement Plans

4.1 Introduction

4.1.1.1 This Draft Stakeholder Engagement Plan provides an overview of the proposed approach to stakeholder engagement throughout the Environmental Impact Assessment (EIA) process of the Morven Offshore Wind Array Project (hereafter, 'Array Project').

4.1.1.2 The Applicant intends to develop a proportionate EIA Report and Report to Inform an Appropriate Assessment (RIAA) for the Array Project. To successfully deliver a proportionate EIA and RIAA, the reports will incorporate advice from stakeholders throughout the development process to address concerns and develop appropriate mitigation, as required.

4.1.1.3 The Applicant also anticipates that stakeholder engagement will aid, where required, the development of appropriate compensation measures following feedback on the Habitats Regulations Appraisal (HRA) Stage 1 Screening Report as part of the HRA process. All consultation feedback provided will, therefore, inform and be included within the Array Project EIA Report (hereafter, the EIA Report'), RIAA and wider supporting documentation that will accompany the final application.

4.2 Application Timeframes

4.2.1.1 The milestones associated with the application for the Array Project are set out in Appendix Table 4.1.

Table 4.1: Indicative EIA and HRA programme for the Array Project

Activity	Date (approximate)
Scoping Workshop	18 April 2023 – 19 April 2023
Submission of Array Project EIA Scoping Request	Q3 2023
Submission of Array Project HRA Stage 1 Screening Report	Q3 2023
Issue of formal Scoping Opinion from Marine Directorate Licensing Operations Team (MD-LOT)	Q4 2023
Submission of Array Project EIA Report	Q4 2024
Submission of Array Project RIAA	Q4 2024
Consent Decision	Q3 2025

4.3 Future Engagement

4.3.1 Post-Scoping

4.3.1.1 Key topic areas have been identified for further stakeholder discussion as part of an iterative EIA and HRA process, which will ensure that stakeholder advice is fully incorporated into the EIA Report and RIAA. The key topic areas to be consulted on are detailed in Appendix Table 4.3.

4.3.1.2 The Applicant recognises there is the potential for new guidance to be published post submission of the Array Project Scoping Report (hereafter, 'Scoping Report'). Therefore, as outlined in Table 4.3, ongoing engagement will also focus on the discussion of new guidance/changes in guidance to develop a robust EIA and HRA and limit the potential for delays to MD-LOT's determination process. The Applicant recognises the importance of addressing key issues in advance of the final application, particularly considering Scotland's net zero ambitions.

4.3.1.3 Table 4.3 sets out an indicative proposed timeline for post-Scoping stakeholder engagement for the Array Project. This information has been provided in advance to aid forward planning and ensure proactive and efficient engagement throughout the development of the Array Project. The Draft

Stakeholder Engagement Plan will be updated, where required, following receipt of the Array Project Scoping Opinion (hereafter, 'Scoping Opinion').

4.3.1.4 The following provides a summary of consultation targets that aim to manage post-Scoping consultation:

- the Applicant will provide reasonable notice prior to a consultation meeting;
- the Applicant will circulate pre-meeting information for discussion during the consultation meeting two weeks in advance of the said meeting;
- stakeholders are requested to review this documentation prior to the consultation meeting;
- the Applicant will ensure that relevant topic-specific technical specialists can attend relevant consultation meetings;
- the Applicant will provide meeting minutes following the consultation meeting;
- stakeholders are requested to review and provide feedback on any changes required to meeting minutes and any actions recorded two weeks after dissemination of meeting minutes.

4.3.2 Proposed Consultation

4.3.2.1 This Draft Stakeholder Engagement Plan has been developed to optimise those EIA topic areas where it is considered that there is the greatest need for post-scoping engagement based on consent risk, uncertainty around EIA methods and technical assessments, including agreeing on key assessment approaches and parameters, HRA considerations including the adequacy of baseline data and derogation including the development of compensation measures (if required).

4.3.2.2 The proposed topic areas that will be consulted upon and details of the key areas for discussion are set out within Table 4.3. It is expected that benthic ecology and fish and shellfish ecology will require less post scoping engagement and it is, therefore, proposed that these topics be excluded from the approach set out within the Draft Stakeholder Engagement Plan, subject to receipt of the advice received in the Scoping Opinion. Engagement is proposed for these topics through consultation on the HRA and Marine Protected Area (MPA) Assessment.

4.3.2.3 Other EIA topics not considered within this Draft Stakeholder Engagement Plan will be subject to their own consultation process, as agreed with relevant stakeholders.

4.3.3 Stakeholders

4.3.3.1 Stakeholders for the Array Project environmental topics identified are listed in Appendix Table 4.2. This table also sets out the remit and role in the context of the EIA and HRA processes for each stakeholder identified.

4.3.3.2 The Applicant will maintain an up-to-date list of contacts/case officers for each organisation, and it is assumed that these organisations will engage their technical specialists as necessary throughout the consultation process.

Table 4.2: Remit and role of stakeholders for the environmental topics identified for further pre-application consultation

Stakeholder	Remit	Role in EIA/HRA process	Relevant topic
Marine Directorate Licensing and Operations Team (MD-LOT) and (where appropriate) Marine Scotland Science (MSS)	Marine Directorate of the Scottish Government; authority responsible for the issuing of Marine Licences for licensable activities in Scottish Waters. MSS (also part of the Scottish Government) supports in managing marine and coastal environments to meet the long-term needs of both nature and people.	Regulatory Authority under the EIA regulations, and Competent Authority under the Habitats Regulations	Marine Mammals Ornithology HRA MPA Assessment
Natural England	Advisory body to the UK Government, and Marine Management Organisation for the natural environment.	Statutory Nature Conservation Advisor to 12nm	Ornithology HRA MPA Assessment
NatureScot	Lead advisory body to the Scottish Government on nature, wildlife management and landscape management across Scotland.	Statutory Nature Conservation Advisor	Marine Mammals Ornithology HRA MPA Assessment
Joint Nature Conservation Committee (JNCC)	Lead advisory body to the Scottish Government on nature, wildlife management and landscape management across Scotland, and avisor for English waters.	Statutory Nature Conservation Advisor beyond 12nm	Marine Mammals Ornithology HRA MPA Assessment
Royal Society for the Protection of Birds (RSPB)	Lead advisory body to the Scottish Government on ornithology.	Non-statutory Consultee	Ornithology
Maritime and Coastguard Agency (MCA)	Lead advisory body to the Scottish Government on shipping and navigation.	Statutory Advisor	Shipping and Navigation
Northern Lighthouse Board (NLB)	Lead advisory body to the Scottish Government on navigational safety in Scottish waters.	Statutory Advisor	Shipping and Navigation
Scottish Fishermen's Federation (SFF)	Lead advisory body to the Scottish Government on commercial fisheries.	Non-statutory Consultee	Commercial Fisheries
Scottish White Fish Producers Association (SWFPA)	Advisory body to the Scottish Government on commercial fisheries.	Non-statutory Consultee	Commercial Fisheries
North and East Coast Regional Inshore Fisheries Group (NECRIFG)	Advisory body to the Scottish Government on commercial fisheries in northern and east coast Scottish waters.	Non-statutory Consultee	Commercial Fisheries

4.4 Strategic Collaboration

4.4.1.1 The Applicant acknowledges that it may be possible to combine stakeholder consultation events with other ScotWind developers, where appropriate to do so, to minimise stakeholder resourcing requirements. The Applicant will consider this approach and discuss with other ScotWind developers if it is considered appropriate.

4.5 Next Steps

4.5.1.1 Following submission of the EIA Scoping Report and HRA Stage 1 Screening Report, the Applicant will continue to engage with stakeholders, where required, throughout the pre-application and post-application phases of the Array Project. The next steps are to:

- consult with relevant stakeholders on this Draft Stakeholder Engagement Plan, as part of the Array Project EIA/HRA Scoping process;
- update the Draft Stakeholder Engagement Plan based on feedback received from stakeholders as part of the Scoping Opinion;
- incorporate feedback received in the Scoping Opinion into the EIA Report and RIAA;
- monitor stakeholder consultation following receipt of the Scoping Opinion.

Table 4.3: Indicative stakeholder engagement in relation to offshore receptors for the Array Project

Topic	2023			2024			
	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Marine Mammals							
Present evidence base (including site specific surveys and results), baseline characterisation (including key receptors and study areas) and agree on scoping of impacts.		×					
Discussion of the approach to underwater sound modelling; discussion of assessment approaches for quantifying effects on marine mammal receptors; agreement on densities estimates to carry forward to quantitative assessment.			×				
Approach to population modelling and cumulative assessment discussion of the initial findings of EIA assessment and mitigation measures and monitoring.				×			
Offshore Ornithology							
Approach to calculating abundance metrics (densities and population estimates).			×		×	×	
Agreeing approach and parameters for Collision Risk Modelling (CRM).			×		×	×	
Agreeing approach and parameters for displacement analysis.			×		×	×	
Agreeing approach to the apportionment of impacts to SPA colonies.			×		×	×	
Agreeing requirement and parameters for Population Viability Analysis (PVA) to understand long term effects on seabird colonies.			×		×	×	
Developing appropriate EIA methods in the context of Highly Pathogenic Avian Influenza (HPAI) and associated impacts on affected colonies.			×		×	×	
Mitigation measures.			×		×	×	
Derogation and compensation measures development.			×		×	×	
MPA Assessment							
Discuss preliminary conclusions of the MPA assessment.				×			
Present final conclusions of MPA assessment.						×	

Topic	2023			2024			
	Q2	Q3	Q4	Q1	Q2	Q3	Q4
HRA							
Discuss HRA screening including agreeing the relevant sites, receptors and impact pathways to be screened into the RIAA.	×	×					
Commercial Fisheries							
Define the baseline environment as well as the assessment approach to the EIA data sources and data analysis (including how these will be used, interrogated, analysed and presented).			×				
Discuss Project Design Envelope (PDE) and Maximum Design Scenarios (MDS).			×				
Regular Array Project updates.		×	×				
Data collection/evidence collected from fishers to inform the baseline.							
Shipping and Navigation							
Hazard Workshop.		×	×				
MD-LOT quarterly meetings and other workshops:							
Strategic Compensation Measures.		×	×			×	×
Iterative Plan Review of Sectoral Marine Plan.	×						
Cumulative Effects Framework and the general approach to cumulative assessment given the number of ScotWind projects.	×	×					
Update to Licensing and Consenting Manual.	×	×	×	×	×	×	×

5 Appendix 5 – Underwater Sound Methodology Statement

5.1 Introduction

5.1.1.1 This appendix of the Array Project Scoping Report (hereafter, the 'Scoping Report') outlines the methodology for modelling the impact of underwater sound generated during construction, Operations and Maintenance (O&M) of the Morven Offshore Wind Array Project (hereafter, 'Array Project').

5.1.1.2 Underwater noise is identified as one of the Descriptors (number 11: Introduction of Energy, including noise) for achieving Good Environmental Status (GES) under the EU Marine Strategy Framework Directive (MSFD; Directive 2008/56/EC). The two relevant criteria (D11C1 and D11C2) stipulate that the spatial distribution, temporal extent, and levels of anthropogenic impulsive and continuous low-frequency sound (respectively) do not exceed levels that adversely affect populations of marine animals (original Decision 2010/477/EU, later superseded by Commission Decision 2017/848). The MSFD was transposed into UK law by the Marine Strategy Regulations 2010.

5.1.1.3 The impact of sound will be assessed using a combination of source and propagation models, as appropriate for the activity under consideration. The sound generated from the following sources will be modelled:

- pile driving for wind turbine foundations;
- detonation of unexploded ordnance (UXO);
- non-impulsive sound sources (e.g., vessel sounds, rock dumping, cable-laying, geophysical sources and drilling).

5.2 Acoustic Impact Criteria

5.2.1 Overview

5.2.1.1 Underwater sound can affect marine fauna in several ways, and the criteria on which impact assessments are based can be complex. At least three primary severity levels for how sound affects marine fauna should be considered when assessing impacts: chronic and cumulative effects, auditory injury, and disturbance. Chronic and cumulative effects are hard to quantify, however, and evaluating them is complex; hence, there is little consensus at the moment on how to perform those assessments.

5.2.1.2 There are two categories of auditory threshold shifts or hearing loss:

- permanent threshold shift (PTS): an irreversible loss of hearing sensitivity;
- temporary threshold shift (TTS): a temporary reduction in an animal's hearing sensitivity.

5.2.1.3 The impact criteria to be used represent the most recent guidance and best available science.

5.3 Marine Mammals

5.3.1 Auditory Injury and Temporary Threshold Shift (TTS)

5.3.1.1 Historical approaches to assessing the impact of sound on marine mammals considered solely root-mean-square (rms) sound pressure level ($L_{p,\mathrm{rms}}$; Sound Pressure Level (SPL) without consideration of overall duration of the sound or its frequency content. Since 2007, however, several expert groups have developed assessment approaches for evaluating auditory injury considering sound exposure level ($L_{E,p}$; Sound Exposure Level (SEL)) criteria for non-impulsive sounds and dual metric criteria considering both SEL and peak sound pressure level ($L_{p,\mathrm{pk}}$; Peak Pressure Level (PK)) for impulsive sounds. Key works include Southall *et al.* (2007), Finneran and Jenkins (2012), United States National

Marine Fisheries Service (NMFS 2018) and Southall *et al.* (2019). To help assess the potential for the possible injury and hearing sensitivity changes in marine mammals, the criteria recommended by Southall *et al.* (2019) will be applied, considering both PTS and TTS.

5.3.1.2 Southall *et al.* (2019) specifies injury criteria for both impulsive and non-impulsive sources. For impulsive sources, dual auditory injury criteria are applied considering both PK and cumulative SEL (SEL_{24h}); the subscript 24h indicates the duration of accumulation is 24 hours. The PK criterion is not frequency weighted, whereas the SEL criterion is frequency weighted according to marine mammal species hearing group. For non-impulsive sounds, only SEL criteria are applied, similarly frequency weighted by hearing group.

5.3.1.3 Marine mammal hearing groups are defined for cetaceans, pinnipeds, sirenians and other marine carnivores, and further categorised based on the generalised frequency range of hearing. The marine mammal hearing groups defined in Southall *et al.* (2019) under consideration are:

- Low-frequency (LF) cetaceans: comprising all mysticetes (baleen whales).
- High-frequency (HF) cetaceans: comprising odontocetes (toothed whales) including most delphinid species, beaked whales, sperm whales, and killer whales.
- Very high-frequency (VHF) cetaceans: comprising true porpoises and other odontocetes specialised at using very high frequencies (primarily 100 kHz and above).
- Phocid carnivores in water (PCW): comprising all true seals including harbour seal (*Phoca vitulina)* and grey seal (*Halichoreus grypus).*

5.3.1.4 PTS and TTS onset criteria from Southall *et al.* (2019) are presented in Appendix Table 5.1 and Appendix Table 5.2 for impulsive and non-impulsive noise respectively.

Table 5.1: PTS and TTS onset criteria for effects of impulsive sound on marine mammals (Southall *et al.* 2019)

Hearing Group	PTS onset thresholds		TTS onset thresholds	
	Weighted SEL24h (dB re 1 µPa2s)	PK (dB re 1 µPa)	Weighted SEL24h (dB re 1 µPa2s)	PK (dB re 1 µPa)
Low-frequency (LF) cetaceans	183	219	168	213
High-frequency (HF) cetaceans	185	230	170	224
Very high-frequency (VHF) cetaceans	155	202	140	196
Phocid carnivores in water (PCW)	185	218	170	212

Table 5.2: PTS and TTS onset criteria for effects of non-impulsive sound on marine mammals from Southall *et al.* (2019)

Hearing Group	Weighted SEL24h (dB re 1 µPa2s)	
	PTS onset thresholds	TTS onset thresholds
Low-frequency (LF) cetaceans	199	179
High-frequency (HF) cetaceans	198	178
Very high-frequency (VHF) cetaceans	173	153
Phocid carnivores in water (PCW)	201	181

5.3.2 Disturbance

5.3.2.1 Numerous studies on marine mammal behavioural responses to sound exposure have not resulted in a consensus in the scientific community regarding the appropriate metric and associated levels for assessing behavioural reactions due to the complexity and variability of those reactions. However, it is recognised that the context in which the sound is received affects the nature and extent of responses to a stimulus (Southall *et al.* 2007, Ellison and Frankel 2012, Southall *et al.* 2016).

5.3.2.2 Various means of assessing marine mammal behavioural responses to sound are being developed and are in use, including step function (all-or-none) thresholds, probabilistic response and dose response relationships. On an internationally recognised regulatory level, National Oceanic and Atmospheric Administration (NOAA) Fisheries currently uses step function SPL thresholds to assess and regulate level B sound-induced behavioural impacts for marine mammals (NOAA 2019). The recommended SPL thresholds are 160dB re 1 µPa for impulsive sounds and 120dB re 1 µPa for non-impulsive sounds. Whilst the newly published Southall *et al.* (2021) provides recommendations and discusses the nuances of assessing behavioural response, the authors do not recommend new numerical thresholds for onset of behavioural responses for marine mammals. The NOAA (2019) criteria for assessing behavioural responses to underwater sound will, therefore, be applied.

5.3.2.3 Additionally, for assessing marine mammal disturbance from pile driving strikes, an SEL dose response approach will be implemented. In this, contours representing unweighted SEL for a single strike (SEL_{ss}) in 5dB increments will be plotted on a map. This predicted ensonified area will then be combined with a precautionary estimate of specific-species population densities and then the dose response applied, to give a prediction of the total number of individuals that might respond to the sound.

5.4 Fish (Adults, Eggs, and Larvae)

5.4.1.1 In 2006, the Working Group on the Effects of Sound on Fish and Turtles, sponsored by the Acoustical Society of America, was formed to continue developing sound exposure criteria for fish and sea turtles, work that a NOAA panel began two years earlier. The guidelines developed by this working group (Popper *et al.* 2014) provide received sound levels based on the best available science that are suitable as provisional criteria for assessing onset of injury to fish from various sources.

5.4.1.2 Popper *et al.* (2014) categorise fish into three groups based on their hearing capabilities, which are typically determined by whether a swim bladder is present and, if it is, whether it is directly used to hear. Thus, different thresholds are proposed for:

- group 1: fish without a swim bladder (also appropriate for sharks and applied to whale sharks in the absence of other information);
- group 2: fish with a swim bladder not used for hearing;
- group 3: fish that use their swim bladders for hearing;
- fish eggs, and fish larvae.

5.4.1.3 Popper *et al.* (2014) proposed separate criteria for explosions, pile driving, and continuous sound sources. which will all be considered. Within each source category, criteria are outlined for the following effects:

- mortality and potential mortal injury;
- recoverable injury (including injuries unlikely to result in mortality, such as hair cell damage and minor haematoma);
- TTS;
- masking;
- behaviour.

5.4.1.4 Where numerical thresholds are not defined, risks of effect are instead assessed qualitatively with relative risk rather than specific sound level thresholds. Risks are assessed subjectively based on the proximity of the receiver to the source — near, intermediate, or far — terms that loosely correspond to near being tens of metres, intermediate being hundreds of metres and far being thousands of metres. Risks are then categorised as high, moderate, or low.

5.5 Methods

5.5.1 Environmental Parameters

5.5.1.1 In shallow environments, interactions between the acoustic field, the sea surface, and the seabed are important, hence accurate parameterisation of the environment is needed for proper acoustic modelling. The primary environmental parameters used for modelling are the wide area bathymetry, water column sound speed profile, and geoacoustic properties of the seabed.

5.5.1.2 Bathymetric data for the Underwater Sound Study Area will be generated from the best available data. This will be a combination of high-resolution data obtained during the pre-construction geophysical survey within the Scoping Boundary, and publicly available data outside of it, for example the EMODnet European bathymetry grid (EMODnet Bathymetry Consortium 2020).

5.5.1.3 The water column sound speed profile is a function of changes in water temperature and salinity with depth, which vary between seasons. The derived sound speed profile must span the full water range of depth within the Underwater Sound Study Area. Where site specific measured profiles for temperature and salinity are available from survey these will be used, and where unavailable, public datasets such as the US Naval Oceanographic Office's Generalized Digital Environmental Model (GDEM; Teague *et al.* 1990, Carnes 2009) will be used.

5.5.1.4 The geoacoustic parameters of the seabed used in the acoustic modelling are the speed and attenuation of both compressional and shear waves in the medium, as well as substrate density. Profiles will be defined based on data provided by the Applicant, which may include desk studies, sediment grabs, and boreholes. Where the exact geoacoustic parameters are not available, values will be determined from public data or based on the predicted lithology using models such as Hamilton (1980), Buckingham (2005), or Holzer *et al.* (2005).

5.5.2 Acoustic Source Modelling

Pile driving

5.5.2.1 A physical model of pile vibration and near-field sound radiation will be used to calculate source levels of piles. The physical model employed computes the underwater vibration and sound radiation of a pile by solving the theoretical equations of motion for axial and radial vibrations of a cylindrical shell. These equations of motion are solved subject to boundary conditions, which describe the forcing function of the hammer at the top of the pile and the soil resistance at the base of the pile. Damping of the pile vibration is computed for Mach waves emanating from the pile wall. The equations of motion are discretised using the finite difference (FD) method and are solved on a discrete time and depth mesh.

5.5.2.2 To model the sound emissions from the piles, the force of the pile driving hammers will be modelled. The force at the top of each pile will be computed using the GRLWEAP 2010 wave equation model (GRLWEAP, Pile Dynamics 2010), which includes a large database of simulated hammers—both impact and vibratory — based on the manufacturer's specifications. The forcing functions from GRLWEAP will be used as inputs to the FD model to compute the resulting pile vibrations.

5.5.2.3 The sound radiating from the pile itself is simulated using a vertical array of discrete point sources. The point sources are centred on the pile axis. Their amplitudes are derived using an inverse technique, such that their collective particle velocity, calculated using a near-field wavenumber integration model, matches the particle velocity in the water at the pile wall.

Unexploded ordnance (UXO)

5.5.2.4 Modelling detonation (shock) waves is challenging because the theory governing wave propagation close to a blast is non-linear due to the high pressures. Most modelling solutions use linear approximations of pressure wave propagation and consequently have limited accuracy close to the detonation. These models can, however, be accurate beyond a few metres from a blast, so they are suitable for biological effects assessments.

5.5.2.5 The peak pressure and acoustic source spectra will be modelled using the empirical equations defined in Cheong *et al.* (2020). This method predicts the pressure signal and spectrum using a number of empirical equations based on the charge weight, geometry of the detonation and geoacoustic parameters of the substrate.

Non-impulsive sound sources

5.5.2.6 Sources of non-impulsive sound are likely to be related to construction, O&M of the installation, including (but not limited to) vessels, cable laying, rock dumping, geophysical sources and drilling.

5.5.2.7 Underwater sound radiated from vessels is produced mainly by propeller and thruster cavitation (Ross, 1976) with a smaller fraction of sound transmitted through the hull, such as by engines, gearing, and other mechanical systems. A vessel's sound signature, therefore, depends on the vessel's size, power output and propulsion system characteristics (e.g. blade shape and size). These characteristics differ greatly between vessels depending on the vessel's purpose. Suitable proxy source levels will be selected for each modelled vessel considering both the type of vessel and the specific characteristics where known. The types of vessel which may be used include:

- various construction vessels (e.g. cable installation, rock placement);
- boulder clearance vessels;
- jack-up rigs;
- tugs and anchor handlers;
- survey and support vessels;
- guard vessels;
- crew transfer vessels;
- seabed preparation/installation vessels.

5.5.2.8 Mid- and high-frequency geophysical sources vary in their source characteristics, but such characteristics are generally well defined by the manufacturer. The parameters which will be considered when modelling these sources include:

- source level;
- operating frequency;
- pulse length;
- pulse repetition rate;
- transducer shape and beamwidth;
- beam count;
- swath coverage (directionality).

5.5.2.9 Where possible, source levels for other sources of non-impulsive sound will be derived from measurements of the exact activity or similar. Where such data are unavailable, an appropriate proxy source level will be selected based on characteristics of the activity.

5.5.3 Sound Propagation Modelling

Propagation loss

5.5.3.1 The propagation of sound through the environment will be modelled by predicting the acoustic propagation loss — a measure, in decibels, of the decrease in sound level between a source and a receiver some distance away. Geometric spreading of acoustic waves is the predominant way by which propagation loss occurs. Propagation loss also happens when the sound is absorbed and scattered by the seawater and absorbed, scattered, and reflected at the water surface and within the seabed. Propagation loss depends on the acoustic properties of the ocean and seabed; its value changes with frequency.

Pile driving

5.5.3.2 For impulsive sounds from impact pile driving, time-domain representations of the pressure waves generated in the water are required for calculating SPL and PK levels. Furthermore, the pile must be represented as a distributed source to accurately characterise vertical directivity effects in the near-field zone.

5.5.3.3 For this study, synthetic pressure waveforms will be computed using a time-domain acoustic model based on a wide-angle parabolic equation (PE) solution to the acoustic wave equation (Collins, 1993). Synthetic pressure waveforms are computed for receivers increasing in range from the source and at depths throughout the water column and seabed taking into account the environmental parameters discussed in section 5.5.1. The synthetic pressure waveforms will be post-processed, after applying a travel time correction, to calculate standard SEL, SPL, and PK metrics versus range and depth from the source.

5.5.3.4 Acoustic fields will be modelled in three dimensions by calculating received levels within multiple two-dimensional vertical planes. Vertical planes will be aligned along radials eminating outwards from the source with sufficiently dense angular separation to be representative of the sound field in a full 360° swath from the source.

5.5.3.5 Mitigation systems implemented in the water column can also be applied in the propagation modelling if required. Depending on the type of mitigation, frequency-dependent attenuation can either be applied to the source level or at a fixed radial distance from the pile as appropriate. If required, attenuation values will be determined from measured performance, e.g. Bellmann *et al.* (2020) presents performance for a number of typical piling sound mitigation measures.

Unexploded ordnance

5.5.3.6 Sound propagation from impulsive sounds of UXO disposal will be undertaken using the same model as for pile-driving.

5.5.4 Non-Impulsive Sound Sources

5.5.4.1 Propagation loss for non-impulsive sound sources will be modelled using a combination of a PE model and Gaussian beam acoustic ray-trace model. The combined model similarly accounts for the site specific environmental properties outlined in section 5.5.1. Propagation loss is modelled at centre frequencies of decidecade bands as a function of range and depth in vertical planes, and the three-dimensional sound field for each frequency is assembled as described in paragraph 5.5.3.4. Received levels are calculated by subtracting propagation loss values from the source level in that frequency band and composite broadband levels are calculated by summing the received decidecade band levels.

5.5.4.2 The PE model is based on the same underlying algorithm as for impulsive sources and will be used for modelling frequencies of 1kHz and below. The Gaussian beam acoustic ray-trace model (Porter and Liu, 1994) will be used to model frequencies above 1kHz. This model accounts for sound attenuation due to energy absorption through ion relaxation and viscosity of water in addition to acoustic attenuation due to reflection at the medium boundaries and internal layers (Fisher and Simmons, 1977). The former type of sound attenuation is important for frequencies higher than 1kHz and cannot be neglected without noticeably affecting the model results.

5.5.4.3 The geophysical sources, which typically only operate in a specific narrow frequency band, will only be modelled using the acoustic ray-trace model if appropriate for the frequency of operation.

5.5.5 Moving Receiver Analysis

5.5.5.1 For the pile driving component, an analysis will be conducted to investigate the total accumulated sound energy by receivers moving directly away from the pile over the course of an entire piling sequence.

5.5.5.2 For each auditory group (see section 5.3) one candidate species will be considered, applying appropriate swim depths and speeds. For the purposes of the calculations, the receivers (animals) will start moving at a species-dependent speed at a specified water depth for a set swim duration. After resting, the receiver then continues for the swim duration before resting again. Representative swim speeds for marine mammals that are likely to occur within the Underwater Sound Study Area, as outlined in the Marine Mammals Annex, are:

- 2.3m/s for minke whales (Boisseau *et al.,* 2021);
- 1.52m/s for bottlenose dolphins, white-beaked dolphins, short beaked common dolphins and Risso's dolphins (Bailey *et al.,* 2010);
- 1.5m/s for harbour porpoise (Otani *et al.,* 2000);
- 1.8m/s for grey seals and harbour seals (Thompson *et al.,* 2015).

5.5.5.3 Total accumulated sound energy is then calculated by summing the received levels at the new position of the animal for each pile strike for the duration of the specified piling sequence.

5.6 Conservative Assumptions in Assessment

5.6.1.1 When modelling potential impacts on marine fauna from underwater sound, a balance must be struck between a realistic representation of the proposed noisy activities and minimising the risk of underestimating sound exposure. As such, a number of assumptions are incorporated into the underwater sound modelling and subsequent assessment of results to ensure a conservative approach.

5.6.1.2 The modelled environment will be selected based on conditions likely to result in longest range acoustic propagation. This will involve consideration of the combination of water depth, seasonal sound speed profile, and geoacoustic parameters at any given site.

5.6.1.3 For pile-driving, the soft-start and piling sequence will be assumed to occur fully sequentially with no pauses. Such pauses would, otherwise, reduce the sound exposure of a receiver moving directly away from the source. Additionally, a realistic worst-case will be considered with regards to the piling energy required and the number of blows required to drive the pile, which may overestimate the actual sound energy imparted into the water.

5.6.1.4 The nature of an impulsive pressure waveform changes to become less impulsive as it propagates through the underwater environment due to seafloor and surface reflections, and other waveguide dispersion effects. Several quantitative metrics exist by which acoustic signals may be classified as either impulsive or non-impulsive, such as kurtosis, crest factor, and Harris impulse factor (Harris, 1998; Martin *et al.,* 2020). Definitions of impulsivity based on these metrics have not yet been incorporated into any internationally recognised guidelines, however, and as such there is no definitive method for determining where the transition to non-impulsivity may occur. The impulsive injury criteria (which are more stringent, see section 5.3.1) are, therefore, applied for the sound generated from pile driving and UXO clearance at ranges where the received signal may be better characterised as non-impulsive.

5.6.1.5 Distances reported for isopleths not considering moving receivers will be reported as maximum-over-depth results, i.e. maximum value that occurs over all sampled depths within the water column. The reported level may only, therefore, occur at a specific depth in the water column and a receiver at a different depth may not, therefore, be exposed at that level. The moving receiver analysis considers the animal's depth in the water column but assumes the animals swim at constant, conservative average speeds. This could overestimate effects ranges where actual species fleeing rates may exceed the modelled speeds.

6 Appendix 6 - Marine Protected Area Screening

6.1 Introduction

6.1.1 Background

6.1.1.1 The Marine and Coastal Access Act 2009 and the Marine (Scotland) Act 2010 introduced requirements to consider provisions to support the management of nature conservation Marine Protected Areas (ncMPAs) (hereafter, referred to as an MPA). In Scotland, the MPA network includes sites for nature conservation, the protection of biodiversity, demonstrating sustainable management and protecting marine heritage.

6.1.1.2 Under section 126 of the Marine and Coastal Access Act 2009 ("the 2009 Act") and section 83 of the Marine (Scotland) Act 2010, public authorities (in this case the Marine Directorate Licensing and Operations Team (MD-LOT) operating on behalf of the Scottish Ministers) have specific duties for MPAs in relation to certain decisions. The public authority is required to consider whether the activity that is the subject of the application (i.e. marine licensable activities subject to a marine licence application) can affect, other than insignificantly, a MPA or any ecological or geomorphological processes on which the conservation of any protected feature in a MPA is dependant.

6.1.1.3 MD-LOT must only grant authorisation for the activity if the person applying for the authorisation satisfies MD-LOT that there is no significant risk of the activity hindering the achievement of the conservation objectives for the MPA. If MD-LOT considers that there is, or may be, a significant risk of the proposal hindering the achievement of the conservation objectives, then they must notify the appropriate statutory conservation bodies (NatureScot for MPAs within 12 nautical miles (nm) or the Joint Nature Conservation Committee (JNCC) for MPAs outside 12nm).

6.1.1.4 If MD-LOT is not satisfied that there is no significant risk of the licensable activity hindering the achievement of the conservation objectives, then a licence will only be granted if:

- MD-LOT is satisfied that there are no other means of proceeding with the licensable activity that would create a substantially lower risk of hindering the achievement of those objectives.
- MD-LOT is satisfied that the benefit to the public of proceeding with the licensable activity clearly outweighs the risk of damage to the environment that will be created by proceeding with it.
- MD-LOT is satisfied that the person seeking the authorisation will undertake, or make arrangements for undertaking, measures of equivalent environmental benefit to the damage that the activity will, or is likely to have, in or on the MPA concerned.

6.1.1.5 This appendix to the Array Project Scoping Report (hereafter, 'Scoping Report') provides a summary of the approach to the MPA Assessment that is proposed for the Morven Offshore Wind Array Project (hereafter, 'Array Project') and which will be presented, in full, as an Appendix to the Array Project EIA Report (hereafter, the 'EIA Report'). This report also presents the results of a preliminary initial screening of designated MPAs, which it is proposed are carried forward for consideration in the MPA main assessment in the EIA Report.

6.1.1.6 The following sections describe the proposed approach to the MPA Assessment. This has been informed by the approach adopted on other offshore windfarm (OWF) projects in Scotland and accepted by MD-LOT and NatureScot/Joint Nature Conservation Committee (JNCC). This approach is consistent with the methodology outlined in Marine Scotland's Nature Conservation Marine Protected Areas: Draft Management Handbook (Marine Scotland, 2013). While this draft guidance was never formally adopted, it nonetheless outlined a potential approach that satisfied the requirements of the Marine (Scotland) Act 2010 and the Marine and Coastal Access Act 2009.

6.2 Methodology

6.2.1.1 An MPA Assessment will be prepared and presented as an appendix to the EIA Report. The following sections outline the proposed approach to the Array Project MPA screening.

6.2.2 Preliminary Screening Methodology

6.2.2.1 In the first instance, an initial screening stage will be undertaken to focus on what impacts can reasonably be predicted to occur because of the Array Project and whether the Array Project can affect (other than insignificantly) a protected feature of an MPA. The screening will use the available information on activities proposed and consider aspects such as the scale, timing and duration of proposed activities/developments. These considerations will include proposals for developments or activities outwith the boundaries of an MPA.

6.2.2.2 Firstly, consideration of capability of affect should result in removing from further consideration all proposals/functions that are not connected to the protected feature(s). A capability that is both remote (in terms of likelihood of occurrence) and hypothetical should not be the basis of a conclusion that further assessment is required. This can be determined by considering whether the activity will exert pressures to which the protected feature(s) is sensitive; this information is provided in the Advice on Operations document for each MPA.

6.2.2.3 Secondly, if the conclusion is that there is a capability of affecting an MPA, the focus will then be on considering whether the activity will affect the protected features of an MPA other than insignificantly. Consideration of the degree of pressure that could be exerted by the activity on a spatial basis will help to establish what level of effect might occur. Where it is concluded that the act or function is capable of affecting, other than insignificantly, the protected features of an MPA, then a main assessment will be required considering the conservation objectives.

6.2.2.4 To determine the capability of activities associated with the Array Project to affect the features of any MPA, the following spatial screening criteria are proposed:

- Does the Array Project Scoping Boundary (hereafter, the 'Scoping Boundary') overlap with the boundary of an MPA?
- Do any MPAs lie within the Zone of Influence (ZoI) of the Array Project for individual topics as follows:
  - Benthic habitats/species and geodiversity features of MPAs – ZoI defined as one maximum tidal ellipse over a spring tide[2] around the Array Project, which equates to approximately 5.5km to 13.5km (depending on the orientation). A precautionary approach has been adopted for MPA screening and this buffer has been increased to 15km.
  - Fish features of MPAs - ZoI defined as an area comprising the wider northern North Sea habitats and neighbouring, consented, developing, and planned offshore wind farms (OWF) and designated sites, extending from the coastline within the Firth of Forth to a radius of approximately 30km to 65km around the Array Project. This area is considered sufficient to address direct and indirect impacts to fish features of MPAs.
  - Marine mammal features of MPAs - ZoI defined as the Regional Marine Mammal Study Area described in chapter 8.3: Marine mammals of the Scoping Report.
  - Ornithology features of MPAs – ZoI defined as a 100km buffer from the Scoping Boundary.

[2] One spring tidal excursion has been identified through interim numerical modelling techniques. It is defined as the distance that suspended sediment is transported before being carried back on the returning tide. The interim model was informed from bathymetric datasets from the Marine Environmental Data Information Network (MEDIN). The area is asymmetrical due to the orientation of the tidal currents compared to the Scoping Boundary.

6.2.2.5 These buffers are sufficiently precautionary to capture all sites likely to be in the ZoI from indirect effects associated with construction activities. These buffers will be reviewed and refined in the EIA based on the outputs of the underwater sound assessment and physical processes modelling.

6.2.2.6 Section 6.3 of this appendix presents the results of a preliminary screening of designated MPAs, which it is proposed are carried forward for consideration in the MPA main assessment in the EIA Report. The preliminary outputs of early assessment work undertaken to inform the Scoping Report (e.g. physical processes desk-based calculations), together with expert opinion and experience of impacts arising from other OWF projects, have been used in this preliminary MPA Screening to determine the potential for associated activities to affect (other than insignificantly) the protected habitat features of sites identified through the application of these screening criteria.

6.2.3 Main Assessment Methodology

6.2.3.1 The main assessment (if required) will be presented as a standalone document submitted alongside the EIA Report and will consider the extent of the potential impact of the Array Project on the MPAs screened into the assessment in more detail. The main assessment stage focuses on determining whether there is, or may be, a significant risk of the Array Project hindering the achievement of the conservation objectives of MPA(s).

6.2.3.2 As with the initial screening process described in section 6.2.2, aspects such as scale, timing and duration of the proposed activities or developments are considered. However, whilst the initial screening focuses on the protected features, this main assessment will focus on the potential impact on achieving the conservation objectives of the protected features. Therefore, this stage will also include consideration of the scale of the potential impact. Consideration of cumulative effects with other activities and functions should also be undertaken.

6.2.3.3 The conservation objectives for MPA features are high level criteria describing the desired condition of the MPA feature. There are two objectives for features within an MPA, which are that the protected features:

- so far as already in favourable condition, remain in such condition;
- so far as not already in favourable condition, be brought into such condition and remain in such condition.

6.2.3.4 The MPA main assessment for the Array Project (if required) will, therefore, consider whether the Array Project could potentially affect these conservation objectives for each MPA screened into the assessment. An assessment will be made of whether the Array Project could potentially impact the MPA so that the features are no longer in favourable condition or prevent the features from recovering to a favourable condition.

6.3 Results of the Preliminary MPA Screening

6.3.1.1 Based on the methodology and screening buffers described above in section 6.2, the Applicant has undertaken a preliminary MPA screening exercise. This will be reviewed and, if necessary, updated once the results of the EIA Report assessments are available (e.g. the full physical processes modelling and underwater sound modelling).

6.3.2 Preliminary Screening for MPAs with Benthic Habitats/Species and Geodiversity Features

6.3.2.1 Direct impacts to benthic habitats and species (e.g. those arising from temporary habitat disturbance, long term habitat loss, colonisation of hard structures, electromagnetic fields (EMF), thermal effects from cabling etc.) will be confined to within the Scoping Boundary. There is no physical overlap between the Scoping Boundary and any MPA designated for benthic and/or geodiversity features. As such, no MPAs are screened in for this criterion.

6.3.2.2 There is the potential for indirect effects to MPAs designated for benthic features and geodiversity features within the 15km ZoI. Indirect impacts on benthic features may be associated with increased suspended sediment concentrations (SSC) arising from construction activities or changes to the hydrodynamic regime due to the presence of offshore infrastructure associated with the Array Project. A single MPA, the Firth of Forth Banks Complex MPA, has been identified within the 15km screening buffer for benthic receptors (see Appendix Figure 6.1).

Firth of Forth Banks Complex MPA

6.3.2.3 The Firth of Forth Banks Complex MPA is located off the east coast of Scotland and partially overlaps with the Array Projects' ZoI (Appendix Figure 6.1). The Firth of Forth Banks Complex MPA is a composite site and the boundaries of each of the three areas were determined by the presence and extent of the important features contained within them: Berwick Bank, Scalp Bank and Wee Bankie and Montrose Banks. The MPA covers an area of 2,130km^2 and was designated by Marine Scotland in 2014 for four protected features: ocean quahog aggregations; offshore subtidal sands and gravels, shelf banks and mounds; and moraines representative of the Wee Bankie Key Geodiversity Area (Table 6.1).

Table 6.1: Designated features of the Firth of Forth Banks Complex MPA, conservation objectives and condition

Designated site	Protected features	Type of feature	Conservation objective	View of condition
Firth of Forth Banks Complex MPA	Offshore subtidal sands and gravels	Habitat	Recover to favourable condition. With respect to the offshore subtidal sands and gravels within the MPA, this means that: • extent is stable or increasing; • structures and functions, quality, and the composition of characteristic biological communities (which includes a reference to the diversity and abundance of species forming part of or living within the habitat) are such as to ensure that they remain in a condition which is healthy and not deteriorating. Any temporary deterioration in condition is to be disregarded if the habitat is sufficiently healthy and resilient to enable its recovery from such deterioration. Any alteration to that feature brought about entirely by natural processes is to be disregarded.	Unfavourable (JNCC, 2020)
	Ocean quahog aggregations	Low or limited mobility species	Recover to favourable condition. For the ocean quahog aggregations within the MPA, this means that: • The quality and quantity of its habitat and the composition of its population in terms of number, age and sex ratio are such to ensure that the population is maintained in numbers which enable it to thrive. Any temporary reduction of numbers is to be disregarded if the population of	Unfavourable (JNCC, 2020)

Designated site	Protected features	Type of feature	Conservation objective	View of condition
			ocean quahog aggregations is sufficiently thriving and resilient to enable its recovery. Any alteration to that feature brought about entirely by natural processes is to be disregarded.	
	Shelf banks and mounds large-scale feature	Large scale feature	Maintain in favourable condition. With respect to the shelf banks and mounds large-scale feature within the MPA, this means that: • the extent, distribution and structure are maintained; • the function is maintained so as to ensure that it continues to support its characteristic biological communities (which includes a reference to the diversity of any species associated with the large-scale feature) and their use of the site for, but not restricted to, feeding, courtship, spawning, or use as nursery grounds; • the processes supporting that feature are maintained. Any alteration to that feature brought about entirely by natural processes is to be disregarded.	Favourable (JNCC, 2020)
	Wee Bankie Key Geodiversity Area	Geomorphological	Maintain in favourable condition. For the Wee Bankie Key Geodiversity Area within the MPA, this means that: • the processes supporting that feature are maintained; • its extent, component elements and integrity are maintained; • its structure and functioning are unimpaired; • its surface remains sufficiently unobscured for the purposes of determining whether the above criteria are satisfied. Any obscuring of that feature entirely by natural processes is to be disregarded. Any alteration to that feature brought about entirely by natural processes is to be disregarded.	Favourable (JNCC, 2020)

6.3.2.4 Interim physical processes modelling (i.e. determination of the spring tidal ellipse) has been undertaken to inform the scoping process for the Array Project and to inform this preliminary MPA screening. The modelling has been used to determine whether the activities associated with the Array Project have the potential to affect (other than insignificantly) the protected habitat features of the Firth of Forth Banks Complex MPA. The outputs of this exercise have demonstrated that only the Montrose Bank section of the MPA has the potential to overlap with the ZoI with the extent of the potential overlap between the ZoI and the MPA equating to approximately 330km^2 (Appendix Figure 6.1).

6.3.2.5 Appendix Figure 6.1 illustrates the known distribution of designated features within the Firth of Forth Banks Complex MPA. It should be noted that the offshore subtidal sands and gravels feature, together with suitable habitat for the ocean quahog aggregations feature, are assumed to extend across the entirety of the Firth of Forth Banks Complex MPA (JNCC, 2018). Appendix Figure 6.1 demonstrates that the shelf banks and bounds feature and the moraines geodiversity feature both lie well outside the modelled spring tidal ellipse, making it highly unlikely these designated features will be affected by changes in physical processes (e.g., increases in SSC and sediment deposition). Furthermore, as sedimentary features, they will not be affected by longer range impacts such as underwater sound. Therefore, these features have been screened out of further assessment due to a lack of potential impact pathways.

6.3.2.6 Appendix Figure 6.1 indicates that only the ocean quahog aggregations and offshore subtidal sands and gravels features have the potential to overlap with the ZoI and, therefore, may be indirectly affected by the Array Project.

6.3.2.7 In summary, indirect impacts on two benthic features (ocean quahog and offshore subtidal sands and gravels) within the Firth of Forth Banks Complex MPA may occur due to increases in SSC and associated deposition and changes in physical processes. Based on these conclusions, only the ocean quahog and offshore subtidal sands and gravels features of the Firth of Forth Banks Complex MPA are proposed to be screened in for further assessment.

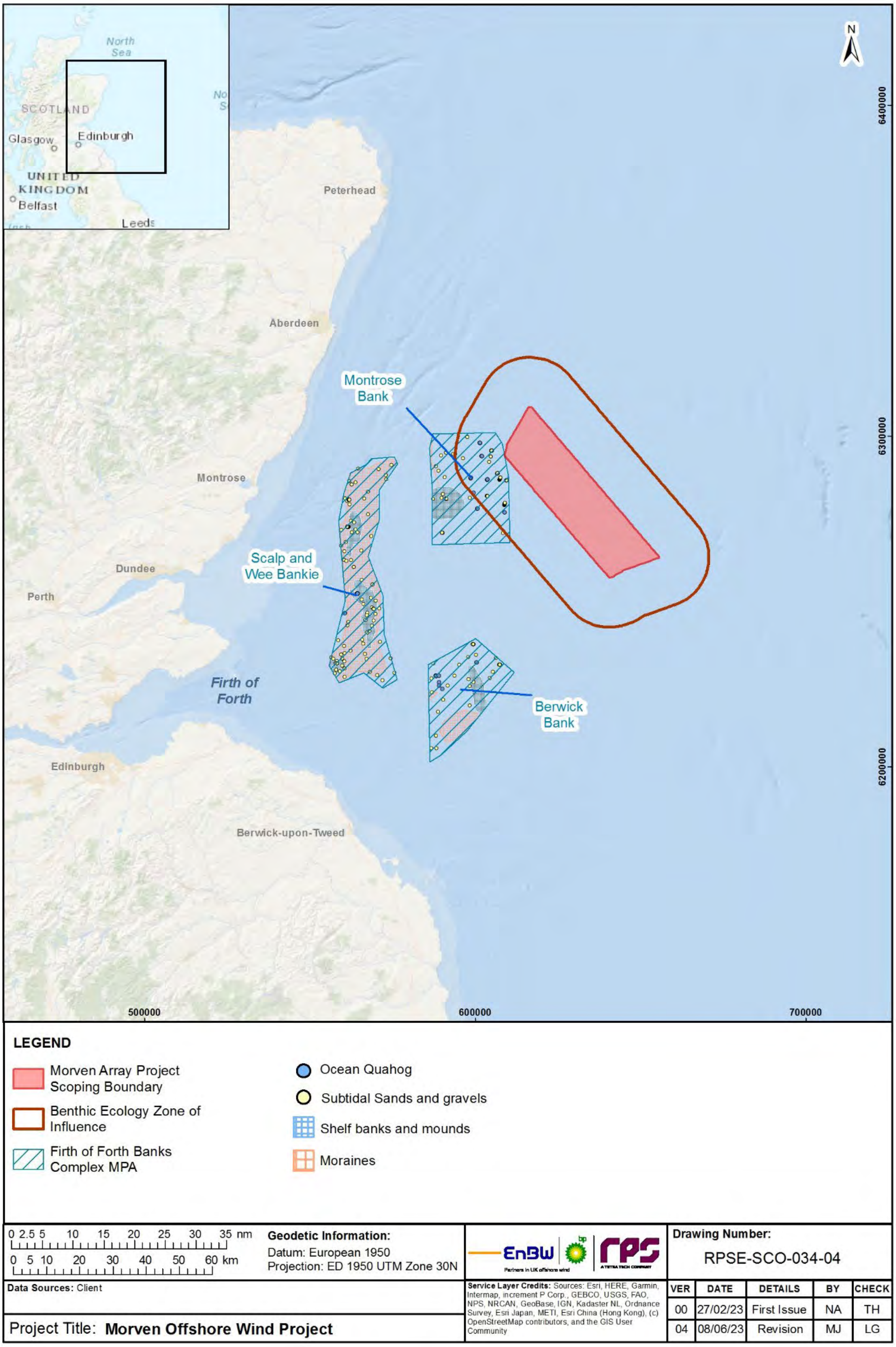


Figure 6.1: Distribution of designated features of the Firth of Forth Banks Complex MPA in relation to the Array Project and 15km screening buffer for MPAs with benthic habitats/species and geodiversity features

6.3.3 Preliminary Screening for MPAs with Fish Features

6.3.3.1 Direct impacts to fish features of MPAs (e.g. arising from temporary habitat disturbance, long term habitat loss, colonisation of hard structures and EMF) will be confined to the area within the Scoping Boundary. There is no physical overlap between the Scoping Boundary and any MPA designated for fish features. As such, no MPAs are screened in for this criterion.

6.3.3.2 Direct impacts to fish features of MPAs (e.g. sandeels) may occur because of increased underwater sound (e.g. from piling), with effects potentially extending beyond the boundaries of the Array Project. The ZoI of potential effect has been defined as the Regional Fish and Shellfish Study Area as described in chapter 8.2: Fish and Shellfish Ecology of the Scoping Report. A single MPA, the Turbot Bank MPA, which is designated for sandeels, has been identified within this screening buffer. The Turbot Bank MPA is located 46.5km from the Scoping Boundary. At this distance, and using experience gained on other OWF projects in the Firth of Forth, the MPA will be located outside the area within which mortality and recoverable injury to sandeels could potentially occur, which is likely to be within tens to a few hundred metres. The Turbot Bank MPA is also considered likely to be beyond the zone within which temporary threshold shift (TTS, i.e. a temporary reduction in hearing sensitivity) may be experienced by sandeels, which is likely to be within less than 10km. Regarding behavioural effects, at a distance of 46.5km, the risk to sandeels from behavioural effects is considered to be low. The extent of underwater sound contours associated with sound pressure levels above 150dB re 1µPa Root Mean Squared (RMS), the criterion typically used for indicating the extent of onset of potential behavioural effects due to impulsive piling, is considered unlikely to extend to the Turbot Bank MPA. Whilst this will be reviewed and confirmed through the underwater sound modelling undertaken as part of the EIA Report, for this preliminary screening it is concluded that underwater sound would not be capable of resulting in anything other than insignificant effects on the protected sandeel feature of the Turbot Bank MPA (see Appendix Table 6.2). On this basis, no MPAs are screened in for underwater sound impact pathways.

6.3.3.3 Indirect impacts on fish features of MPAs may occur due to increases in SSC and associated deposition. The ZoI applied for SSC and sediment deposition, together with the justification, is as outlined in section 6.3.2 (i.e. 15km). On this basis, no MPAs with fish features are screened in.

6.3.3.4 These conclusions will be reviewed following the completion of the underwater sound modelling and the physical processes modelling.

6.3.4 Preliminary Screening Criteria for MPAs with Marine Mammal Features

6.3.4.1 Direct impacts to marine mammal features of MPAs (e.g. arising from temporary habitat disturbance, long term habitat loss, etc.) will be confined to the area within the Scoping Boundary. There is no physical overlap between the Scoping Boundary and any MPA designated for marine mammal features. As such, no MPAs are screened in for this criterion.

6.3.4.2 Direct impacts on marine mammal features of MPAs may occur due to increased underwater sound, with effects potentially extending beyond the boundaries of the Array Project. The ZoI of potential effect has been defined as the Regional Marine Mammal Study Area described in chapter 8.3: Marine Mammals of the Scoping Report. A single MPA, the Southern Trench MPA, is within the regional marine mammal Study Area designated for minke whale (*Balaenoptera acutorostrata*). The Southern Trench MPA is 56.8km from the Scoping Boundary. At this distance, and using experience gained on other OWF projects in the Firth of Forth, the MPA will be located outside the area within which injury to minke whales could potentially occur. Regarding behavioural effects, at a distance of 56.8km, the risk to minke whales is considered low. The extent of underwater sound contours associated with sound pressure levels above 140dB re 1µPa (RMS), the criterion typically used for indicating the extent of onset of potential low-level marine mammal disturbance effects from impulsive sound, is considered unlikely to extend to the Southern Trench MPA. Whilst this will be reviewed and confirmed through the underwater sound modelling undertaken as part of the EIA Report, for the purposes of this preliminary screening, it is concluded that underwater sound would, therefore, not be capable of resulting in anything other than insignificant effects on the protected minke whale feature of the Southern Trench MPA (see Appendix Table 6.2). On this basis, no MPAs are screened in for underwater sound impact pathways. This conclusion will be reviewed following the completion of the underwater sound modelling.

6.3.4.3 Indirect impacts on marine mammal features of MPAs may occur due to changes in prey availability. The indirect effect of impacts such as SSC and sediment deposition on prey species (i.e. fish and shellfish) has been considered in section 6.3.3. No MPAs with fish and shellfish features were screened in and, therefore, no MPAs with marine mammal features have been screened in on this basis. The indirect effect of increases in SSC and sediment deposition on fish and shellfish outside of MPAs will be considered in chapter 7.1: Physical Process of the Scoping Report.

6.3.5 Preliminary Screening Criteria for MPAs with Ornithological Features

6.3.5.1 There is no physical overlap between the Scoping Boundary and any MPA designated for ornithology features. The Berwick to St Mary's Marine Conservation Zone (MCZ)[3] lies 97.8km from the Scoping Boundary. This is within the pre-determined screening criterion 100km buffer for MPAs with seabird features. The MCZ is designated for the common eider (*Somateria mollissima)*, a seaduck rarely found far from the coast. This is due to their dependence on coastal habitats as a food source, with their diet consisting primarily of molluscs such as mussels (RSPB, 2022), and on coastal habitats for nesting habitats, with their preferred habitat being sheltered shallow coves, bays and islets (British Waterfowl Association, 2022). Common eider are known to migrate; however, in Scotland, these routes are closely tied to the coast (Milne, 1965). Based on their habitat and feeding preferences, as well as the distance between the Berwick to St Mary's MCZ and the Scoping Boundary, there is no realistic capability of the Array Project impacting features of this MCZ (e.g. collisions with rotating wind turbine blades, temporary habitat loss, increased SSC, barrier to movement, collision risk and changes in prey availability). No MPAs or MCZs designated for ornithology features have been screened in because there is no impact pathway.

6.3.6 Summary of Preliminary MPA Screening Conclusions

6.3.6.1 Three MPAs and one MCZ were considered in the MPA screening for the Array Project, which comprised those located within the ZoI for individual receptors, as detailed in sections 6.3.2 to 6.3.5. The screening has concluded that the Array Project is not capable of affecting (other than insignificantly) the fish, marine mammal and ornithological features of any MPAs, as summarised in Appendix Table 6.2 below.

6.3.6.2 A single MPA, the Firth of Forth Banks Complex MPA, has been identified for initial inclusion in the MPA assessment on the basis that the Array Project is deemed to be potentially capable of affecting (other than insignificantly) two of the protected features of the site: ocean quahog aggregations; and offshore subtidal sands and gravels (Table 6.2).

6.3.6.3 The results of the preliminary MPA screening undertaken for the Scoping Report were presented to the Statutory Nature Conservation Bodies (SNCBs) during the Scoping Workshop on 18 April 2023. During this workshop, NatureScot confirmed that they agreed that the Turbot Bank MPA and Southern Trench MPA can be screened out. NatureScot further agreed that the Firth of Forth Banks Complex MPA should be screened in for subtidal sands and gravels and ocean quahog aggregations, but the geological features can be screened out.

[3] MCZs are a type of Marine Protected Area that can be designated in English, Welsh and Northern Irish territorial and offshore waters through the Marine and Coastal Access Act 2009, so are also considered in this screening.

Table 6.2: Summary of screening conclusions for MPAs

Designated site	Distance to Scoping Boundary (km)	Feature	Potential impact pathway	Screening conclusion and justification
Firth of Forth Banks Complex MPA	0.04	Ocean quahog; Offshore subtidal sands and gravels; Shelf banks and mounds; Quaternary of Scotland: Moraines.	Potential pathways identified	**Screened in** – the Firth of Forth Banks Complex MPA does not spatially overlap with the Scoping Boundary. The site does, however, overlap with the ZoI associated with the indirect impacts on benthic ecology features. Based on current knowledge regarding the distribution of designated features within the Firth of Forth Banks Complex MPA, only the offshore subtidal sands and gravels and ocean quahog aggregations features are considered to have the potential to occur in area of the Firth of Forth Banks Complex MPA that overlaps with the Array Project ZoI. These two features of the Firth of Forth Banks Complex MPA are, therefore, proposed to be screened in and are considered likely to require a main assessment. All of the other features of the MPA (i.e. Shelf banks and mounds Quaternary of Scotland: Moraines) are proposed to be screened out of the main MCZ assessment.
Turbot Bank MPA	46.5	Sandeels	No potential pathways identified	**Screened out** – the Turbot Bank MPA does not spatially overlap with the Scoping Boundary. The site also falls outside the likely ZoI for significant behavioural disturbance to sandeels, as determined by the assessment presented in section 6.3.3 and the likely impact zone for underwater sound. The Turbot Bank MPA also falls outside the 15km ZoI identified for impact pathways associated with increased SSC that have the potential to affect fish features. The Turbot Bank MPA is, therefore, proposed to be screened out and is not considered likely to require a main assessment.

Designated site	Distance to Scoping Boundary (km)	Feature	Potential impact pathway	Screening conclusion and justification
Southern Trench MPA	56.8	Minke whale[4]	No potential pathways identified	**Screened out** – the Southern Trench MPA does not spatially overlap with the Scoping Boundary. The site also falls outside the likely ZoI for significant behavioural disturbance to minke whale, as determined by the assessment presented in section 6.3.4 and the likely impact zone for underwater sound. The Southern Trench MPA also falls outside the 15km ZoI identified for impact pathways associated with increased SSC that have the potential to affect marine mammal features. The Southern Trench MPA is, therefore, proposed to be screened out and is not considered likely to require a main assessment.
Berwick to St Mary's MCZ	99.8	Common eider	No potential pathways identified	**Screened out** – the Berwick and St Mary's MCZ does not spatially overlap with the Scoping Boundary. The MCZ falls just within the 100km screening buffer and is located 97.8km from the Scoping Boundary. The MCZ is designated for common eider and, considering the distance from the Scoping Boundary as well as migratory, feeding and nesting patterns of the species, identified in section 6.3.5, it is considered highly unlikely there will be anything other than an insignificant impact on the designated feature of this MCZ. The Berwick and St Mary's MCZ also falls outside the 15km ZoI identified for impact pathways associated with indirect impacts, such as increased SSC that have the potential to affect ornithology features. The Berwick and St Mary's MCZ is, therefore, proposed to be screened out and is not considered likely to require a main assessment.

[4] The Southern Trench MPA is also designated for three other biodiversity features: burrowed mud, fronts and shelf deeps and two geodiversity features: Submarine Mass Movement and Quaternary of Scotland. However, these are all outside the respective screening ranges applied in the preliminary screening (see section 6.2.2).

7 Appendix 7 - Marine Mammals Methodology Statement

7.1 Introduction

7.1.1.1 This appendix of the Array Project Scoping Report (hereafter, 'Scoping Report') presents the methods proposed for use in the Environmental Impact Assessment (EIA) of the potential impacts of the Morven Offshore Wind Array Project (hereafter, 'Array Project') on marine mammals. Specifically, this appendix describes the proposed assessment of potential impacts of the Array Project seaward of Mean High Water Springs (MHWS) during its construction, Operations and Maintenance (O&M) and decommissioning phases.

7.1.1.2 The purpose of this appendix is to provide a series of technical briefings on methods to be used in the EIA and includes the following:

- delineation of study areas for assessment (section 7.2);
- data that will be used to inform the baseline characterisation (section 7.3);
- overview of underwater sound propagation modelling approach (section 7.6);
- modelling of population level effects (section 7.10).

7.2 Baseline and Study Areas

7.2.1.1 For the purpose of the EIA, two marine mammal study areas (Appendix Figure 7.1) have been defined:

- Project Marine Mammal Study Area for the Array Project, which is defined as the area encompassing the Scoping Boundary plus a buffer of 4km.
- Regional Marine Mammal Study Area, which extends over a large part of the North Sea geographic region. Marine mammals are highly mobile and may range over large distances; therefore, the Regional Marine Mammal Study Area for the Array Project provides wider context. To ensure a proportionate approach, the Regional Marine Mammal Study Area focuses on a region within which receptor-impact pathways are likely (since cumulative effects from the Array Project within the North Sea are considered unlikely to occur with projects in the Celtic or Irish seas, for example). This Regional Marine Mammal Study Area will also be used in the cumulative impact assessment.

7.2.1.2 Species specific populations will also be considered within the context of their relevant species Management Units (MUs) as defined by the Inter-Agency Marine Mammal Working Group (IAMMWG) (2022). The MU for harbour porpoise management is the North Sea MU, for bottlenose dolphin (*Tursiops truncatus*) the Greater North Sea MU and a single Celtic and Greater North Seas (CGNS) MU, has been defined for common dolphin (*Delphinus delphis*), white-beaked dolphin (*Lagenorhynchus albirostris*), Atlantic white-sided dolphin (*Lagenorhynchus acutus*), Risso's dolphin (*Grampus griseus*) and minke whale (*Balaenoptera acutorostrata*) (IAMMWG, 2022).

7.2.1.3 For bottlenose dolphin, two distinct ecotypes of bottlenose dolphin are recognised in UK waters; a wide-ranging offshore type and a more philopatric inshore type (IAMMWG, 2021). A number of inshore populations have been identified in the UK and there is limited interchange between them (Robinson *et al*., 2012; Cheney *et al*., 2013; ICES 2014; IAMMWG 2015; Lohrengel *et al*., 2018). Whilst the Array Project is located within the Greater North Sea MU, there is also the Coastal East Scotland MU which has an estimated 224 animals (Arso Civil *et al*., 2021) and occupies the coastal waters around eastern Scotland, ca. 37.7km from the Array Project.

7.2.1.4 For grey seal (*Halichoerus grypus*) and harbour seal (*Phoca vitulina*), combined seal management units (SMUs) are proposed as a reference population but the movement of the species following telemetry studies will also be considered. The Regional Marine Mammal Study Area spans the following SMUs: 4 (North Coast and Orkney), 5 (Shetland), 6 (Moray Firth), 7 (East Scotland) and 8 (Northeast England).

Figure 7.1: The marine mammal study areas for the Array Project

7.3 Estimating Baseline Densities

7.3.1.1 The baseline uses the latest scientific evidence to develop the most suitable and precautionary estimate of species density for use in quantitative impact assessments (e.g. for impacts on underwater sound from piling, unexploded ordnance (UXO) clearance). These density estimates are based upon the most precautionary estimates of density from site specific survey data where sufficient data is available for species (section 7.4) and baseline studies (section 7.5). These densities are used in quantitative assessments to determine how many animals may be affected by the impact and the proportion of the reference population (e.g. MU). This is used to help assessing the scale of population level impacts and to inform the magnitude of an impact.

7.4 Site Specific Survey Data

7.4.1.1 The Applicant has commissioned aerial surveys of marine mammals to be carried out by APEM for the Array Project, covering the Scoping Boundary plus a buffer of 4km. The survey data have been collected monthly between January 2021 and March 2023, with the initial two years extended to March 2023 to ensure they capture the full breeding seasons for birds. In the processing of aerial data, marine mammals identified in the images are categorised to the lowest taxonomic level possible. Size of individuals can be measured to aid in species-level identification. APEM uses the precautionary principle and only identifies to species level when there is 100% confidence and includes a comprehensive internal Quality Assurance (QA) process. Full details of the survey methodology, data processing, data analyses, assumptions and limitations will be provided in the application.

7.4.1.2 APEM only gives definite species sightings where an animal can be identified to species level with high confidence. Where a marine mammal sighting cannot be identified with high confidence to species level, sightings are given in their own non-species-specific categories (e.g. ‘seal species’, ‘dolphin/porpoise’, ‘marine mammal’). Sightings data from each category will be presented and discussed further in the Marine Mammal Technical Report alongside baseline data gathered as part of the desk study, describing the distribution, abundance/density and seasonality of marine mammal species most likely to occur across the Project Marine Mammal Study Area.

7.4.1.3 To ensure a conservative assessment in calculating densities of key species, the data from some of these broader non-species-specific classifications will be assigned to a species category in proportion to the representation of each species in the dataset as follows:

- Dolphin/porpoise assigned to a species of dolphin (e.g. white-beaked dolphin) or to harbour porpoise, in proportion to the percentage of any high confidence dolphin or porpoise sightings identified at species level.
- Seal species assigned to grey seal or harbour seal in proportion to the percentage of sightings identified at species level across both seal species.
- Whale species assigned to species of whale (e.g. minke whale) in proportion of the percentage of sightings identified at species level across all whale species.

7.4.1.4 This approach ensures that sighting data is not disregarded as the limitations of aerial surveys in achieving accurate identification of marine mammal species is recognised. Densities will be presented both with and without unidentified species allocation. For example, densities derived from using high-confidence harbour porpoise sightings only and densities derived from those of ‘harbour porpoise’ and ‘dolphin/porpoise’ in combination to give a further conservative assessment.

7.4.1.5 Both design-based densities and modelled estimates will be calculated from site specific survey data. Where data is sufficient, model-based density estimates will be calculated using the statistical software R v4.2.0 (R Core Team, 2022), and the MRSea package v1.3.1 (Scott-Hayward *et al.*, 2013). Covariates such as bathymetry, distance to coast, latitude and longitude and season will be used within the modelling to predict species distribution.

7.4.2 Availability Bias

7.4.2.1 It is important to correct for availability bias when using snapshot data such as site specific surveys. Aerial survey data represent a snapshot of marine mammal distribution and densities within a given survey per month and may not fully capture the natural variability of marine mammal distribution or densities over time. In most cases animals are noted and identified from digital images where the animal is under the sea surface. Changes in sightings rates may be influenced by environmental conditions; however, due to the short time frames (single day) of data collection, it is not possible to analyse this. Therefore, whilst differences in sightings rates between months may be due to seasonal changes, environmental conditions also have the potential to influence these results.

7.4.2.2 Relative density estimates can be corrected for availability bias using published correction factors based on the proportion of time individuals are likely to be at or near the surface and available for detection. Telemetry studies of the diving behaviour of different species can be useful in indicating the average proportion of time that individuals of a species may be on, or near, the surface and available for detection. Note that these are considered to be the best estimates of absolute densities, subject to limitations recognised in studies (e.g. potentially subject to geographic, seasonal, diurnal, and individual animal variation).

7.4.2.3 A summary of diving behaviour and estimated correction factors is provided for a range of species in Appendix Table 7.1. Mannoconi *et al.* (2018) provides an equation to derive correction factors from the latest available literature per species; this is an approach used in previous offshore wind farm consenting studies and has been used to derive the correction factors in Appendix Table 7.1.

Table 7.1: Summary of estimated correction factors from relevant studies

Reference	Description	Species	Correction factor
Teilman *et al*. (2013)	Tagging study in Baltic/North Sea looking at proportion of time surfacing in top 0m to 2m. Most conservative correction factor based on winter months, where surfacing lower.	Harbour porpoise	42.5%
van Beest *et al*. (2018)	Tagging study of fine scale movements of harbour porpoise in the Danish North Sea. Estimated a mean dive duration of 53 seconds and a mean surfacing time of 39 seconds.	Harbour porpoise	42.4%
Thompson *et al*. (1991)	Tagging study of three male grey seal in the Farne Islands (northeast England). Average proportion of time animals were submerged as they travelled was 84.3%, slightly lower during short duration trips (83.4%).	Grey seal	15.7% to 16.6%
Ørsted (2018)	Tagging (deployed by SMRU) on grey seal in North Sea. 60% of surfacing periods were between 15 and 45 seconds, with an average of 40 seconds and dive durations varied between 20 and 496 seconds with an average of 216 seconds.	Grey seal	15.6%
McGarry *et al*. (2017)	Visual tracking study in Iceland recorded surfacing duration between short and long dive sequences. Surfacing estimated at 58 seconds, dive mean 73 seconds.	Minke whale	44.0%
Rasmussen *et al*. (2013)	Bio-logging study of two individual free-ranging white-beaked dolphin in Iceland. Spent on average 18% of time close to the surface (0 to 2m deep) and 82% of the time diving.	White-beaked dolphin	18.0%

7.4.2.4 The assessment will review the literature to determine suitable availability bias and apply the most appropriate correction factors. Therefore, within the impact assessment, both relative abundance and density will be calculated from site specific data and then absolute values are calculated, correcting for availability bias.

7.4.3 Modelling in MRSea

7.4.3.1 Species distribution modelling will be carried out using the MRSea package (Scott-Hayward *et al.*, 2013) to predict the density of marine mammals within aerial survey areas. MRSea generates spatial maps of density of marine mammals within the survey areas. Previous consenting applications have modelled relative abundance and density by month, or bioseason (such as those for harbour porpoise defined in Heinänen and Skov, 2015[5]).

7.4.3.2 As discussed in paragraph 7.4.1.4, densities will be presented both with and without unidentified species level allocation.

7.5 Desktop Data

7.5.1.1 Desktop studies will also be reviewed in detail to identify the most appropriate and precautionary estimate of density for each species and aim to use the most up-to-date recent literature, where possible, that is suited to the Array Project. These densities are then taken forward into the assessment, where site specific data is either not available or not suitable.

7.5.1.2 Likely key datasets are presented in Appendix Table 7.2, with a summary of the species included and type of density output available per dataset.

Table 7.2: Examples of key datasets with densities for marine mammals for use in the Array Project impact assessment

Reference	Description	Species of relevance (from those scoped in)	Outputs
Waggitt *et al.* (2020)	Distribution maps of cetacean and seabird populations in the northeast Atlantic, at 10km^2 density scale from collated heterogeneous datasets.	Harbour porpoise; Bottlenose dolphin (offshore ecotype); White-beaked dolphin; Minke whale; Short-beaked common dolphin.	Predicted density maps.
Hague *et al.* (2020)	Dedicated reviews and up to date information for the baseline abundance and distribution within Scottish waters.	Harbour porpoise; Bottlenose dolphin; White-beaked dolphin; Minke whale; Short-beaked common dolphin; Grey seal; Harbour seal.	Summary of abundance and distribution of marine mammal species in the Scottish Northern North Sea region and Scottish Atlantic waters.
Hammond *et al.* (2021)	Small Cetaceans in European Atlantic waters and the North Sea (SCANS) III - shipboard and aerial line transect surveys provide design-based abundance and density estimates.	Harbour porpoise; Bottlenose dolphin; White-beaked dolphin; Minke whale; Short-beaked common dolphin.	Block-wide design-based abundance and density estimates.
Carter *et al.* (2022)	Telemetry data used to generate at-sea distribution estimates for the entire UK.	Grey seal; Harbour seal.	At-sea distribution estimates.
Heinänen and Skov (2015)	Analysis of a collation of data sources from Joint Cetacean Protocol (JCP).	Harbour porpoise.	Density surface maps.

[5] To note, it is acknowledged that Heinänen and Skov (2015) has not been supported by the Scottish Government due to concerns about the underlying evidence.

Reference	Description	Species of relevance (from those scoped in)	Outputs
Paxton *et al.* (2014)	Density surface for 'observed adjusted densities' for minke whales - noting this is a year average, given minke whales are primarily present in summer months.	Minke whale.	Relative density estimates in Scottish waters.
Lacey *et al.* (2022)	Modelled density surfaces of cetaceans in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys.	Harbour porpoise; Bottlenose dolphin; White-beaked dolphin; Minke whale; Short-beaked common dolphin.	Density surface maps for comparison against site specific density estimates.

7.5.1.3 For bottlenose dolphin, there are two different ecotypes in Scottish waters: the wide-ranging offshore ecotype and the philopatric coastal ecotype (Louis *et al*., 2014). Coastal ecotypes are concentrated mostly within distinct populations in the west and east coast of Scotland, namely the Moray Firth, the Firth of Tay and the Hebrides (Hague *et al*., 2020; Cheney *et al*., 2013). These coastal ecotypes are primarily limited to coastal waters and, as a result, unlikely to overlap with the Project Marine Mammal Study Area. There is less certainty in the distribution and abundance of the offshore ecotypes (Cheney *et al*., 2013). The East Coast Marine Mammal Acoustic Study (ECOMMAS) utilised acoustic recorders (C-PODs) to collect data on the relative abundance of bottlenose dolphins in 30 locations off the east coast of Scotland (NMPi, 2022; Hague *et al*., 2020; Williamson, 2018). Deployments are undertaken twice per year since 2013 (currently ongoing), with data covering the months of April to November (Hague *et al*., 2020). Data collected from 2013–2016 (available via Marine Directorate) illustrated that the greatest presence of bottlenose dolphin was detected at Cromarty, situated approximately 200km northwest of the Array Project, almost certainly representing the coastal ecotype only (NMPi, 2022). Therefore, maps from Waggitt *et al.* (2020) or Lacey *et al.* (2022), which represent the offshore ecotype, are more suitable for obtaining densities for the Project Marine Mammal Study Area.

7.5.1.4 For seal species, a telemetry and haul-out report will be provided by SMRU Consulting Ltd. It is anticipated that the current cable search area will include both the East Scotland and the North East England Seal MUs. SMRU will include the following data within their report for seal MUs East Scotland and North East England:

- Harbour seal count data from August moult census surveys from 1996 to 2021 examine site specific abundance and interannual patterns in counts over time. Associated grey seal counts from these same August surveys.
- Grey seal pup production estimates from all regularly surveyed breeding sites from 1997 to 2021 for East Scotland MU and 1996 to 2021 for North East England MU.
- Seal satellite tracking data from tagged harbour and grey seals; these comprise either animals tagged at the Special Areas of Conservation (SACs) and visiting the specified area or visiting the MUs (East Scotland and North East England) and also hauling out at the SACs. It will also include satellite tracking data from all harbour or grey seals that cross the MUs (East Scotland and North East England), regardless of where tagged (if not already included in previous datasets). This will give a basic quantification of the degree of connectivity between the MUs (East Scotland and North East England) and haul-out sites.

7.6 Underwater Sound Propagation Modelling Approach

7.6.1 Underwater Sound Propagation Modelling Approach from JASCO

7.6.1.1 Data collected during the site specific geophysical and geotechnical survey campaign, or from public data sources if required, will provide information to characterise the geoacoustic environment as needed for underwater sound propagation modelling, to be carried out by JASCO. Numerical modelling will be conducted to assess the impact of underwater sound on marine mammals. The broad outline of the procedure is as follows:

- estimate source levels for each activity either through source modelling or use of a suitable proxy source;
- conduct sound propagation modelling in three dimensions around the source and estimate distances to impact criteria thresholds;
- consider cumulative impacts of multiple events and multiple operations;
- incorporate animal swim speeds to assess accumulated sound exposure.

7.6.1.2 Full detail of the sound methodology is presented in the Underwater Sound Methodology Statement.

7.6.1.3 The underwater sound modelling will assume that an animal would swim away from the sound source at the onset of activity at a constant rate and, subsequently, conservative species-specific swim speeds will be incorporated into the model (Table 7.3). Indicative swim speeds are given in Appendix Table 7.3.

Table 7.3: Indicative assessment swim speeds of marine mammals that are likely to occur within the North Sea for the purpose of exposure modelling for the Array Project

Species	Hearing group	Swim speed (m/s)	Source reference
Harbour seal	Phocid Carnivores in Water (PCW)	1.8	Thompson *et al*. (2015)
Grey seal	Phocid Carnivores in Water (PCW)	1.8	Thompson *et al*. (2015)
Harbour porpoise	Very High Frequency (VHF)	1.5	Otani *et al*. (2000)
Minke whale	Low Frequency (LF)	2.3	Boisseau *et al*. (2021)
Bottlenose dolphin	High Frequency (HF)	1.52	Bailey *et al*. (2010)
White-beaked dolphin	HF	1.52	Bailey *et al*. (2010)
Short beaked common dolphin	HF	1.52	Bailey *et al*. (2010)
Risso’s dolphin	HF	1.52	Bailey *et al*. (2010)

7.6.1.4 The following sound-producing activities will be considered in the underwater sound modelling assessment:

- pile driving for wind turbine foundations;
- clearance of UXO;
- non-impulsive sound sources (e.g. vessel use, rock dumping, cable laying, drilling etc);
- pre-construction site investigation surveys (geophysical only).

7.6.1.5 Maximum design scenarios (MDS) will be defined on the basis of the range of metrics in the project design envelope. For example, to assess the impact of pile driving, a range of monopiles and pin piles with different diameters will be modelled with the maximum required hammer energy to determine the scenario likely to result in the largest ranges for injury and disturbance for the key species. The maximum temporal scenario will also be determined on the basis of the longest duration of piling (leading to the maximum number of piling days) over the offshore construction period. Similarly, to assess the impact of UXO clearance, the underwater sound model will consider the range of potential UXOs likely to be encountered within the Scoping Boundary and the possible different approaches to clearance. Given the potential uncertainties at this stage of the Array Project, high order clearance will be considered as a worst case noting that low-order or low-yield clearance may be possible as more detailed information becomes available subject to site investigations.

7.6.1.6 These models will then be taken forward to the underwater sound density quantitative assessment for injury and disturbance, discussed in sections 7.7 to 7.9. The thresholds used in underwater sound propagation modelling are presented in the Underwater Sound Methodology Statement.

7.7 Piling

7.7.1.1 Injury and disturbance can arise from loud, impulsive sound produced during activities such as piling (and some geophysical surveys) and is, therefore, important to consider in impact assessments. Marine mammals, in particular cetaceans, are capable of generating and detecting sound (Au *et al.*, 1974; Bailey *et al.*, 2010) and are dependent on sound for many aspects of their lives (i.e. prey identification; predator avoidance; communication and navigation). Increases in anthropogenic sound may consequently lead to a potential effect within the marine environment (Parsons *et al.*, 2008; Bailey *et al.*, 2010) and effects on marine mammals.

7.7.2 Injury

7.7.2.1 For the Array Project, potential auditory injury will focus on Permanent Threshold Shift (PTS), where there is no hearing recovery in the animal. Whilst temporary threshold shift (TTS) will be modelled, this is temporary and reversible and likely to induce a moving away response from the ensonified area, it is not included in the assessment of injury for piling.

7.7.2.2 Furthermore, for TTS the derived thresholds are based on the smallest measurable shift in hearing (i.e. the lowest level that exceeds recorded variation and leads to onset of TTS) (National Marine Fisheries Service (NMFS, 2016)) and as such are likely to result in overestimates of the effect ranges. Therefore, TTS is not considered a useful predictor of the injury to marine mammals.

Dual metric approach

7.7.2.3 For marine mammals, injury thresholds are based on both unweighted peak sound pressure levels (i.e. peak SPL, commonly referred to as PK or SPLpk) and marine mammal hearing-weighted sound exposure level (SEL) as per the latest guidance from Southall *et al.* (2019). The two metrics are applied under the condition that exceeding either threshold by the specified level is sufficient to result in predicted PTS (or TTS) onset. The different exposure metrics account for different aspects of exposure level and duration. PK characterises the amplitude of the sound and in marine mammal assessments is measured as the zero-to-peak pressure of the sound wave to determine the potential for an instantaneous injury at a point in time. SEL is a measure of sound energy of exposure accumulated over time taking into account the received level and duration of exposure as an animal moves across a sound field (Southall *et al.*, 2019). To assess injury, SEL is computed for multiple pulses over a 24-hour period (SEL_{24}) and assumes an animal moves away from the sound source in a directional movement based on conservative swim speeds (Table 7.3).

7.7.2.4 SEL_{24} is considered a precautionary metric for determining injury due to the conservative assumptions in the model (e.g. assumptions that an animal would be exposed over the entire duration of the piling sequence with no sound pressure release during pauses in piling or when an animal breaks the surface), which may lead to overestimates of the effect. Another key point to note is that there is currently no agreed approach to modelling the cross-over point from impulsive to continuous sound and this is an ongoing active area of research. The Underwater Sound Methodology Statement provides an overview of the conservative assumptions in modelling SEL_{24}. Notwithstanding the caveats described for the SEL_{24} metric, the dual metric approach is recommended by Southall *et al.* (2019) for assessment of injury.

7.7.2.5 The underwater sound modelling will investigate a range of different scenarios (including concurrent piling if applicable) to determine the scenario likely to lead to the largest potential impact range for each species. Suitable conservative densities derived from baseline characterisation are then used in combination with the injury ranges from underwater sound modelling to give an area of effect and the number of animals impacted. Population effects are assessed against relevant MUs. The quantitative assessment will be interpreted subject to the caveats highlighted above and considering the environmental context as highlight by Southall *et al*. (2021).

Threshold for mitigation ranges

7.7.2.6 The PK metric will be used to determine the pre-piling mitigation zone (MZ), using the largest predicted instantaneous injury range up to a maximum hammer energy. This MZ is defined as the maximum potential PTS-onset impact ranges and is the radius around the sound source over which mitigation should be focused. It is a prescribed area within which no marine mammals should be present before noisy activity begins and is applied to reduce to potential for injury (PTS) to negligible levels.

7.7.2.7 Mitigation measures will be implemented as follows:

- Designed in measures will include the use of a low hammer energy initiation, soft start to piling before ramping up to full hammer energy.
- Standard industry measures including the use of marine mammal observers and passive acoustic monitoring (PAM) to monitor the MZ prior to hammer initiation and the use of an acoustic deterrent device (ADD), if required, to deter animals from the MZ.

7.7.2.8 With respect to deterrence using an ADD for the PK metric, swim speeds (see Appendix Table 7.3) will be used to estimate whether an animal can move beyond the modelled distances to PTS thresholds for each species over a set deployment duration of the ADD (e.g. 30 minutes). If the swim distance is larger than the injury range, it will be deemed there is no residual risk of injury. For the SEL_{24} metric, the underwater sound model may incorporate the use of an ADD for the specified duration to model injury zones for each species and where the threshold is not exceeded, there will be no risk of injury.

7.7.2.9 The designed in measures will evolve over the development process as the EIA progresses. The assessment will consider the potential for any residual risk of injury after implementation of designed in measures and standard industry measures. Any further mitigation requirements for reducing the risk of injury from piling will be dependent on the significance of the effects, which are determined in part due to injury ranges determining magnitude of impact.

7.7.3 Disturbance

7.7.3.1 Beyond the zone of injury, sound levels are such that auditory or physical injury is less likely to occur but can result in disturbance to marine mammal behaviour. This response will depend on the individual and the context; previous experience and acclimatisation will affect whether an individual exhibits an aversive response to sound, particularly in an area with high sound levels related to human activities.

Threshold approach

7.7.3.2 Typically, a threshold approach has been adopted in OWF assessments in the UK to quantify the scale of the effects. For example, the National Oceanic and Atmospheric Administration (NOAA, 2018) defines strong disturbance in all marine mammals as Level B harassment and for impulsive suggests a threshold of 160dB re 1µPa (root mean square (rms)). This threshold meets the criteria defined by JNCC (2010) as a 'non-trivial' (i.e. significant) disturbance and is equivalent to the Southall *et al.* (2007) severity score of five or more on the behavioural response scale. Beyond this threshold the behavioural responses are likely to become less severe (e.g. minor changes in speed, direction and dive profile, modification of vocal behaviour and minor changes in respiratory rate (Southall *et al.*, 2007)). Previous NMFS guidelines also suggest a precautionary level of 140dB re 1µPa (rms) to indicate the onset of low-level marine mammal disturbance effects for all mammal groups for impulsive sound (NMFS, 2005), although this is not considered likely to lead to a 'significant' disturbance response.

7.7.3.3 Tougaard *et al.*, (2021) reviewed the available scientific literature on the behavioural reactions to pile driving and suggested that there was sufficient empirical evidence to recommend a generalised hearing-weighted threshold of 103dB re 1µPa (rms) for harbour porpoise. There was insufficient data available to provide similar thresholds for dolphins and mysticete whales, although the limited studies reviewed suggested that dolphins are likely to have a higher threshold for the onset of disturbance (i.e. less sensitive compared to harbour porpoise) and mysticete whales also may have higher thresholds but due to their sensitivity to the low frequencies components of piling, the actual reaction distances may be similar (Tougaard *et al.,* 2021). There was also limited empirical data on seals, however, studies suggest that a hearing-weighted behavioural response thresholds are likely to be in the range of 120 to 138dB re 1µPa (rms) (Tougaard *et al.,* 2021).

7.7.3.4 The thresholds applied to the assessment will be species and impact appropriate based on the latest scientific understanding and recommendations. The NOAA criteria of non-trivial (strong) disturbance at 160dBrms will be considered for impulsive sound sources, including geophysical surveys and piling. The exception to this is where a hearing-weighted threshold can be applied, such as the VHF-weighted threshold for harbour porpoise of 103dB re 1µPa (rms) during piling.

7.7.3.5 In addition to the threshold approach, the assessment of behavioural responses during piling will also be investigated using a dose-response approach as described below.

Dose-response

7.7.3.6 Dose-response is an accepted approach to understanding the behavioural effects from piling and has been applied in other recent UK offshore wind farms environmental assessments (for example Awel y Môr (RWE, 2022), Seagreen (Seagreen Wind Energy Ltd, 2012), Hornsea Project Three (Ørsted, 2018) and Berwick Bank (SSE, 2022).

7.7.3.7 Empirical evidence from monitoring at offshore wind farms during construction suggests that pile driving is unlikely to lead to 100% disturbance of all individuals exposed to sound above a specific sound level, and that there will be a proportional decrease in the duration of response at greater distances from the pile driving source (Brandt *et al*., 2011). This has been demonstrated at other wind farms, such as Horns Rev Offshore Wind Farm (Brandt *et al*., 2011), Beatrice Offshore Wind Farm (Graham *et al*., 2019) and Lincs Offshore Wind Farm (Russell *et al*., 2016).

7.7.3.8 The assessment proposes to use a dose-response curve derived from Graham *et al*. (2019) for harbour porpoise and dose-response curve derived from Whyte *et al*. (2020) for pinnipeds. In the absence of species-specific data, the harbour porpoise dose-response curve may be considered for the assessment of other cetacean species, although where this is undertaken the caveats will be acknowledged. Modelled contours in unweighted 5dB single pulse SEL isopleths will be provided to inform this dose-response assessment.

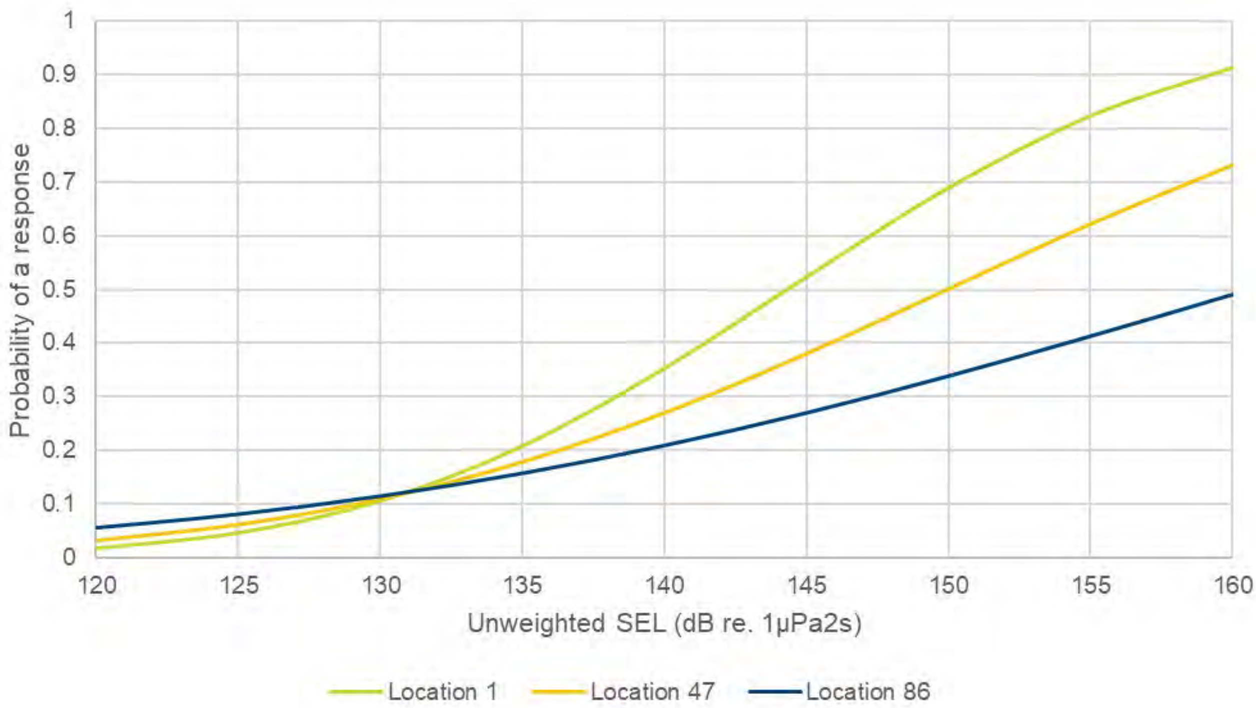


Figure 7.2: The probability of a harbour porpoise response in relation to the partial contribution of unweighted received single-pulse SEL at 3 locations (first location piled, the middle location and the final location)

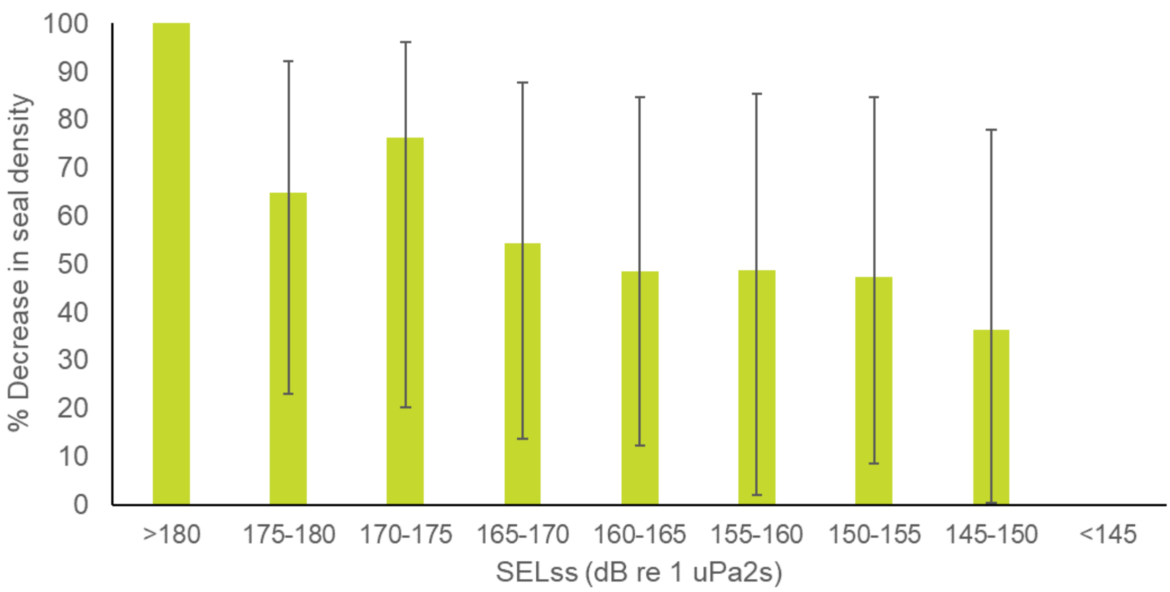


Figure 7.3: Predicted decrease in seal density as a function of estimated SEL (error bars show 95% CI)

7.7.4 Quantifying Effects

7.7.4.1 To obtain the numbers of animals disturbed, contours from underwater sound modelling derived using the relevant injury and disturbance thresholds are plotted in a Geographical Information System (GIS) for all modelled locations. For each species, the location taken forward for assessment will be that which results in the greatest number of animals affected for that species, thereby representing the maximum adverse scenario.

7.7.4.2 The number of animals out to the modelled thresholds will be estimated based on the relevant densities. Note, however, that the NOAA (2018) guidance suggested an estimate of 3km for transition from impulsive to continuous (although this was not subsequently presented in the later peer-reviewed paper, Southall *et al*., 2019). Hastie *et al*., (2019) suggest that some measures of impulsiveness (for seismic airguns and pile-driving) change markedly within approximately 10km of the source. It is, therefore, clear that caution should be used in interpreting predicted injury ranges based upon sound level thresholds defined for impulsive sounds to signals that are no longer impulsive, as they are likely to be lower than predicted.

7.7.4.3 As discussed in paragraph 7.7.2.4, there is currently no agreed approach to modelling the cross-over point from impulsive to continuous sound and this is an ongoing active area of research, with Southall *et al.* (2019) noting specific methods to estimate the transition from impulsive sound to non-impulsive sound are being developed. Therefore, caution should be used when interpreting any results with predicted injury ranges in the order of tens of kilometres that have used impulsive sound thresholds for the whole contour range, as the PTS ranges are likely to be significantly lower than predicted.

7.7.4.4 With respect to the dose-response approach for assessing behavioural effects the areas within each 5dB isopleth will be calculated from the spatial GIS map and a proportional expected response (derived from the dose-response curve for each isopleth area, discussed further in paragraphs 7.7.3.6 to 7.7.3.8) used to calculate the number of animals potentially disturbed. These numbers will be subsequently summed across all isopleths to estimate the total number of animals disturbed during piling. The number of animals predicted to respond will be based on species-specific densities derived from site specific surveys and desktop data.

7.8 Unexploded Ordnance

7.8.1.1 The clearance of UXO prior to commencement of construction may result in detonation (high order) of a UXO. This activity has the potential to generate some of the highest peak sound pressures of all anthropogenic underwater sound sources (von Benda-Beckman *et al*., 2015), and is considered a high energy, impulsive sound source characterised by a shock wave with a very rapid rise time and amplitude. The potential effects of this activity will depend on sound source characteristics, the receptor species, distance from the sound source and sound attenuation within the environment. According to Robinson *et al*. (2020), low order deflagration results in a much lower amplitude of peak sound pressure than high order detonations.

7.8.1.2 For UXO clearance (both low and high order events), due to a combination of physical properties of high frequency energy, the sound is unlikely to still be impulsive in character once it has propagated more than a few kilometres (see paragraph 7.8.1.1).

7.8.1.3 The duration of the impact (elevated sound) for each UXO clearance is very short (seconds) and effects on marine mammal receptors could be either permanent (i.e. PTS) or temporary (i.e. TTS). Potential effects of underwater sound from high order UXO clearance on marine mammals include mortality, physical injury, auditory injury or behavioural disturbance. The modelling approach and thresholds for PTS and TTS are provided in the Underwater Sound Methodology Statement.

7.8.1.4 TTS is the onset of a temporary auditory impairment but also represents a threshold for the onset of a moving away response (behavioural disturbance). The resulting effect of TTS would be a potential temporary loss in hearing. Whilst similar ecological functions would be inhibited in the short term due to TTS, these are reversible on recovery of the animal's hearing and, therefore, not considered likely to lead to any long-term effects on the individual. There is no current accepted behavioural threshold for UXO and, therefore, the assessment will use TTS as a proxy for disturbance for this impact only.

7.8.1.5 The quantitative assessment approach is as described above for piling (section 7.7), where injury ranges are calculated from underwater sound modelling and then the number of animals and percentage of the reference population (e.g. relevant species-specific MUs) is derived using species-specific densities from baseline characterisation.

7.8.1.6 Modelling with be carried out for high order UXO clearance, alongside low order clearance, noting the unexploded ordnance clearance joint interim position statement (DEFRA, 2022). Assessment of multiple scenarios will be undertaken in the impact assessment process (including maximum and most likely UXO sizes), and the resulting mitigation requirements will be based on a scenario where the UXO fully detonates - e.g. high order detonation.

7.8.1.7 There is currently no commitment to low order clearance, but an assessment of multiple scenarios in the impact assessment process and the resulting mitigation requirements will be based on a scenario where the UXO fully detonates (e.g. high order detonation).

7.9 Vessel Sound

7.9.1.1 Unlike piling and UXO, elevated underwater sound from vessels is non-impulsive sound. Increased levels of vessel activity will contribute towards total underwater sound levels.

7.9.1.2 A conservative assumption for modelling elevated underwater sound is that individual marine mammals will respond adversely to increases in vessel sound (i.e. that there is no intra or inter-specific variation or context-dependent differences). The distance over which effects may occur will, however, vary according to the species, the ambient sound levels, hearing ability, vertical space use and behavioural response differences.

7.9.1.3 Disturbance from vessel sound is likely to occur only where vessel sound associated with the construction of the Array Project exceeds the background ambient sound level. The main drivers influencing the magnitude of the impact are vessel type, speed and ambient sound levels (Wilson *et al*., 2007).

7.9.1.4 For impulsive sound sources there is an understanding of the difference between strong and mild disturbance, whereas for non-impulsive (continuous) sound sources, there is only a single threshold available (120dB re 1µPa (rms) (NMFS, 2005), which is classed as the level below which no animals would be disturbed. Unlike piling, there is no distinction between strong and mild disturbance and, therefore, it will be assumed that not all animals found within those ranges would be disturbed. Moreover, for those animals disturbed, there is likely to be a proportional response (i.e. not all animals will be disturbed to the same extent), although there is currently no dose-response curve available to apply in the context of non-impulsive sound sources (unlike piling, see section 7.7). It is important to note that the life history of an individual and the context will also influence the likelihood of an individual to exhibit an aversive response to sound and these impacts will not be continuous over the construction phase, instead carried out over a shorter number of days within the period.

7.9.1.5 Types of vessel may include the following:

- sandwave clearance vessels, installation vessels, construction vessels, rock placement vessels and cable installation vessels;
- boulder clearance vessels;
- jack-up rigs;
- tug/anchor handlers;
- survey vessel and support vessels;
- guard vessels;
- crew transfer vessels;
- seabed preparation/installation vessels.

7.9.1.6 The methodology for assessing vessel sound is a qualitative assessment. Given the limited quantitative information available, as described in paragraph 7.9.1.4, any simplified calculation would likely lead to an unrealistic overestimation of the number of animals likely to be disturbed and, therefore, values will not be quantified.

7.10 Population Level Effects

7.10.1.1 Long term population effects from piling will be modelled using the interim Population Consequences of Disturbance (iPCoD) framework (Harwood *et al.,* 2014)[6]. There is limited understanding of how behavioural disturbance and auditory injury affect survival and reproduction in individual marine mammals and, consequently, how this translates into effects at the population level. The iPCoD model uses a process of expert elicitation to determine how physiological and behavioural changes affect individual vital rates (i.e. the components of individual fitness that affect the probability of survival, production of offspring, growth rate and offspring survival). Species available for iPCoD modelling are:

- harbour seal;
- grey seal;
- bottlenose dolphin;
- harbour porpoise;
- minke whale.

7.10.1.2 Expert elicitation is a widely accepted process in conservation science whereby the opinions of many experts are combined when there is an urgent need for decisions to be made but a lack of empirical data with which to inform them (Donovan *et al*., 2016). In the case of the iPCoD model, the marine mammal experts (detailed in Sinclair *et al.,* 2020) were asked for their opinion on how changes in hearing resulting from PTS and behavioural disturbance (equivalent to a score of 5 or higher on the 'behavioural severity scale' from Southall *et al*. (2007)) associated with offshore renewable energy developments affect calf and juvenile survival, and the probability of giving birth (Harwood *et al*., 2014). Experts were asked to estimate values for two parameters that determine the shape of the relationships between the number of days of disturbance experienced by an individual and its vital rates, and, therefore, provide parameter values for functions that form part of the iPCoD model (Harwood *et al*., 2014). Following the initial development of the iPCoD model, a study was undertaken to update the transfer functions on the effects of PTS and disturbance on the probability of survival and giving birth to a viable young for harbour porpoise, harbour seal and grey seal (again via expert elicitation) (Booth and Heinis, 2018; Booth *et al*., 2019).

7.10.1.3 The iPCoD model has been updated in light of additional work undertaken since it was originally launched in February 2014 (Version 1) and the most recent version of iPCoD will be used (currently iPCoD Version 5.2).

7.10.1.4 A potential limitation of the iPCoD model is that no form of density dependence has been incorporated into the model due to the uncertainties as to how to estimate carrying capacity or how to model the mechanism of density dependence. As discussed by Harwood *et al*. (2014), the concept of density dependence is fundamental to understanding how animal populations respond to a reduction in population size. Density-dependent factors, such as resource availability or competition for space, can limit population growth. If the population declines, these factors no longer become limiting and, therefore, for the remaining individuals in a population, there is likely to be an increase in survival rate and reproduction. This then allows the population to expand back to previous levels at which density-dependent factors become limiting again (i.e. population remains at carrying capacity). The limitations for assuming a simple linear ratio between the maximum net productivity level and carrying capacity have been highlighted by Taylor and Master (1993) as simple models demonstrate that density dependence is likely to involve several biological parameters which themselves have biological limits (e.g. fecundity and survival). For UK populations of harbour porpoise (and other marine mammal species), however, there is no published evidence for density dependence and therefore, density dependence assumptions will not be included within the iPCoD model.

[6] The Cumulative Effects Framework (CEF) will be used if the platform is available at the time of drafting, otherwise the iPCoD model will be used (which in any case underpins the CEF).

7.11 Demographics Overview (e.g. Sinclair, 2020)

7.11.1.1 To enable the iPCoD model to be run, the following data will be put into the model:

- demographic parameters for the key species;
- user specified input parameters including vulnerable subpopulations (i.e. assumes that only a proportion of the population are disturbed by piling) and number of residual days of disturbance (i.e. number of days when animals continue to experience disturbance after piling has ceased);
- number of animals predicted to experience PTS and/or disturbance during piling;
- estimated piling schedule during the proposed construction programme.

7.11.1.2 Demographic parameters chosen will be based upon Sinclair *et al.* (2020) for the most relevant area to the Array Project (Table 7.4), unless parameters recommended by stakeholders are provided specific to this project.

Table 7.4: Summary of recommended parameters for iPCoD relevant species and MUs for the Array Project

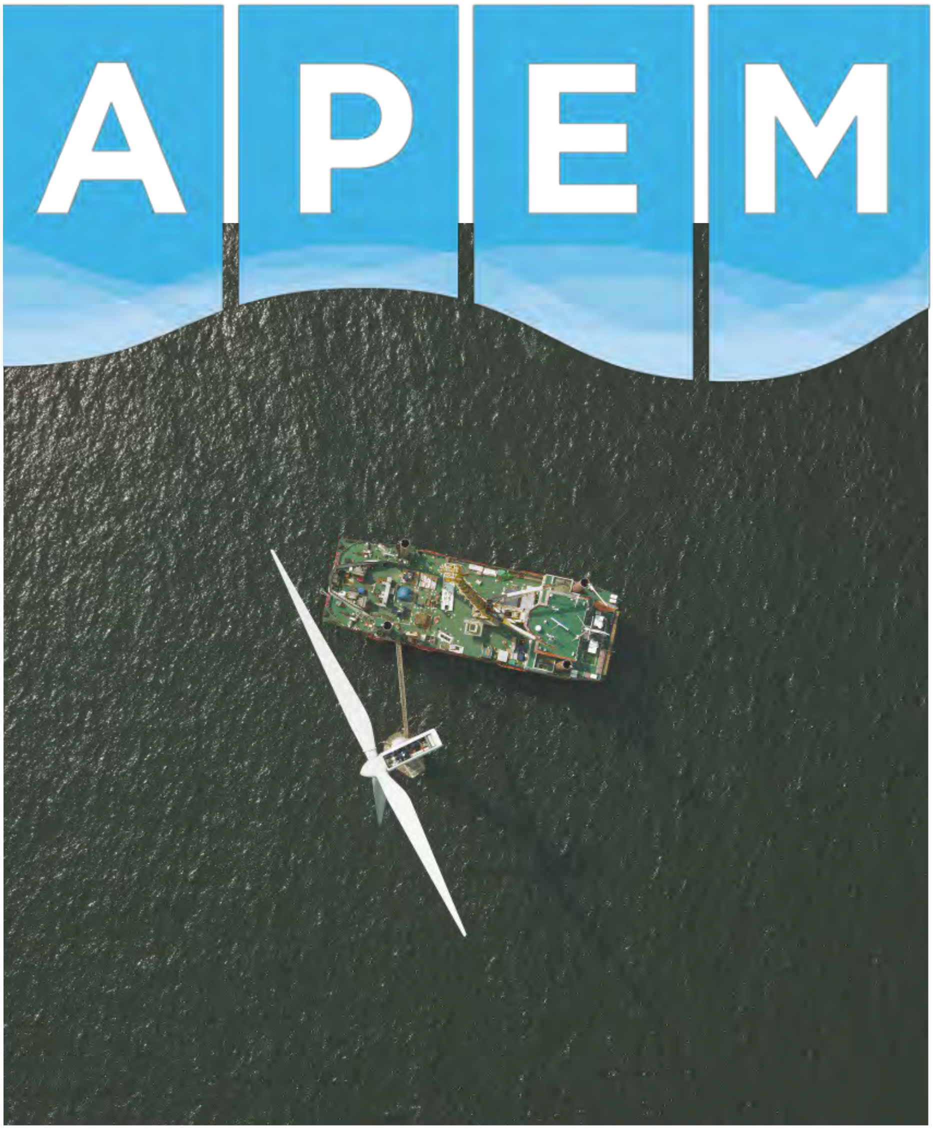
Species	MU/SMA	Age calf becomes independent	Age of first birth	Calf/pup survival	Juvenile survival	Adult survival	Fertility	Growth rate
Harbour porpoise	North Sea	1	5	0.8455	0.85	0.925	0.34	1
Grey seal	All UK	1	6	0.222	0.94	0.94	0.84	1.01
Harbour seal	East Scotland (SMU 7)	1	4	0.4	0.78	0.92	0.85	1
Minke whale	European waters	1	9	0.7	0.77	0.96	0.91	1
Bottlenose dolphin	Greater North Sea MU (all other MUs)	2	9	0.8	0.94	0.94	0.25	1

7.12 Cumulative Modelling Approach

7.12.1.1 The cumulative assessment will use information from the maximum adverse scenarios for other offshore wind projects within the Regional Marine Mammal Study Area. Therefore, given that in-combination maximum adverse scenarios for multiple activities are assumed, it is considered that an additional layer of precaution has been incorporated into our assessment. Where quantitative assessments are provided by projects with piling identified in the Cumulative Marine Mammal Study Area, the numbers of animals experiencing PTS and disturbance will be modelled in a cumulative impact assessment using iPCoD.

7.12.1.2 The number of animals for a given species potentially disturbed during piling and number of days of piling at relevant projects will be derived from respective published environmental statements. Indicative piling schedules will be put into the model to assess temporal overlap between projects. Where actual piling schedules are unknown, the piling days will be spread evenly throughout the offshore construction phases in the model. Population level effects will be measured against the relevant MUs for which an overlap with cumulative projects has been identified and the demographic parameters will apply as per the Array Project alone iPCoD values (Table 7.4).

8 Appendix 8 - Offshore Ornithology Yield 1 data (15 months)



Ornithology & Marine Megafauna Digital Aerial Digital Surveys

Morven Array Project

BP Alternative Energy Investments Ltd

15 Month Report

Year One January 2021 – March 2022

APEM Ref: P00005975

Client:	**BP Alternative Energy Investments Ltd**
Address:	**Chertsey Road, Sunbury on Thames, Middlesex TW16 7BP**
Project reference:	**P00005975**
Date of issue:	**July 2023**

Project Director:	**Gillian Sutherland**
Project Manager:	**Saskia Bloor**
Other:	**Amy J. Williams, Anya Wicikowski, Phoebe Meredith**

APEM Ltd
Aviation Park
Hawarden Airport
Flint Road
Saltney Ferry
Chester
Ch4 0GZ

Tel: 01244 520 460
Fax: 01244 533 741

Registered in England No. 2530851

This report should be cited as:

APEM (2022). Morven 15 Month Report - Aerial Bird & Marine Megafauna Digital Survey, Year 01 January 2021 – March 2022. APEM Scientific Report P5975, BP, 06/07/2023, 327 pp.

Revision and Amendment Register

Version Number	Date	Section(s)	Page(s)	Summary of Changes	Approved by
Draft	08/03/2023	All	All	Creation	SB
V1	16.03.2023	All	All	Review	TC
V2	06/07/2023	All	All	Auk ID and Terms update	SB

Contents

List of Figures

List of Tables

1. Executive Summary

APEM Ltd have been commissioned on behalf of BP Alternative Energy Investments Ltd (BP) to conduct monthly digital aerial surveys of the Morven Development Area off the East coast of Scotland. The aims and objectives of the work were to assess the abundance and distribution of birds and marine megafauna in the development area and four-kilometre (km) buffer surrounding the area (Array Project). The key findings for each of the monthly aerial digital surveys during the first 15 months *(Y01:January 2021– March 2022)* are summarised:

- Survey 01 – January 2021
    - 739 birds were recorded. The most abundant species group was guillemot (n=396), followed by guillemot / razorbill (n=203), kittiwake (n=37), razorbill (n=33), unidentified auk (n=27), fulmar (n=23), puffin (n=9), little auk (n=6), great black-backed gull (n=2), unidentified wader (n=1), herring gull (n=1) and unidentified large gull (n=1).
    - 53 birds (7%) were recorded flying and 686 birds (93%) sitting.
    - One marine megafauna was recorded - seal (n=1), submerged.

- Survey 02 – February 2021
    - 448 birds were recorded. The most abundant species group was guillemot (n=216), followed by razorbill (n=90), guillemot / razorbill (n=60), kittiwake (n=38), fulmar (n=18), puffin (n=12), unidentified auk (n=13) and gannet (n=1).
    - 40 birds (10%) were recorded flying and 408 birds (90%) sitting.
    - Four marine megafauna were recorded - seals (n=2) and dolphin / porpoise (n=2).

- Survey 03 – March 2021
    - 425 birds were recorded. The most abundant species was kittiwake (n=151), followed by guillemot (n=121), puffin (n=53), guillemot / razorbill (n=35), fulmar (n=24), gannet (n=14), unidentified auk (n=11), razorbill (n=10), great black backed gull (n=3), unidentified small gull (n=1), herring gull (n=1) and unidentified diver (n=1).
    - 178 birds (42%) were recorded flying and 247 birds (58%) sitting.
    - Three marine megafauna were recorded - seals (n=1) and dolphin / porpoise (n=2).

- Survey 04 – April 2021
    - 373 birds were recorded. The most abundant species was guillemot (n=184), followed by puffin (n=41) fulmar (n=41), gannet (n=38), kittiwake (n=25), razorbill (n=20), guillemot / razorbill (n=16), unidentified auk (n=7), unidentified small gull (n=1).
    - 107 birds (28%) were recorded flying and 266 birds (72%) sitting.
    - 12 marine megafauna were recorded - seals (n=7), harbour porpoise (n=3) and dolphin / porpoise (n=2).

- Survey 05 – May 2021
    - 803 birds were recorded. The most abundant species was guillemot (n=468), followed by gannet (n=96), puffin (n=64), kittiwake (n=59), fulmar (n=36), guillemot / razorbill (n=21), razorbill (n=20) unidentified auk (n=19), unidentified wader (n=9), golden plover (n=5), Arctic tern (n=2), unidentified small gull (n=1), black guillemot (n=1), red-throated diver (n=1) and Manx shearwater (n=1).
    - 180 birds (22%) were recorded flying and 623 birds (78%) sitting.

  - 160 marine megafauna were recorded - harbour porpoise (n=116); dolphin / porpoise (n=32), dolphins (n=9), seals (n=2),common minke whale (n=1). One unidentified shark (n=1) was also recorded.

- Survey 06 – June 2021
  - 3,684 birds were recorded. The most abundant species was guillemot (n=2,308), followed by kittiwake (n=891), razorbill (n=195), guillemot / razorbill (n=64), gannet (n=142), puffin (n=46), unidentified auk (n=12), fulmar (n=12), unidentified gull (n=5), auk / shearwater (n=3), herring gull (n=2), Manx shearwater (n=2), storm petrel (n=1) and osprey (n=1).
  - 578 birds (16%) were flying, 3,105 birds (84%) sitting and one (<1%) diving.
  - 19 marine megafauna were recorded - white-beaked dolphin (n=10); harbour porpoise (n=3); dolphin / porpoise (n=2); grey seal (n=1); unidentified dolphin (n=1); common minke whale (n=1); unidentified marine mammal (n=1).

- Survey 07 – July 2021
  - 6,195 birds were recorded. The most abundant species was guillemot (n=3,888), followed by razorbill (n=1,142), guillemot / razorbill (n=454), gannet (n=268), auk / shearwater (n=99), unidentified auk (n=90), kittiwake (n=69), Manx shearwater (n=49), puffin (n=46), herring gull (n=41), fulmar (n=40), Arctic tern (n=4), common / Arctic ('commic') tern (n=3), unidentified tern (n=3), unidentified large gull (n=2), great black-backed gull (n=1), unidentified skua (n=1) and unidentified bird (n=1).
  - 247 birds (4%) were recorded flying and 5,948 birds (96%) sitting.
  - 60 marine megafauna were recorded - harbour porpoise (n=47), white-beaked dolphin (n=4), marine mammal (n=3), common minke whale (n=2), dolphin / porpoise (n=2), seal (n=1), unidentified whale (n=1).

- Survey 08 – August 2021
  - 579 birds were recorded. The most abundant species was guillemot (n=161), followed by fulmar (n=159), gannet (n=83), puffin (n=79), guillemot / razorbill (n=31), unidentified auk (n=18), razorbill (n=16), kittiwake (n=13), commic tern (n=13), small gull (n=2), great skua (n=1), unidentified gull (n=1), unidentified large gull (n=1) and unidentified storm petrel (n=1).
  - 128 birds (22%) were recorded flying and 451 (78%) sitting.
  - A total of 10 marine megafauna were recorded - harbour porpoise (n=7), white-beaked dolphin (n=2) and unidentified marine mammal (n=1).

- Survey 09 – September 2021
  - 2,117 birds were recorded. The most abundant species recorded was guillemot (n=1,257), followed by puffin (n=291), gannet (n=166), kittiwake (n=123), guillemot / razorbill (n=121), razorbill (n=81), fulmar (n=50), unidentified auk (n=19), Arctic skua (n=2), sooty shearwater (n=2), unidentified bird (n=2), Arctic / long-tailed skua (n=1), great skua (n=1) and small gull (n=1).
  - A total of 183 birds (9%) were recorded in flight during this survey, 1,933 birds (91%) were recorded sitting, and one deceased (<1%).
  - 19 marine megafauna were recorded - harbour porpoise (n=9), white-beaked dolphin (n=8), and unidentified marine mammal (n=2).

- Survey 10 – October 2021
  - 448 birds were recorded. The most abundant species recorded was fulmar (n=127), followed by guillemot (n=112), gannet (n=101), guillemot / razorbill (n=49), kittiwake (n=39), puffin (n=8), razorbill (n=6), unidentified storm petrel

(n=2), common gull (n=1), great black-backed gull (n=1), great skua (n=1) and unidentified bird (n=1).
  - 179 birds (40%) were recorded flying and 269 birds (60%) sitting.
  - Nine cetaceans were recorded - harbour porpoise (n=5) and dolphin / porpoise (n=4).

- Survey 11 – November 2021
  - 707 birds were recorded. The most abundant species group recorded was guillemot (n=378), followed by, fulmar (n=185), guillemot / razorbill (n=71), kittiwake (n=16), razorbill (n=16), unidentified auk (n=10), gannet (n=10), great black-backed gull (n=9), unidentified thrush (n=6), puffin (n=4), common gull (n=1) and herring gull (n=1).
  - 105 birds (15%) were recorded flying and 602 birds (85%) sitting.
  - Three marine megafauna were recorded - harbour porpoise (n=2) and unidentified seal (n=1).

- Survey 12 – December 2021
  - 497 birds were recorded. The most abundant species group recorded was guillemot / razorbill (n=203), followed by guillemot (n=153), fulmar (n=91), razorbill (n=26), kittiwake (n=7), puffin (n=7), great black-backed gull (n=5), and gannet (n=3), unidentified auk (n=2).
  - 94 birds (19%) were recorded flying and 403 birds (81%) sitting.
  - 10 marine megafauna were recorded - harbour porpoise (n=7), unidentified marine mammal (n=2), and grey seal (n=1).
- Survey 13 – January 2022
  - 129 birds were recorded. The most abundant species group recorded was guillemot (n=71), followed by guillemot / razorbill (n=28), fulmar (n=11), razorbill (n=9), kittiwake (n=4), unidentified auk (n=2), unidentified bird (n=2), great black-backed gull (n=1), and gannet (n=1).
  - 20 birds (16%) were recorded flying and 109 birds (84%) sitting.
  - Five white beaked dolphin were recorded in the Array Project in January.
- Survey 14 – February 2022
  - 416 birds were recorded. The most abundant species recorded was guillemot (n=206), followed by guillemot / razorbill (n=103), fulmar (n=50), kittiwake (n=34), razorbill (n=8), great black-backed gull (n=7), gannet (n=4), unidentified bird (n=3), and puffin (n=1).
  - 72 birds (n=17%) were recorded flying and 344 birds (83%) sitting.
  - 26 marine megafauna were recorded – white-beaked dolphin (n=8), harbour porpoise (n=7), dolphin / porpoise (n=6), unidentified seal (n=3), grey seal (n=1), and unidentified marine mammal (n=1).
- Survey 15 – March 2022
  - 545 birds were recorded. The most abundant species recorded was guillemot (n=435), followed by guillemot / razorbill (n=37), kittiwake (n=25), fulmar (n=14), razorbill (n=14), puffin (n=3), unidentified auk (n=14), and gannet (n=3).
  - 60 birds (11%) were recorded flying and 500 birds (89%) sitting.
  - Thirteen marine megafauna were recorded – harbour porpoise (n=6), unidentified seal (n=5), and unidentified marine mammal (n=2).

2. Introduction

BP Alternative Energy Investments Ltd (BP) commissioned APEM Ltd (APEM) to undertake two years and three months of monthly aerial digital surveys of the Morven development site plus a four-kilometre (km) buffer around the area (hereafter known as Array Project). The primary objective of the work was to assess the abundance and distribution of birds and marine megafauna present in the Array Project. This data will meet the aims and objectives of the work required by BP to inform future environmental impact assessment work for the proposed wind farm development site.

3. Data Collection and Analysis

3.1 Summary of Aerial and Digital Surveys

The Morven Array Project is located off the east coast of Scotland, in the North Sea (Figure 1). Surveys commenced in January 2021 and are planned to be on-going until September 2023.

The survey method was designed to optimise the data collection for ornithological and marine megafauna by using a grid-based collection method. APEM's bespoke camera system was fitted into a twin-engine aircraft. Custom flight planning software allowed each flight line to be accurately mapped for use before and during the flight. The camera system captured abutting still imagery along 34 survey lines spaced approximately two km between-track. The aircraft collected the data at an altitude of approximately 400 meters (m) and a speed of approximately 120 knots. The data collected were 1.5 cm ground survey distance (GSD) digital still images. At least 30% coverage of the sea surface was collected, of which 10% was analysed in a grid-based survey design.

The Morven Array Project covers approximately 860km^2, with the 4km buffer the total area is 1,420km^2. Of the Array Project plus buffer, approximately 468km^2 of images are collected with 156km^2 analysed. Survey lines vary in length from approximately 3.3km to 23.2km, with a total surveyed length of 711.2km.

No health and safety issues were reported during the surveys. The dates, start and end times for each survey are provided in Table 1, with the corresponding weather conditions in Table 2.

All surveys are undertaken in weather conditions that did not compromise the ability to provide data on the identification, distribution and abundance of bird species and marine megafauna. Favourable conditions for surveying are defined as a cloud base of >396 m, visibility of > five km, wind speed of <30 knots and a sea state of no more than four (moderate). For health and safety, no surveys were undertaken in icing conditions.

Measures were taken to minimise glint and glare (strong reflected light off the sea) that make finding and identifying bird species and marine megafauna more difficult. On days with minimal cloud, surveys were avoided for two hours around midday. This reduced the risk of collecting images that are difficult to analyse.

In winter months weather windows can be short-lived. When days are short, the expected time on task for the survey is assessed against the available daylight hours and our aircraft endurance. The aircraft Apem ltd uses are long range, and the endurance maximises time available on task without requiring refuelling. If the time on task for a survey is too long to be completed in a single day this will be discussed with BP in advance. Where the survey is preferred to be completed in a single day then options for contingency plans include pre-positioning of aircraft ahead of survey or use of more than one aircraft. However, if it is deemed necessary then surveys can be undertaken across two consecutive days.

Table 1 Date and start / end times (Coordinated Universal Time) for each flight for the January 2021 to December 2021 surveys

Survey No.	Date	Start Time (HH:MM)	End Time (HH:MM)
01	18/01/2021	09:54	14:27
02	16/02/2021	09:53	12:35
		14:45	16:36
	17/02/2021	10:08	13:18
		15:40	16:39
03	13/03/2021	09:59	14:02
04	01/04/2021	11:16	15:53
05	09/05/2021	09:29	11:36
		08:25	10:37
06	11/06/2021	08:31	11:09
		13:58	16:29
07	17/07/2021	09:26	13:58
		10:28	17:55
08	02/08/2021	09:55	14:15
09	14/09/2021	10:41	14:44
10	16/10/2021	08:59	13:01
11	09/11/2021	09:58	13:42
		13:02	13:31
12	07/12/2021	10:15	11:58
		10:28	12:47
13	15/01/2022	10:15	15:07
14	19/02/2022	11:13	15:17
15	07/03/2022	10:36	14:40

Table 2 Weather conditions during all surveys from January 2021 to December 2021

Survey No.	Date	Visibility (km)	Sea State	Glint / Glare (%)	Turbidity[2]	Cloud (%)[3]	Air Temp (ºC)	Wind Speed (knots) / Direction
01	18/01/2021	10+	1–2	-	1	20–70	4	25 / W
02	16/02/2021	7–10+	1	-	1	20–40	6–8	30–35 / SSW
	17/02/2021	10+	1–3	-	1	50–60	7	30–40 / S–SSW
03	13/03/2021	10+	1	-	1	30–70	1–2	12 / NNE
04	01/04/2021	10+	0	-	1	50–70	2	6–13 / NNE–NE
05	09/05/2021	10+	1–2	10–50	0–1	10–30	9–10	13–26 / W–SW
06	11/06/2021	10+	4	0–30	0	0–100	12–13	28–39 / W–SW
07	17/07/2021	20+	3	30–40	1–2	0–20	18–21	20–31 / W–WNW
08	02/08/2021	20+	2	0–5	1	90	9–10	1–11 / SW–NNW

Survey No.	Date	Visibility (km)	Sea State	Glint / Glare (%)	Turbidity[2]	Cloud (%)[3]	Air Temp (ºC)	Wind Speed (knots) / Direction
09	14/09/2021	10+	2	0–10	0	50–100	12	8–20 / S
10	16/10/2021	10+	2–3	0	3	5	5–7	12–20 / W–WNW
11	09/11/2021	10+	2	0–5	2	50–100	10	20 / W
12	07/12/2021	10+	2–3	0	2	5–100	3	22–25 / S–SE
13	15/01/2022	10+	4+	0	1–2	50–70	2	31–50 / NW
14	19/02/2022	10+	2–3	0–15	0.5	0–50	0–1	12–20 / NW
15	07/03/2022	10+	3	0	2	0–100	2–3	25 / SW

[1] 0 = Calm (Glassy); 1 = Calm (Rippled); 2 = Smooth; 3 = Slight; 4 = Moderate
[2] 0 = Clear; 1 = Slightly Turbid; 2 = Moderately Turbid; 3 = Highly Turbid
[3] 0 = Clear; 1-10 = Few; 11-50 = Scattered; 51-95 = Broken; 96-100 = Overcast

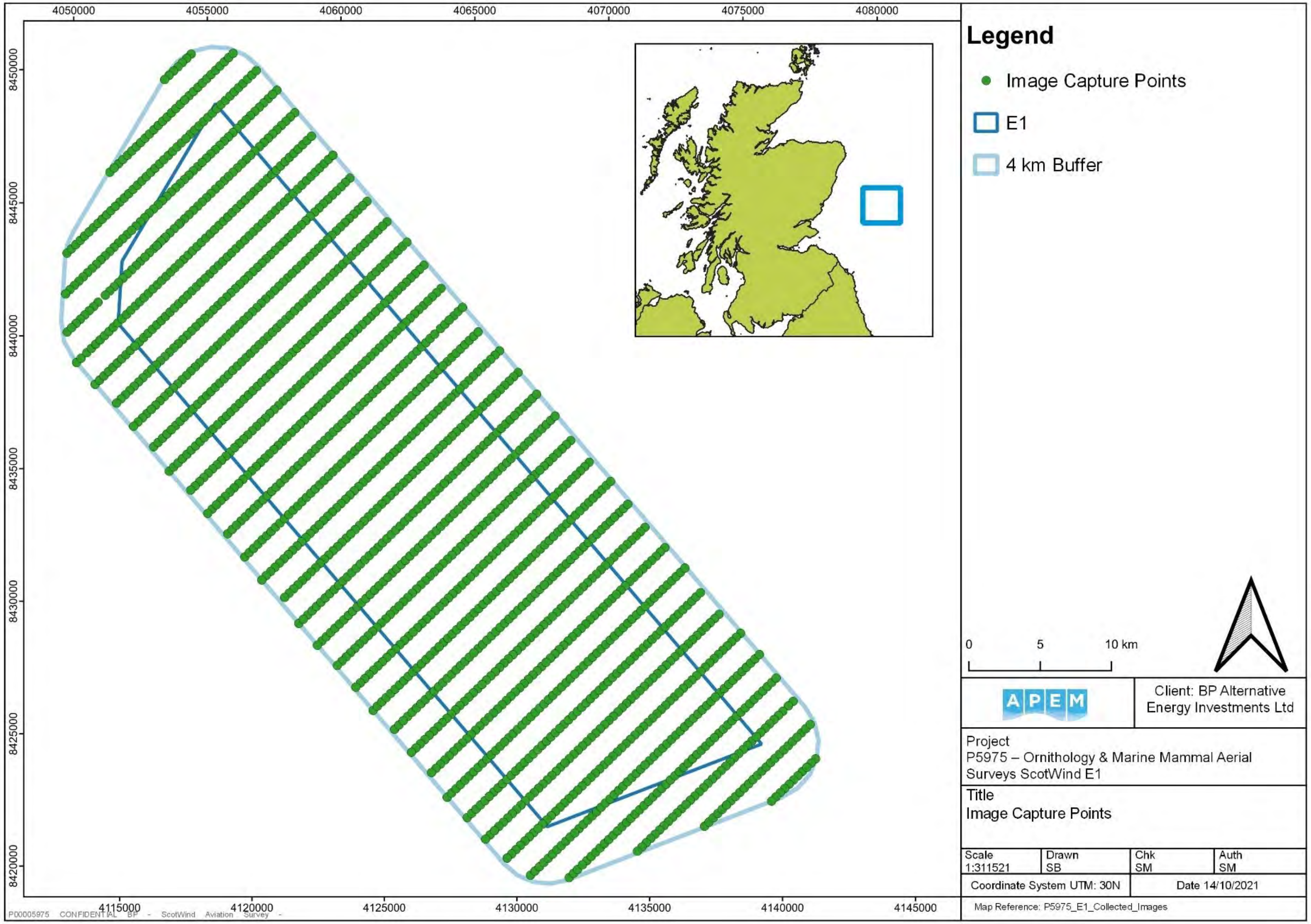


Figure 1 Morven Array Project with 4 km buffer and image capture points

3.2 Data Processing

All images collected were georeferenced using the geographical data derived from the GPS-linked bespoke flight management system. A GPS log was recorded during the survey flights, with GPS positions recorded at the start and end of each line flown and for each image captured. These data were uploaded to a GIS to generate flight log shapefiles to represent the flight lines flown and the image nodes captured.

Images were analysed by trained experts for the presence of birds and marine megafauna. Using APEM's bespoke image analysis software, the images were georeferenced, and the spatial location was accurately determined for any individuals at the water surface or in-flight.

APEM scientists have considerable experience in identifying birds and marine megafauna from aerial images. Every sighting recorded on these surveys was viewed by at least two members of staff as part of our comprehensive quality assurance (QA) process. Blank image QA was performed on at least 10% of the imagery to ensure no birds were missed. Finally, all taxonomic IDs were checked by our experienced QA manager.

Once the image analysis was completed, APEM's BIRD software automatically generated a tabulated database containing information corresponding to each individual sighting including group / species, geographical position of the individual, timing of the sighting and behaviour (flying, sitting, submerged etc.). The database was exported into Excel format to provide simple raw count-based data. Taking the positional information stamped to each sighting, the sightings were plotted directly into a GIS to create shapefiles, whereby each sighting is represented by a single point. The digital nature of both the outputs (tables and shapefiles) has facilitated both the statistical and spatial statistical analyses to be performed on the data.

3.3 Species Abundance Estimates

For each monthly survey species specific abundance and density estimates are produced, with upper and lower confidence limits and precision estimates in the form of a coefficient of variation (*CV*). Georeferenced locations of birds are contained within each individual digital still image to generate raw counts, with bird locations extracted using ArcGIS.

The raw counts were divided by the number of images collected to give the mean number of birds per image (i). Population estimates (N) for each survey month were generated by multiplying the mean number of birds per image by the total number of images required to cover the entire study area (A):

$$N = i\,A$$

Non-parametric bootstrap methods were used for variance estimation - a variability statistic by re-sampling 999 times with replacement from the raw count data. The statistic was evaluated from each of these samples and upper and lower 95% confidence intervals of the 999 values taken as the variability of the statistic over the population.

Measures of precision were calculated using a Poisson estimator, suitable for a pseudo Poisson over-dispersed distribution. This produces a *CV* based on the relationship of the standard error to the mean. A *CV* or target precision of ≤ 0.16 allows the detection of a population change of a factor as small as 2.

All analysis and data manipulation carried out by APEM was conducted in the R programming statistical package and non-parametric 95% confidence intervals generated using the 'boot' library of function.3.4 Species Distribution Maps.

Each bird, marine megafauna, or anthropogenic artefact located in the imagery of the surveys was georeferenced so these locations could be related to the boundary of the Array Project.

3.4 Species Flight Directions and Rose Diagrams

The directions of birds in flight are recorded from all digital still images. The axis of bill to tail is measured in our bespoke image analysis software, taking the bearing relative to the bird's head. When linked to the georeferenced image, this gives us an accurate representation of bird orientation at time of image capture. These data can be used to explore the predominant flight direction of each species during a survey or a season by creating circular statistic outputs or 'rose diagrams' (e.g. Table 4).

In flight direction rose diagrams, proportions of flight directions are given for each survey and the combined surveys. These are shown by dashed circles, and the length of each wedge (shaded in blue) indicates the relative proportions of flights recorded in a particular direction. The black line running from the centre to the outer edge represents the mean flight direction. The arcs extending to either side of the black line represent the 95 % confidence limits of the mean, and if the confidence limit is unreliable the arc is displayed in red.

4. Species Accounts

4.1 Golden Plover – *Pluvialis apricaria*

Golden plovers were recorded in May 2021 only - five individuals, resulting in an abundance estimate of 41 within the Array Project (Table 3).

They were in the southwest of the Array Project (Figure 2).

Golden plovers were recorded flying in a statistically significant north-north-west direction, with a vector of 293.519 ($p<0.05$) (Figure 3).

Table 3 Raw counts, abundance and density estimates of golden plover in the Array Project.

Survey	Raw Count	Sitting	Flying	Abundance	Lower CL	Upper CL	Precision	Density
May-21	5	-	5	41	5	123	0.45	0.03

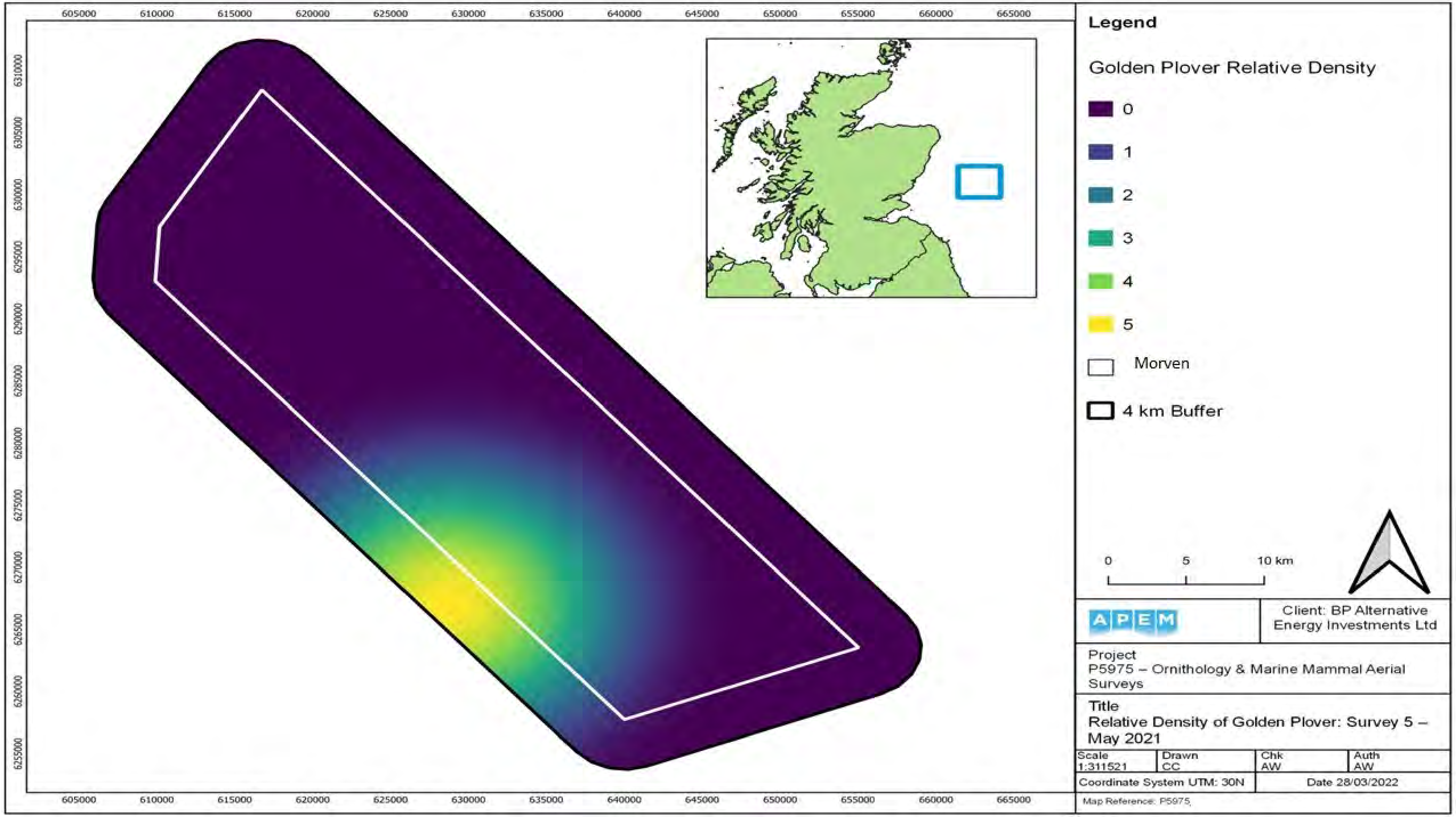
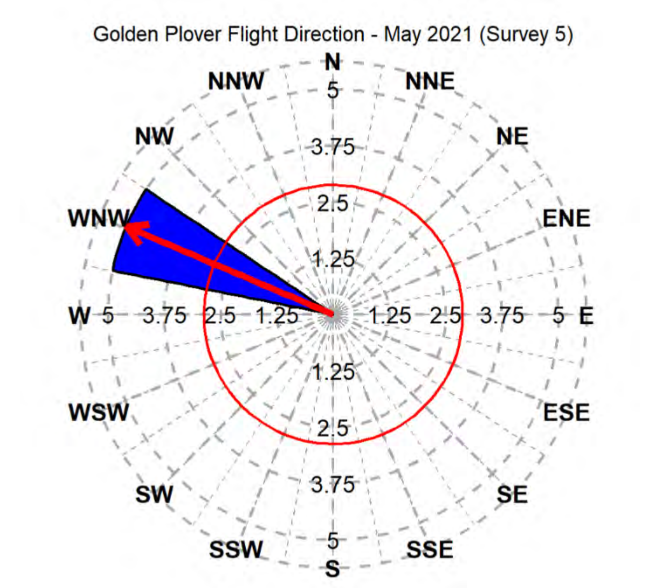


Figure 2 Relative density of golden plover in the Array Project during May 2021 (Survey 05).



Number of Observations	5
Mean Vector (µ)	293.519
Length of Mean Vector (r)	0.996
Rayleigh Test (Z)	4.957
Rayleigh Test (p)	0.001

Figure 3 Summary of flight direction of golden plover recorded in the Array Project.

4.2 Waders – Unidentified

Unidentified waders were recorded in January and May 2021. Peak numbers were in May - nine individuals, resulting in an abundance estimate of 73 within the Array Project (Table 4).

These were in the northeast during January (Figure 4) and southeast during May (Figure 5).

During January, wader species had no significant direction of flight ($p>0.05$). During May, wader species were flying in a significant north north-westerly direction of 333.9° ($p<0.05$) (Figure 6).

Table 4 Raw counts, abundance and density estimates of waders (unidentified) in the Array Project.

Survey	Raw Count	Sitting	Flying	Abundance	Lower CL	Upper CL	Precision	Density
Jan-21	1	-	1	8	1	24	1.00	0.01
May-21	9	-	9	73	9	221	0.33	0.05

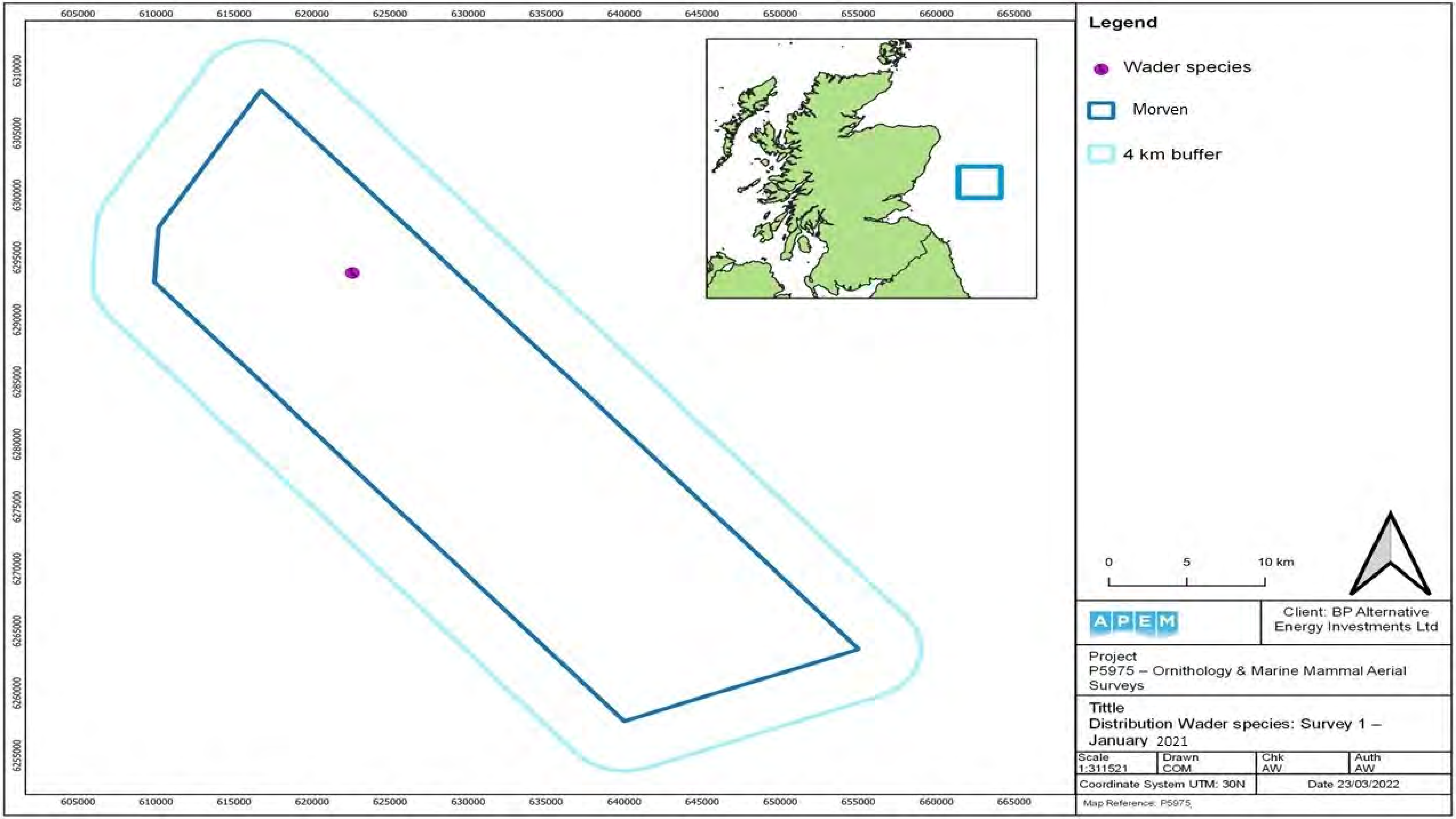


Figure 4 Location of an unidentified wader in January 2021 (Survey 01).

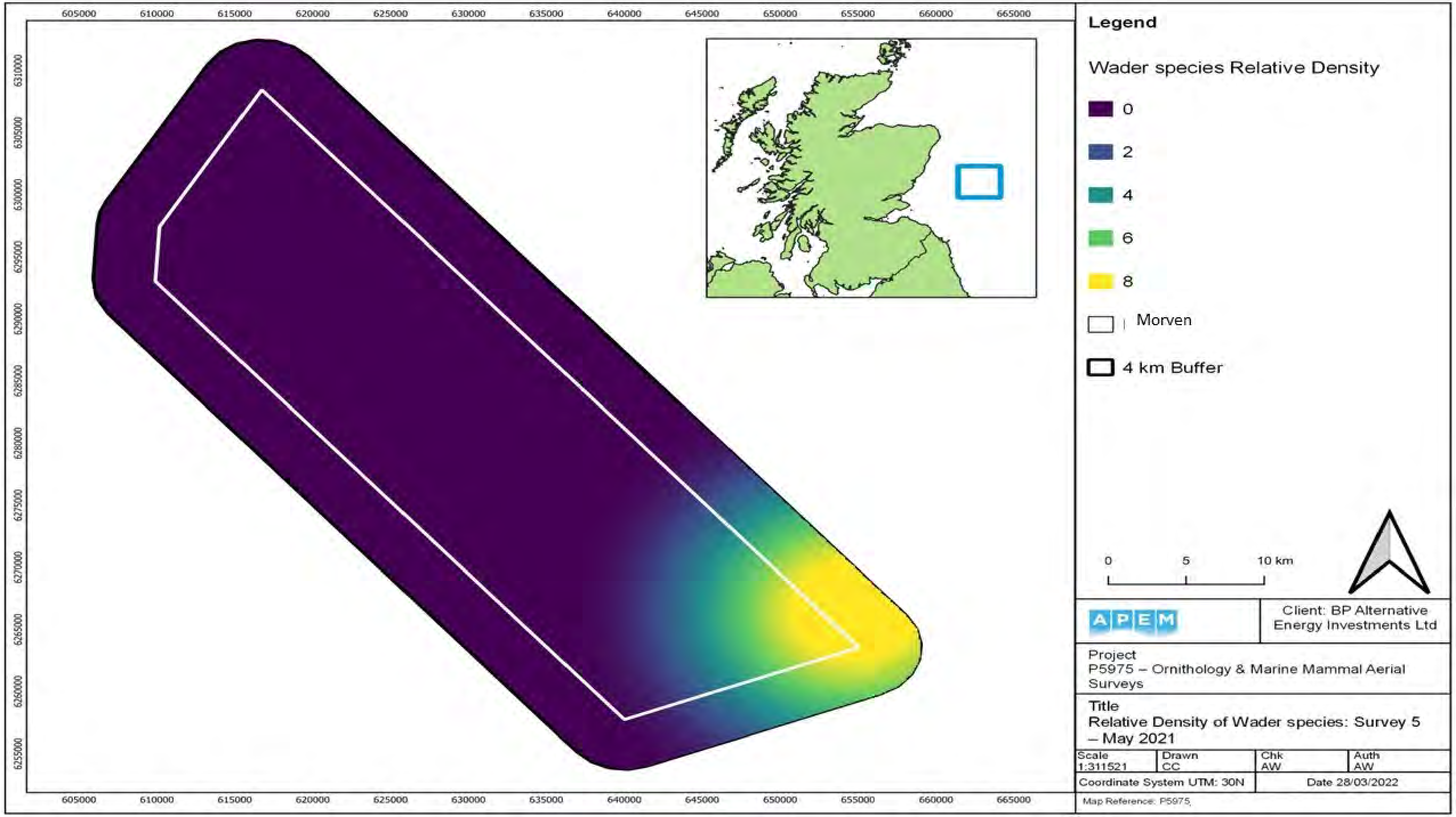
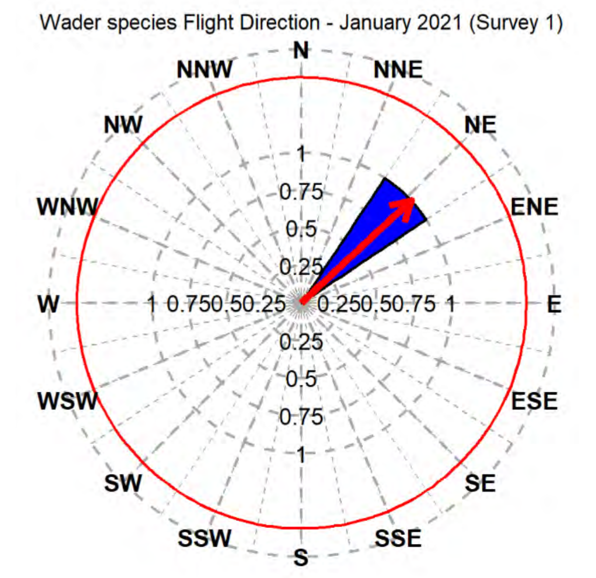
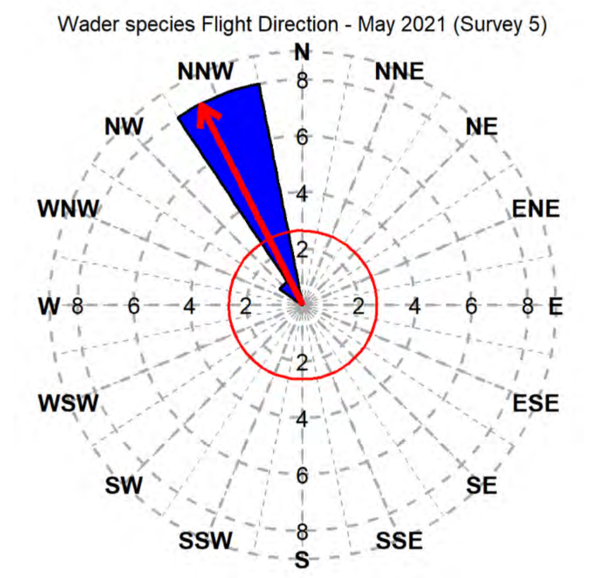


Figure 5 Relative density of unidentified waders in the Array Project during May 2021 (Survey 05).





Number of Observations	1	Number of Observations	9
Mean Vector (μ)	47.088	Mean Vector (μ)	333.942
Length of Mean Vector (r)	1.000	Length of Mean Vector (r)	0.992
Rayleigh Test (Z)	1.000	Rayleigh Test (Z)	8.854
Rayleigh Test (p)	0.512	Rayleigh Test (p)	<0.001
Figure 6a January 2021 (Survey 01)		**Figure 6b May 2021 (Survey 05)**	

Figure 6 Summary of flight direction of unidentified waders recorded in the Array Project.

4.3 Kittiwake – *Rissa tridactyla*

Kittiwake were recorded in all months. Peak numbers were in June - 891 individuals, resulting in an abundance estimate of 7,337 within the Array Project (Table 5).

These were recorded throughout the Array Project - in the north during January 2021 (Figure 7), April (Figure 10), May (Figure 11), July (Figure 13), August (Figure 14), February 2022 (Figure 21) and March 2022 (Figure 21); the south during February 2021 (Figure 8), March 2021 (Figure 9), and December (Figure 18); center during June (Figure 12), September (Figure 15), and November (Figure 17); and central and north in January 2022 (Figure 19).

Kittiwakes were observed flying in a predominantly south-westerly direction, in January 2021, February 2021, May, June, October and November ($p<0.05$). They were flying in a significant north-easterly direction in March ($\mu=43.241$, $p<0.05$), south-easterly in September and December ($\mu=133.623$, $\mu=149.973$; $p<0.05$). In February and March 2022 kittiwake were recorded flying in a significant westerly direction ($p<0.05$), and a significant southerly direction ($p<0.05$) in January 2022.

Age class of kittiwake were recorded in the surveys. 60% of kittiwake were recoded as adult, 32% as unknown, 4% first winter, 2% first summer and 2% juvenile (Table 6).

Kittiwake showed no significant direction of flight in April, July and August ($P>0.05$) (Figure 22).

Table 5 Raw counts, abundance and density estimates of kittiwake in the Array Project.

Survey	Raw Count	Sitting	Flying	Abundance	Lower CL	Upper CL	Precision	Density
Jan-21	37	7	30	301	203	423	0.16	0.21
Feb-21	38	18	20	310	188	457	0.16	0.22
Mar-21	151	13	138	1,250	1,026	1,498	0.08	0.88
Apr-21	25	11	14	202	113	307	0.20	0.14
May-21	59	9	50	482	319	670	0.13	0.34
Jun-21	891	418	473	7,337	6,481	8,202	0.03	5.17
Jul-21	69	62	7	566	139	1,164	0.12	0.4
Aug-21	13	6	7	107	41	172	0.28	0.08
Sep-21	123	55	68	1,011	649	1,438	0.09	0.71
Oct-21	39	-	39	313	185	474	0.16	0.22
Nov-21	16	3	13	133	75	199	0.25	0.09
Dec-21	7	1	6	57	25	99	0.38	0.04
Jan-22	4	-	4	32	8	72	0.50	0.03
Feb-22	34	6	28	276	187	373	0.17	0.19
Mar-22	22	5	17	176	104	265	0.21	0.16

Table 6 Raw counts of age classes of kittiwake

Survey	Raw Count	Juvenile	First Summer	First Winter	Adult	Unknown
Jan-21	37	-	-	9	23	5
Feb-21	38	-	-	11	26	1
Mar-21	151	-	-	16	133	2
Apr-21	25	-	3	-	13	9
May-21	59	0	8	0	51	0
Jun-21	891	-	8	-	523	360
Jul-21	69	1	1	-	26	41
Aug-21	13	-	1	-	5	7
Sep-21	123	33	8	-	29	53
Oct-21	39	-	-	20	19	-
Nov-21	16	-	-	-	16	-
Dec-21	7	-	-	-	7	-
Jan-22	4	-	-	-	4	-
Feb-22	34	1	-	-	26	7
Mar-22	22	-	-	3	14	8
Total	**1,531**	**35**	**29**	**59**	**915**	**493**

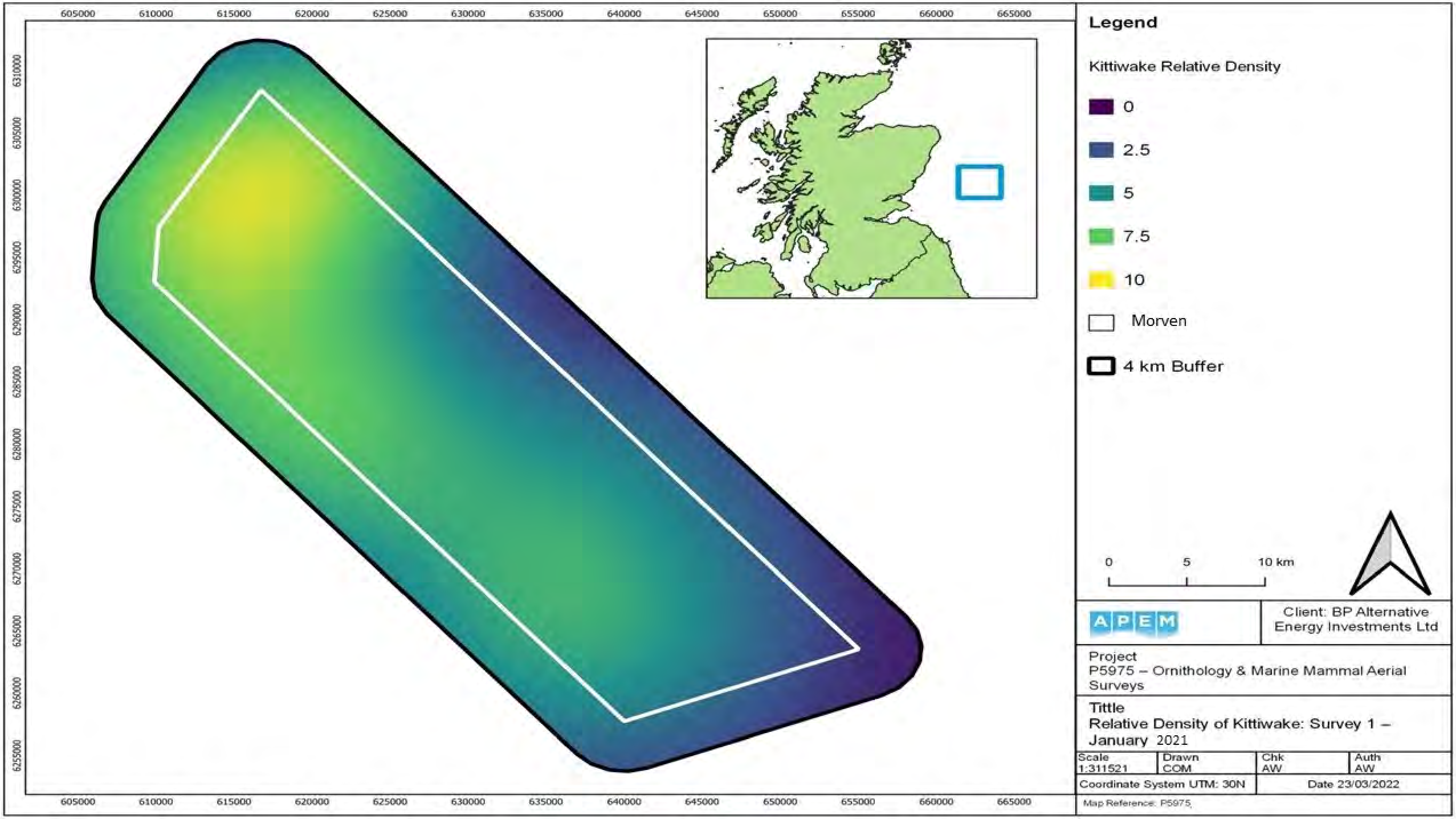


Figure 7 Relative density of kittiwake in January 2021 (Survey 01).

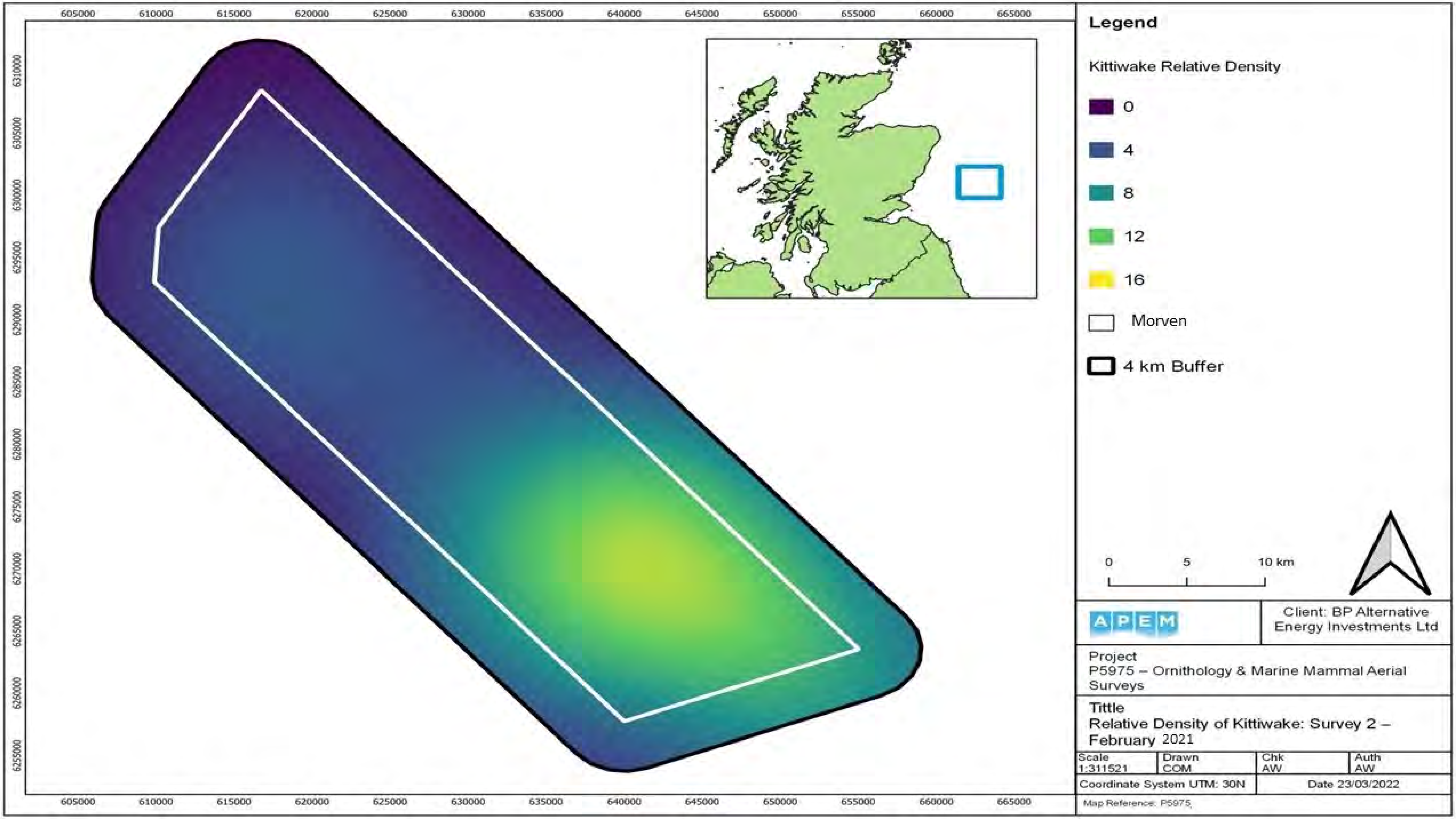


Figure 8 Relative density of kittiwake in February 2021 (Survey 02).

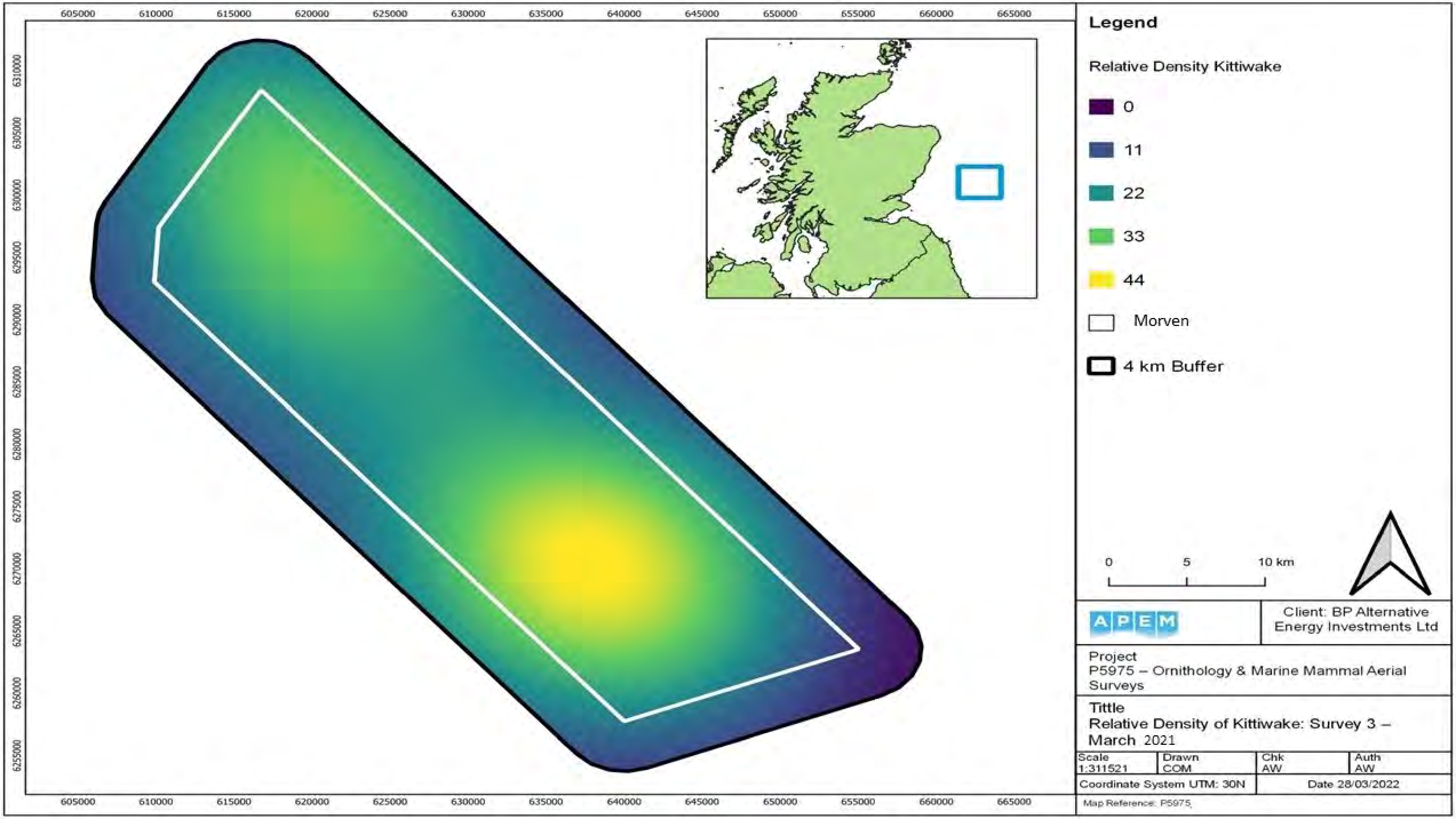


Figure 9 Relative density of kittiwake in March 2021 (Survey 03).

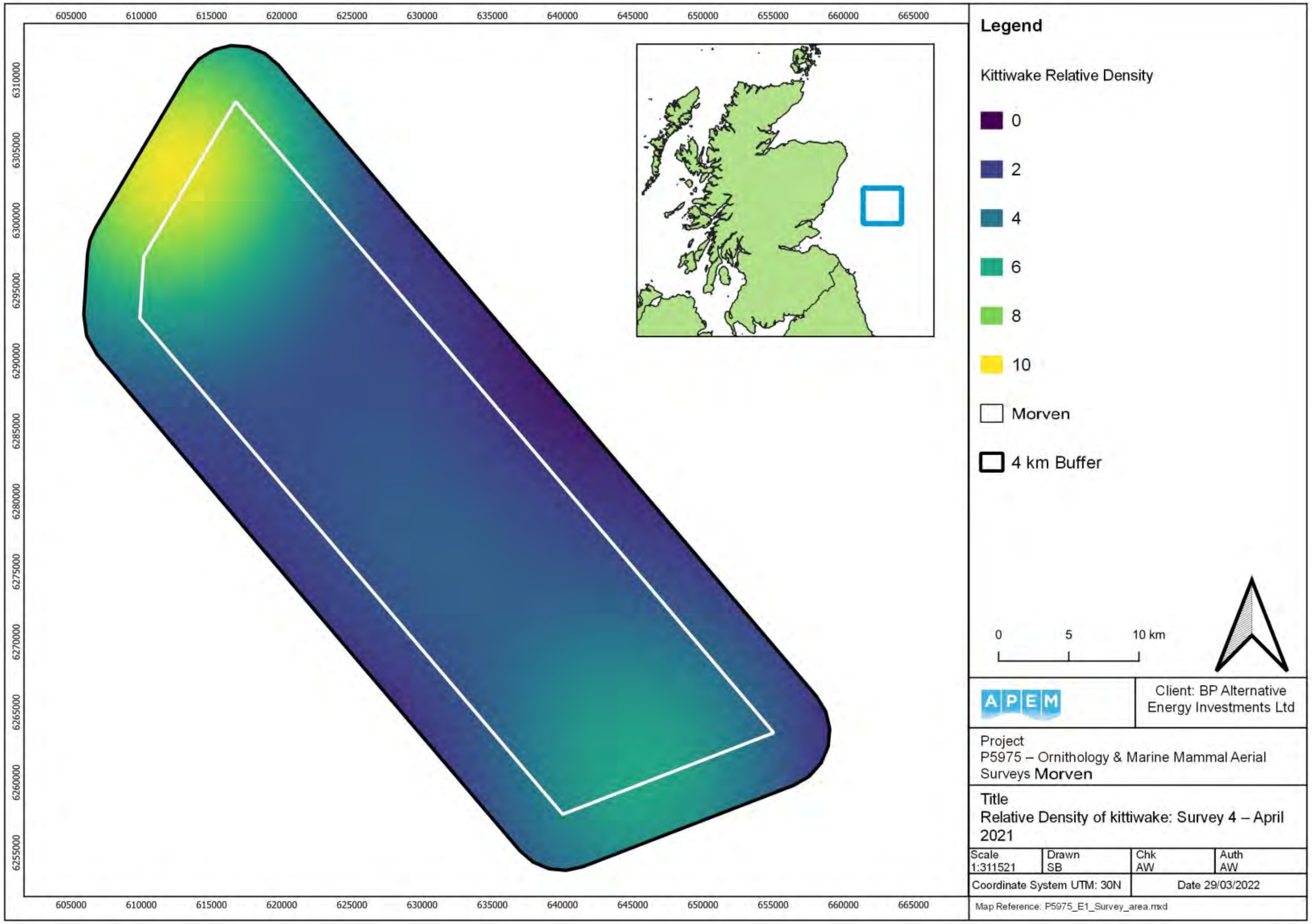


Figure 10 Relative density of kittiwake in April 2021 (Survey 04).

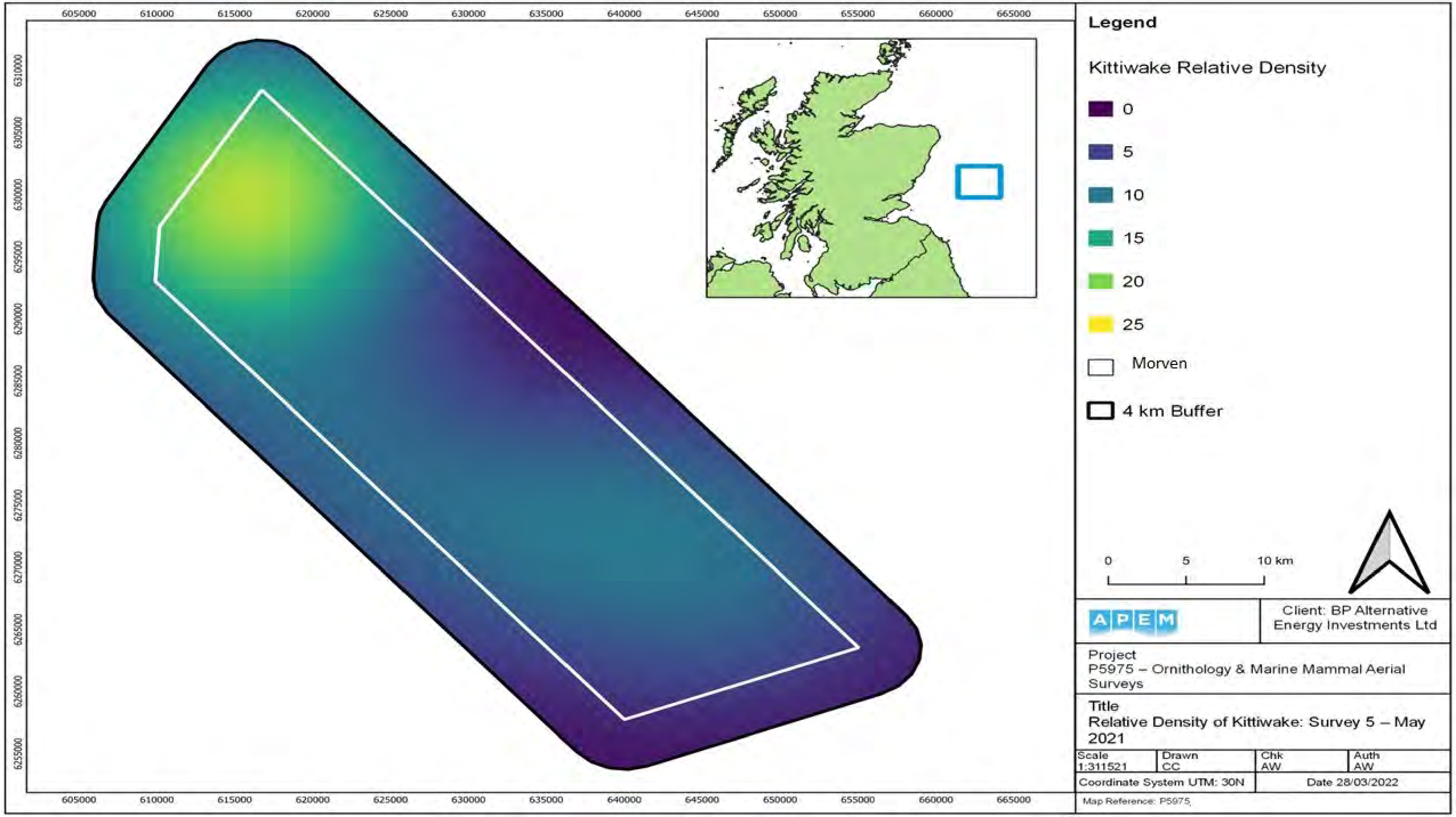


Figure 11 Relative density of kittiwake in May 2021 (Survey 05).

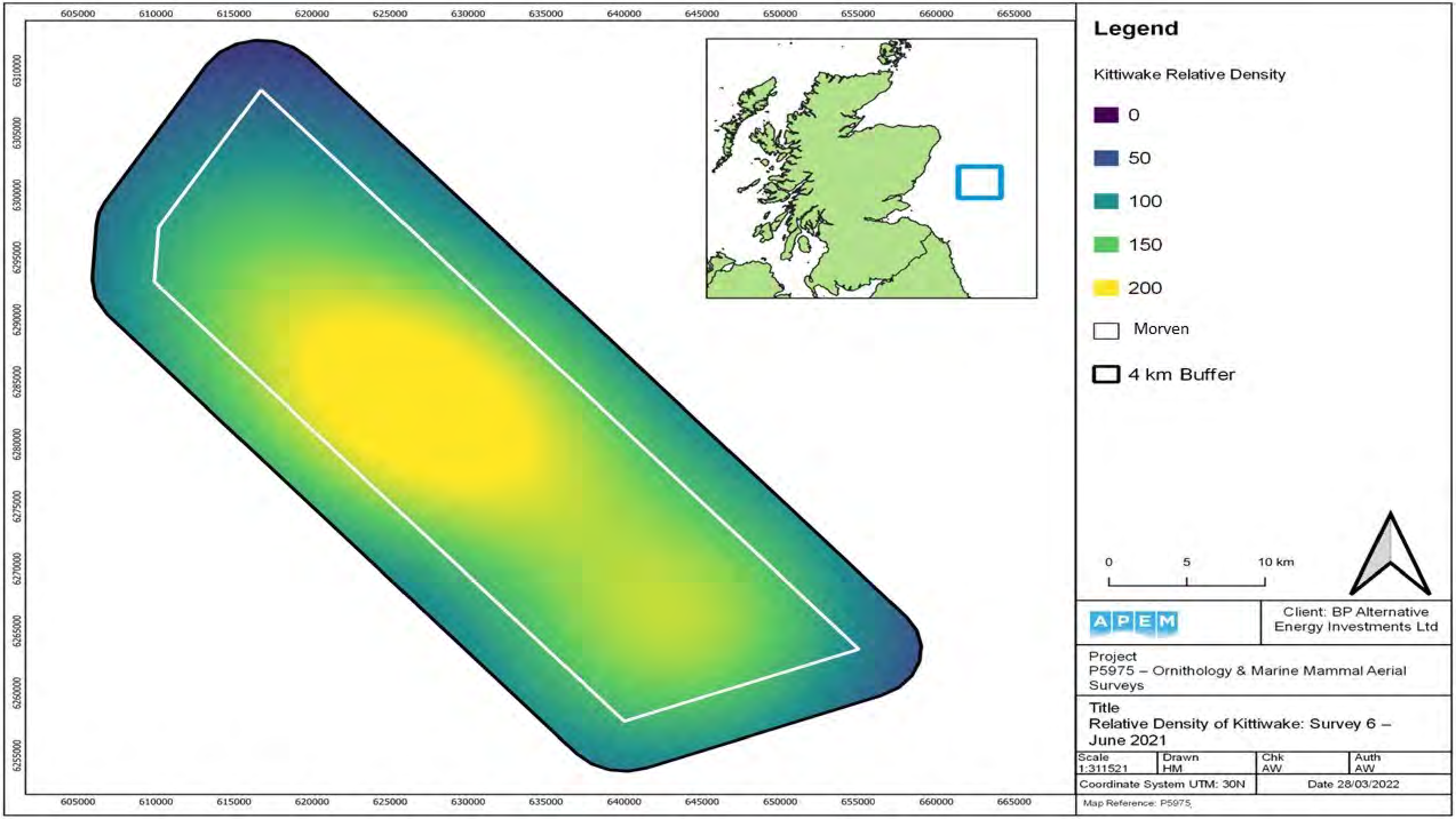


Figure 12 Relative density of kittiwake in June 2021 (Survey 06).

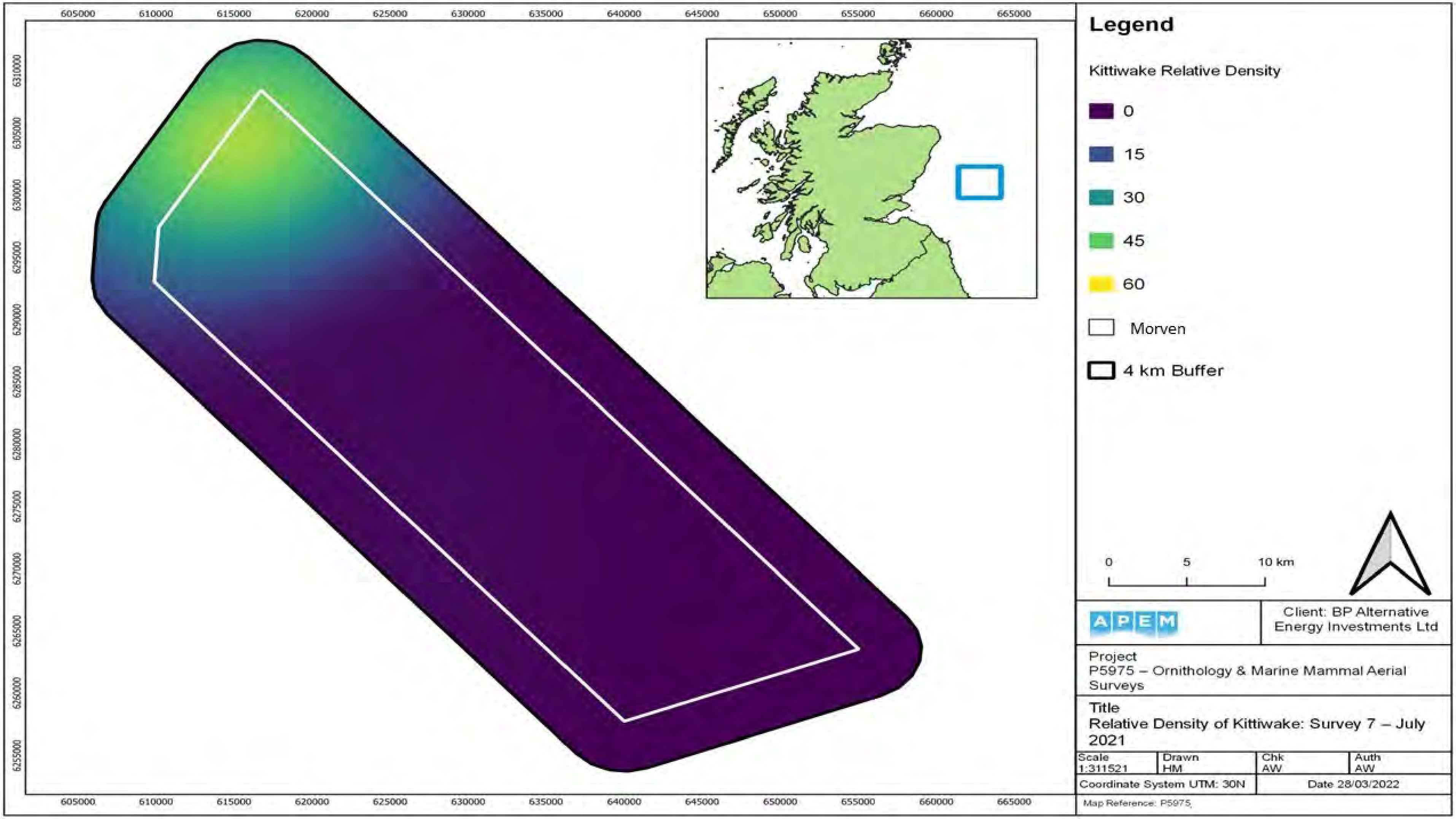


Figure 13 Relative density of kittiwake in July 2021 (Survey 07).

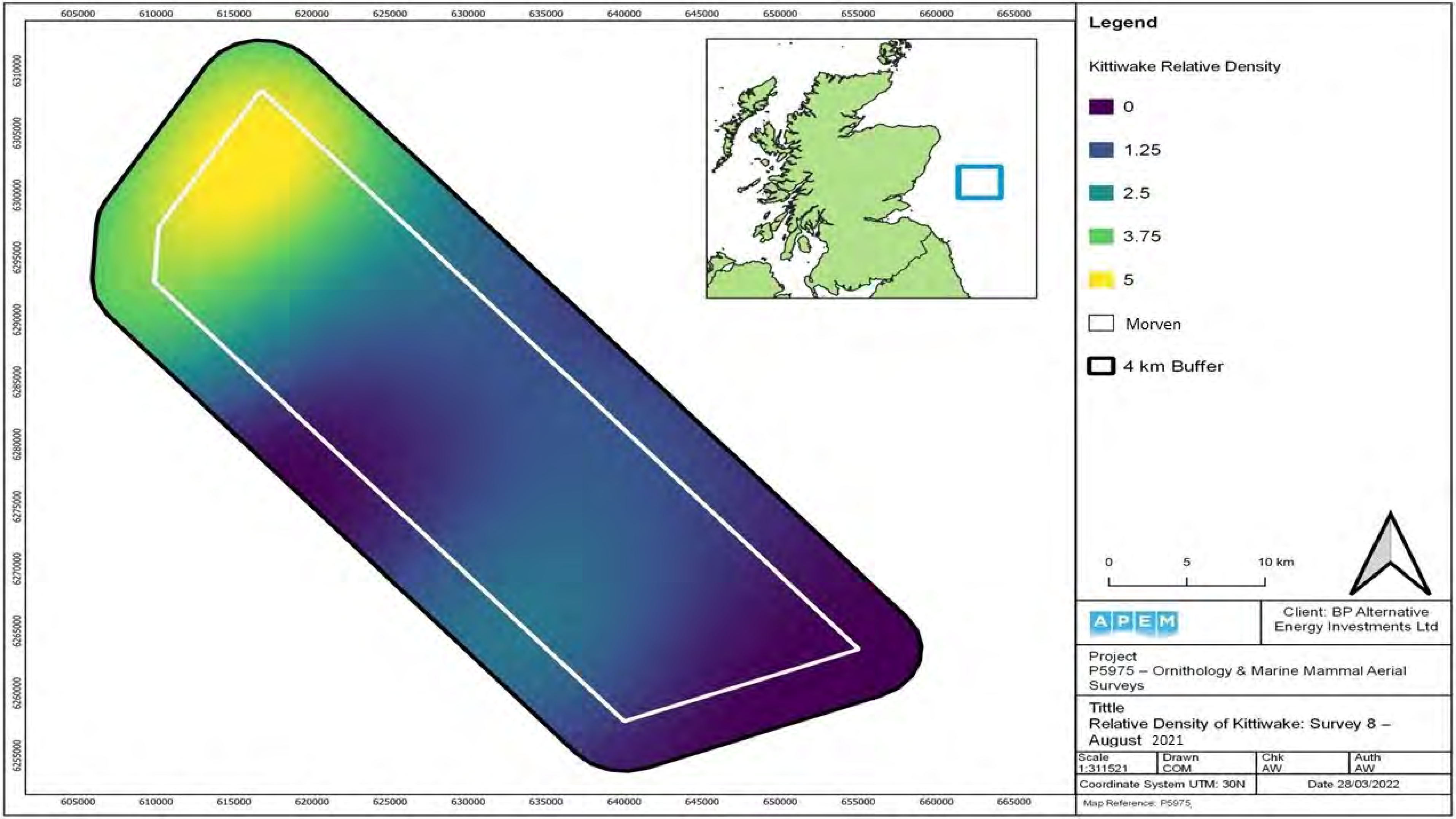


Figure 14 Relative density of kittiwake in August 2021 (Survey 08).

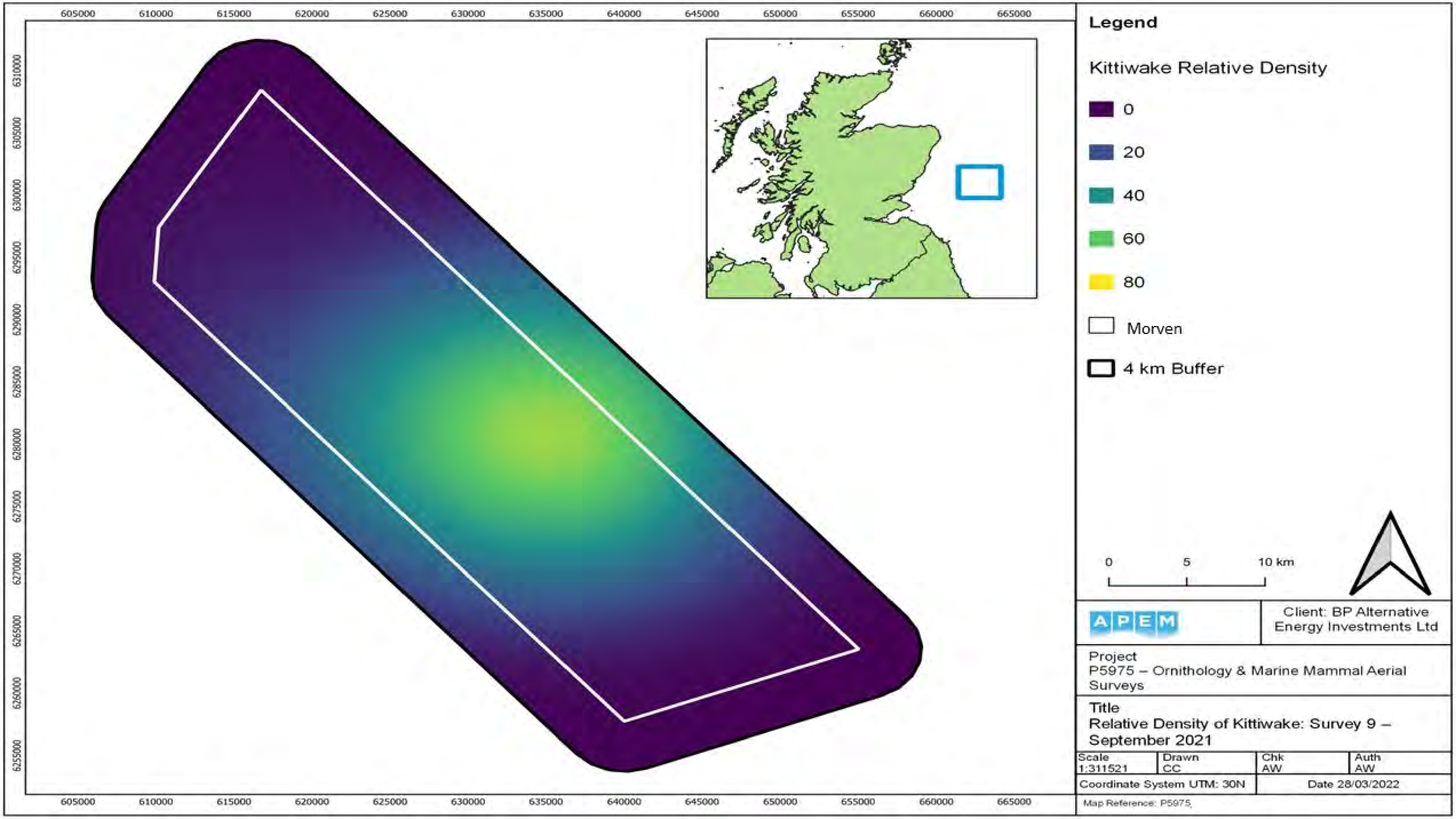


Figure 15 Relative density of kittiwake in September 2021 (Survey 09).

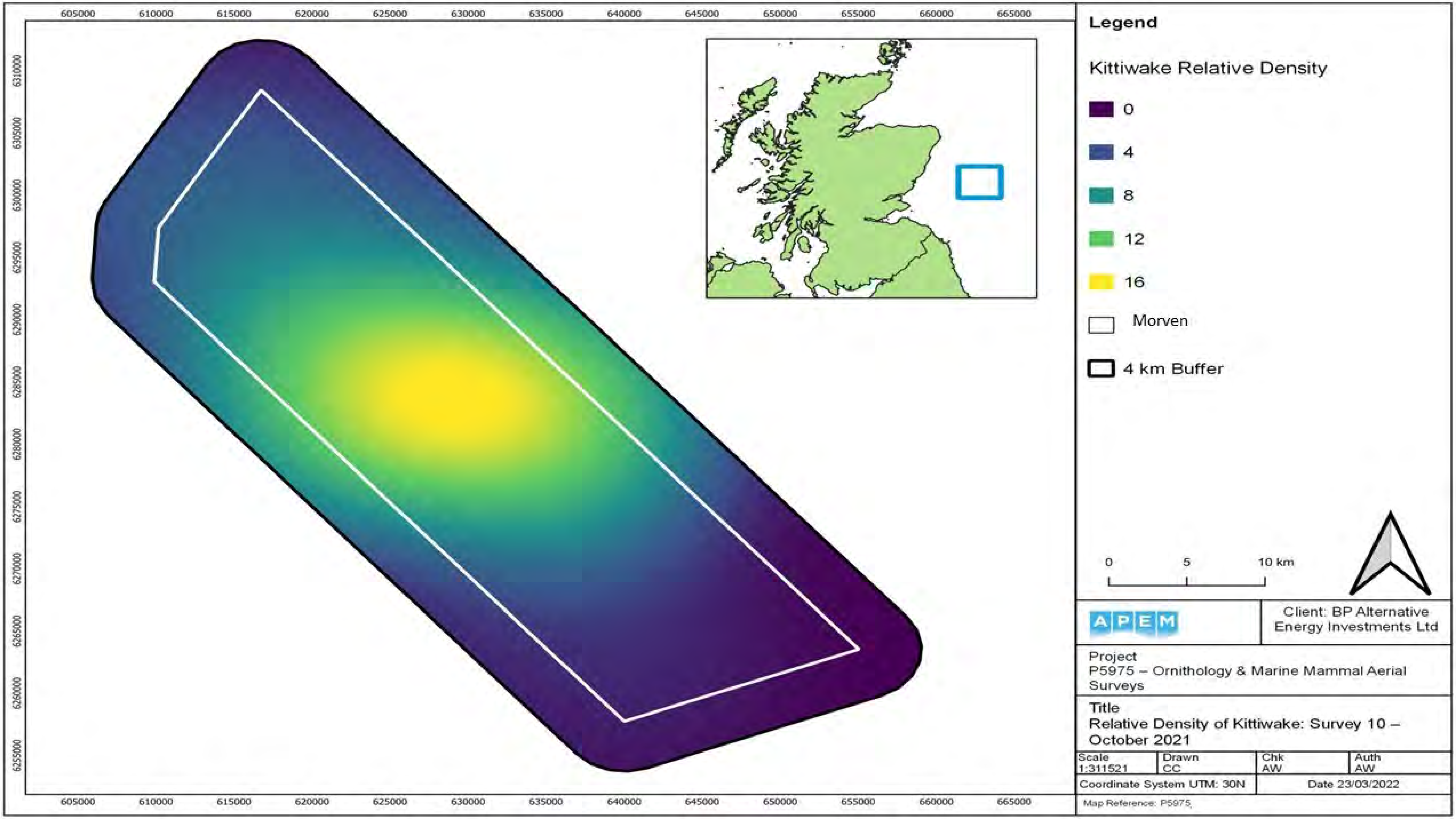


Figure 16 Relative density of kittiwake in October 2021 (Survey 10).

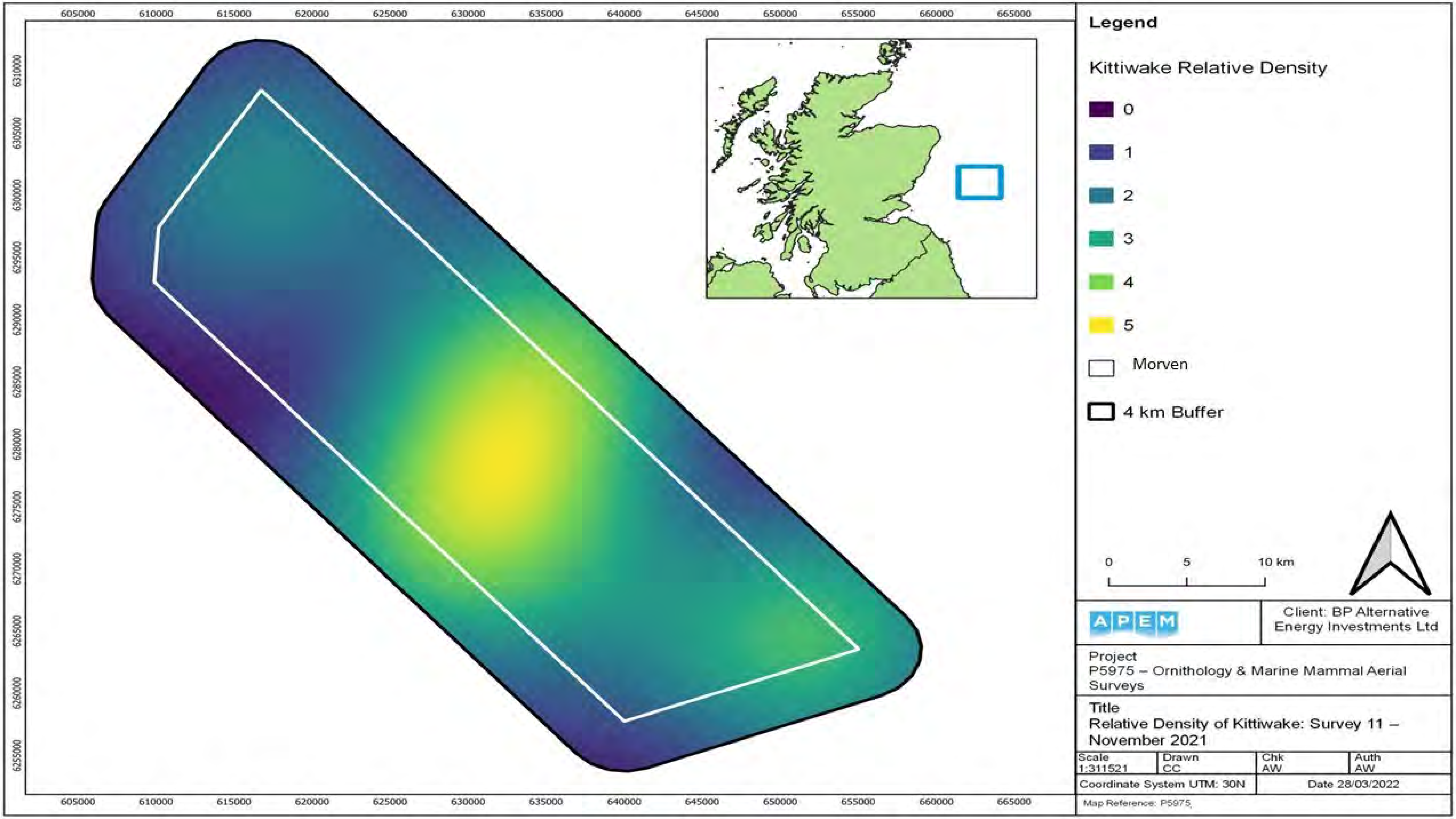


Figure 17 Relative density of kittiwake in November 2021 (Survey 11).

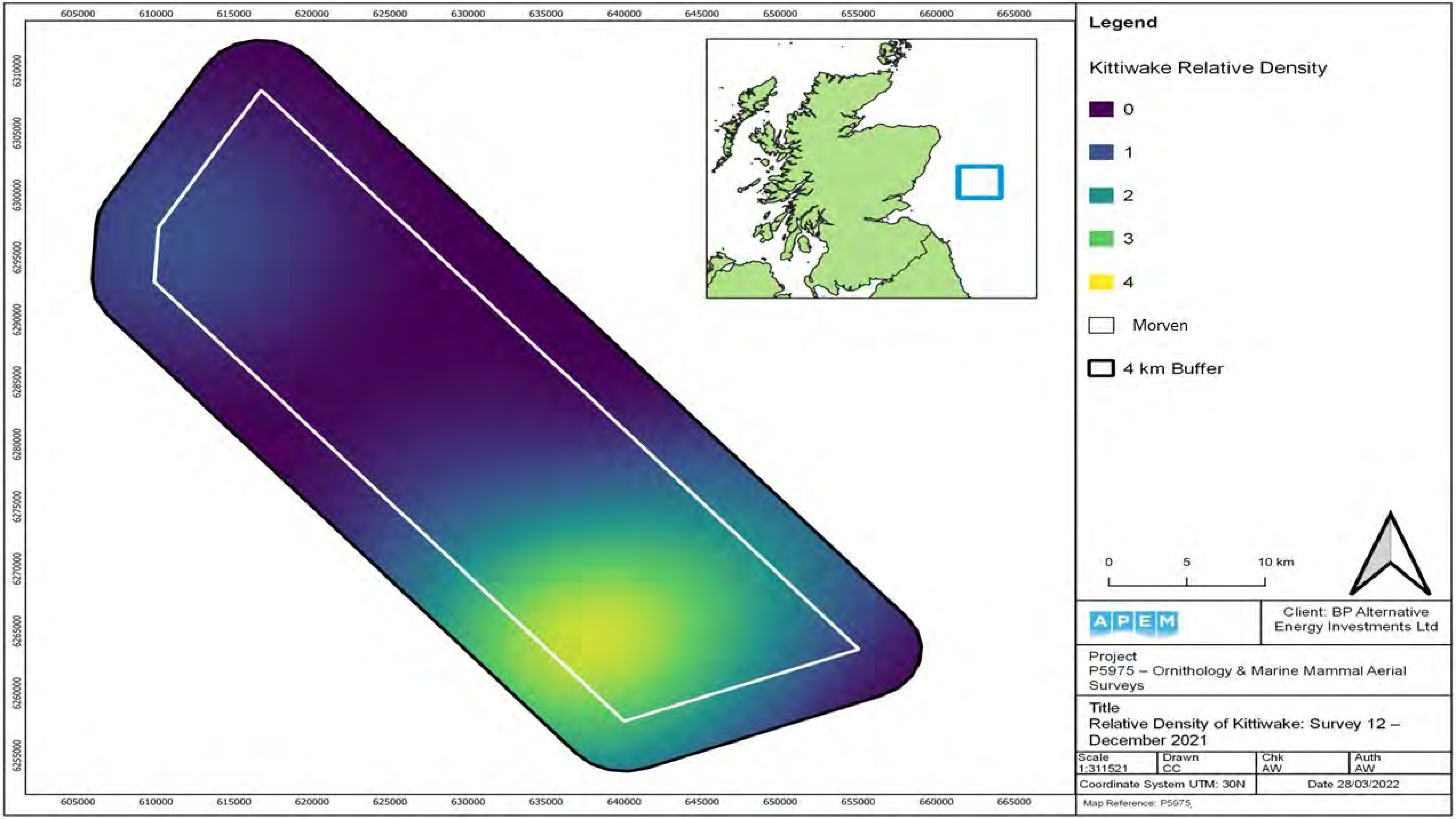


Figure 18 Relative density of kittiwake in December 2021 (Survey 12).

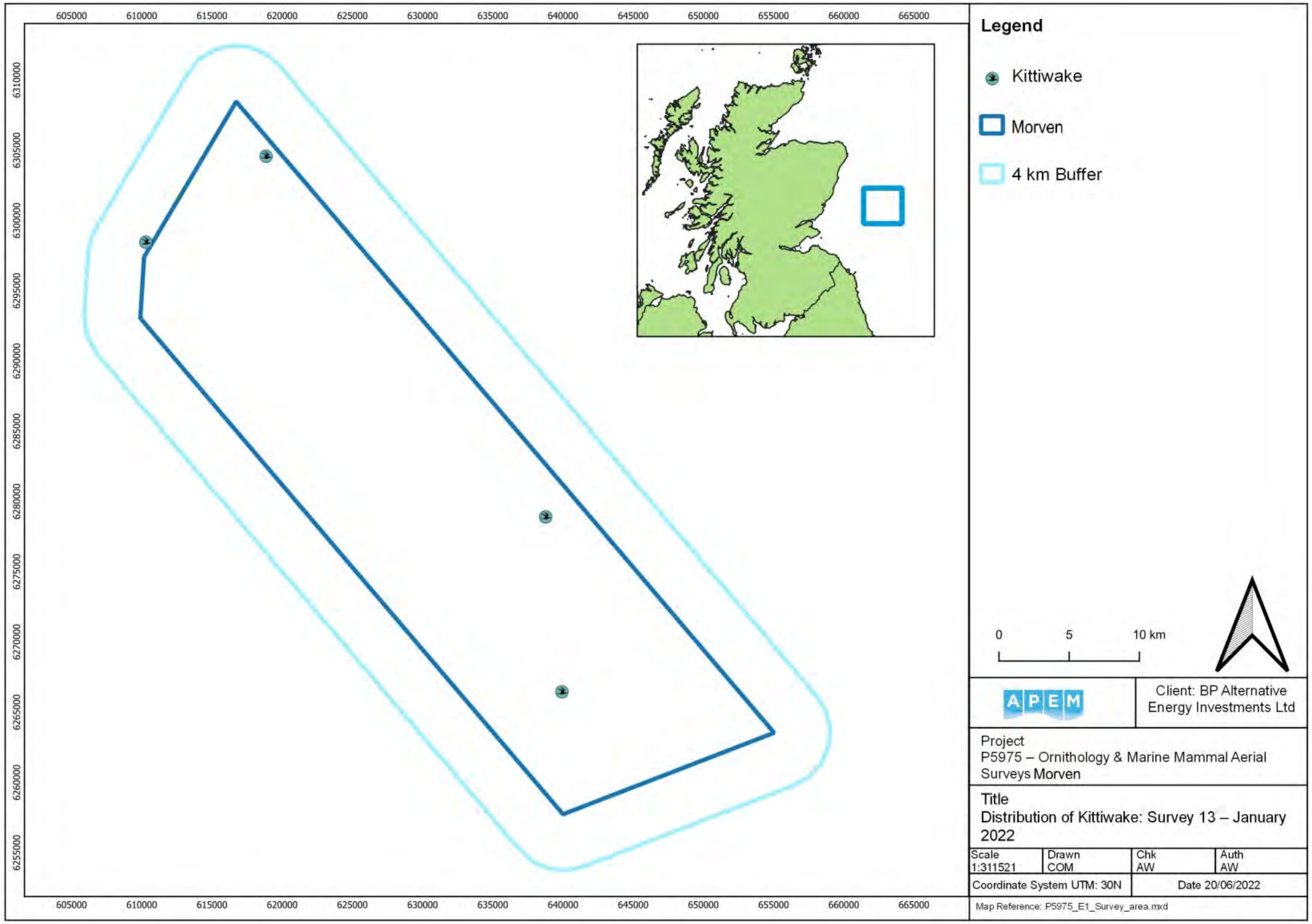


Figure 19 Distribution of kittiwake in January 2022 (Survey 13).

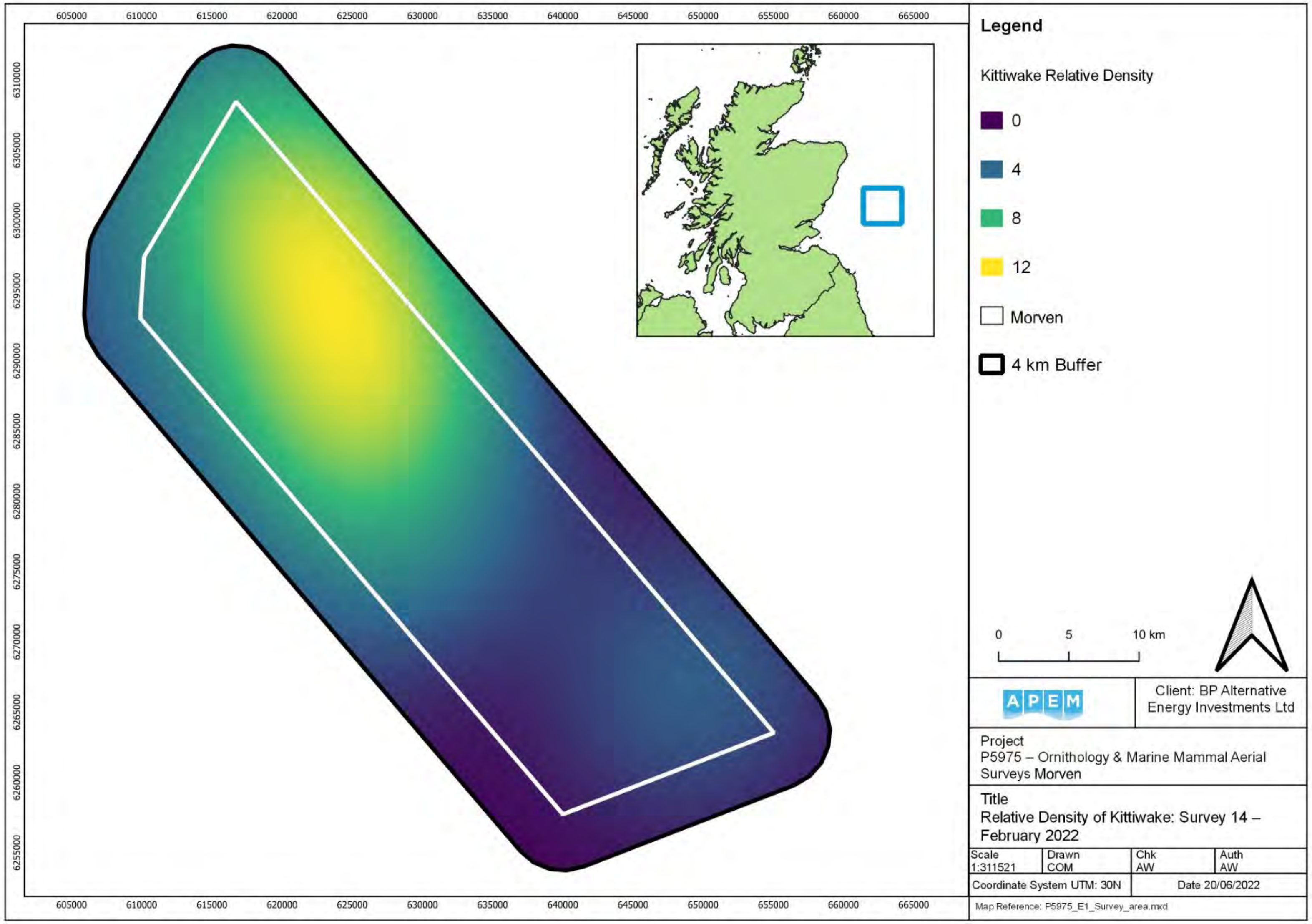


Figure 20 Relative density of kittiwake in February 2022 (Survey 14).

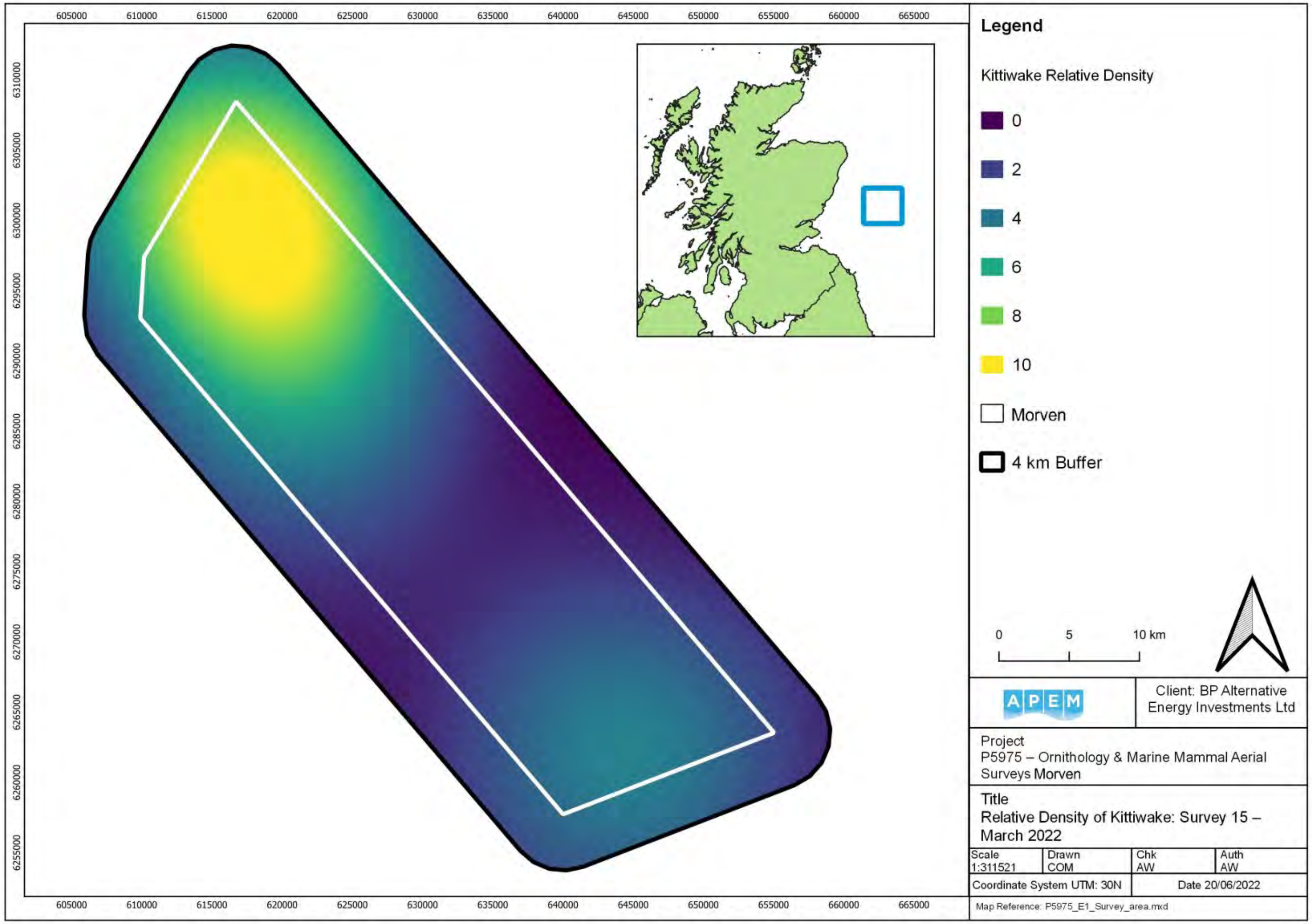
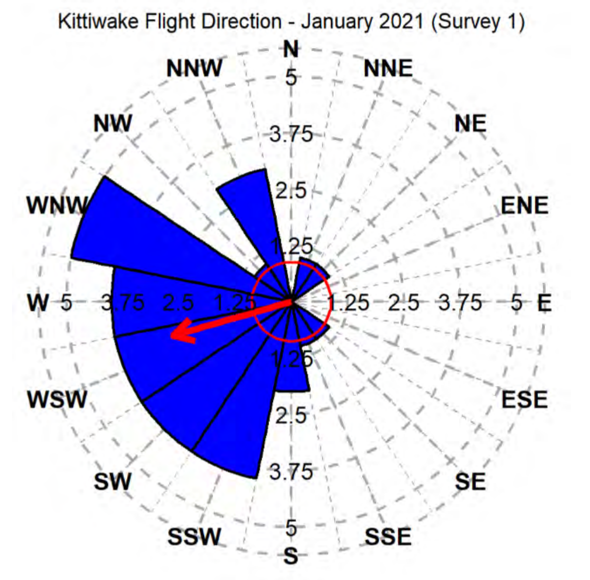
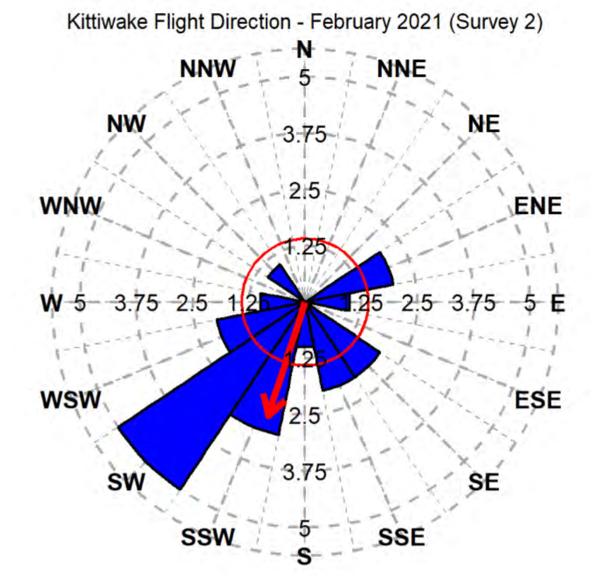


Figure 21 Relative density of kittiwake in March 2022 (Survey 15).



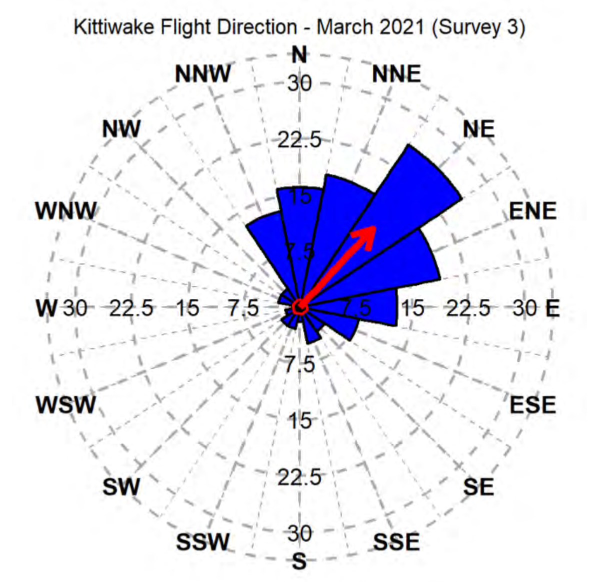
Number of Observations	31
Mean Vector (µ)	254.159
Length of Mean Vector (r)	0.545
Rayleigh Test (Z)	9.216
Rayleigh Test (p)	<0.01

Figure 22a January 2021 (Survey 01)



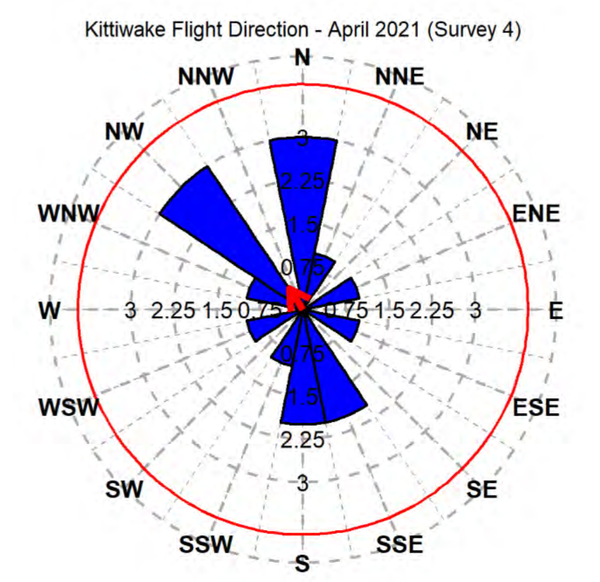
Number of Observations	20
Mean Vector (µ)	198.693
Length of Mean Vector (r)	0.530
Rayleigh Test (Z)	5.614
Rayleigh Test (p)	0.003

Figure 22b February 2021 (Survey 02)



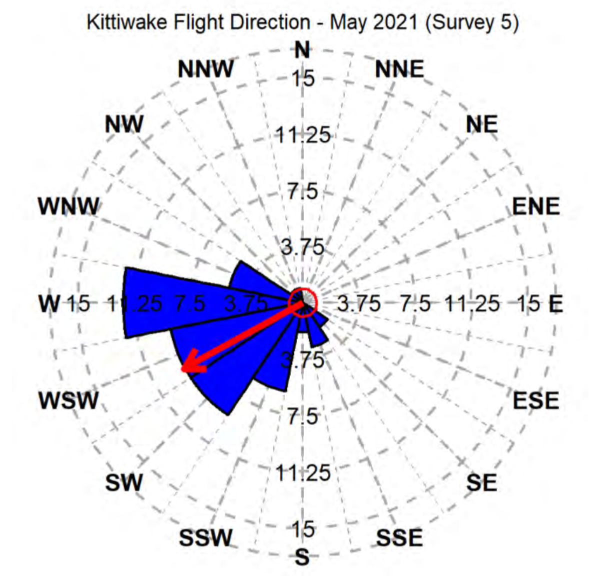
Number of Observations	139
Mean Vector (µ)	43.241
Length of Mean Vector (r)	0.547
Rayleigh Test (Z)	41.650
Rayleigh Test (p)	<0.001

Figure 22c March 2021 (Survey 03)



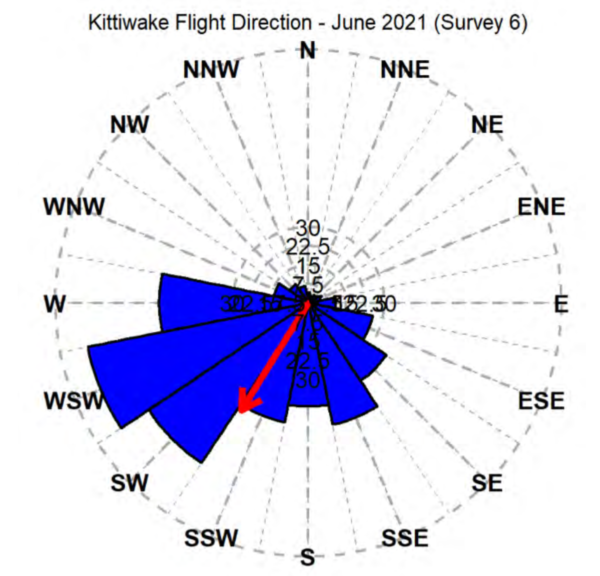
Number of Observations	16
Mean Vector (µ)	327.050
Length of Mean Vector (r)	0.143
Rayleigh Test (Z)	0.328
Rayleigh Test (p)	0.726

Figure 22d April 2021 (Survey 04)



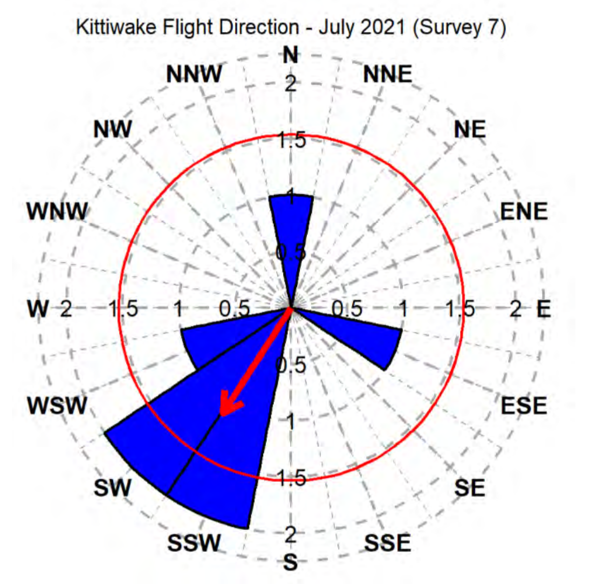
Number of Observations	50
Mean Vector (µ)	241.291
Length of Mean Vector (r)	0.754
Rayleigh Test (Z)	28.440
Rayleigh Test (p)	<0.001

Figure 22e May 2021 (Survey 05)



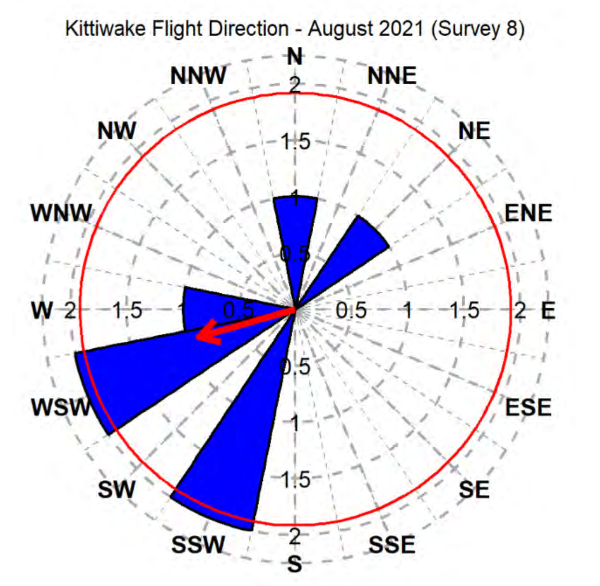
Number of Observations	482
Mean Vector (µ)	212.977
Length of Mean Vector (r)	0.562
Rayleigh Test (Z)	152.298
Rayleigh Test (p)	<0.001

Figure 22f June 2021 (Survey 06)



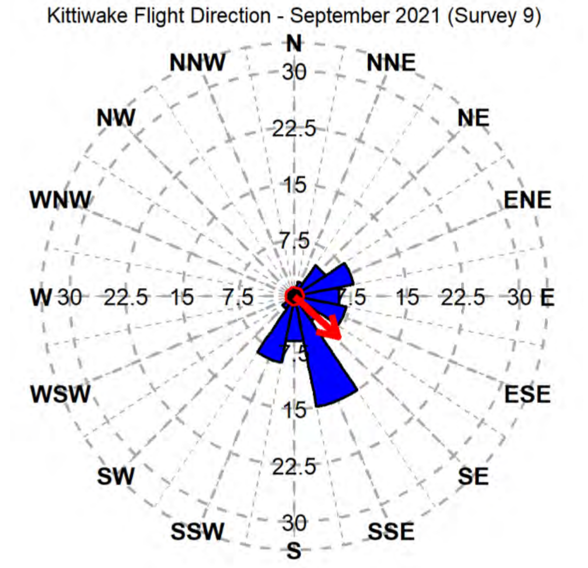
Number of Observations	7
Mean Vector (µ)	213.099
Length of Mean Vector (r)	0.556
Rayleigh Test (Z)	2.167
Rayleigh Test (p)	0.113

Figure 22g July 2021 (Survey 07)



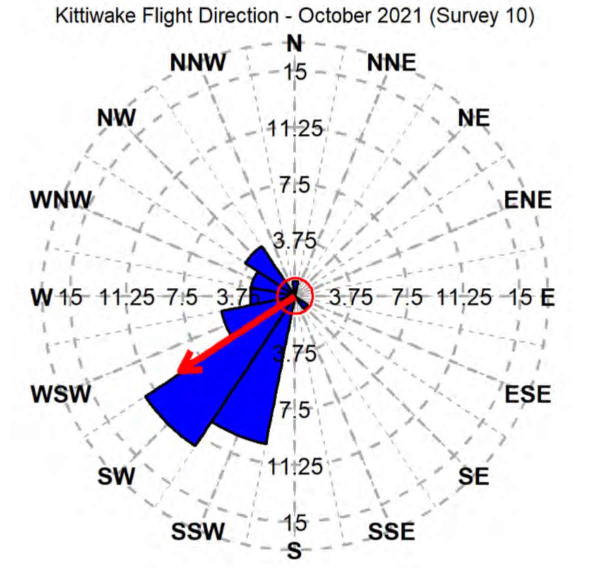
Number of Observations	7
Mean Vector (µ)	254.0307
Length of Mean Vector (r)	0.446
Rayleigh Test (Z)	1.392
Rayleigh Test (p)	0.257

Figure 22h August 2021 (Survey 08)



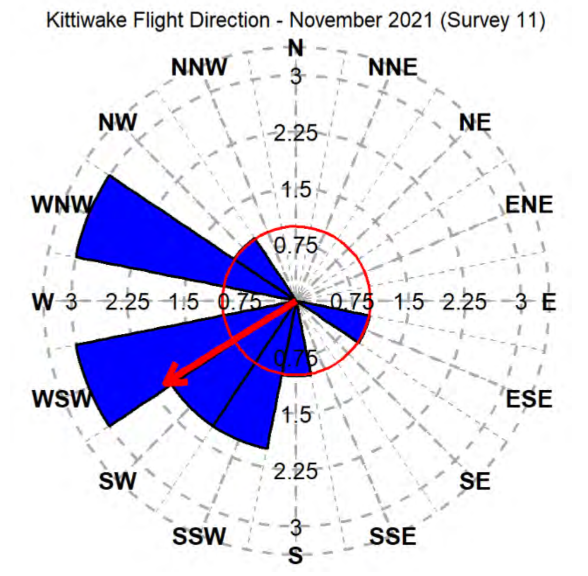
Number of Observations	68
Mean Vector (μ)	133.623
Length of Mean Vector (r)	0.529
Rayleigh Test (Z)	19.058
Rayleigh Test (p)	<0.001

Figure 22i September 2021 (Survey 09)



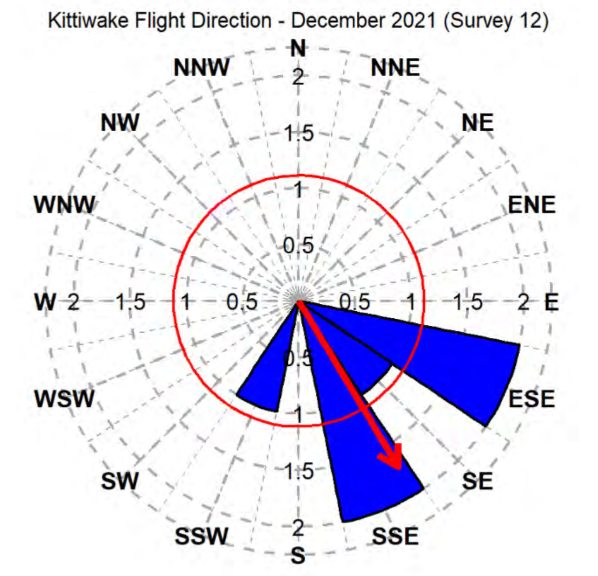
Number of Observations	39
Mean Vector (μ)	237.975
Length of Mean Vector (r)	0.760
Rayleigh Test (Z)	22.541
Rayleigh Test (p)	<0.001

Figure 22j October 2021 (Survey 10)



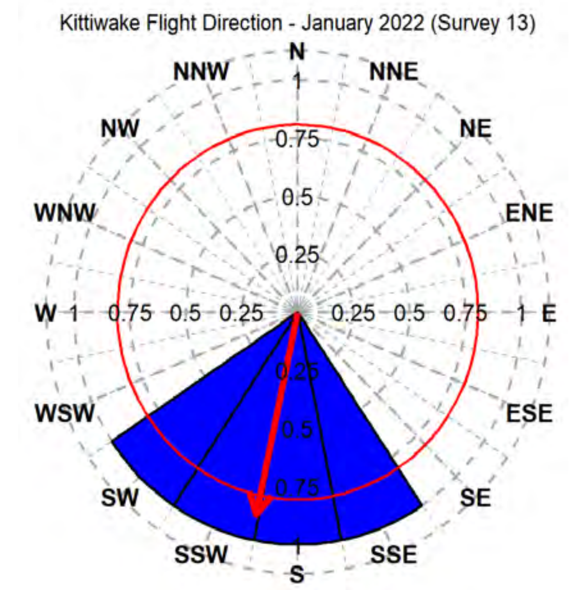
Number of Observations	13
Mean Vector (μ)	238.957
Length of Mean Vector (r)	0.686
Rayleigh Test (Z)	6.123
Rayleigh Test (p)	0.001

Figure 22k November 2021 (Survey 11)



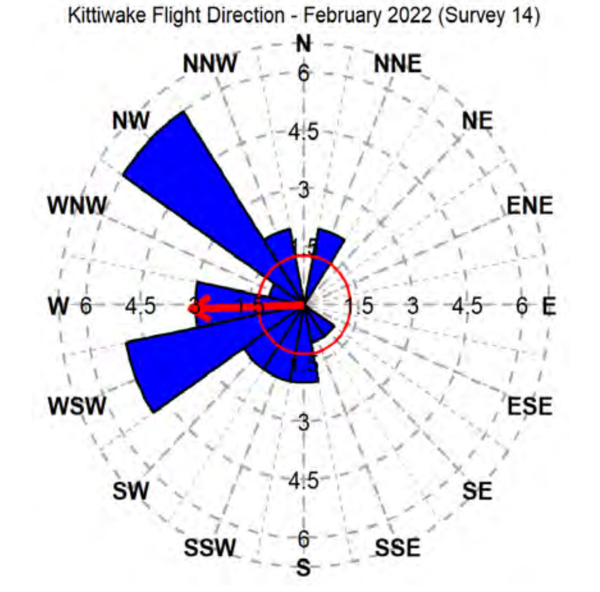
Number of Observations	6
Mean Vector (μ)	149.973
Length of Mean Vector (r)	0.856
Rayleigh Test (Z)	4.397
Rayleigh Test (p)	0.006

Figure 22l December 2021 (Survey 12)



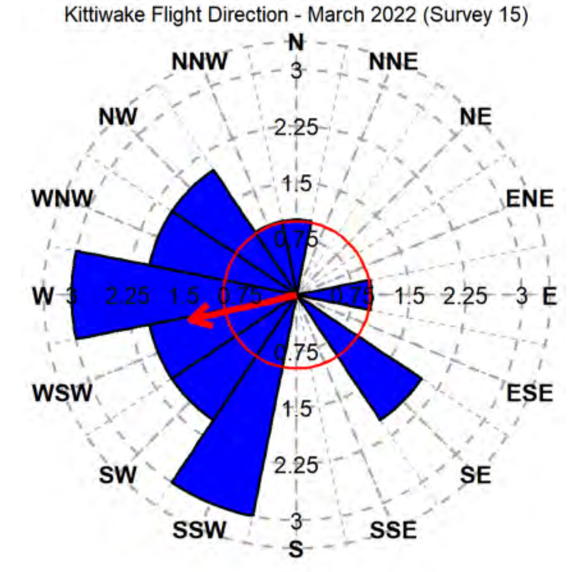
Number of Observations	4
Mean Vector (μ)	192.511
Length of Mean Vector (r)	0.887
Rayleigh Test (Z)	3.146
Rayleigh Test (p)	0.031

Figure 22m January 2022 (S13)



Number of Observations	27
Mean Vector (μ)	268.073
Length of Mean Vector (r)	0.519
Rayleigh Test (Z)	7.283
Rayleigh Test (p)	<0.001

Figure 22n February 2022 (Survey 14)



Number of Observations	19
Mean Vector (μ)	257.365
Length of Mean Vector (r)	0.481
Rayleigh Test (Z)	4.401
Rayleigh Test (p)	0.010

Figure 22o March 2022 (S15)

Figure 22 Summary of flight direction of kittiwakes recorded in the Array Project.

4.4 Common Gull – *Larus canus*

Common gulls were recorded in October and November, with one individual in each month, resulting in an abundance estimate of eight per month within the Array Project (Table 7).

They were in the southeast in October (Figure 23), and southwest in November (Figure 24).

In both surveys, common gulls were flying in south-westerly directions.

Table 7 Raw counts, abundance and density estimates of common gull in the Array Project.

Survey	Raw Count	Sitting	Flying	Abundance	Lower CL	Upper CL	Precision	Density
Oct-21	1	-	1	8	1	24	1.00	0.01
Nov-21	1	-	1	8	1	25	1.00	0.01

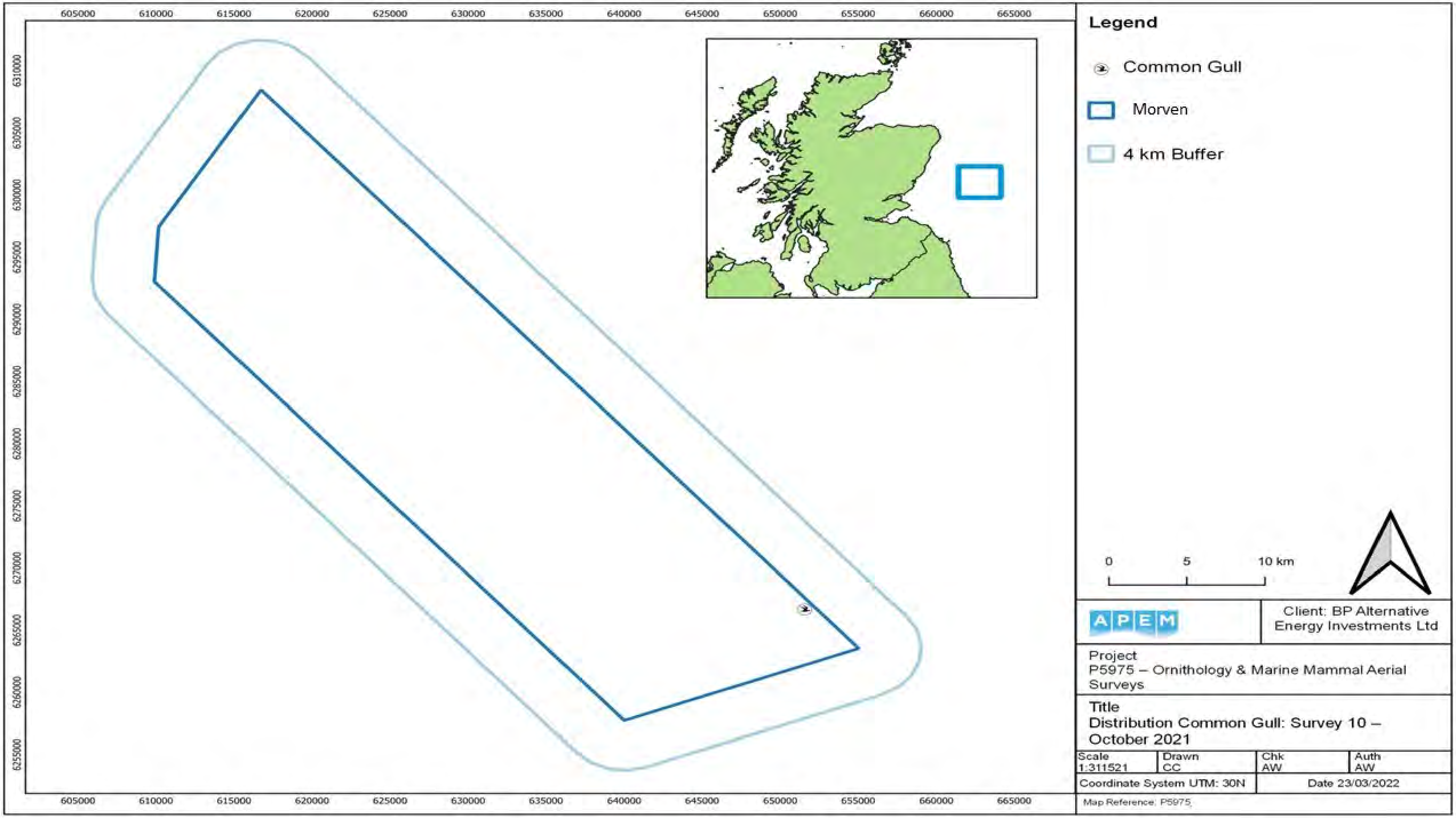


Figure 23 Location of a common gull in October 2021 (Survey 10).

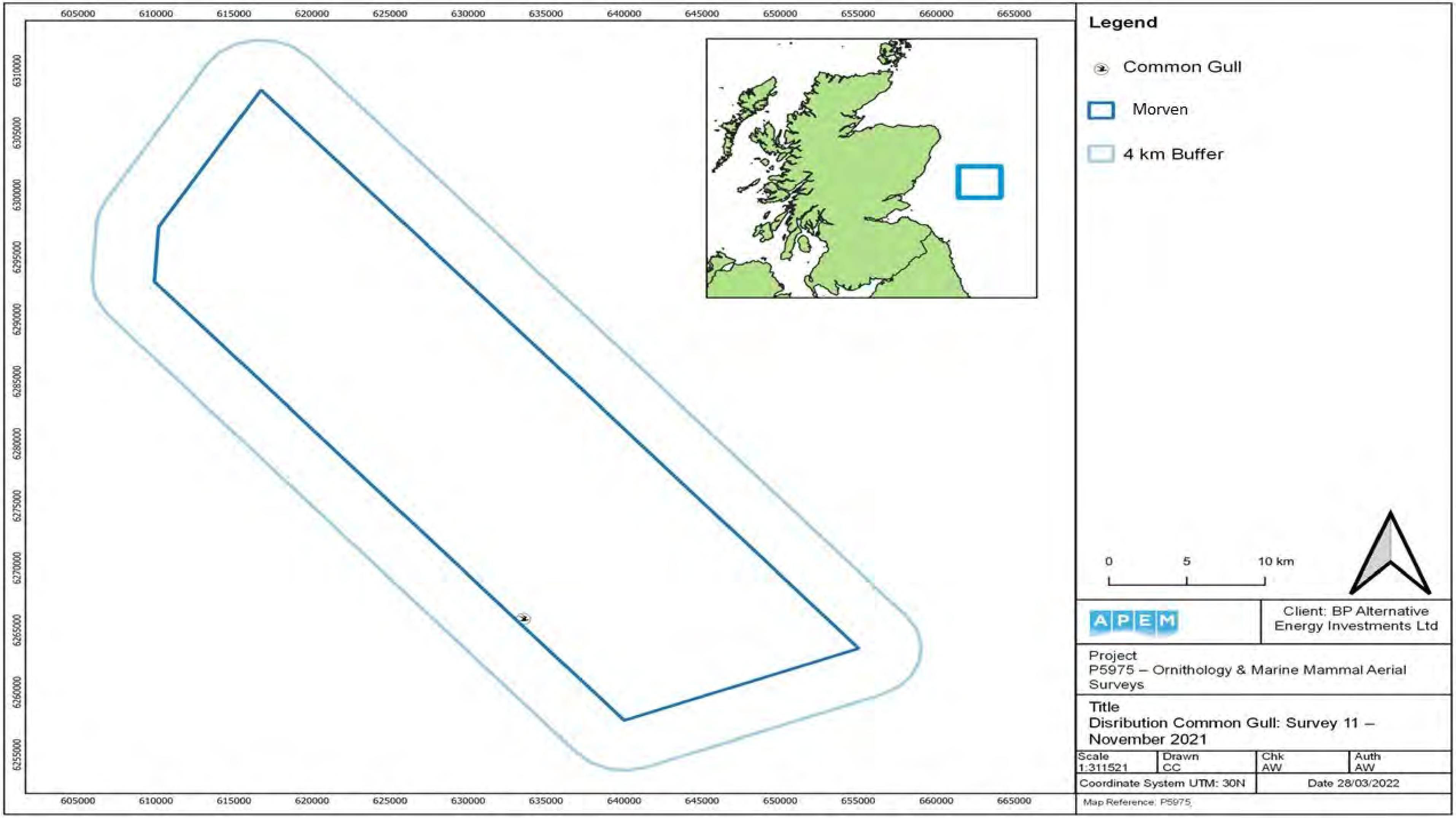


Figure 24 Location of a common gull in November 2021 (Survey 11

4.5 Small Gulls – Unidentified

Individual unidentified small gulls were recorded in March, April, May, and September 2021. Two individuals were recorded in August, resulting in an abundance estimate of 16 within the Array Project (Table 8).

These were recorded throughout the Array Project – in the north half in April (Figure 26), August (Figure 28), and May (Figure 27), in the southeast in March (Figure 25), and the west in September (Figure 29).

Small gull species had no uniform flight direction.

Table 8 Raw counts, abundance and density estimates of unidentified small gull in the Array Project.

Survey	Raw Count	Sitting	Flying	Abundance	Lower CL	Upper CL	Precision	Density
Mar-21	1	1	-	8	1	33	1.00	0.01
Apr-21	1	1	-	8	1	24	1.00	0.01
May-21	1	1	-	8	1	33	1.00	0.01
Aug-21	2	-	2	16	2	41	0.71	0.01
Sep-21	1	1	-	8	1	25	1.00	0.01

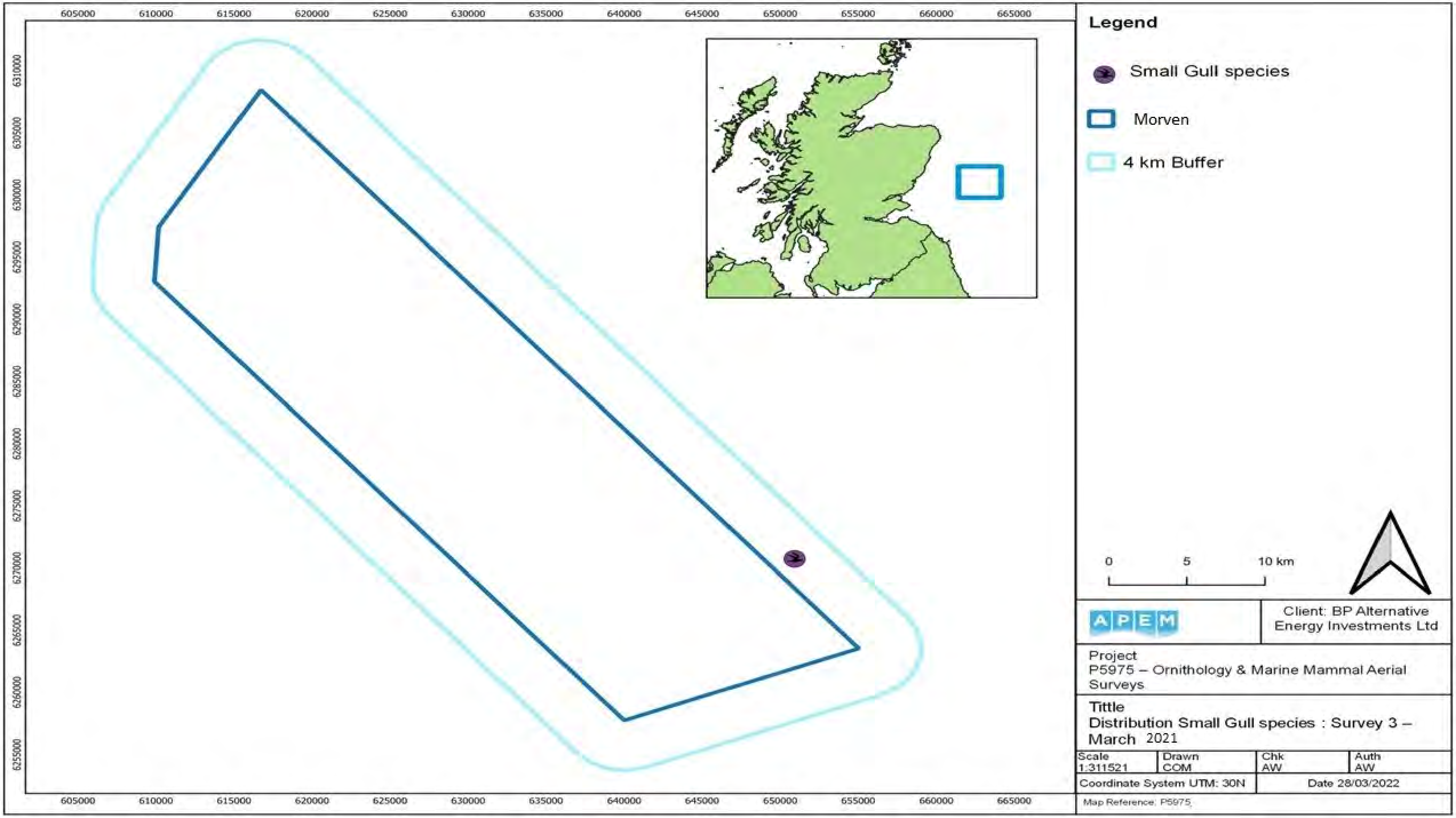


Figure 25 Location of an unidentified small gull in March 2021 (Survey 03).

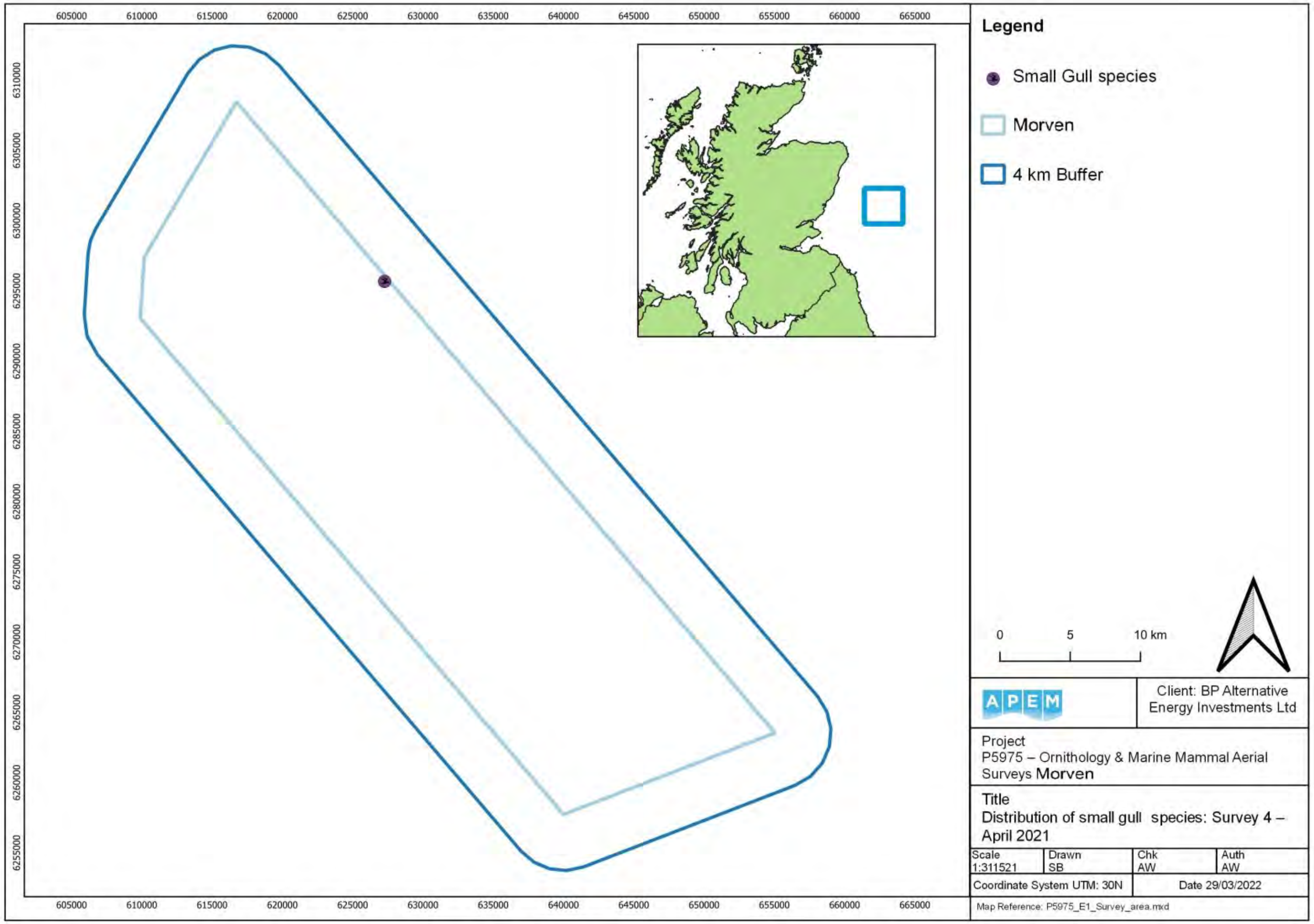


Figure 26 Location of an unidentified small gull in April 2021 (Survey 04).

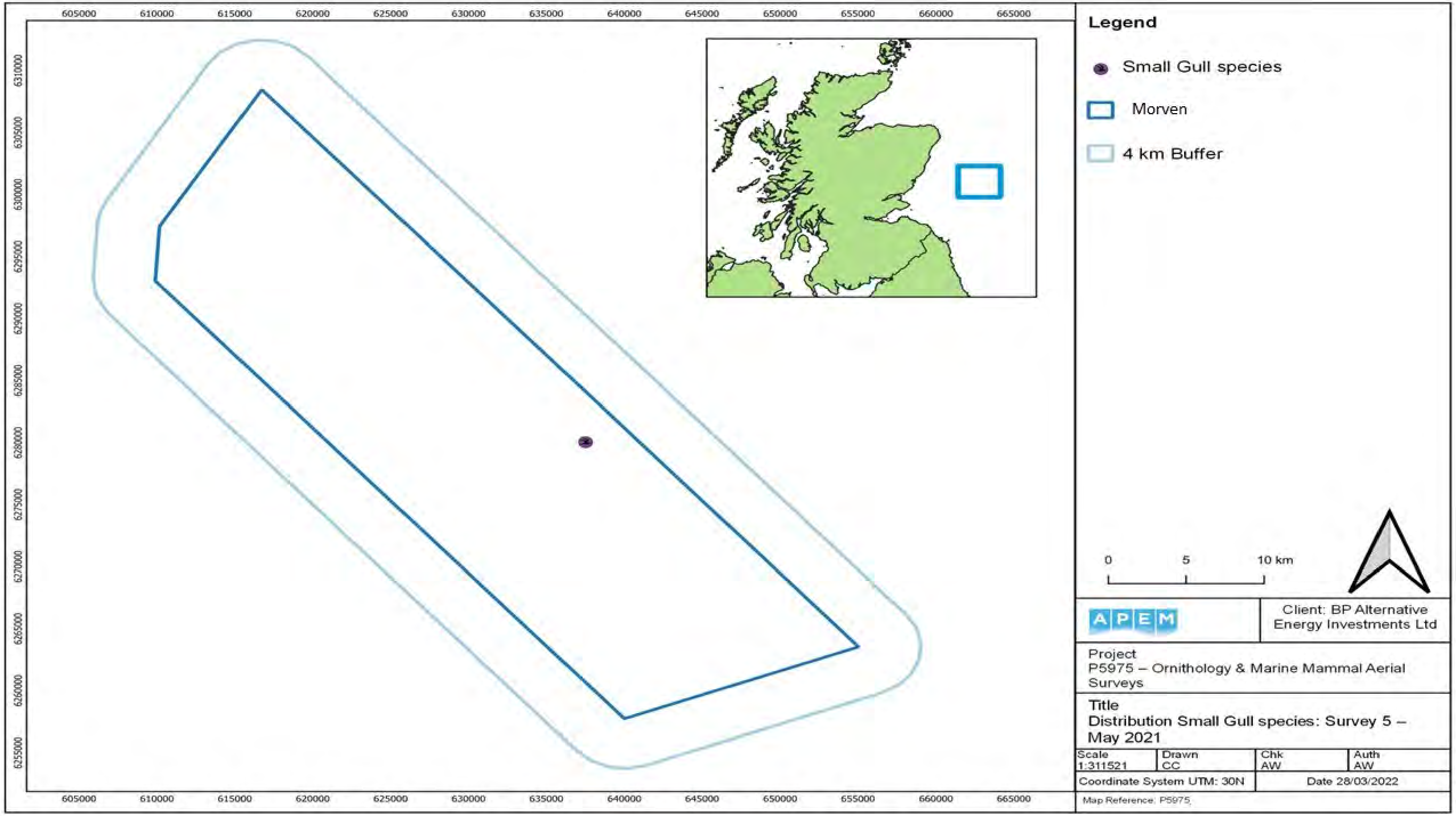


Figure 27 Location of an unidentified small gull in May 2021 (Survey 05).

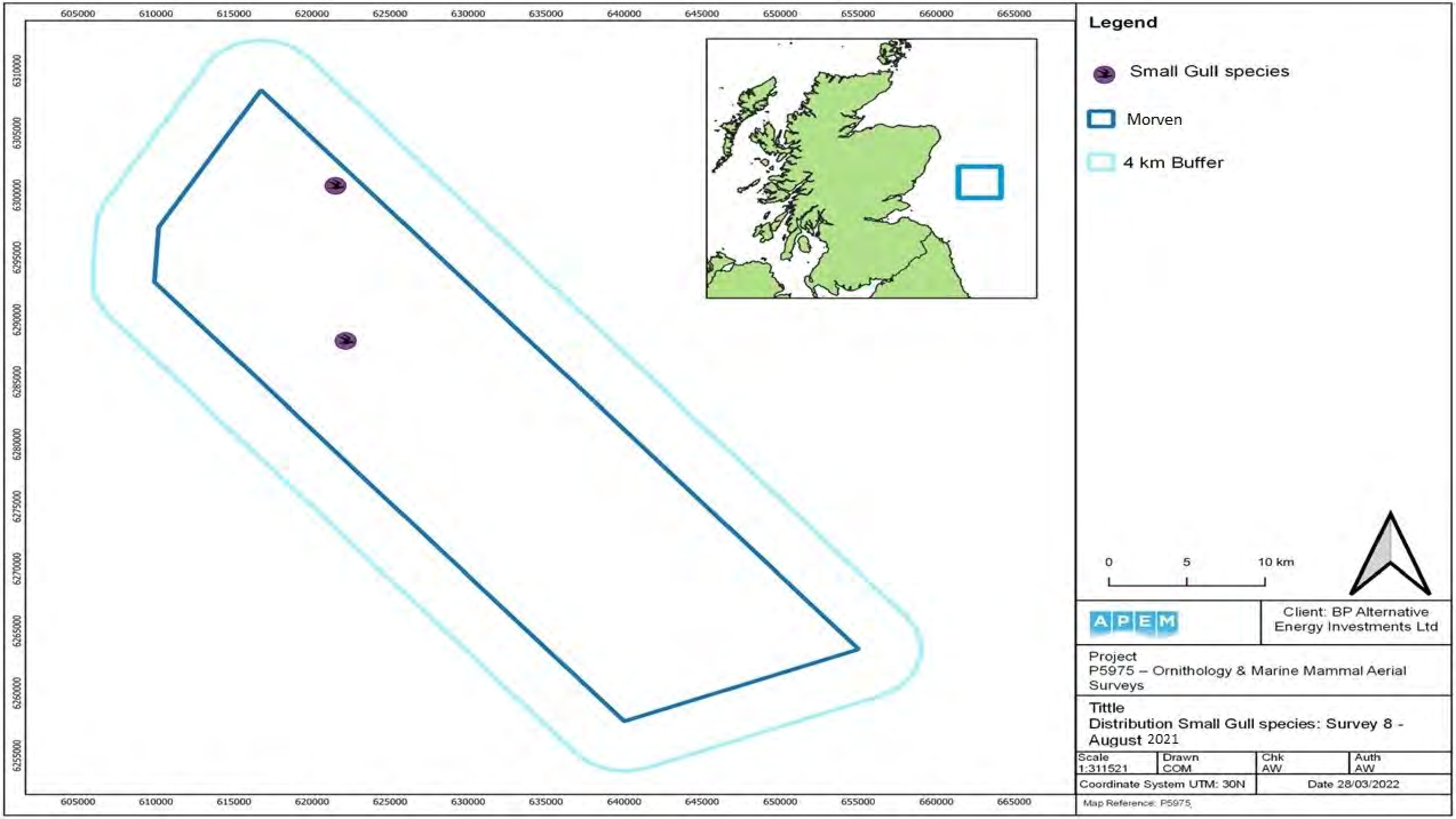


Figure 28 Distribution of unidentified small gulls in August 2021 (Survey 08).

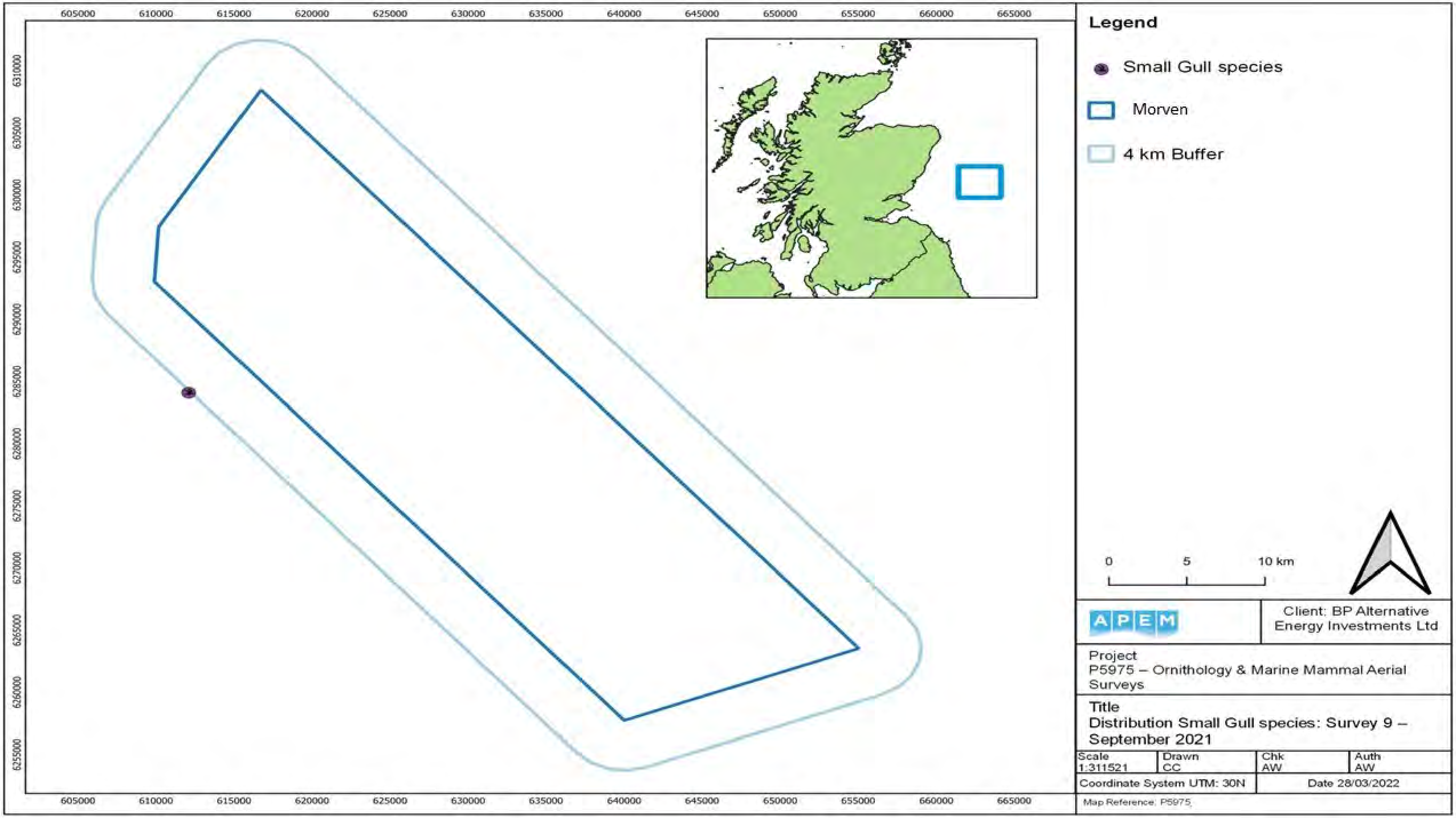


Figure 29 Location of an unidentified small gull in September 2021 (Survey 09)

4.6 Great Black-backed Gull – *Larus marinus*

Great black-backed gulls were recorded in January, March, July, October, November, and December 2021, January, and February 2022. Peak numbers were in November - nine individuals, resulting in an abundance estimate of 75 within the Array Project (Table 9).

These were throughout the Array Project – north and south in January (Figure 30), west in March (Figure 31) and November (Figure 34), north in July (Figure 32), December (Figure 35) and February 2022 (Figure 36),northeast in October (Figure 33) and south in January 2022 (Figure 37).

Great black-backed gulls had no significant flight direction (p>0.05) (Figure 38).

Table 9 Raw counts, abundance and density estimates of great black-backed gull in the Array Project.

Survey	Raw Count	Sitting	Flying	Abundance	Lower CL	Upper CL	Precision	Density
Jan-21	2	2	-	16	2	41	0.71	0.01
Mar-21	3	1	2	25	3	58	0.58	0.02
Jul-21	1	-	1	8	1	25	1.00	0.01
Oct-21	1	-	1	8	1	24	1.00	0.01
Nov-21	9	3	6	75	25	125	0.33	0.05
Dec-21	5	1	4	41	8	82	0.45	0.03
Jan-22	1	-	1	8	1	24	1.00	0.01
Feb-22	7	3	4	57	16	106	0.38	0.04

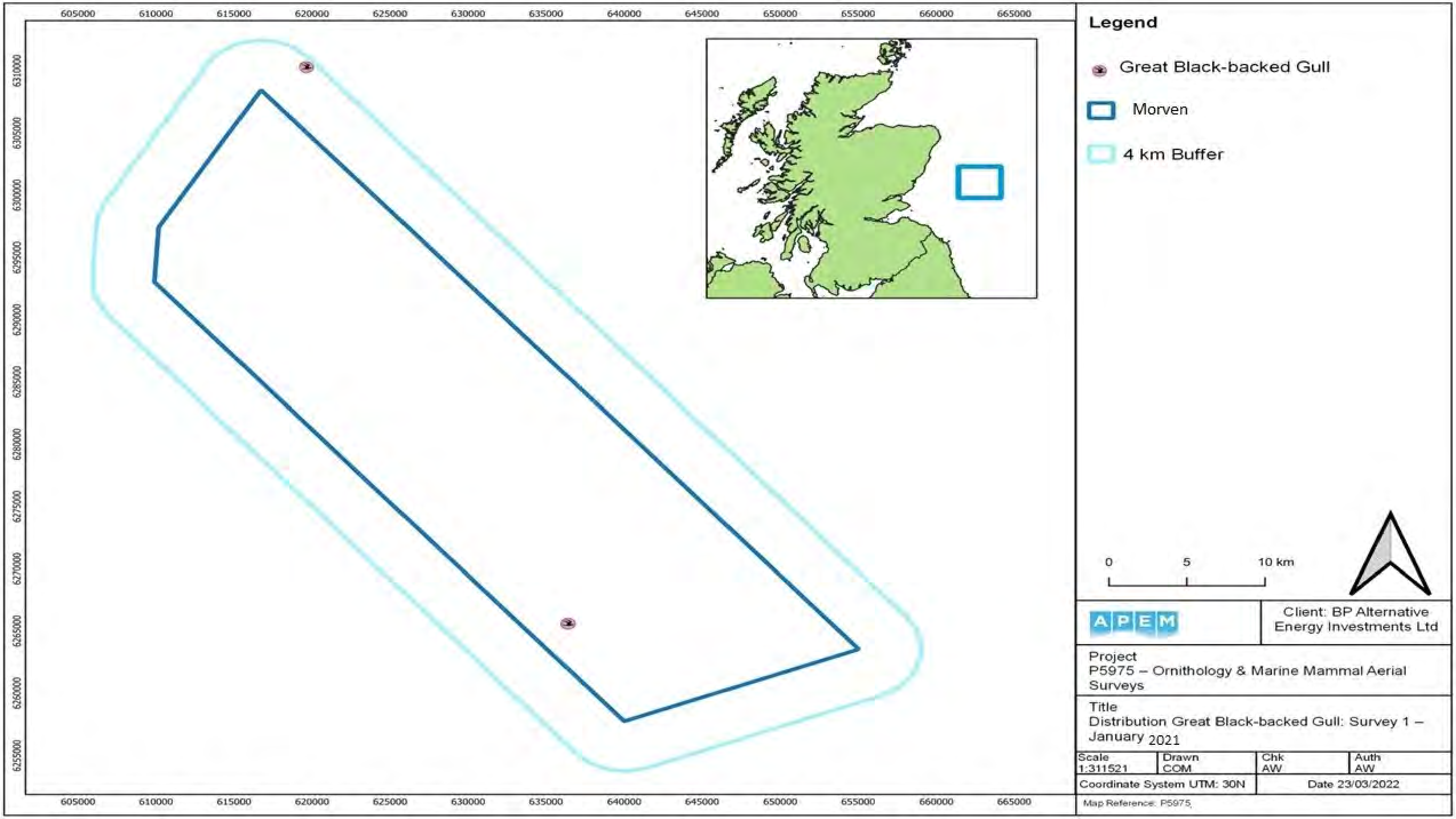


Figure 30 Distribution of great black-backed gulls in January 2021 (Survey 01).

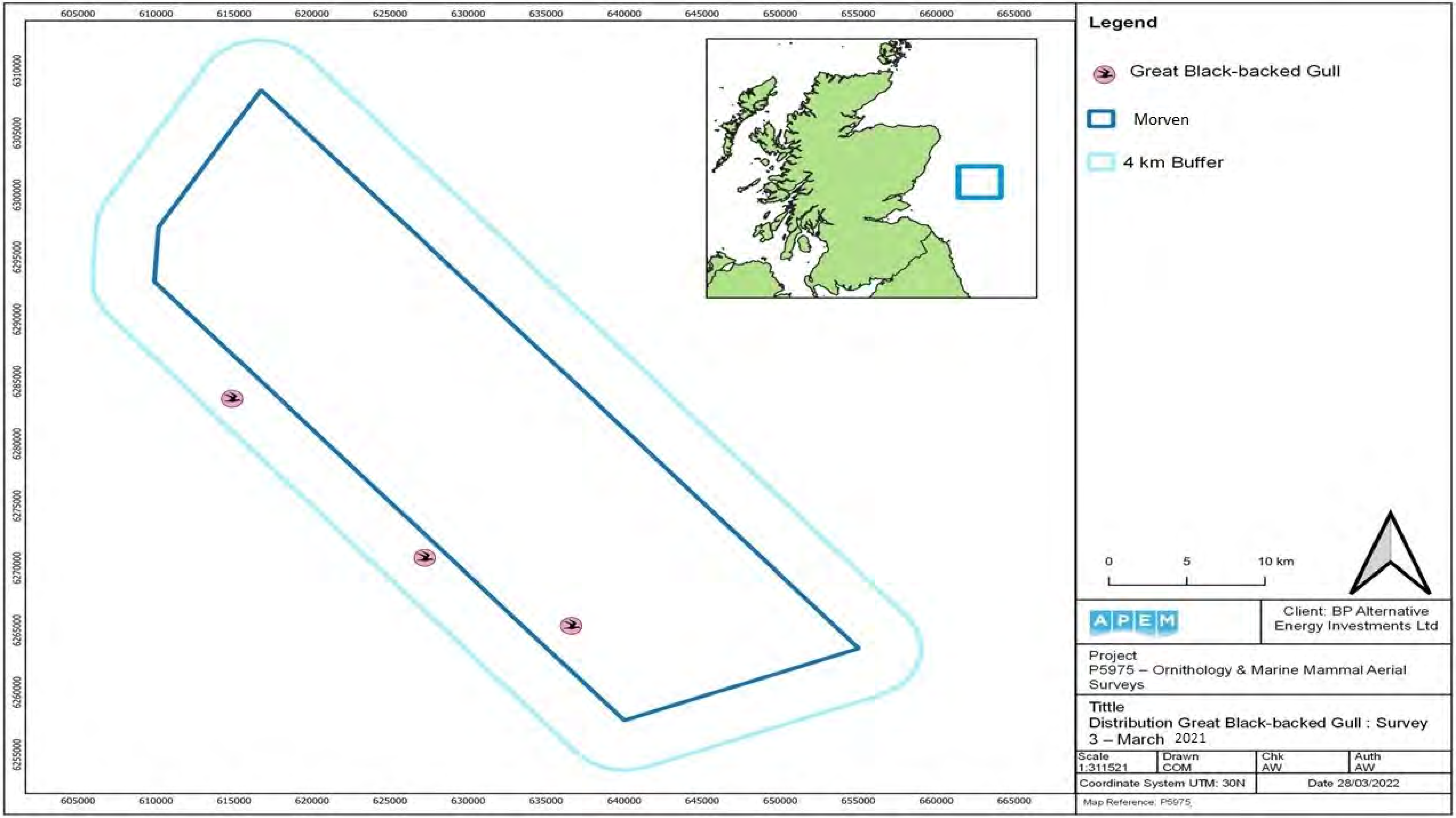


Figure 31 Distribution of great black-backed gulls in March 2021 (Survey 03).

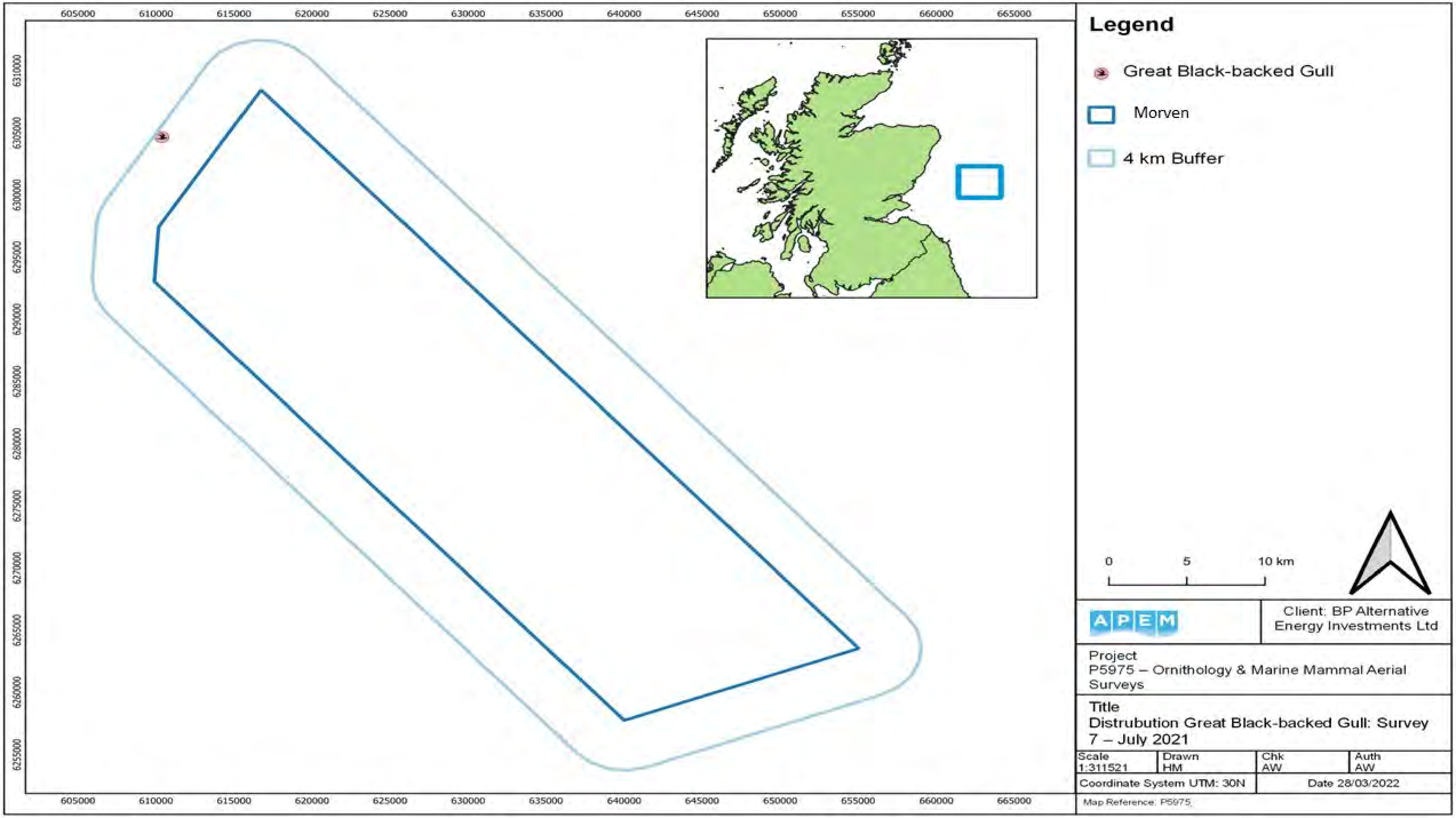


Figure 32 Location of a great black-backed gull in July 2021 (Survey 07).

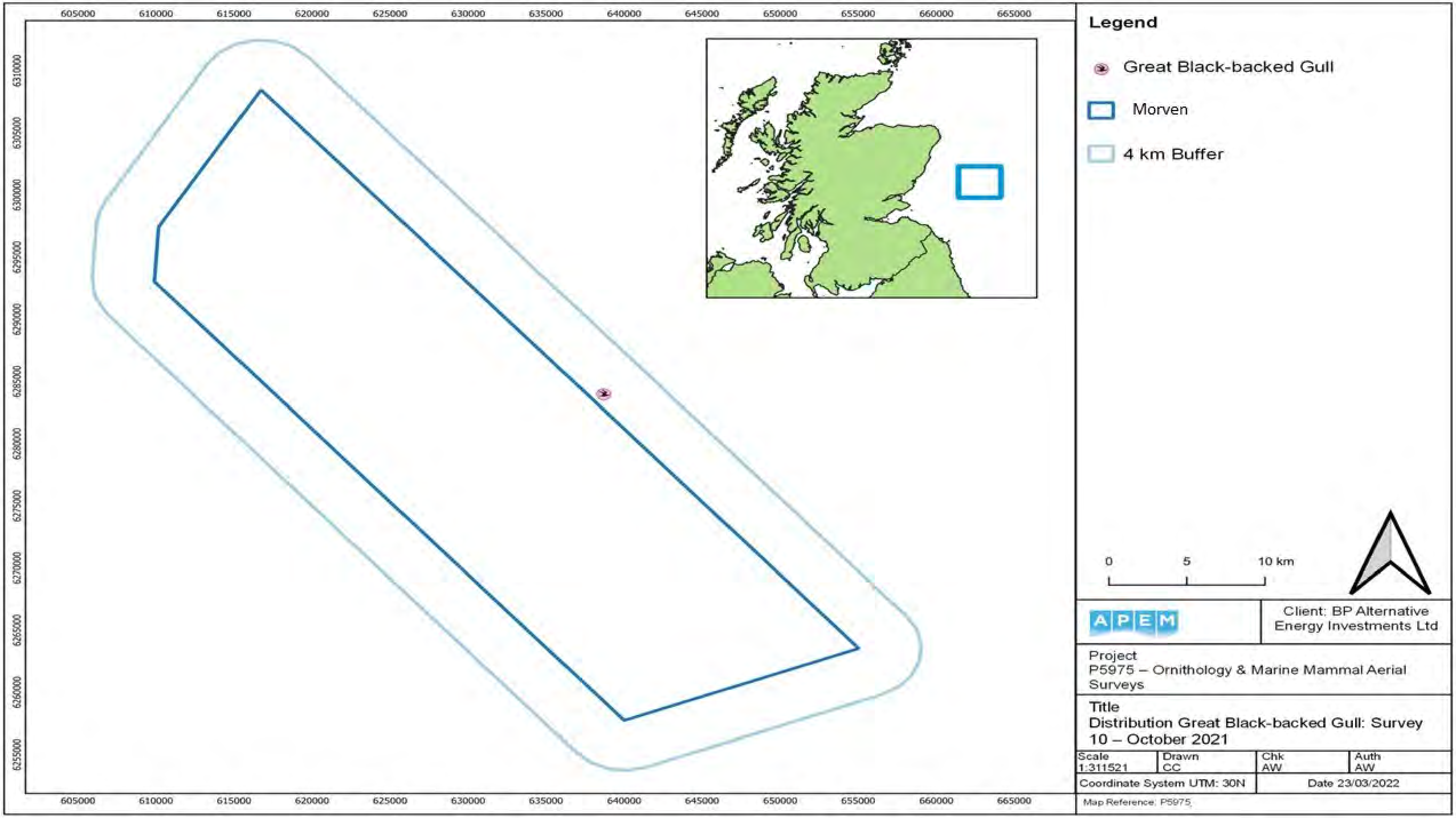


Figure 33 Location of a great black-backed gull in October 2021 (Survey 10).

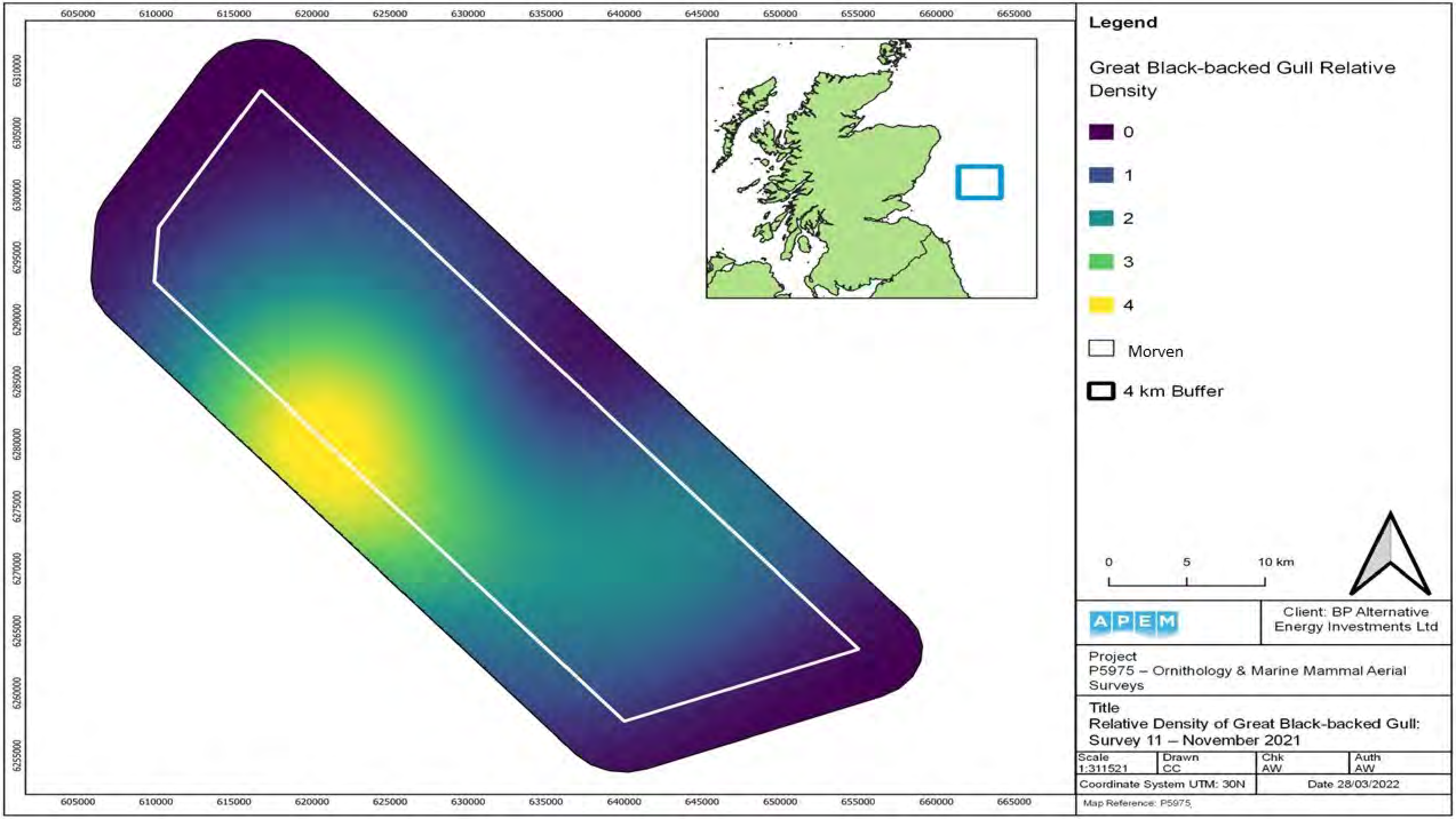


Figure 34 Relative density of great black-backed gull in November 2021 (Survey 11).

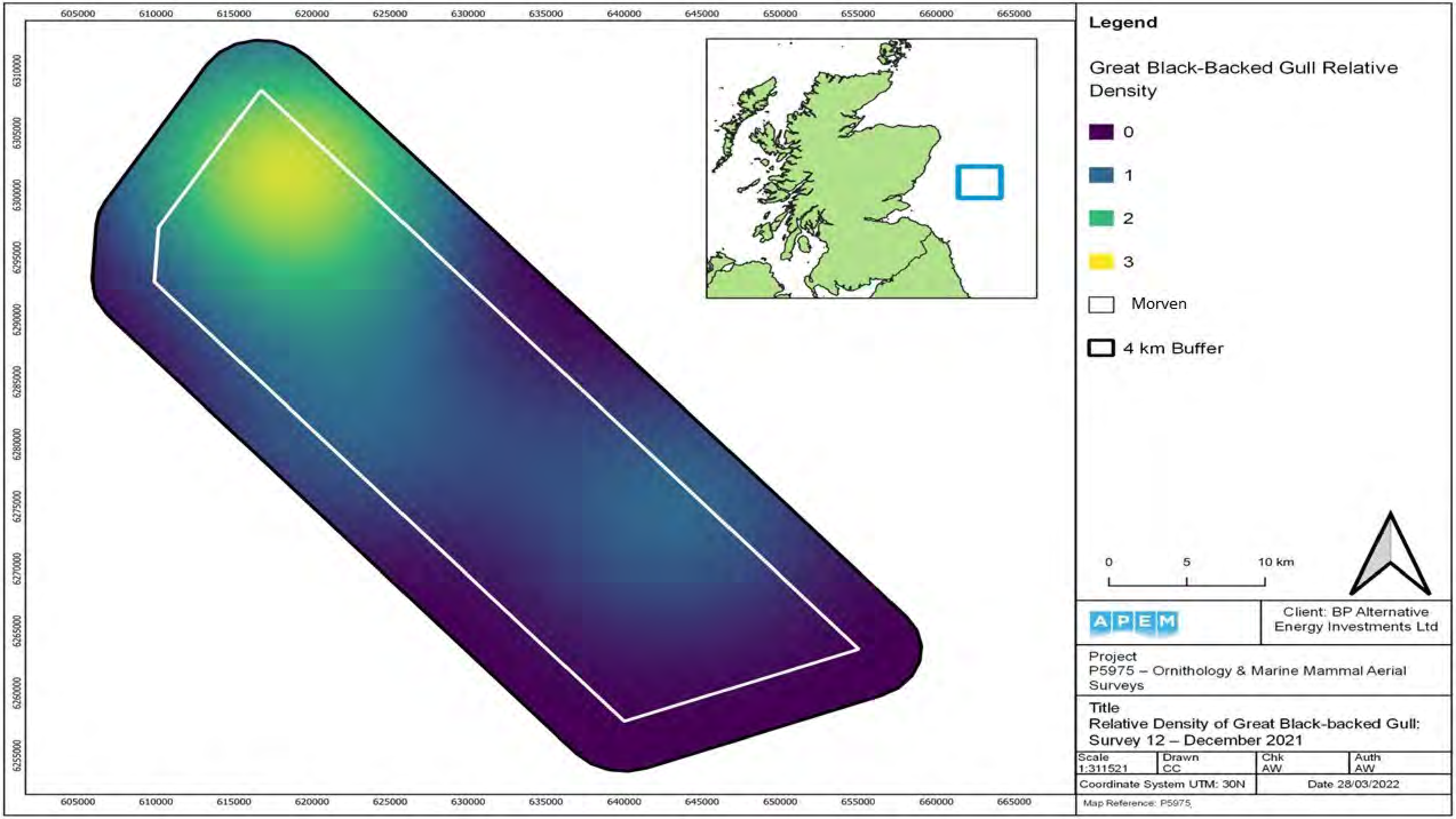


Figure 35 Relative density of great black-backed gull in December 2021 (Survey 12).

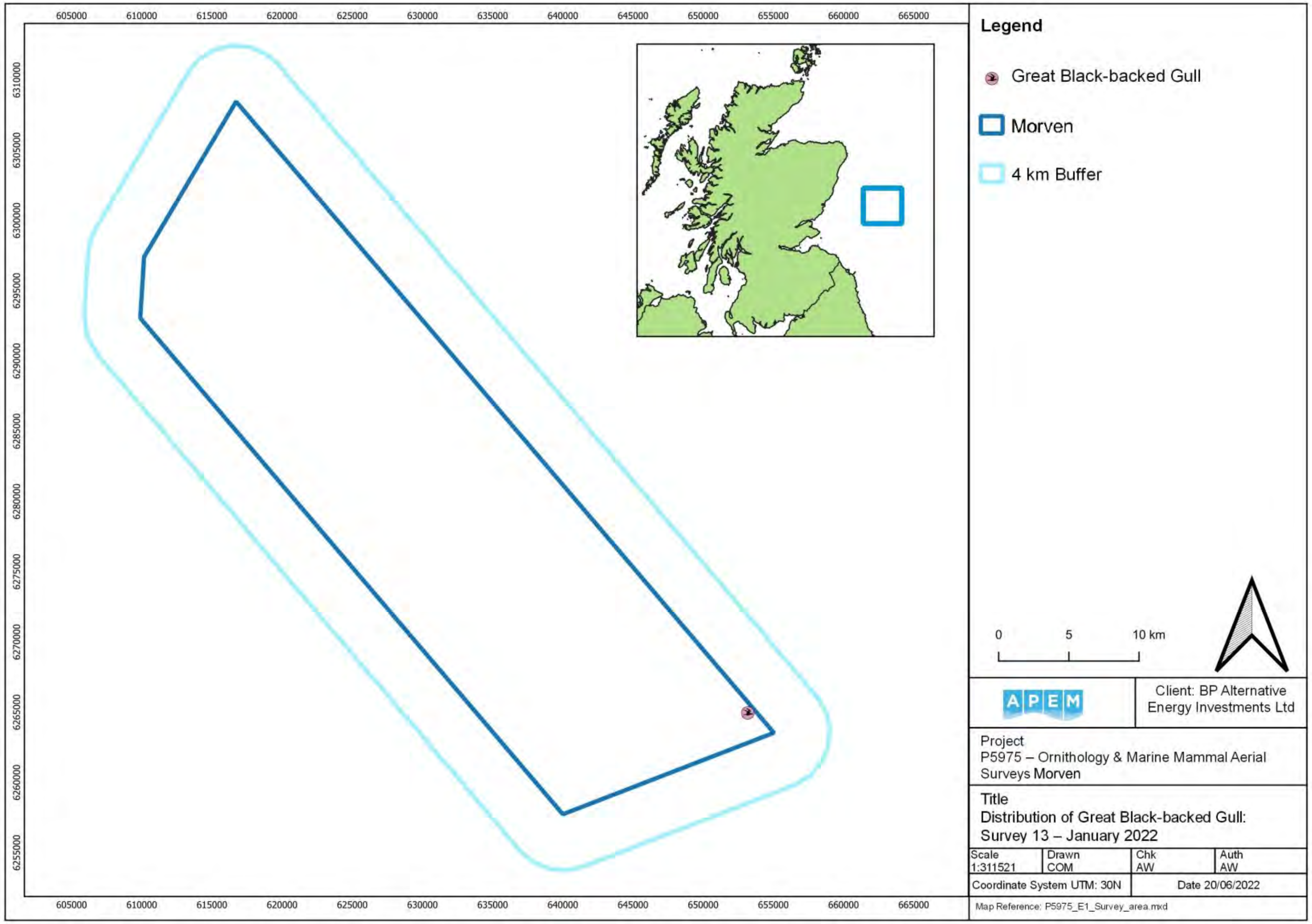


Figure 36 Location of a great black-backed gull in January 2022 (Survey 13).

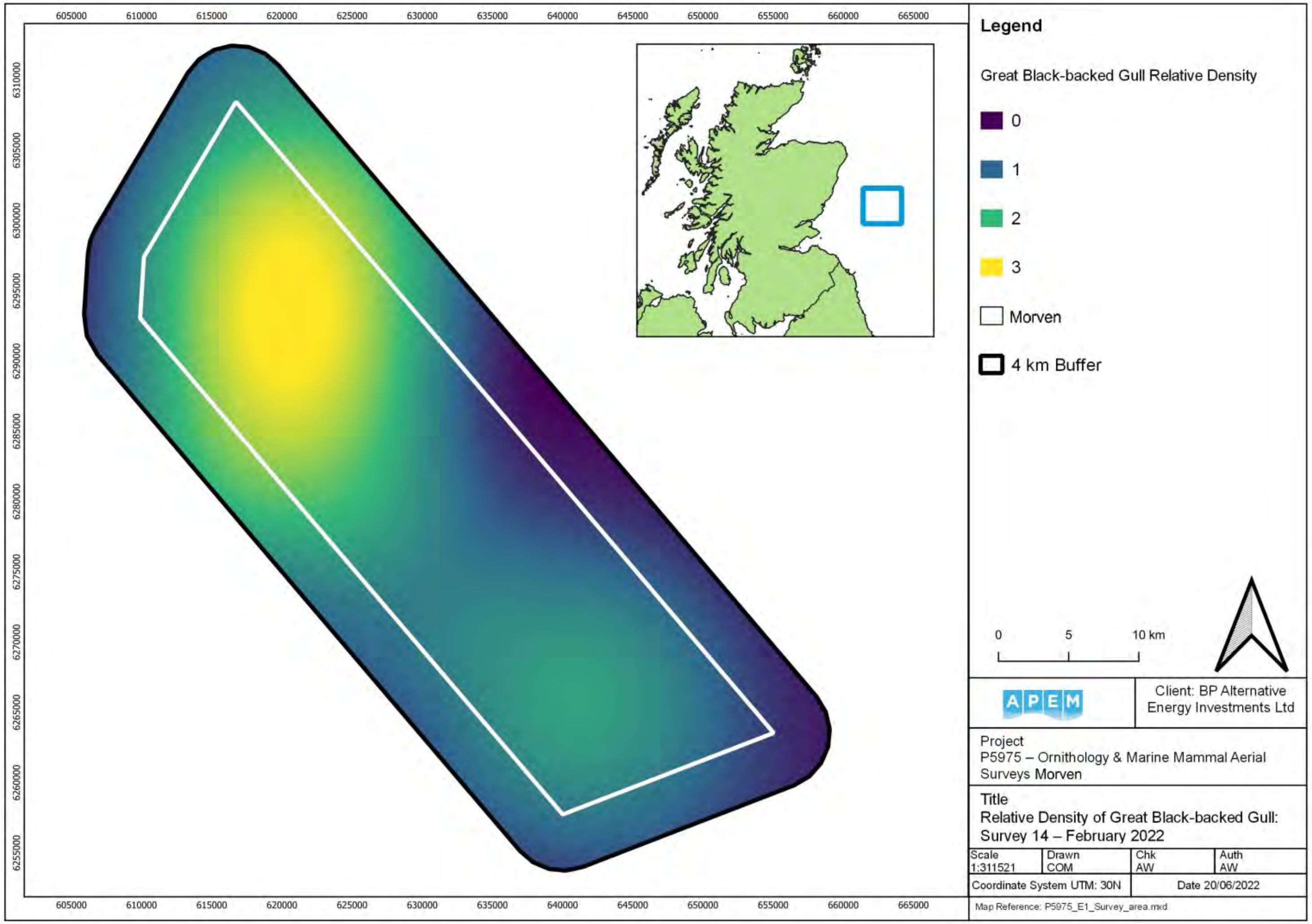
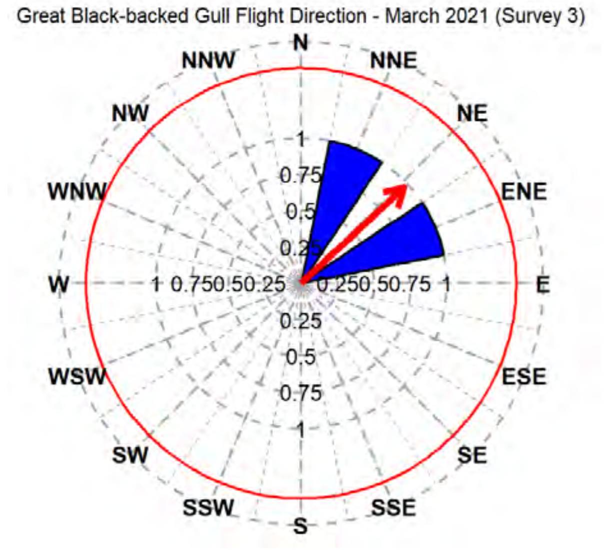
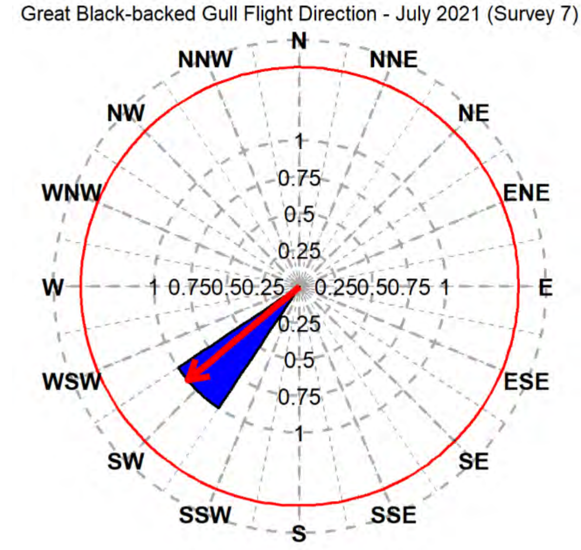


Figure 37 Relative density of great black-backed gull in February 2022 (Survey 14)



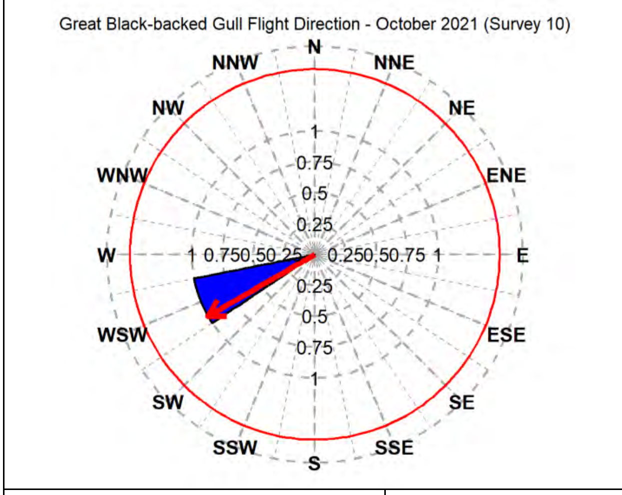
Number of Observations	2
Mean Vector (µ)	47.013
Length of Mean Vector (r)	0.967
Rayleigh Test (Z)	1.869
Rayleigh Test (p)	0.163

Figure 38a March 2021 (Survey 03)



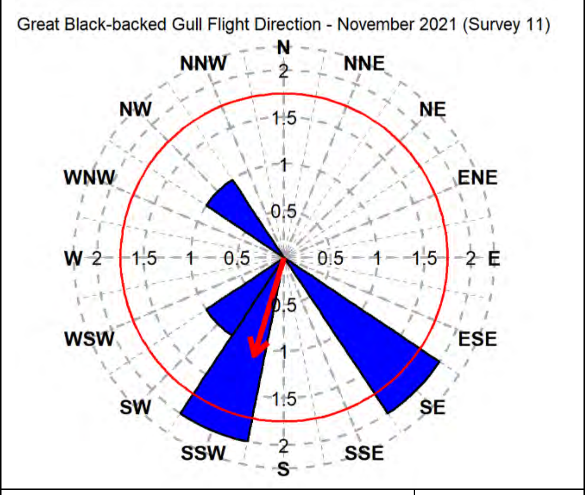
Number of Observations	1
Mean Vector (µ)	230.605
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

Figure 38b July 2021 (Survey 07)



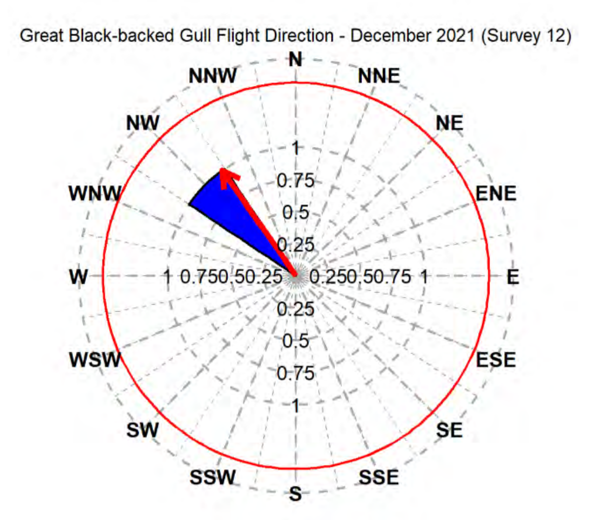
Number of Observations	1
Mean Vector (µ)	240.671
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

Figure 38c October 2021 (Survey 10)



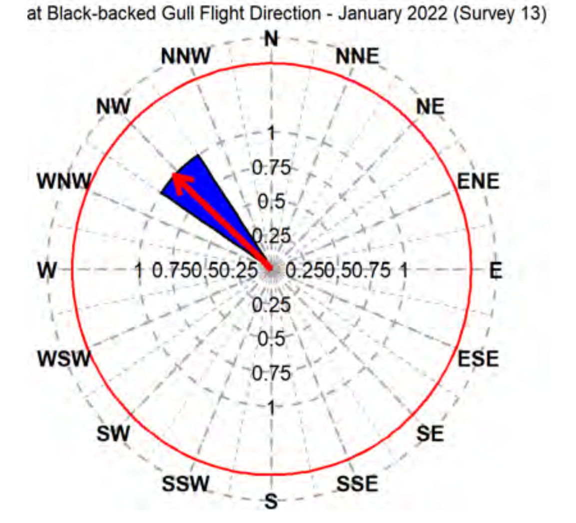
Number of Observations	6
Mean Vector (µ)	197.245
Length of Mean Vector (r)	0.545
Rayleigh Test (Z)	1.782
Rayleigh Test (p)	0.172

Figure 38d November 2021 (Survey 11)



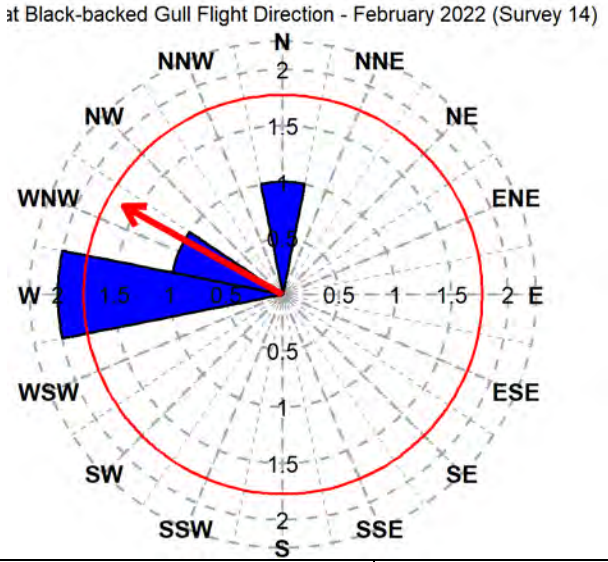
Number of Observations	1
Mean Vector (µ)	325.693
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

Figure 38e December 2021 (Survey 12)



Number of Observations	1
Mean Vector (µ)	313.330
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

Figure 38f January 2022 (Survey 13)



Number of Observations	4
Mean Vector (µ)	299.805
Length of Mean Vector (r)	0.807
Rayleigh Test (Z)	2.605
Rayleigh Test (p)	0.065

Figure 38g February 2022 (Survey 14)

Figure 38 Summary of flight directions of great black-backed gulls recorded in the Array Project.

4.7 Herring Gull – *Larus argentatus*

Herring gull were recorded in January, March, June, July, and November 2021. Peak numbers were in July - 41 individuals, resulting in an abundance estimate of 336 within the Array Project (Table 10).

These were throughout the Array Project – north and south in June (Figure 41), south half in January (Figure 39), and north in March (Figure 40), July (Figure 42), and November (Figure 43).

Age class of herring gull were recorded in the surveys. 63% of herring gull recorded were as adult, 35% unknown and 2% third summer (Table 11).

No significant direction of flight was recorded in herring gull (p>0.05) (Figure 44).

Table 10 Raw counts, abundance and density estimates of herring gull in the Array Project.

Survey	Raw Count	Sitting	Flying	Abundance	Lower CL	Upper CL	Precision	Density
Jan-21	1	-	1	8	1	24	1.00	0.01
Mar-21	1	1	-	8	1	33	1.00	0.01
Jun-21	2	2	-	17	2	41	0.71	0.01
Jul-21	41	38	3	336	41	861	0.16	0.24
Nov-21	1	-	1	8	1	25	1.00	0.01

Table 11 Raw counts of age classes of herring gull

Survey	Raw Count	Adult	Third Summer	Unknown
Jan-21	1	1	-	-
Mar-21	1	-	-	1
Jun-21	2	2	-	-
Jul-21	41	25	1	15
Nov-21	1	1	-	-
Total	**46**	**29**	**1**	**16**

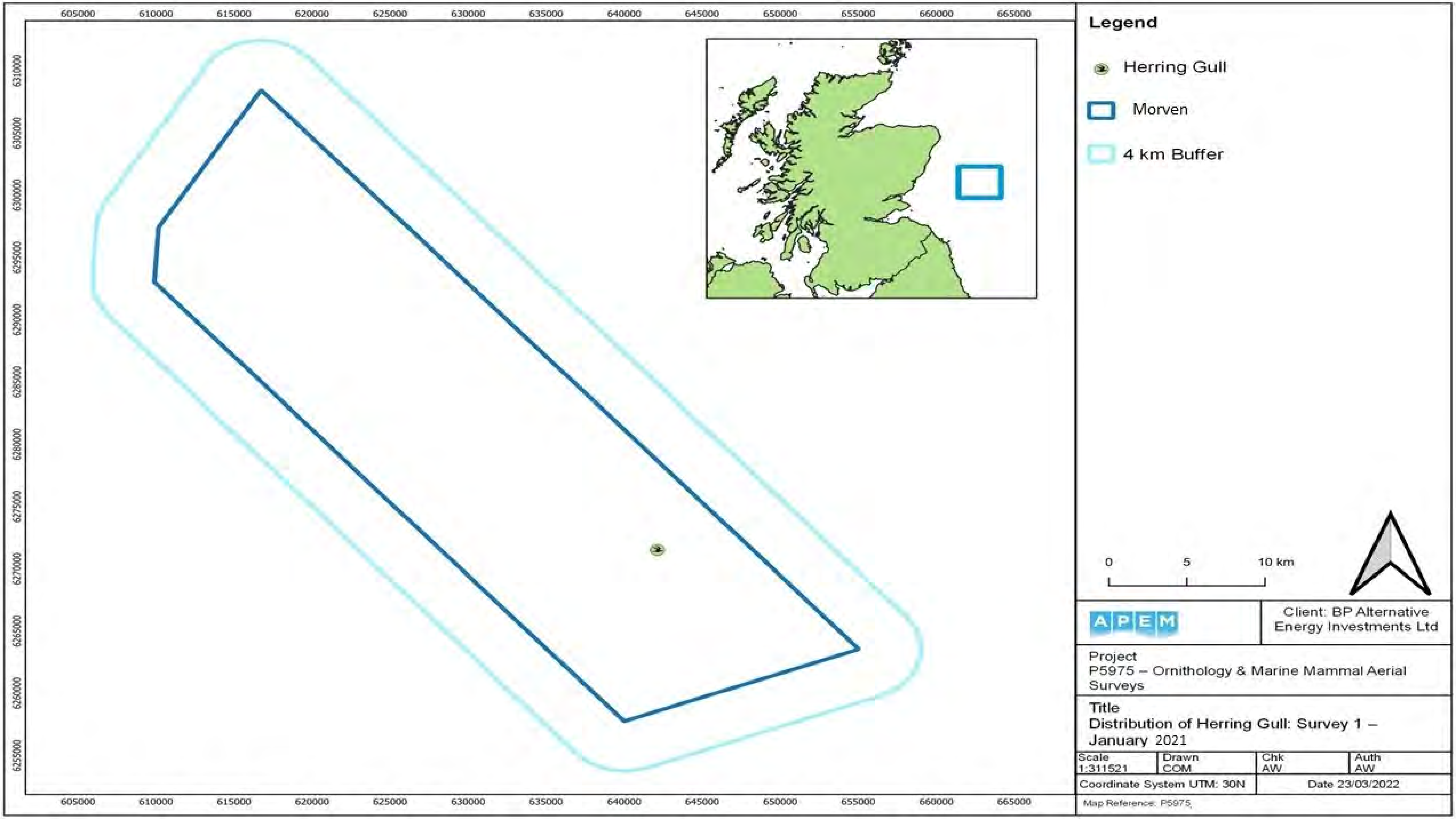


Figure 39 Location of a herring gull in January 2021 (Survey 01).

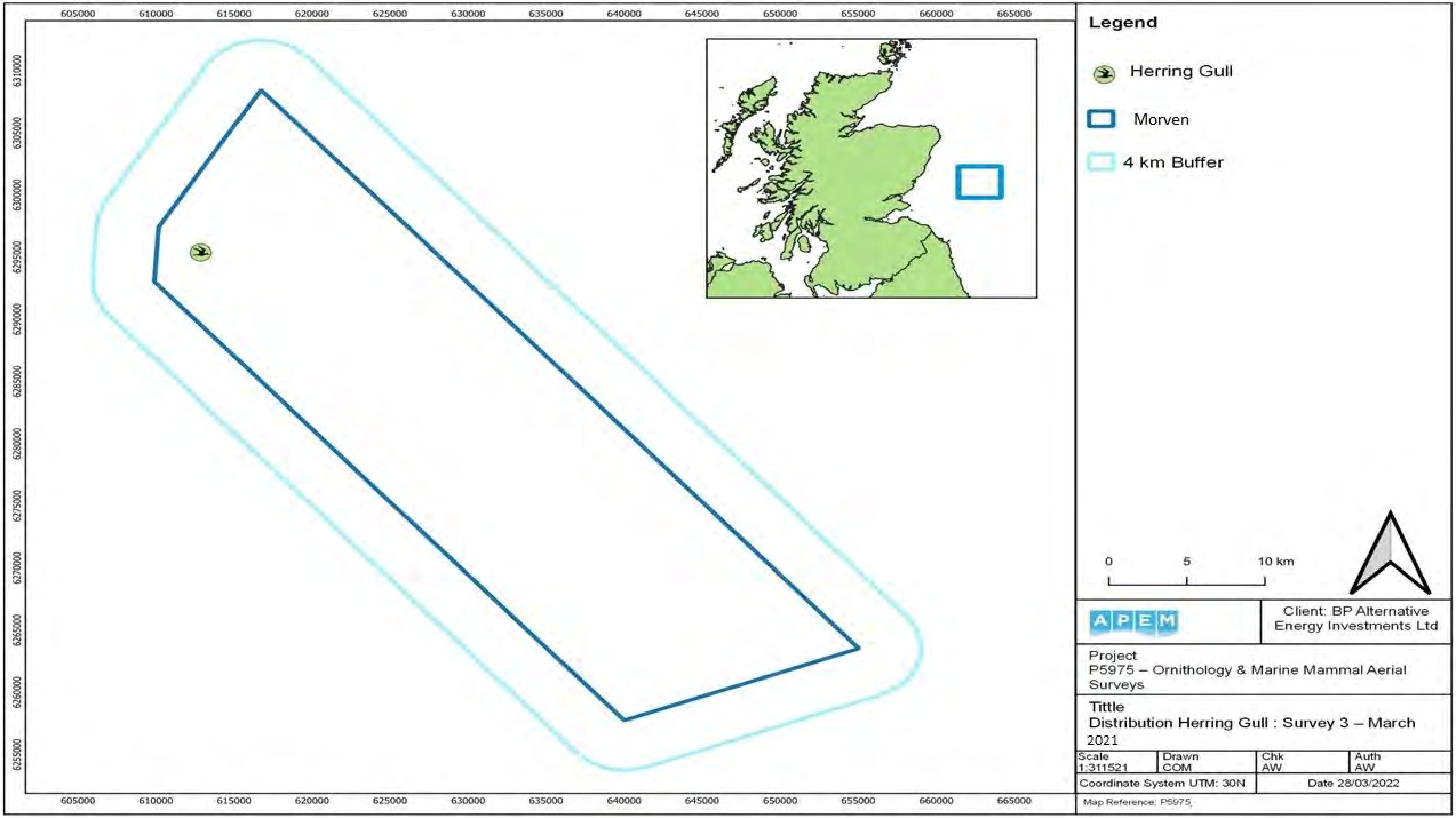


Figure 40 Location of a herring gull in March 2021 (Survey 03).

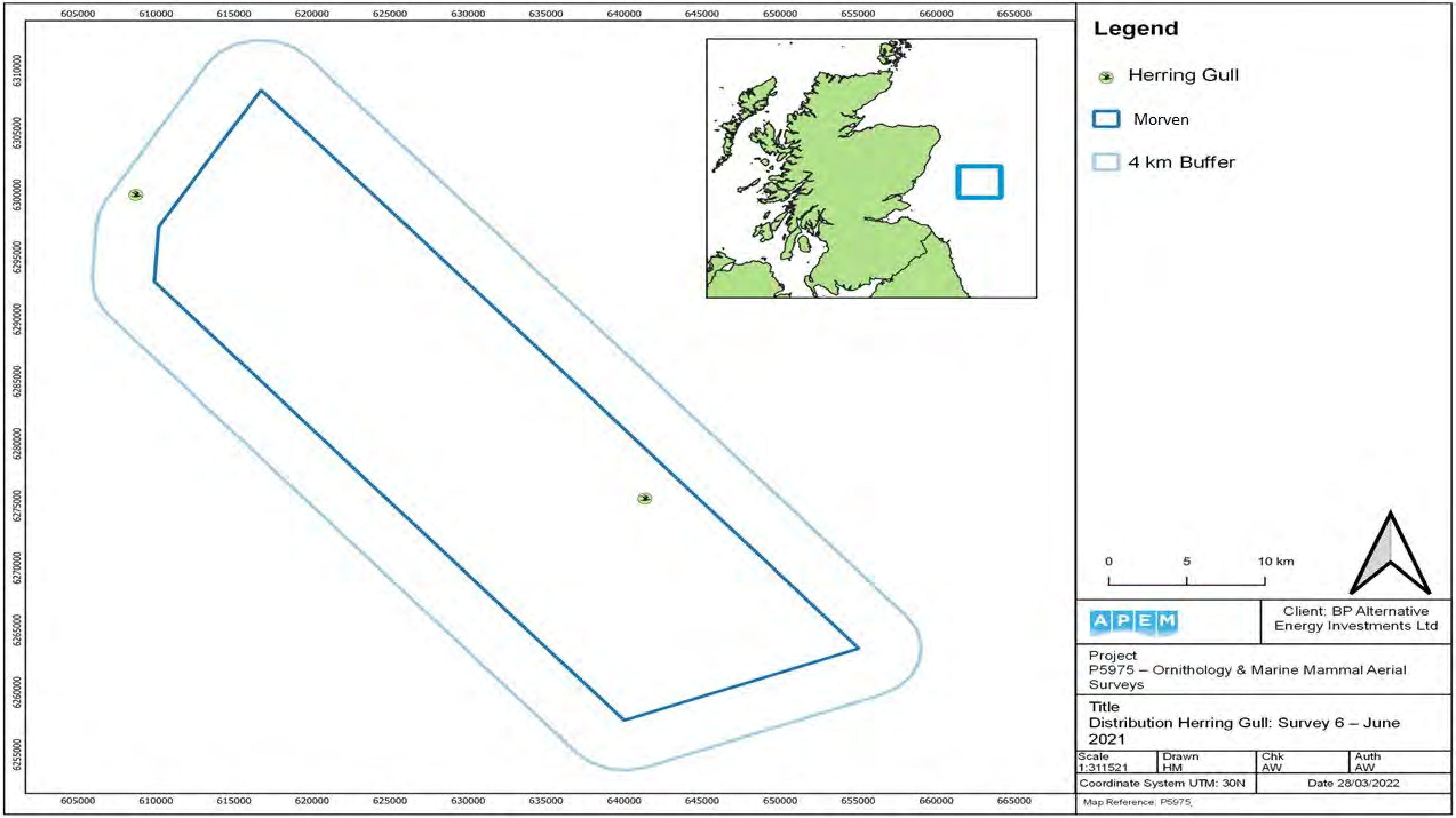


Figure 41 Distribution of herring gulls in June 2021 (Survey 06).

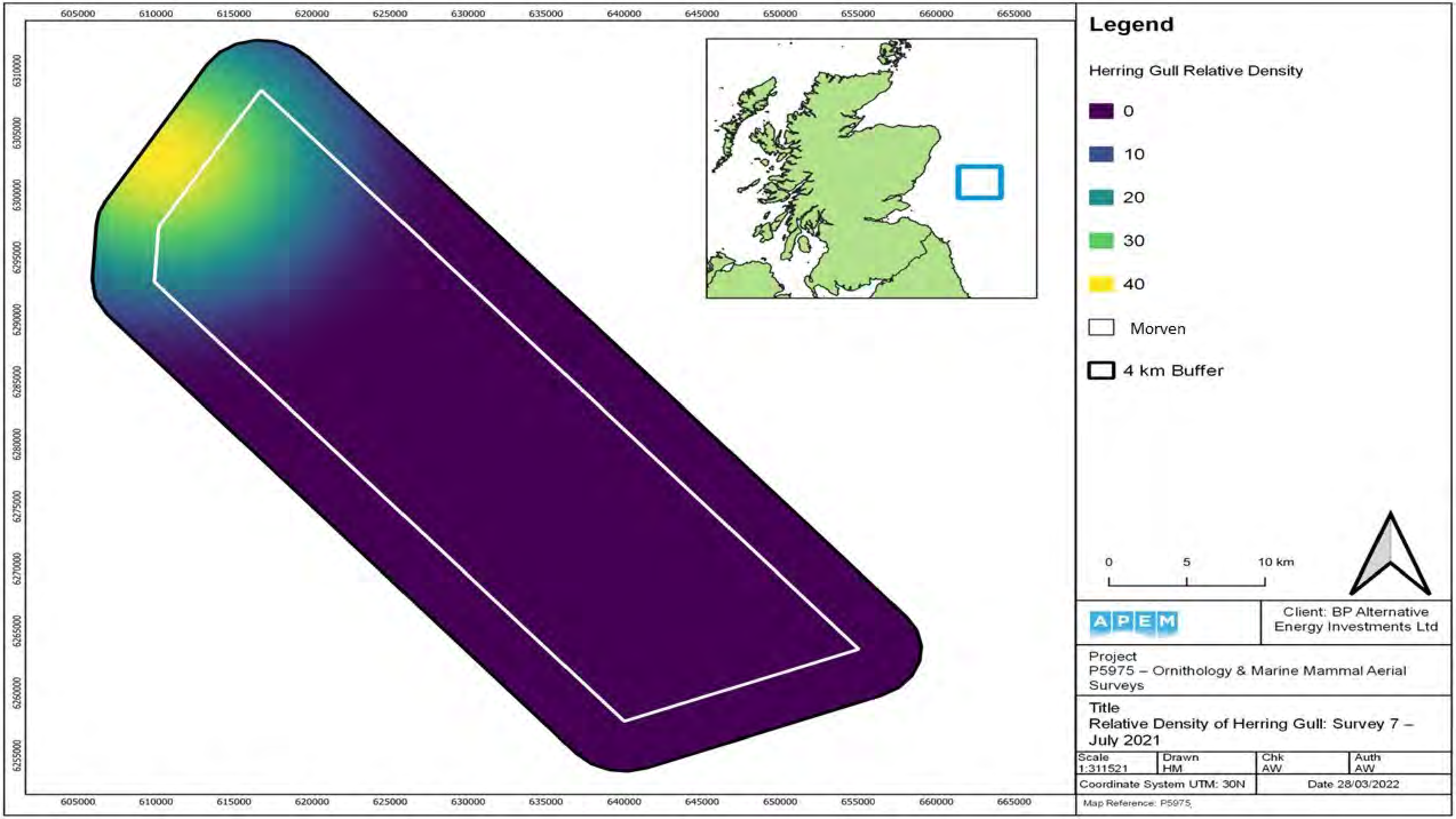


Figure 42 Relative density of herring gull in July 2021 (Survey 07).

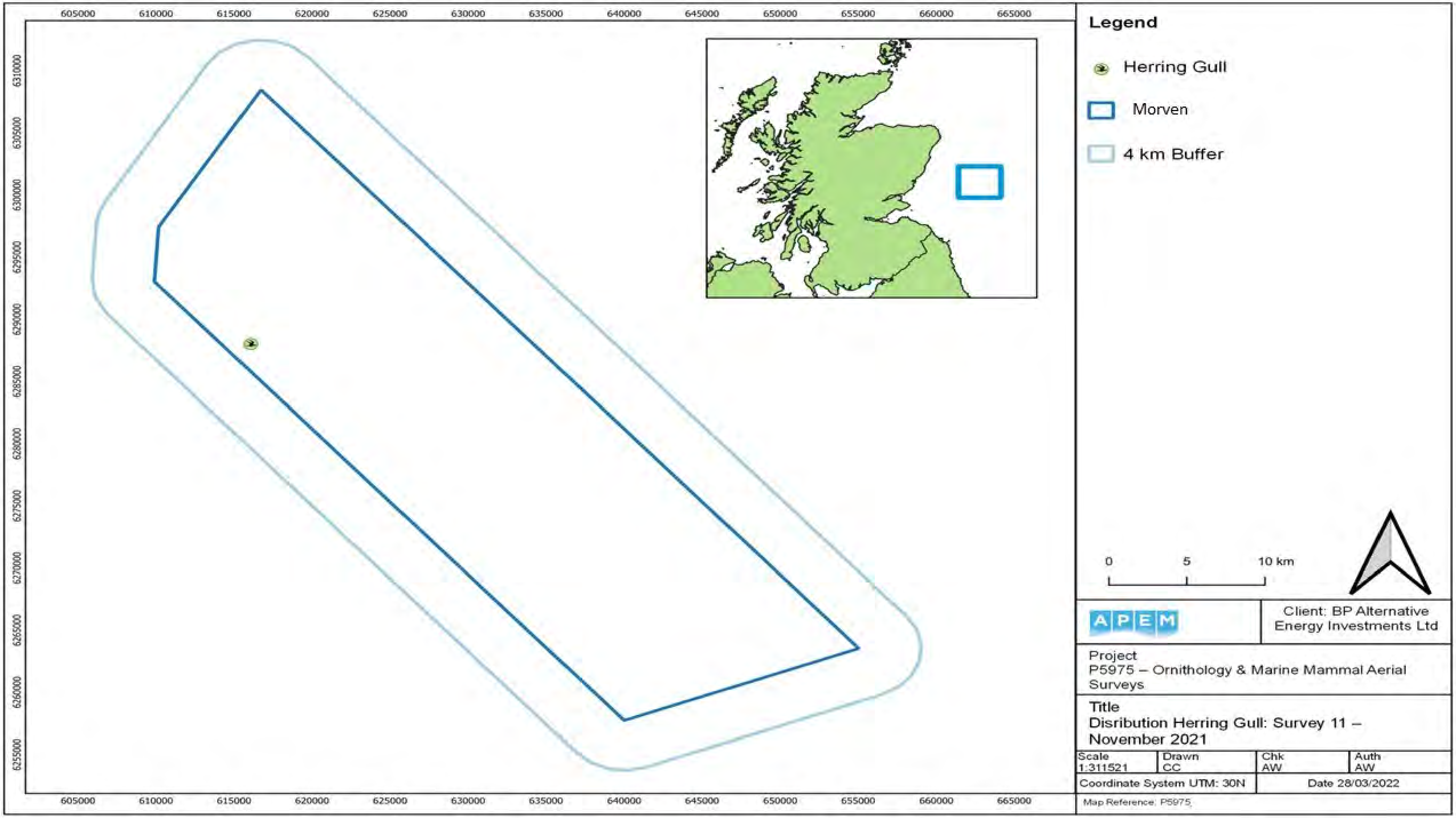
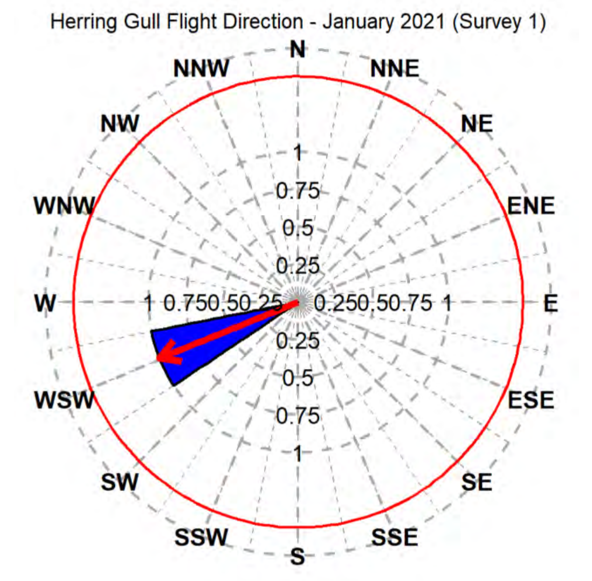
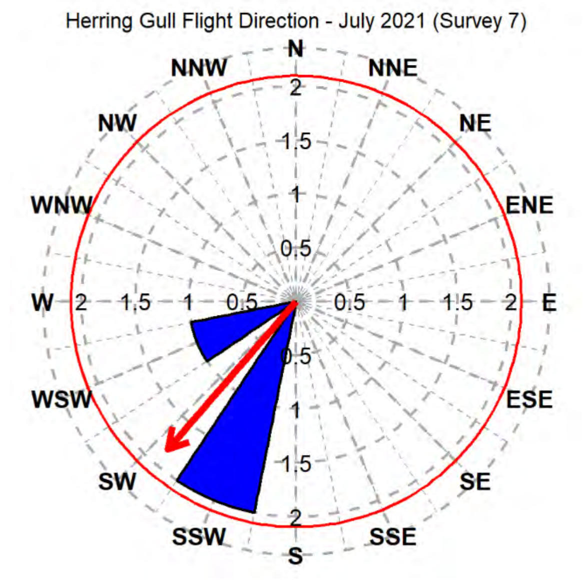


Figure 43 Location of a herring gull in November 2021 (Survey 11).



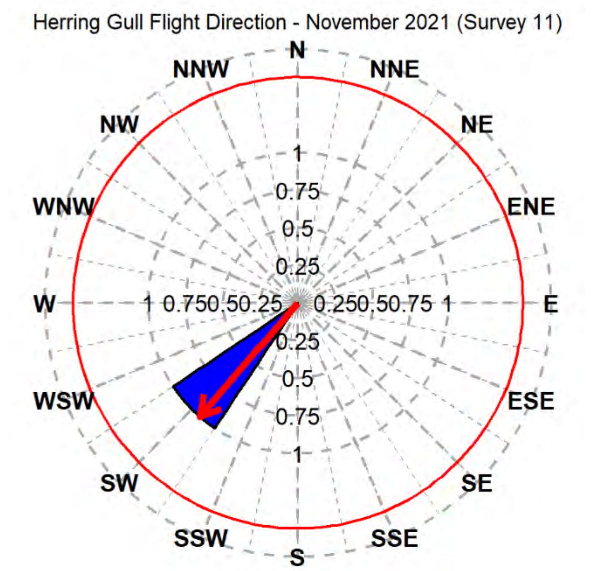
Number of Observations	1
Mean Vector (µ)	248.515
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

Figure 44a January 2021 (Survey 01)



Number of Observations	3
Mean Vector (µ)	221.981
Length of Mean Vector (r)	0.910
Rayleigh Test (Z)	2.485
Rayleigh Test (p)	0.073

Figure 44b July 2021 (Survey 07)



Number of Observations	1
Mean Vector (µ)	221.194
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

Figure 44c November 2021 (Survey 11)

Figure 44 Summary of flight directions of herring gulls recorded in the Array Project.

4.8 Large Gull species – *Unidentified*

Individual unidentified large gulls were recorded in January and August 2021. Two individuals were recorded in July, resulting in an abundance estimate of 16 within the Array Project for that month (Table 12).

These were recorded in the northeast in January (Figure 45) and August (Figure 47), and north in July (Figure 46).

Table 12 Raw counts, abundance and density estimates of unidentified large gull in the Array Project.

Survey	Raw Count	Sitting	Flying	Abundance	Lower CL	Upper CL	Precision	Density
Jan-21	1	-	1	8	1	24	1.00	0.01
Jul-21	2	2	-	16	2	41	0.71	0.01
Aug-21	1	1	-	8	1	25	1.00	0.01

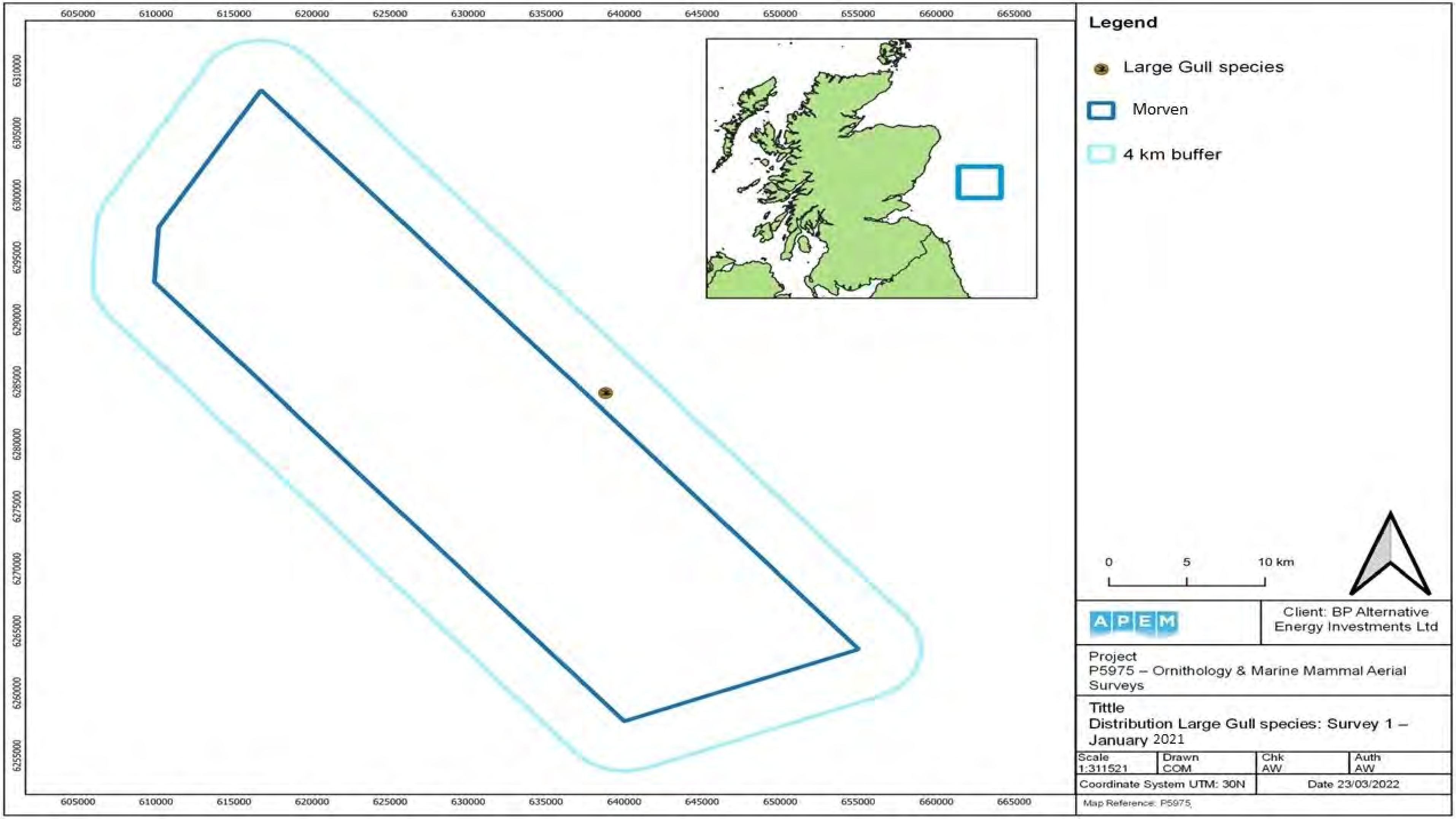


Figure 45 Location of an unidentified large gull in January 2021 (Survey 01).

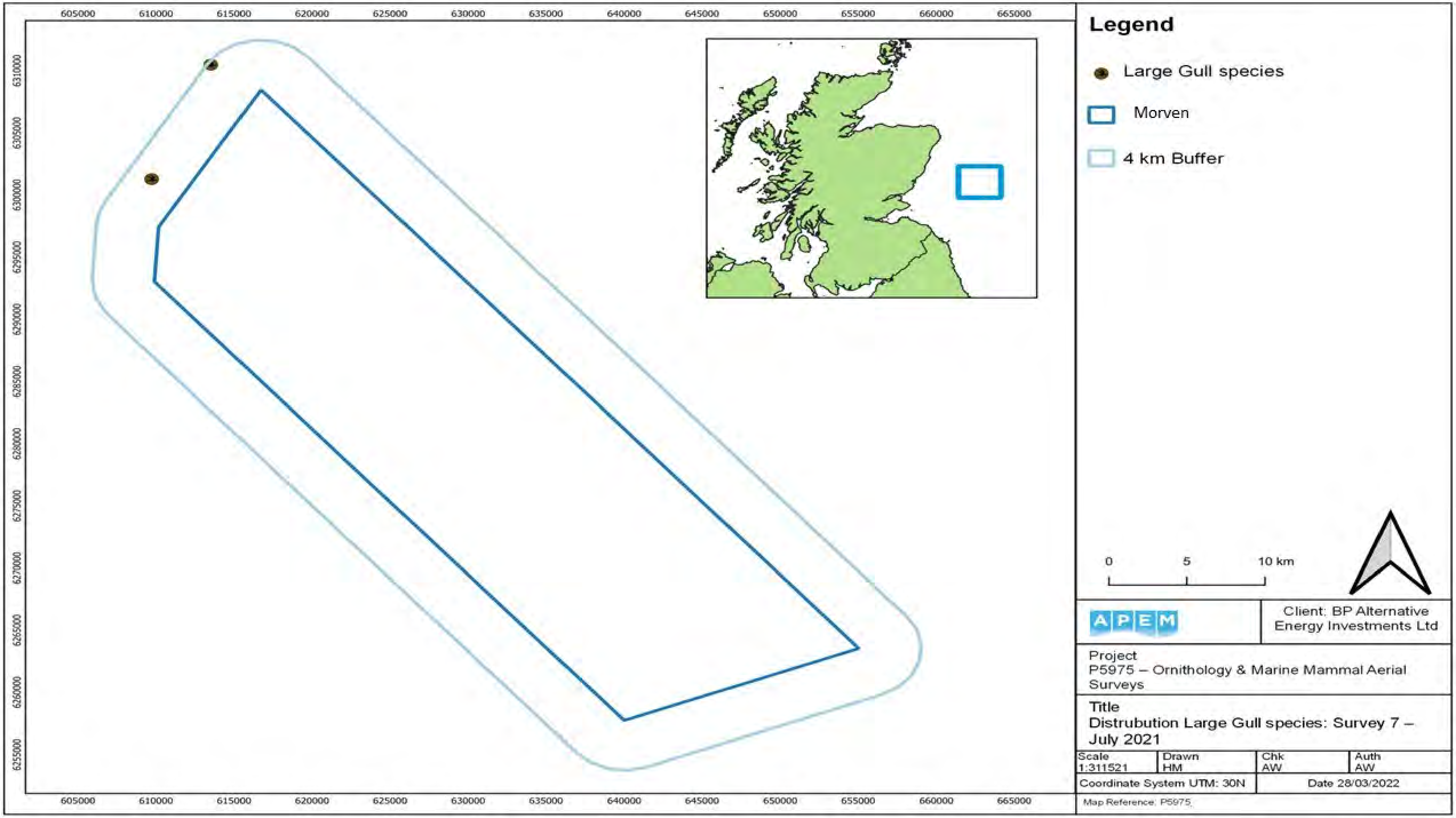


Figure 46 Distribution of unidentified large gulls in July 2021 (Survey 07).

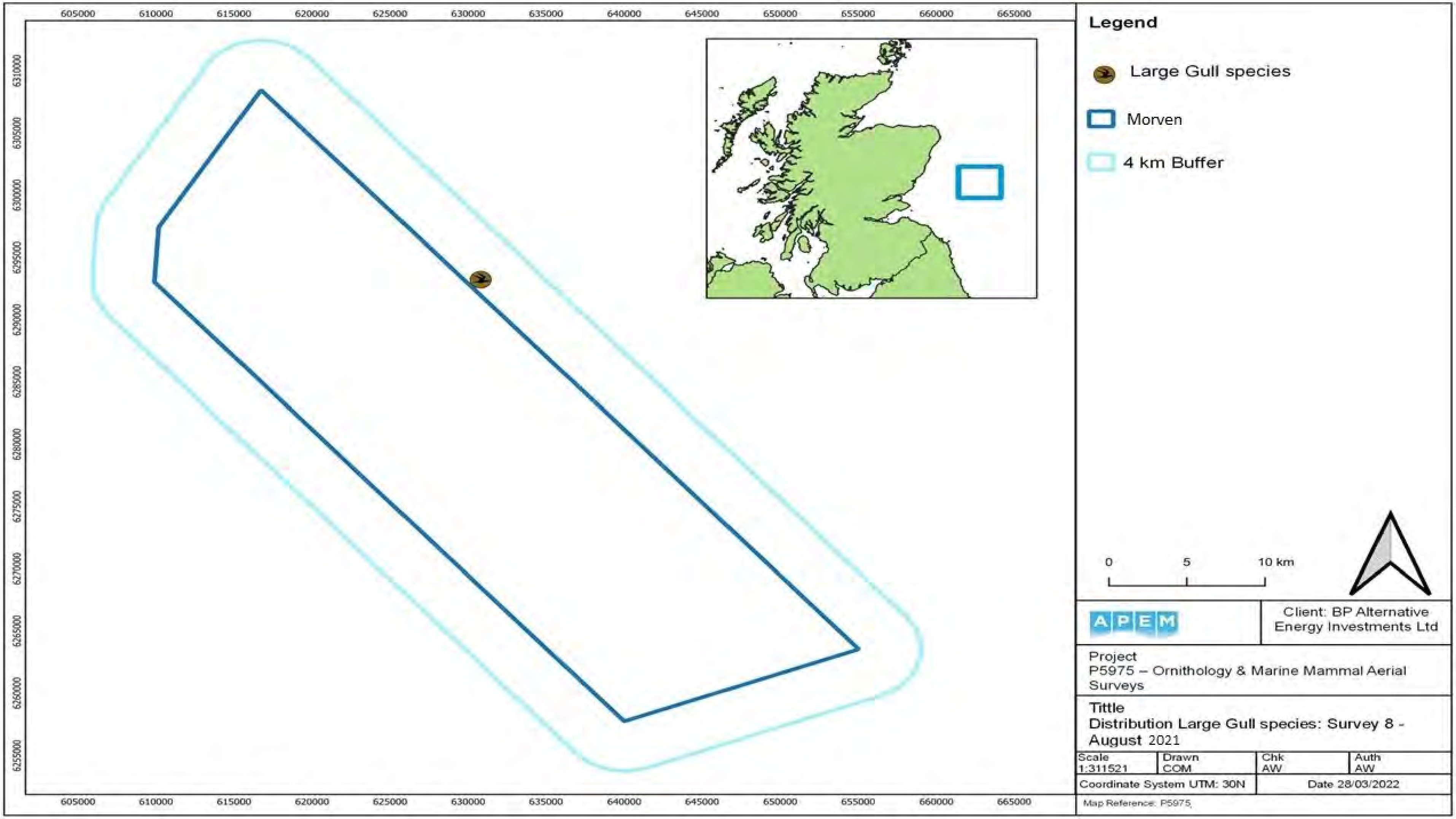


Figure 47 Location of an unidentified large gull in August 2021 (Survey 08).

4.9 Gull species – Unidentified

Unidentified gulls were recorded in June and August 2021, with five individuals in June, resulting in an abundance estimate of 41 within the Array Project (Table 13).

They were found in the central area, in June (Figure 48) and August (Figure 49).

Table 13 Raw counts, abundance and density estimates of unidentified gull in the Array Project.

Survey	Raw Count	Sitting	Flying	Abundance	Lower CL	Upper CL	Precision	Density
Jun-21	5	5	-	41	8	91	0.45	0.03
Aug-21	1	1	-	8	1	25	1.00	0.01

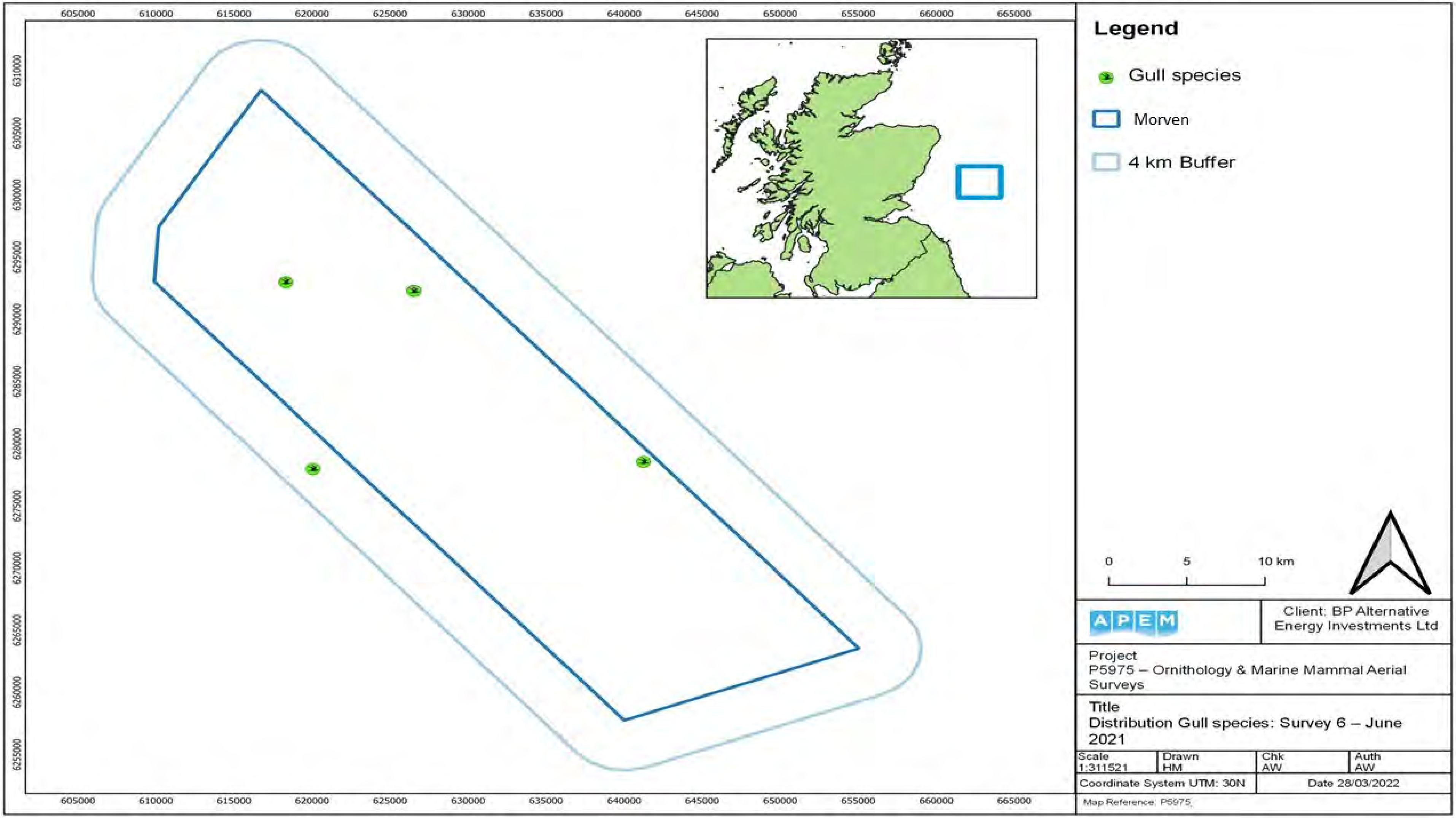


Figure 48 Distribution of unidentified gulls in June 2021 (Survey 06).

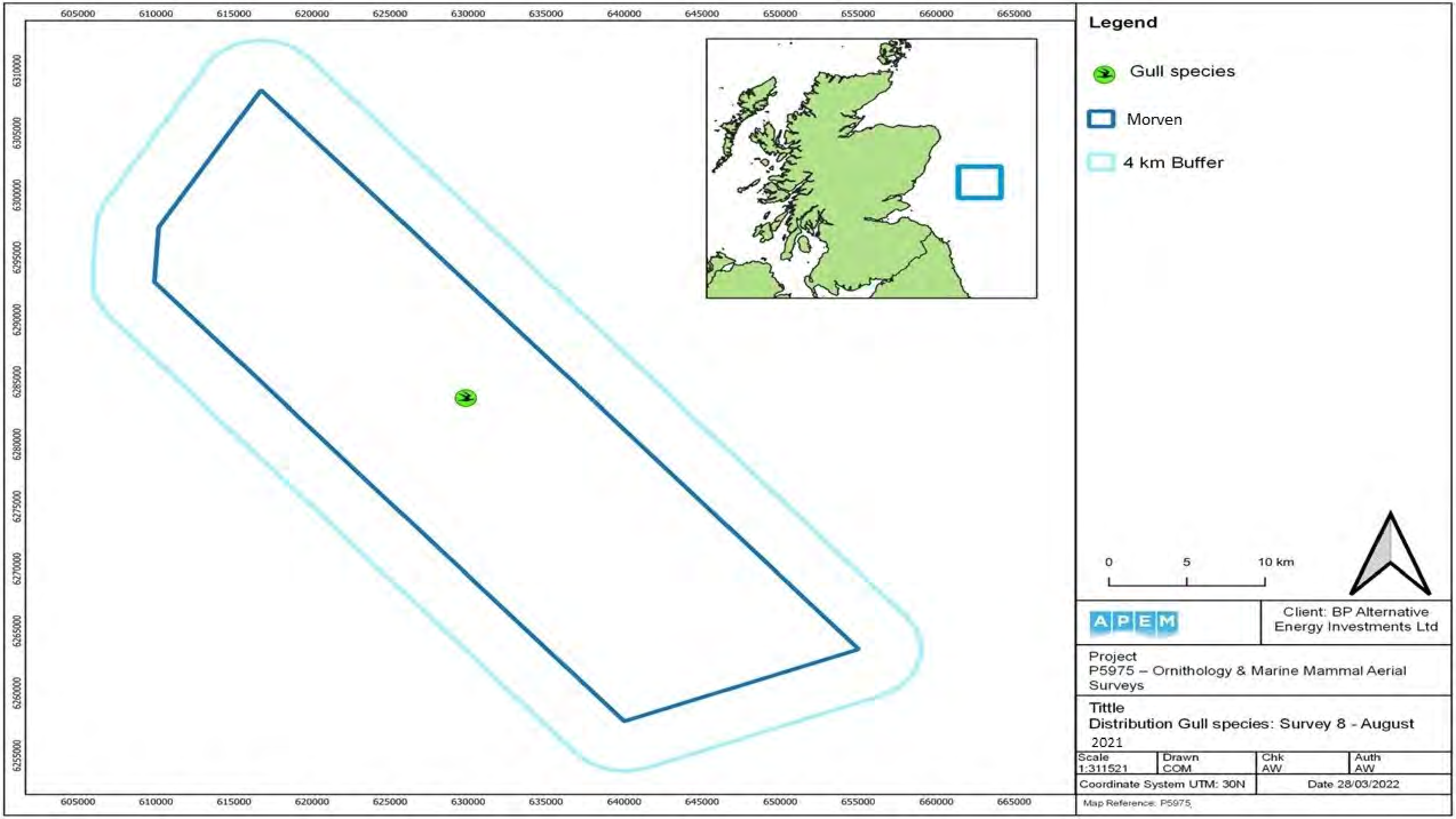


Figure 49 Location of an unidentified gull in August 2021 (Survey 08).

4.10 Arctic Tern – *Sterna paradisaea*

Arctic terns were recorded in May and July 2021, with four individuals in July, resulting in an abundance estimate of 33 within the Array Project for that month (Table 14).

These were in the west of the Array Project in July (Figure 51) and south in May (Figure 50).

In May Arctic tern were not flying in a significant direction ($p>0.05$). In July Arctic tern were recorded flying in a significant south-easterly direction with a mean vector of 147.015 ($p<0.05$). (Figure 52).

Table 14 Raw counts, abundance and density estimates of Arctic tern in the Array Project.

Survey	Raw Count	Sitting	Flying	Abundance	Lower CL	Upper CL	Precision	Density
May-21	2	-	2	16	2	41	0.71	0.01
Jul-21	4	-	4	33	4	131	0.50	0.02

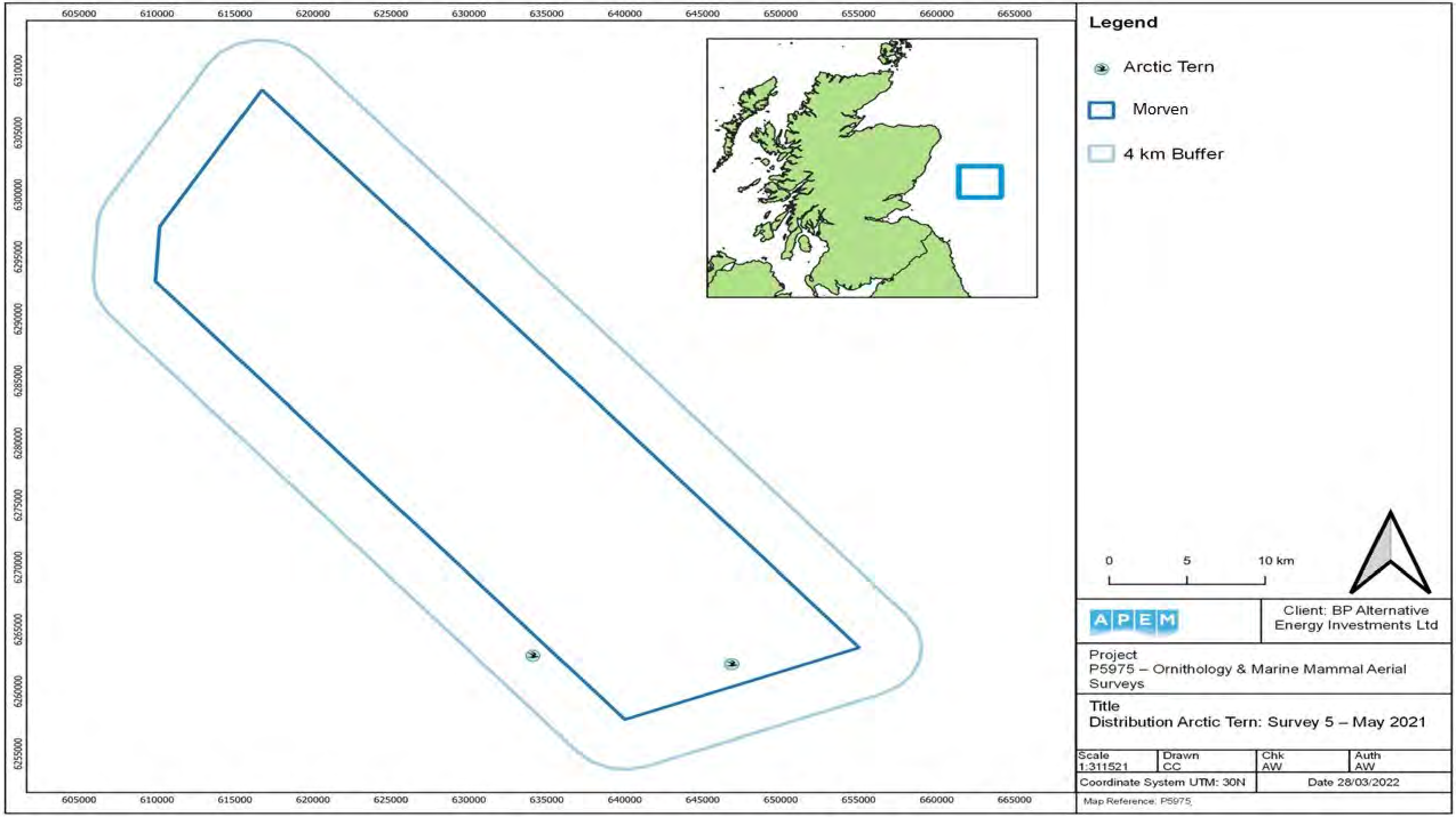


Figure 50 Distribution of Arctic tern in May 2021 (Survey 05).

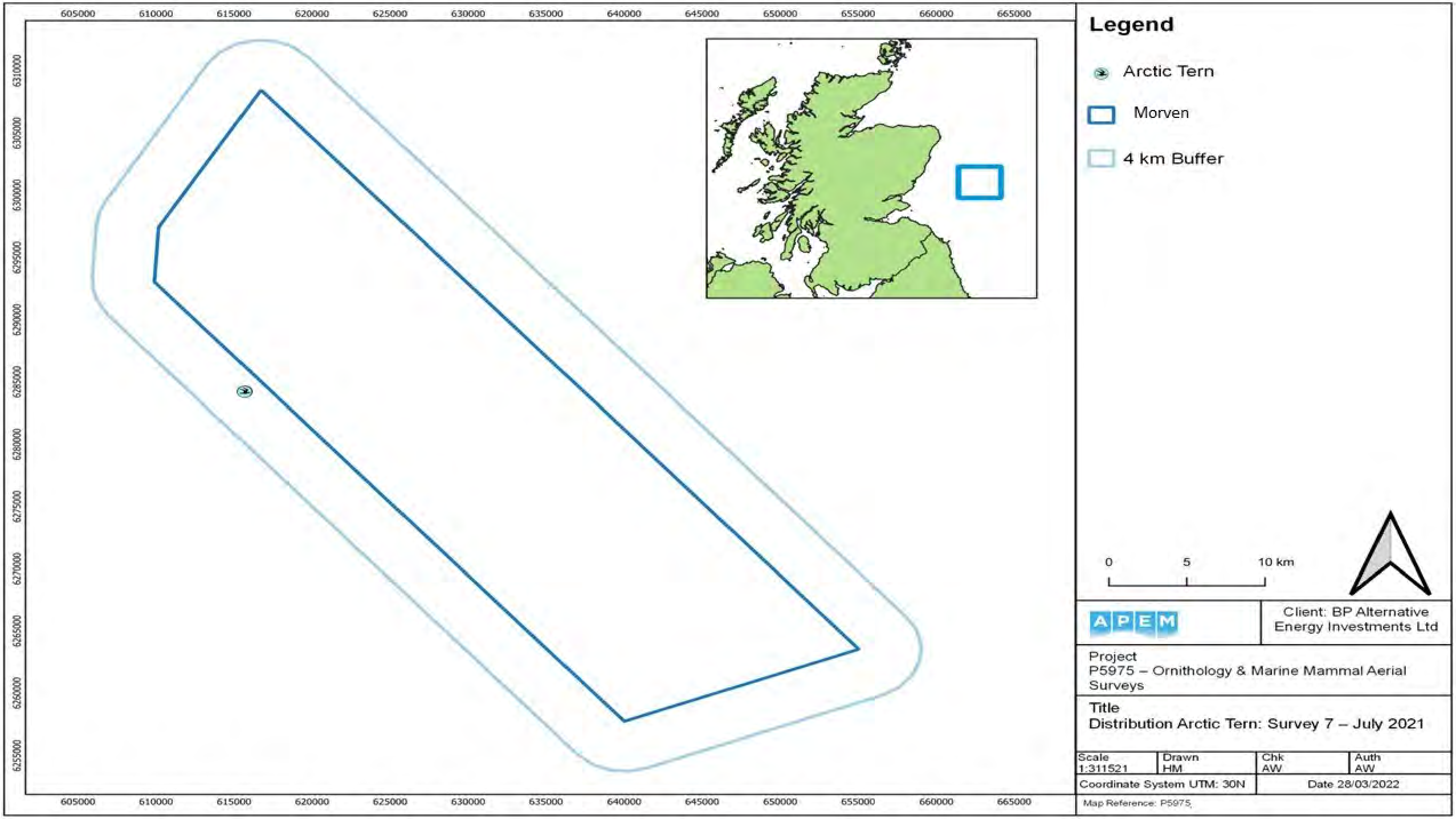
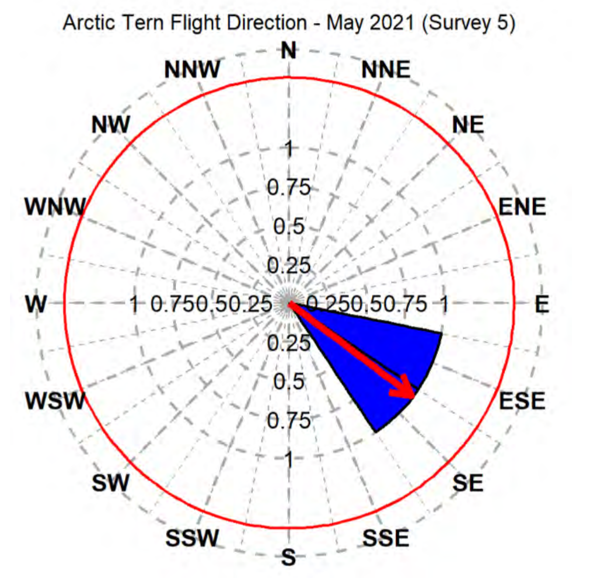
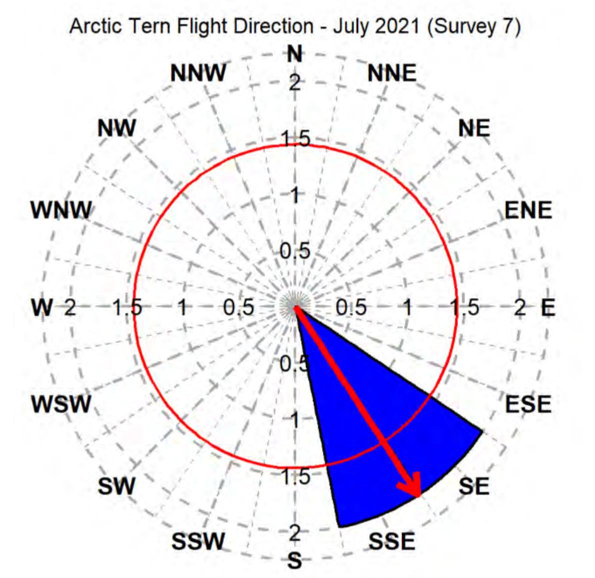


Figure 51 Location of Arctic terns in July 2021 (Survey 07).





Number of Observations	2	Number of Observations	4
Mean Vector (μ)	127.534	Mean Vector (μ)	147.015
Length of Mean Vector (r)	0.986	Length of Mean Vector (r)	0.995
Rayleigh Test (Z)	1.946	Rayleigh Test (Z)	3.962
Rayleigh Test (p)	0.148	Rayleigh Test (p)	0.008
Figure 52a May 2021 (Survey 05)		**Figure 52b July 2021 (Survey 07)**	

Figure 52 Summary of flight directions of Arctic terns recorded in the Array Project.

4.11 Common/Arctic (‘Commic’) Tern - *Sterna hirundo / paradisaea*

‘Commic’ terns were recorded in July and August 2921, with peak numbers in August -13 individuals, resulting in an abundance estimate of 107 within the Array Project (Table 15).

These were mainly in the west, in both July (Figure 53) and August (Figure 54).

The ‘Commic’ terns had no preference for flight direction in August. In July commic tern were recorded flying in a significant south-easterly direction (P<0.05) (Figure 55).

Table 15 Raw counts, abundance and density estimates of ‘commic’ tern in the Array Project.

Survey	Raw Count	Sitting	Flying	Abundance	Lower CL	Upper CL	Precision	Density
Jul-21	3	-	3	25	3	98	0.58	0.02
Aug-21	13	5	8	107	33	213	0.28	0.08

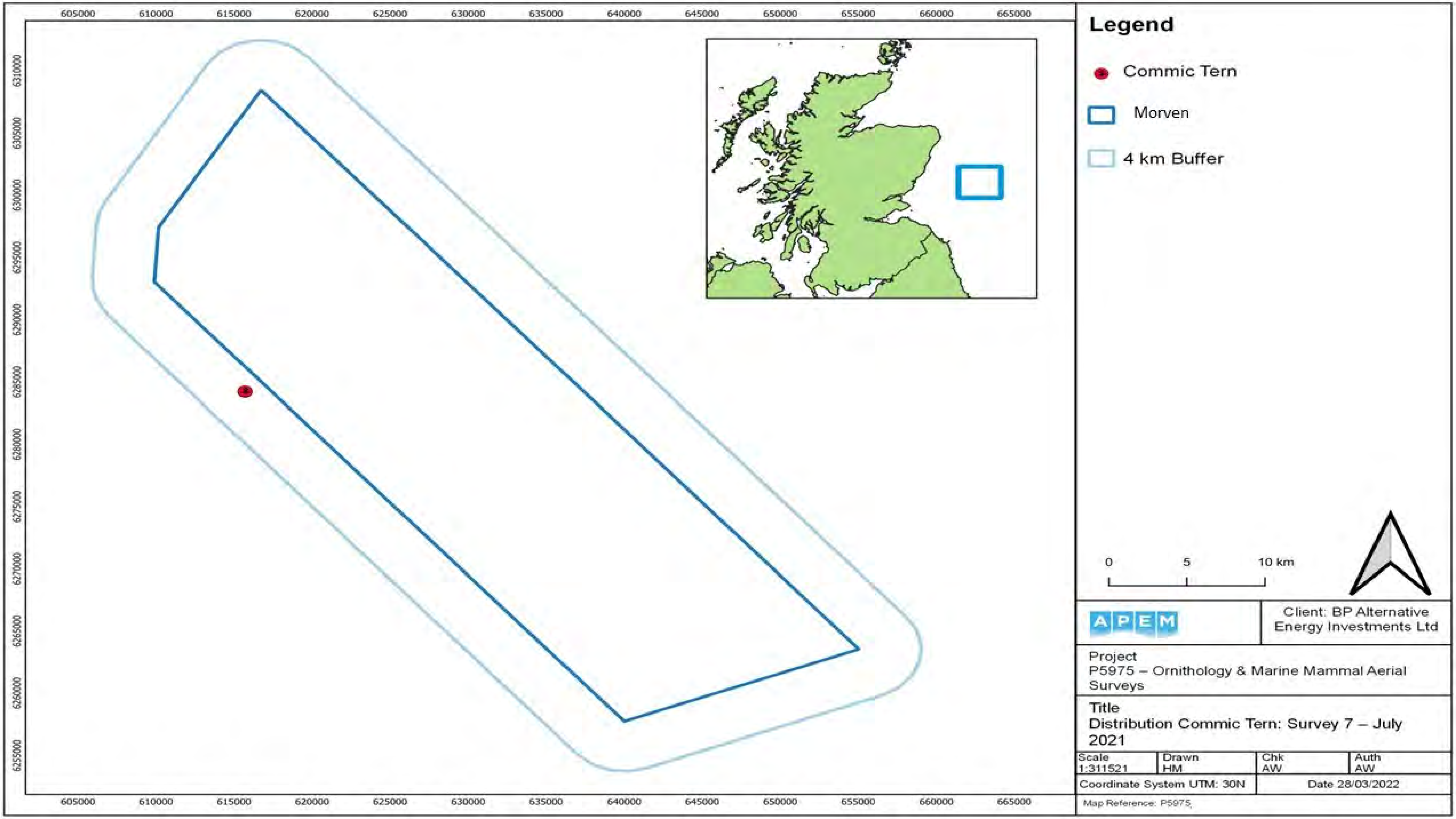


Figure 53 Location of 'commic' terns in July 2021 (Survey 07).

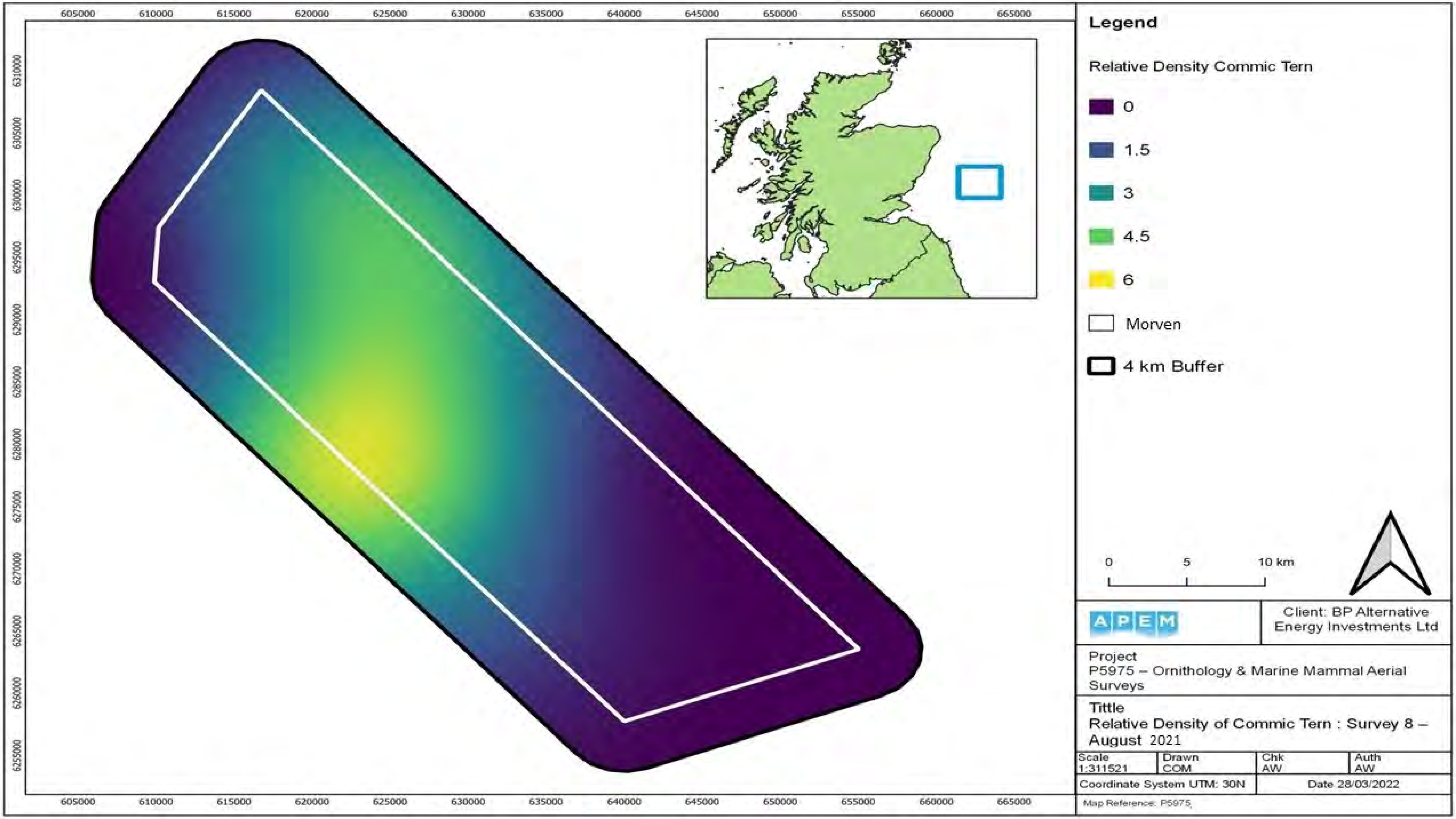
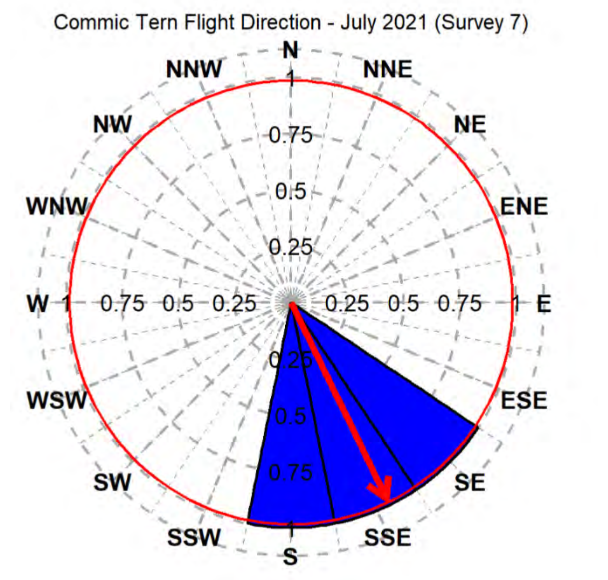
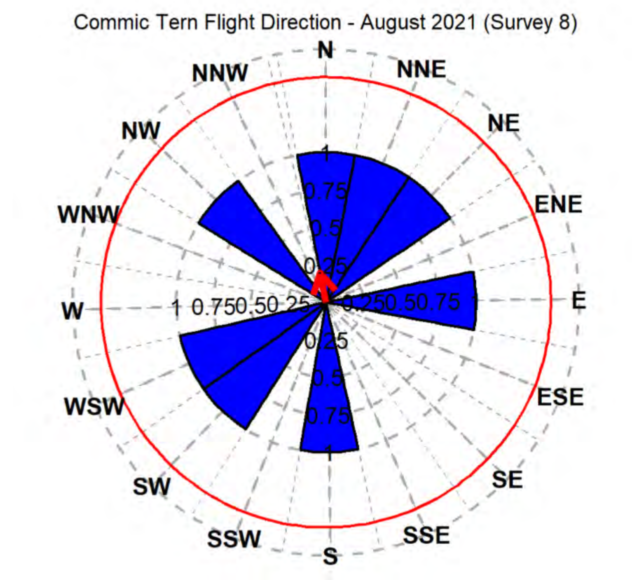


Figure 54 Relative density of 'commic' tern in August 2021 (Survey 08).



Number of Observations	3
Mean Vector (µ)	154.310
Length of Mean Vector (r)	0.967
Rayleigh Test (Z)	2.808
Rayleigh Test (p)	0.045

Figure 55a July 2021 (Survey 07)



Number of Observations	8
Mean Vector (µ)	351.278
Length of Mean Vector (r)	0.197
Rayleigh Test (Z)	0.310
Rayleigh Test (p)	0.745

Figure 55b August 2021 (Survey 08)

Figure 55 Summary of flight directions of 'commic' terns recorded in the Array Project.

4.12 Tern species - *Unidentified*

Unidentified terns were recorded in July 2021only, with three individuals, resulting in an abundance estimate of 25 within the Array Project (Table 16).

These were mainly in the north of the Array Project in July (Figure 56).

Table 16 Raw counts, abundance and density estimates of unidentified tern in the Array Project.

Survey	Raw Count	Sitting	Flying	Abundance	Lower CL	Upper CL	Precision	Density
Jul-21	3	3	-	25	3	74	0.58	0.02

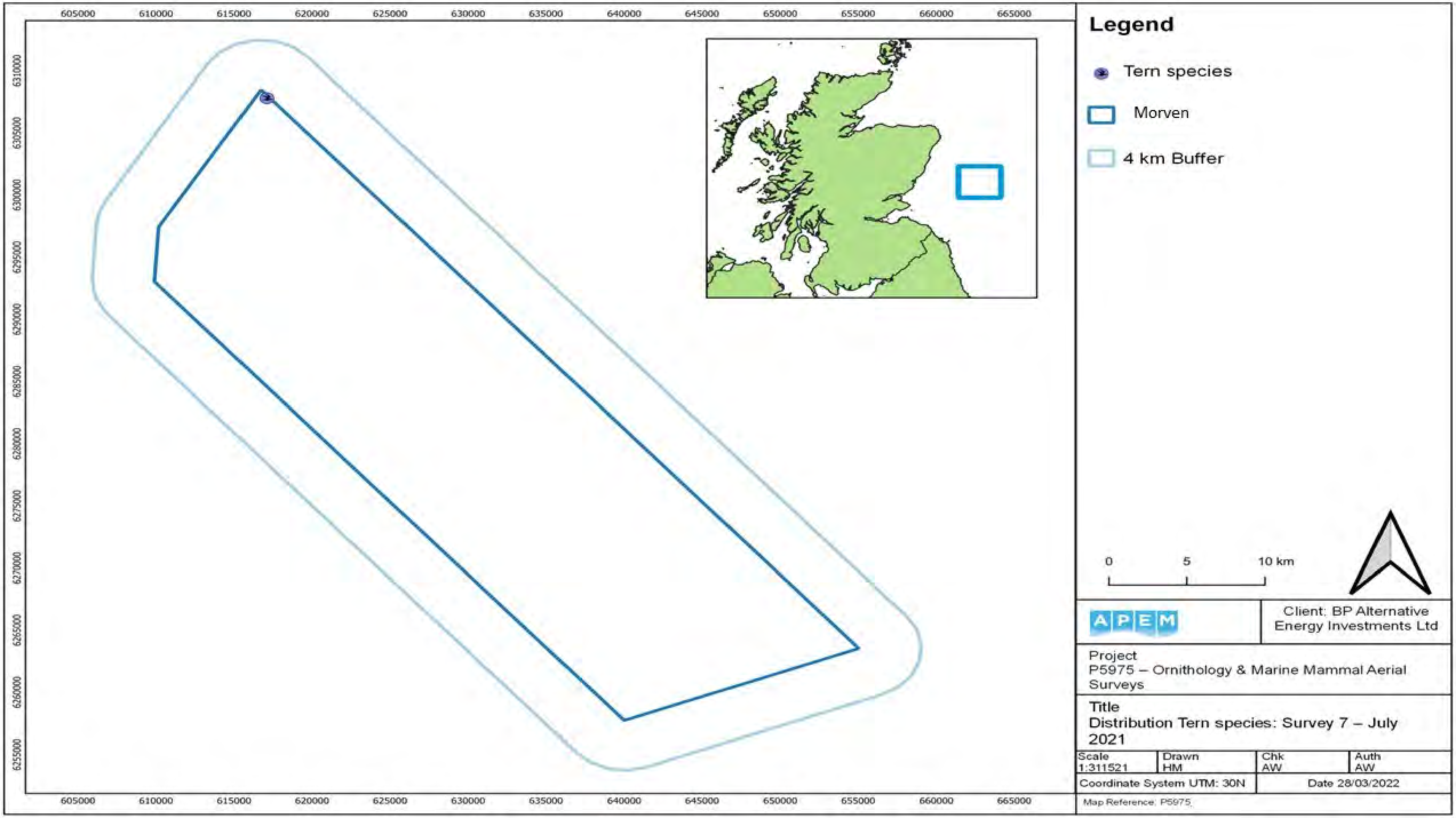


Figure 56 Location of unidentified terns in July 2021 (Survey 07).

4.13 Great Skua – *Stercorarius skua*

Great skuas were recorded in August, September, and October 2021, with one individual each survey month, resulting in an abundance estimate of eight within the Array Project (Table 17).

They were in the northwest in September (Figure 58) and October (Figure 59), and in the central area of the Array Project in August (Figure 57).

Great skuas had no significant direction of flight (p>0.05).

Table 17 Raw counts, abundance and density estimates of great skua in the Array Project.

Survey	Raw Count	Sitting	Flying	Abundance	Lower CL	Upper CL	Precision	Density
Aug-21	1	1	-	8	1	25	1.00	0.01
Sep-21	1	-	1	8	1	25	1.00	0.01
Oct-21	1	-	1	8	1	24	1.00	0.01

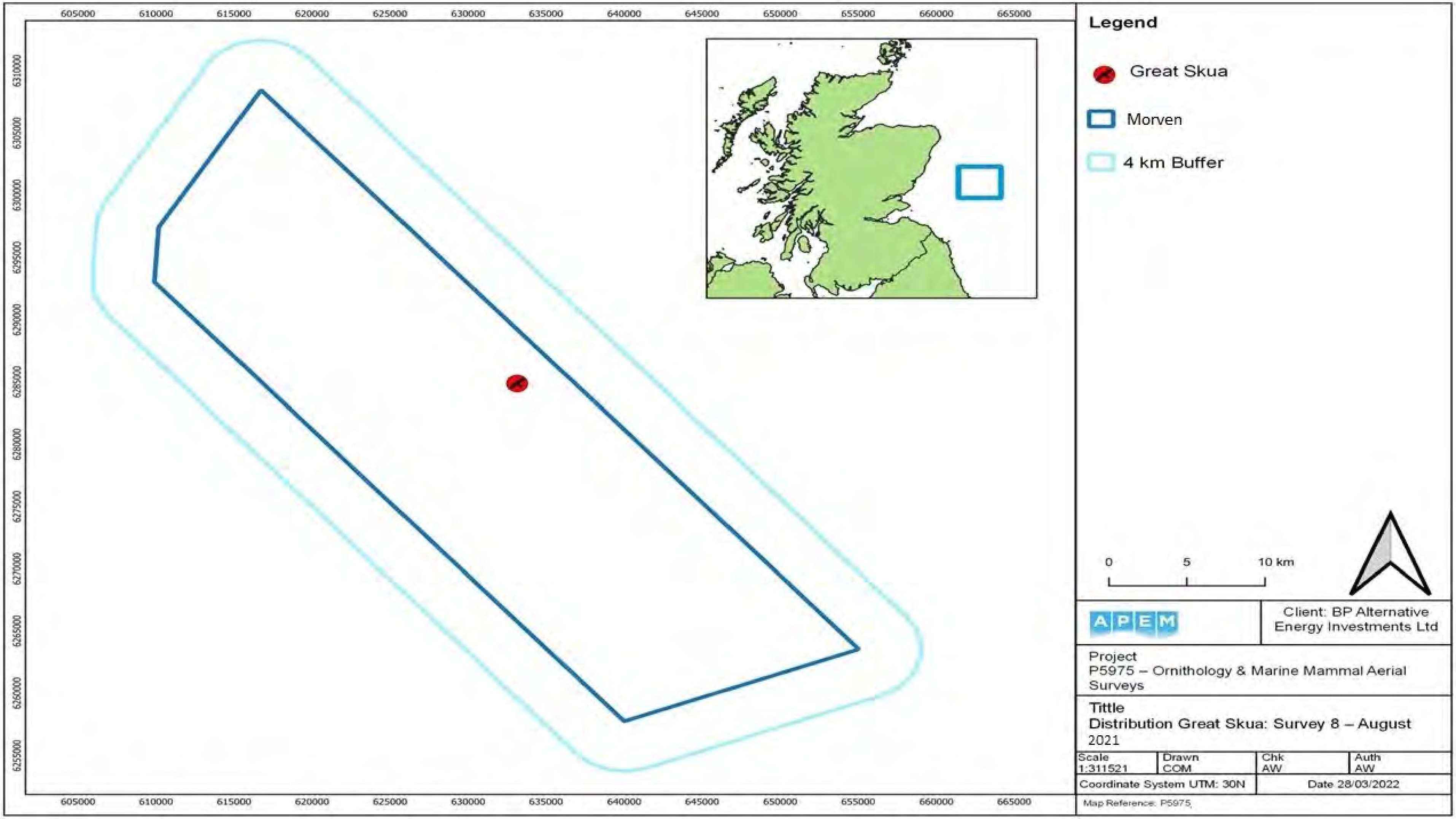


Figure 57 Location of a great skua in August 2021 (Survey 08).

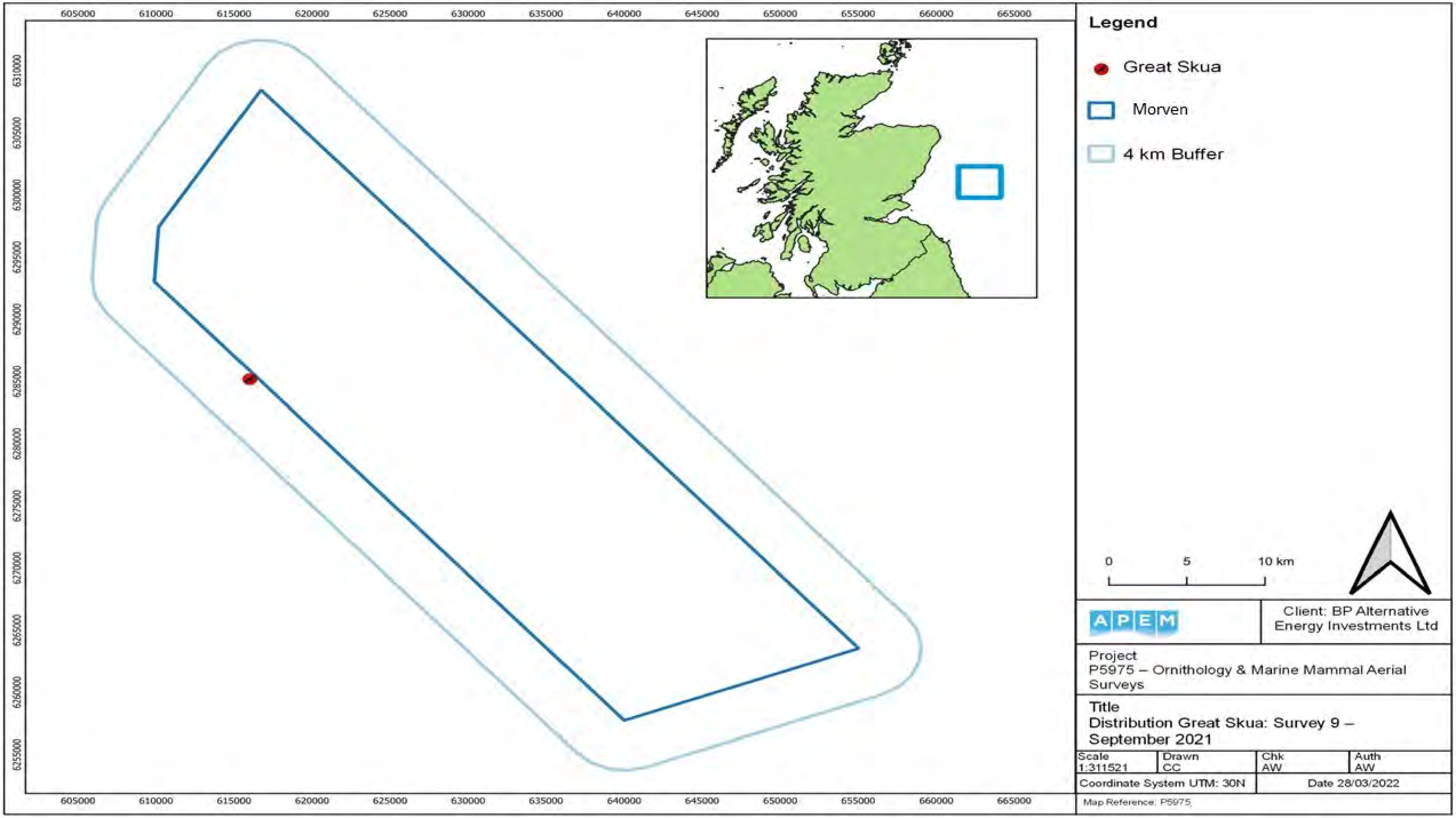


Figure 58 Location of a great skua in September 2021 (Survey 09).

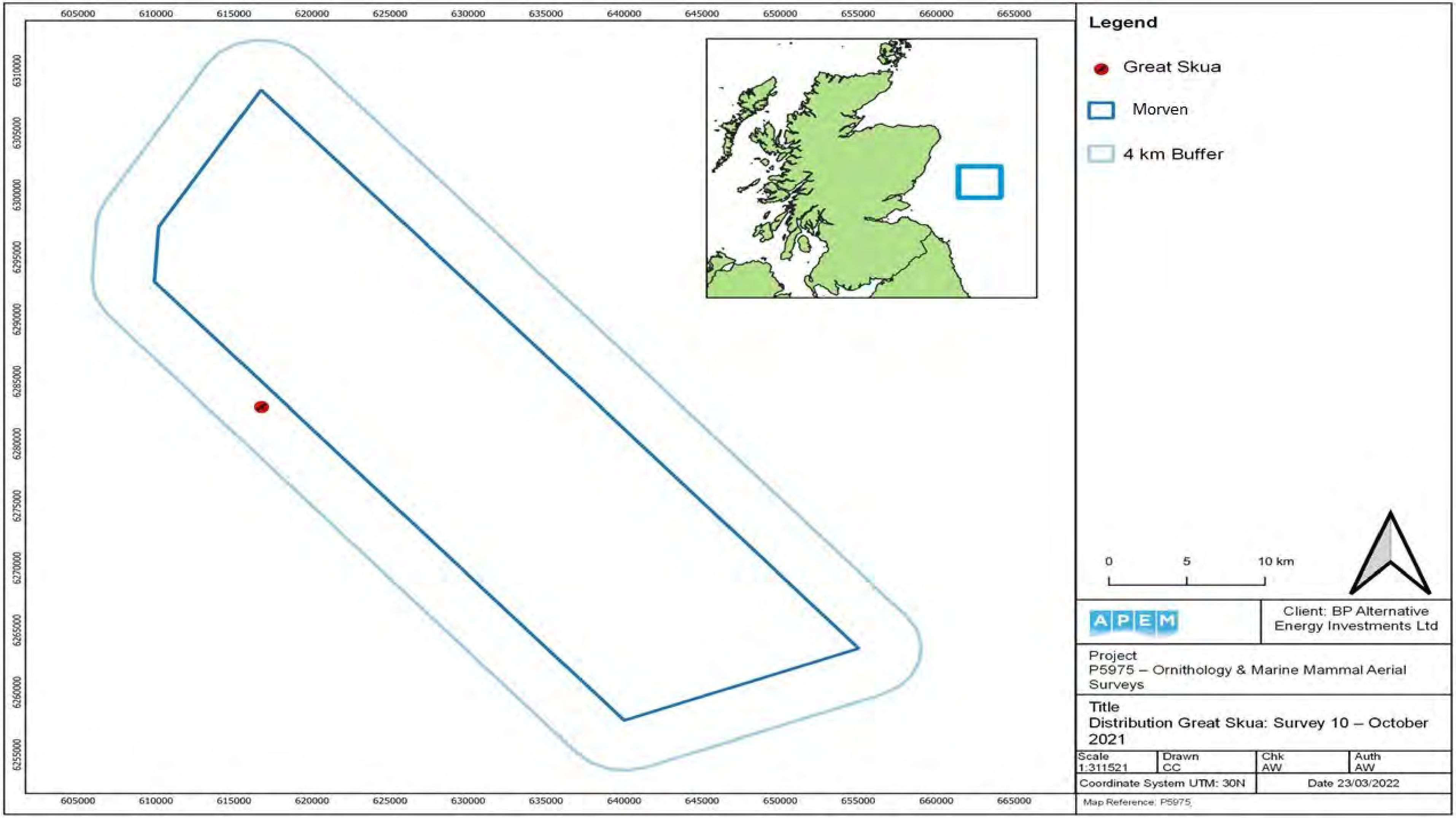


Figure 59 Location of a great skua in October 2021 (Survey 10).

4.14 Arctic Skua – *Stercorarius parasiticus*

Arctic skuas were recorded in September 2021 only, with two individuals in the west of the Array Project (Figure 61), resulting in an abundance estimate of 16 within the Array Project (Table 18).

Arctic skua had no significant direction of flight (p>0.05).

Table 18 Raw counts, abundance and density estimates of Arctic skua in the Array Project.

Survey	Raw Count	Sitting	Flying	Abundance	Lower CL	Upper CL	Precision	Density
Sep-21	2	-	2	16	2	66	0.71	0.01

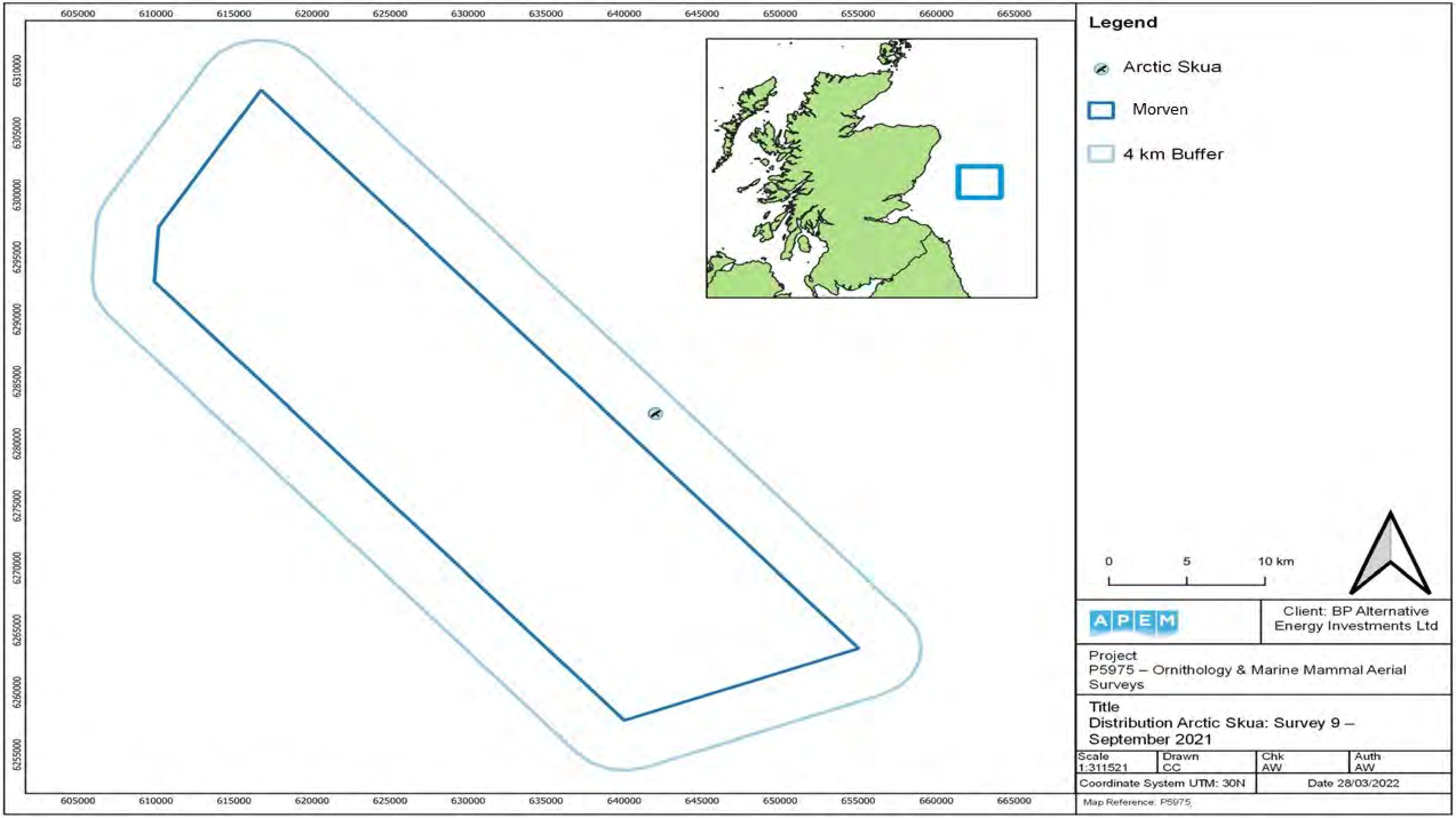


Figure 60 Location of Arctic skuas in September 2021 (Survey 09).

4.15 Arctic / Long-tailed Skua - *Unidentified*

An individual unidentified Arctic / long tailed skua was recorded in September 2021 in the east of the Array Project (Figure 63), resulting in an abundance estimate of eight within the Array Project (Table 19).

No significant direction of flight was recorded in Arctic / long-tailed skua.

Table 19 Raw counts, abundance and density estimates of Arctic / long-tailed skua in the Array Project.

Survey	Raw Count	Sitting	Flying	Abundance	Lower CL	Upper CL	Precision	Density
Sep-21	1	-	1	8	1	25	1.00	0.01

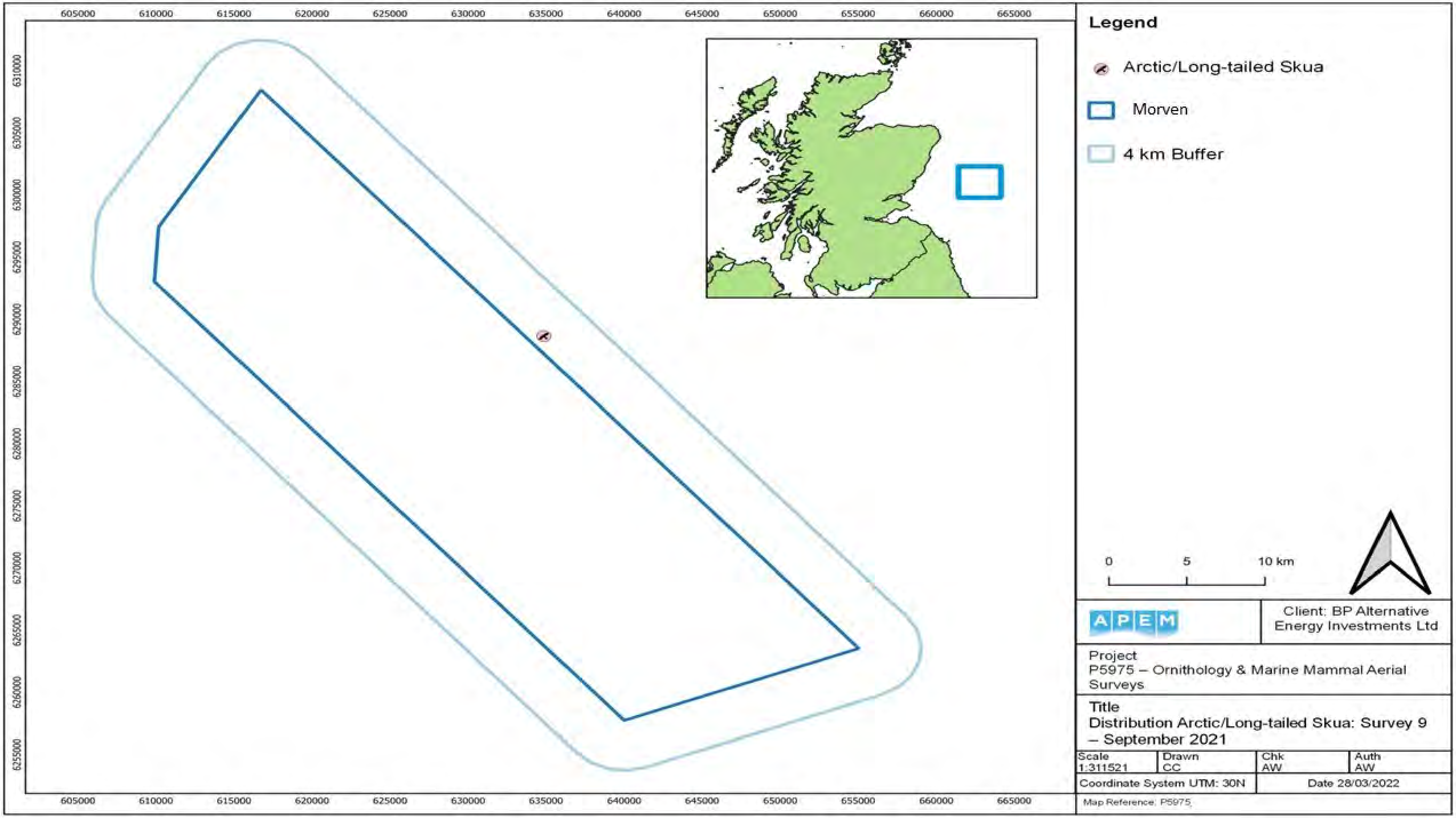


Figure 61 Location of an Arctic / long-tailed skuas in September 2021 (Survey 09).

4.16 Skuas - *Unidentified*

An individual unidentified skua was recorded in July 2021 in the west of the Array Project (Figure 65), resulting in an abundance estimate of eight (Table 20).

Table 20 Raw counts, abundance and density estimates of unidentified skua in the Array Project.

Survey	Raw Count	Sitting	Flying	Abundance	Lower CL	Upper CL	Precision	Density
Jul-21	1	1	-	8	1	25	1.00	0.01

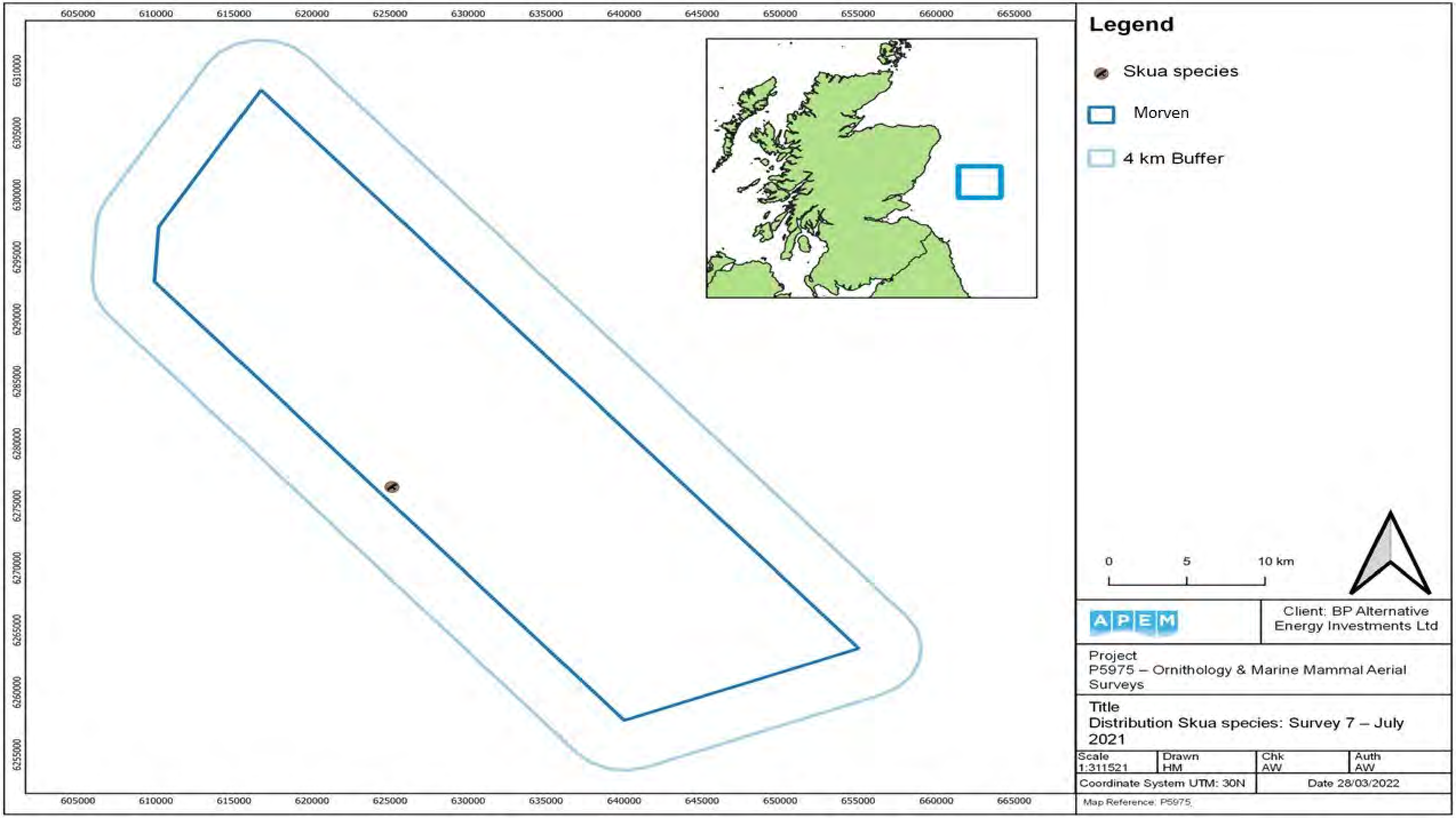


Figure 62 Location of an unidentified skua in July 2021 (Survey 07).

4.17 Little Auk – *Alle alle*

Six little auk were recorded in the south of the Array Project in January 2021 (Figure 63), resulting in an abundance estimate of 49 (Table 21).

Table 21 Raw counts, abundance and density estimates of little auk in the Array Project.

Survey	Raw Count	Sitting	Flying	Abundance	Lower CL	Upper CL	Precision	Density
Jan-21	6	6	-	49	16	98	0.41	0.03

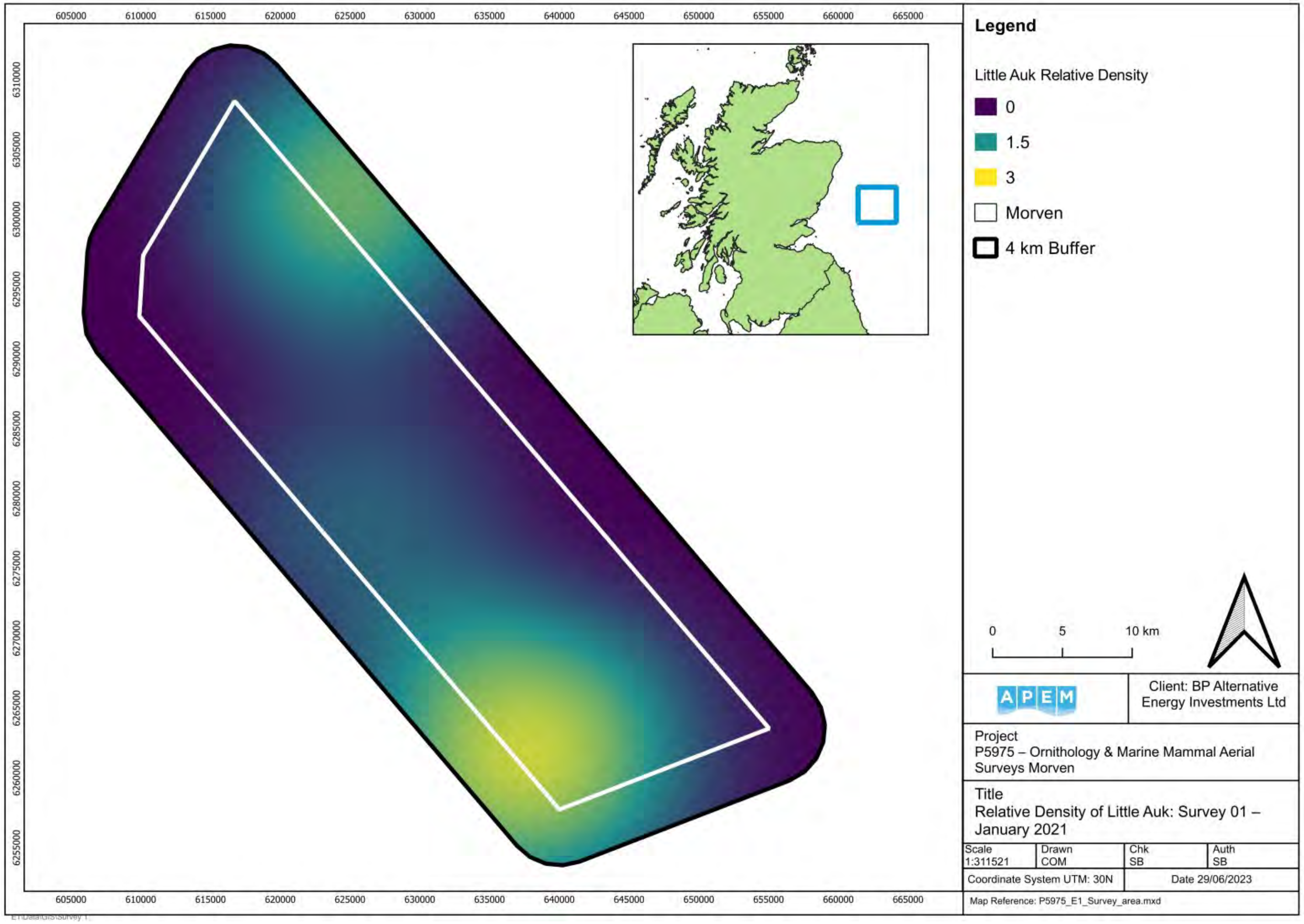


Figure 63 Relative density of little auk in January 2021 (Survey 01).

4.18 Guillemot – *Uria aalge*

Guillemot were recorded in all months. Peak numbers were in July - 3,565 individuals, resulting in an abundance estimate of 31,878 within the Array Project (Table 22).

Guillemot were recorded throughout the Array Project in February 2021, in the south in March, October, and November 2021, and February 2022. In the north in January, July, and December 2021 and, March 2022. East in April 2021, and West in June 2021. Guillemot were found in the center of the Array Project in May, and September 2021, and January 2022, and in the north and south in August 2021 (Figure 64 - Figure 78).

In March 2022 guillemot were recorded flying in a significant north westerly direction ($p<0.05$). Guillemots were recorded flying in a significantly south-westerly direction in July ($p<0.05$), and in a south-easterly direction in March 2021. In all other months where guillemots were recorded flying, there was no significant preference for direction ($p>0.05$) (Figure 79).

Table 22 Raw counts, abundance and density estimates of guillemot in the Array Project.

Survey	Raw Count	Sitting	Flying	Abundance	Lower CL	Upper CL	Precision	Density
Jan-21	396	394	2	3,221	2,879	3,586	0.05	2.27
Feb-21	216	210	6	1,764	1,527	2,017	0.07	1.24
Mar-21	121	116	5	1,001	811	1,192	0.09	0.71
Apr-21	140	129	11	1,118	934	1,310	0.08	1.01
May-21	468	456	12	3,823	3,251	4,411	0.05	2.69
Jun-21	2,308	2,301	7	19,005	17,457	20,718	0.02	13.39
Jul-21	3,888	3,858	30	31,878	28,680	35,420	0.02	22.45
Aug-21	161	161	-	1,321	1,042	1,616	0.08	0.93
Sep-21	1,257	1,256	1	10,328	8,931	11,782	0.03	7.27
Oct-21	112	109	3	900	723	1,101	0.09	0.63
Nov-21	378	377	1	3,140	2,766	3,556	0.05	2.21
Dec-21	153	153	0	1,256	1,010	1,519	0.08	0.88
Jan-22	71	69	2	576	438	722	0.12	0.41
Feb-22	206	203	3	1,673	1,413	1,924	0.07	1.18
Mar-22	428	307	21	3,473	3,027	3,968	0.05	2.45

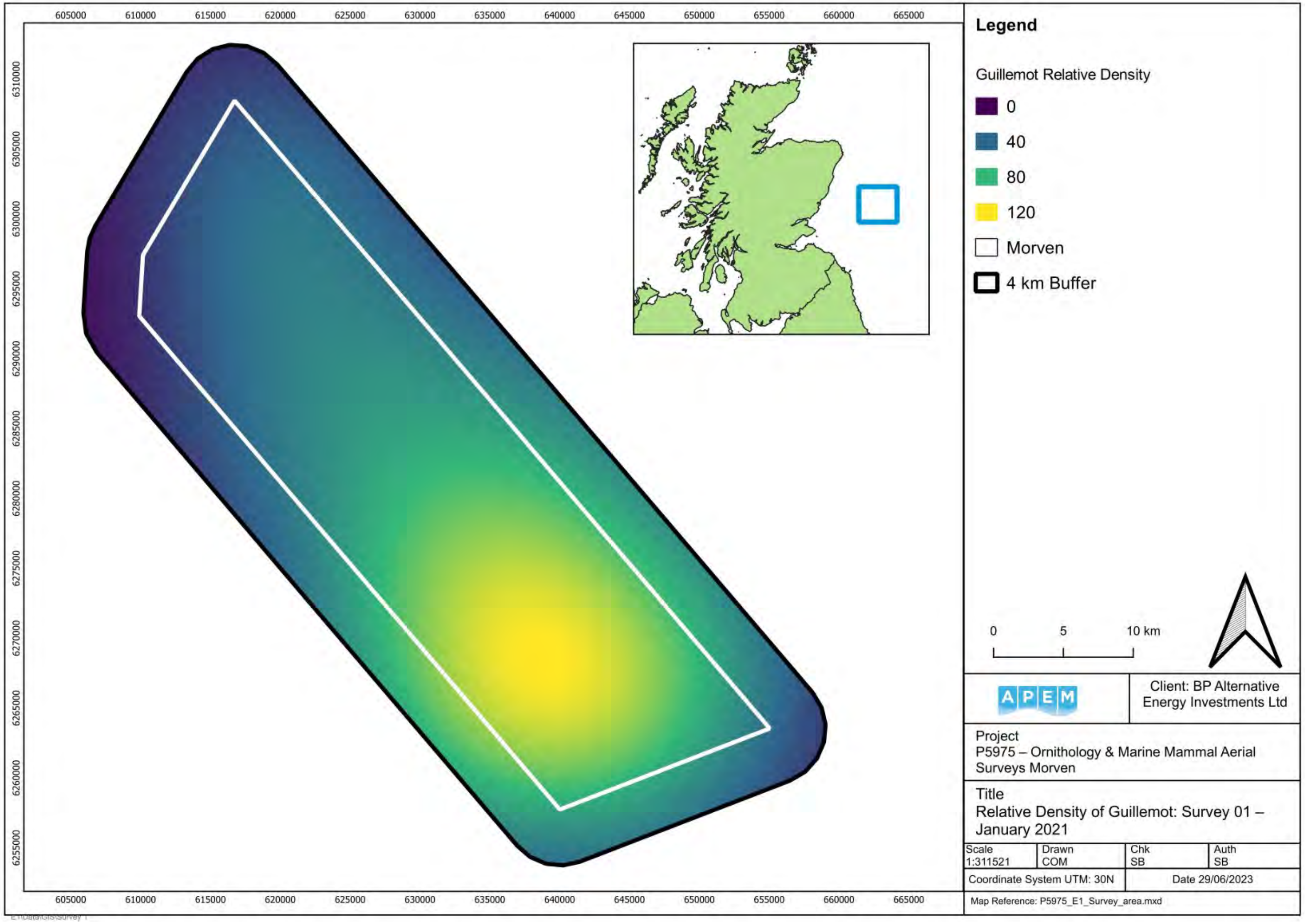


Figure 64 Relative density of guillemot in January 2021 (Survey 01).

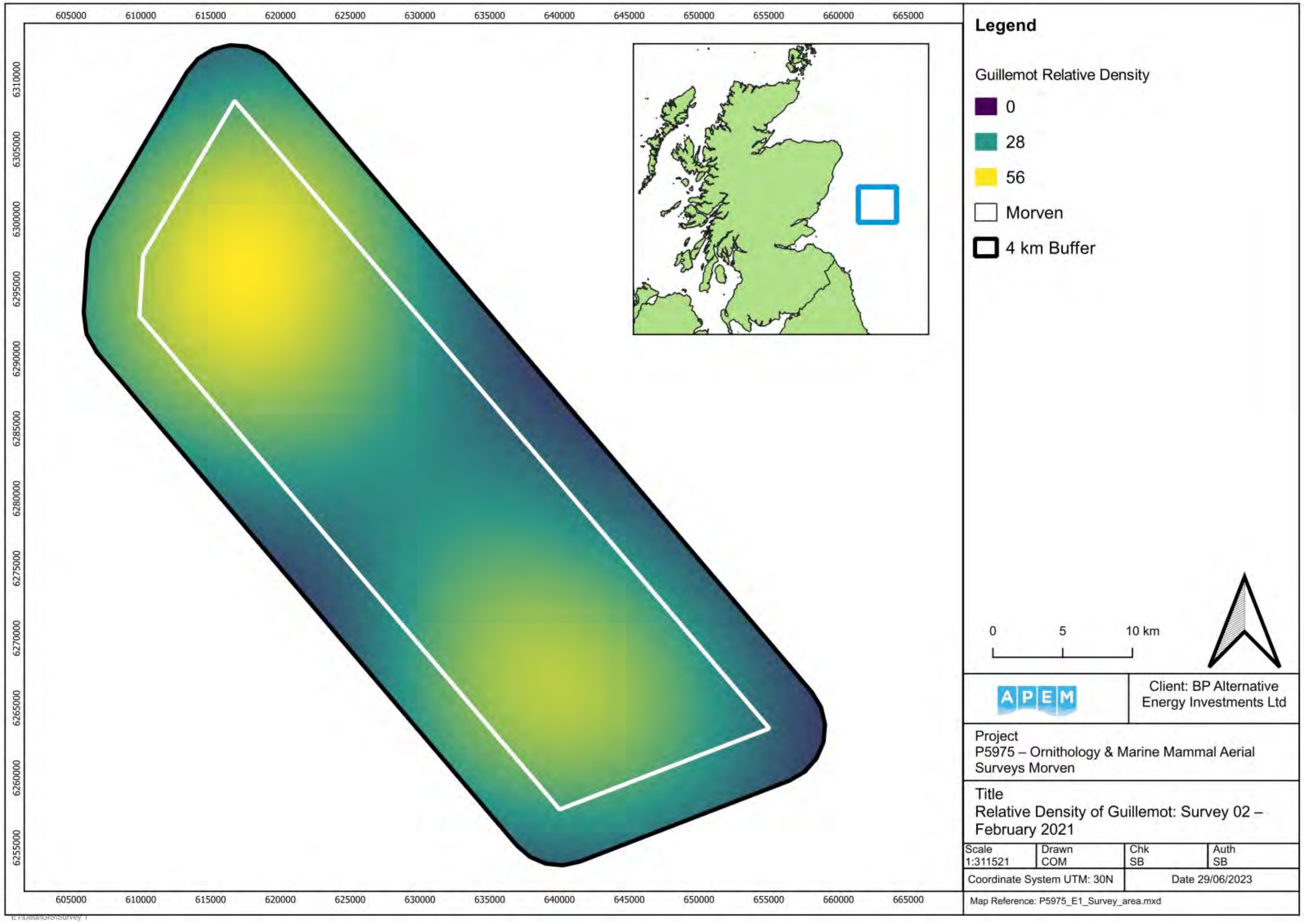


Figure 65 Distribution of guillemots in February 2021 (Survey 02).

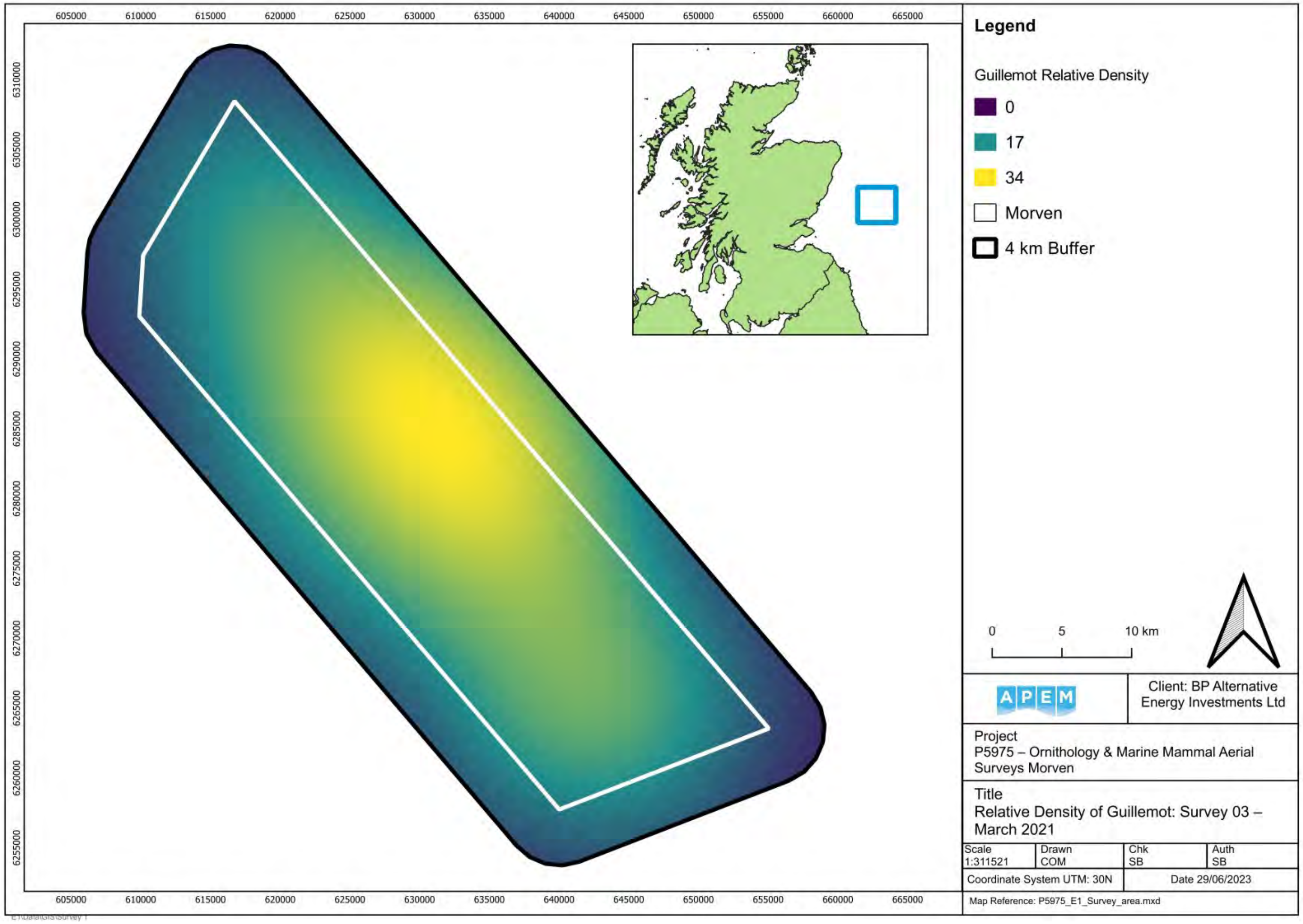


Figure 66 Relative density of guillemot in March 2021 (Survey 03).

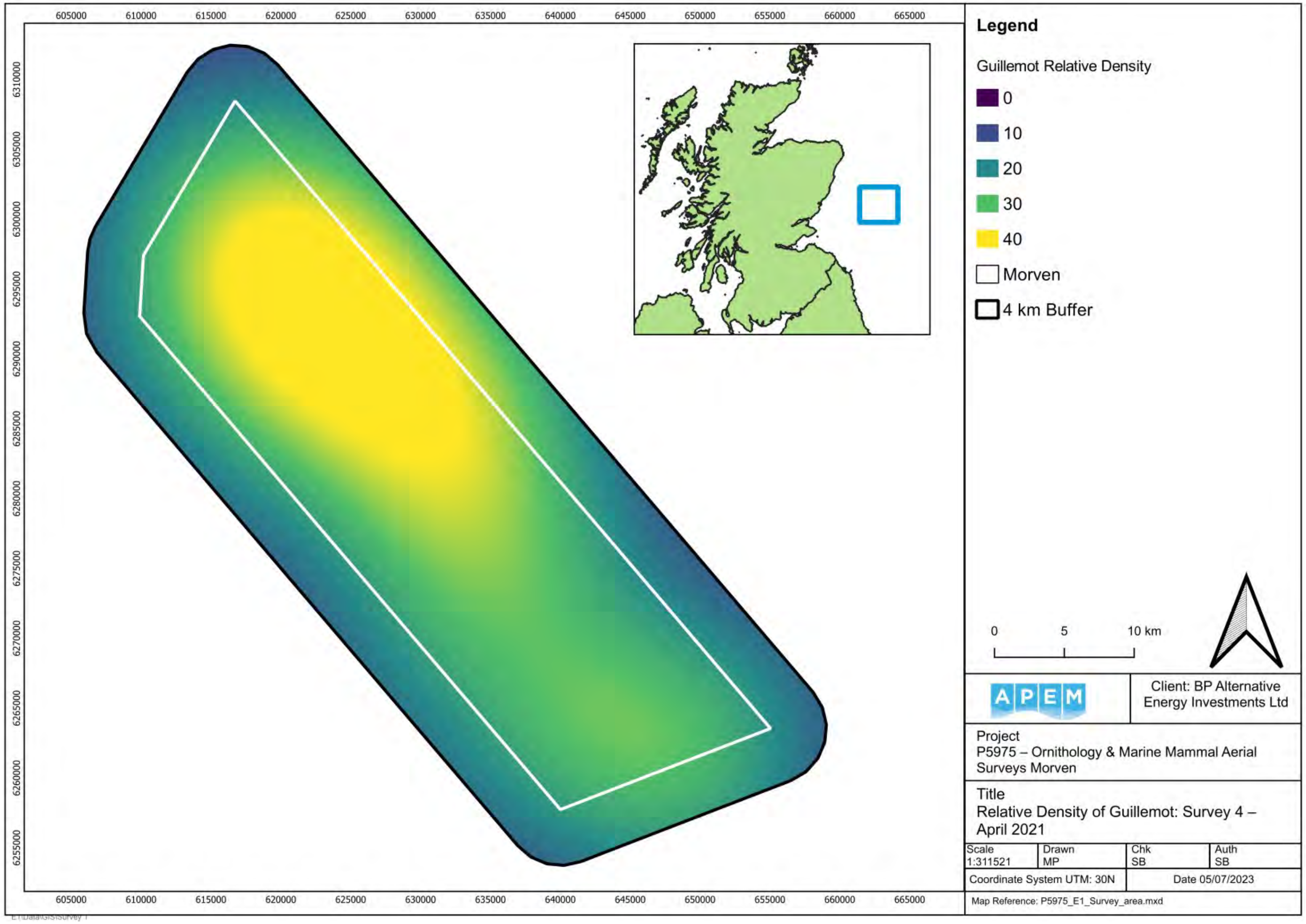


Figure 67 Relative density of guillemot in April 2021 (Survey 04).

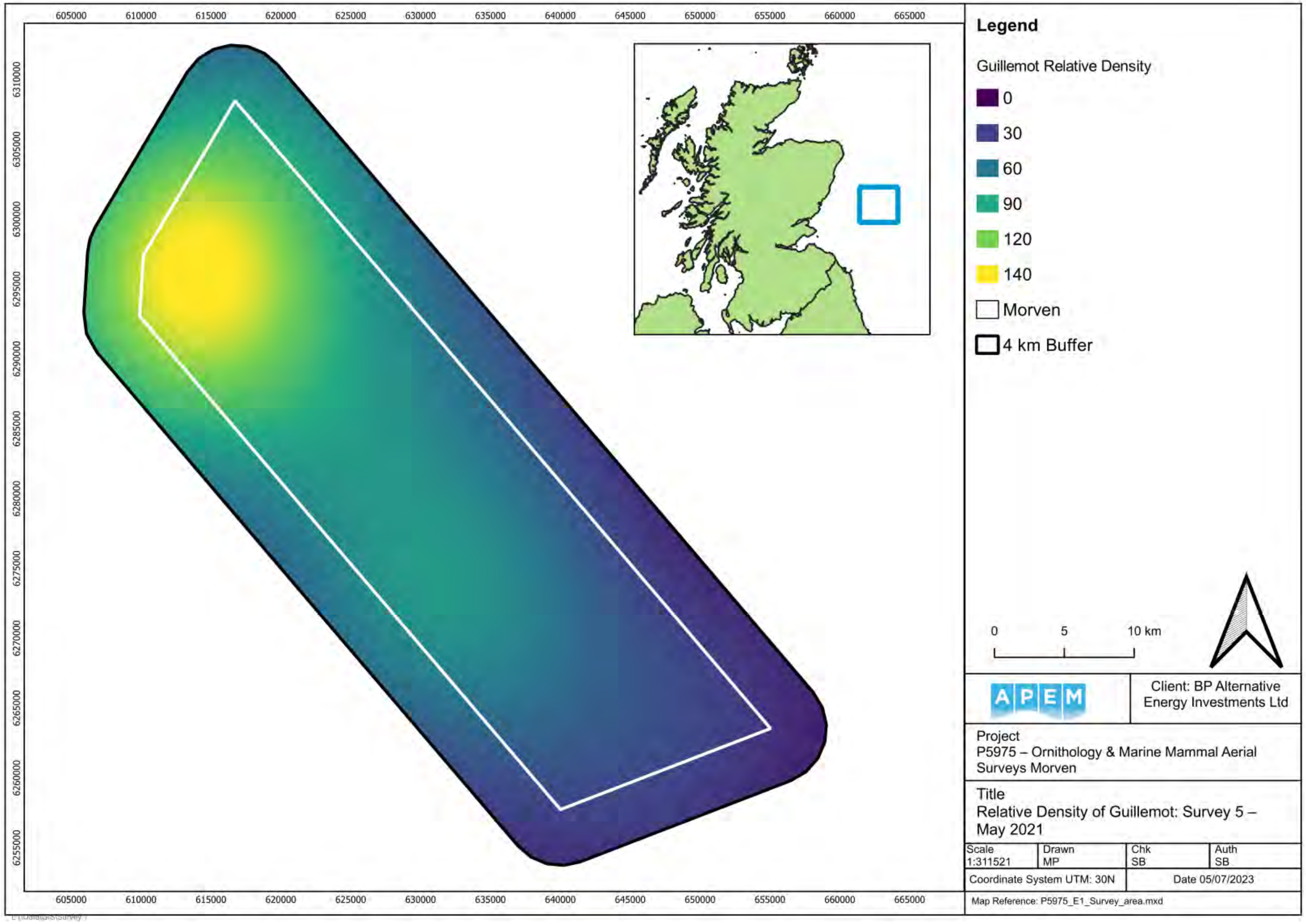


Figure 68 Relative density of guillemot in May 2021 (Survey 05).

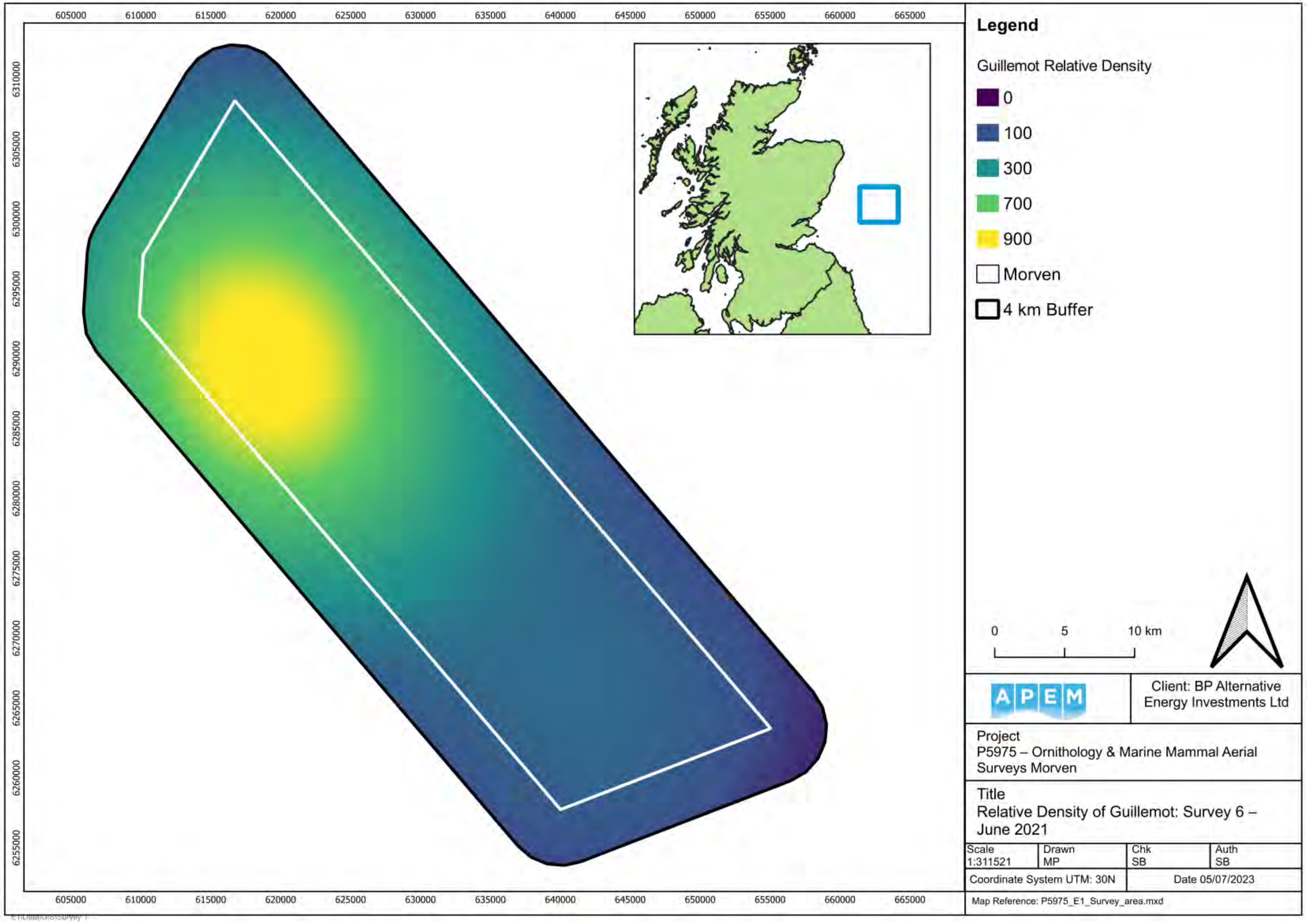


Figure 69 Relative density of guillemot in June 2021 (Survey 06).

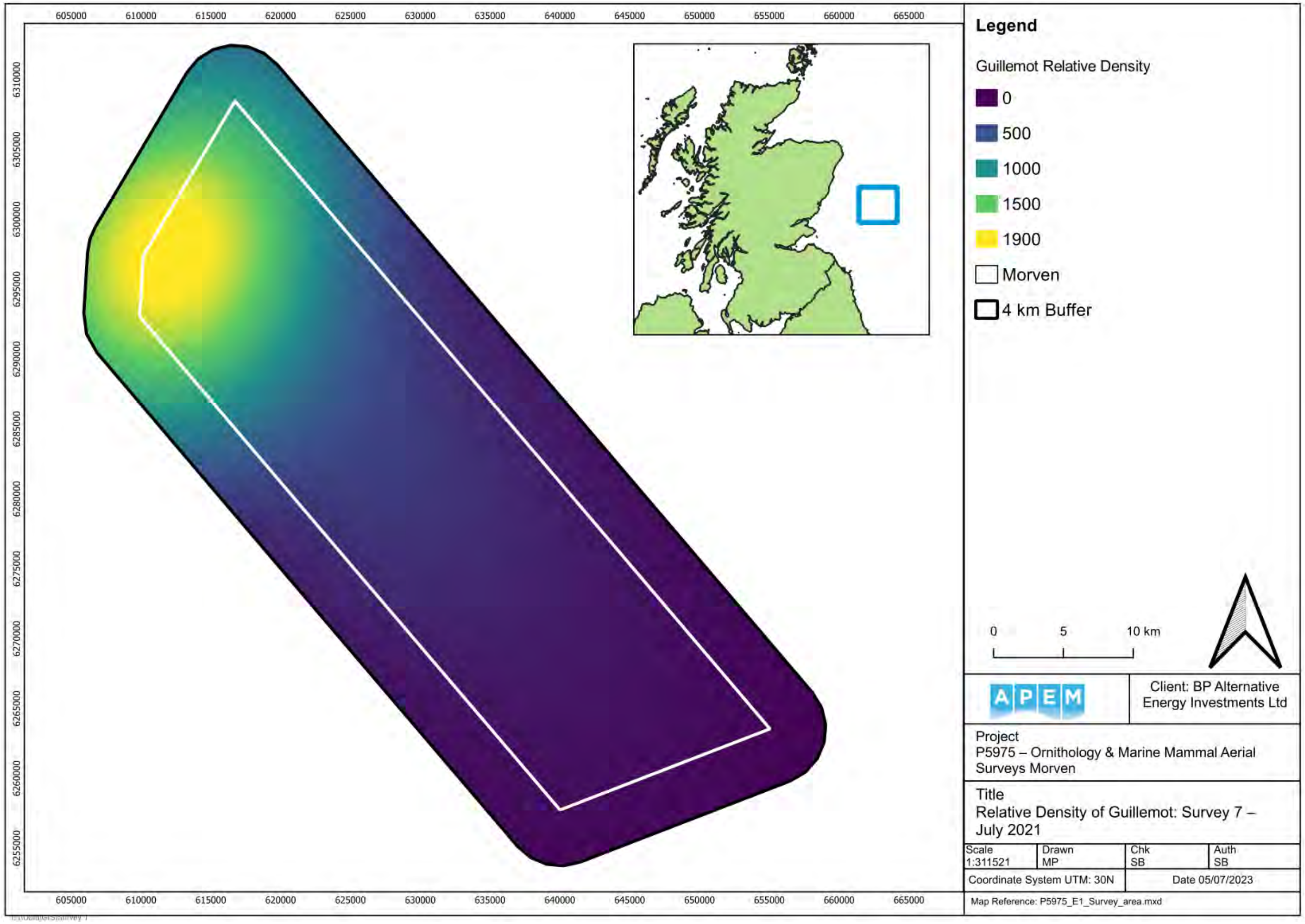


Figure 70 Relative density of guillemot in July 2021 (Survey 07).

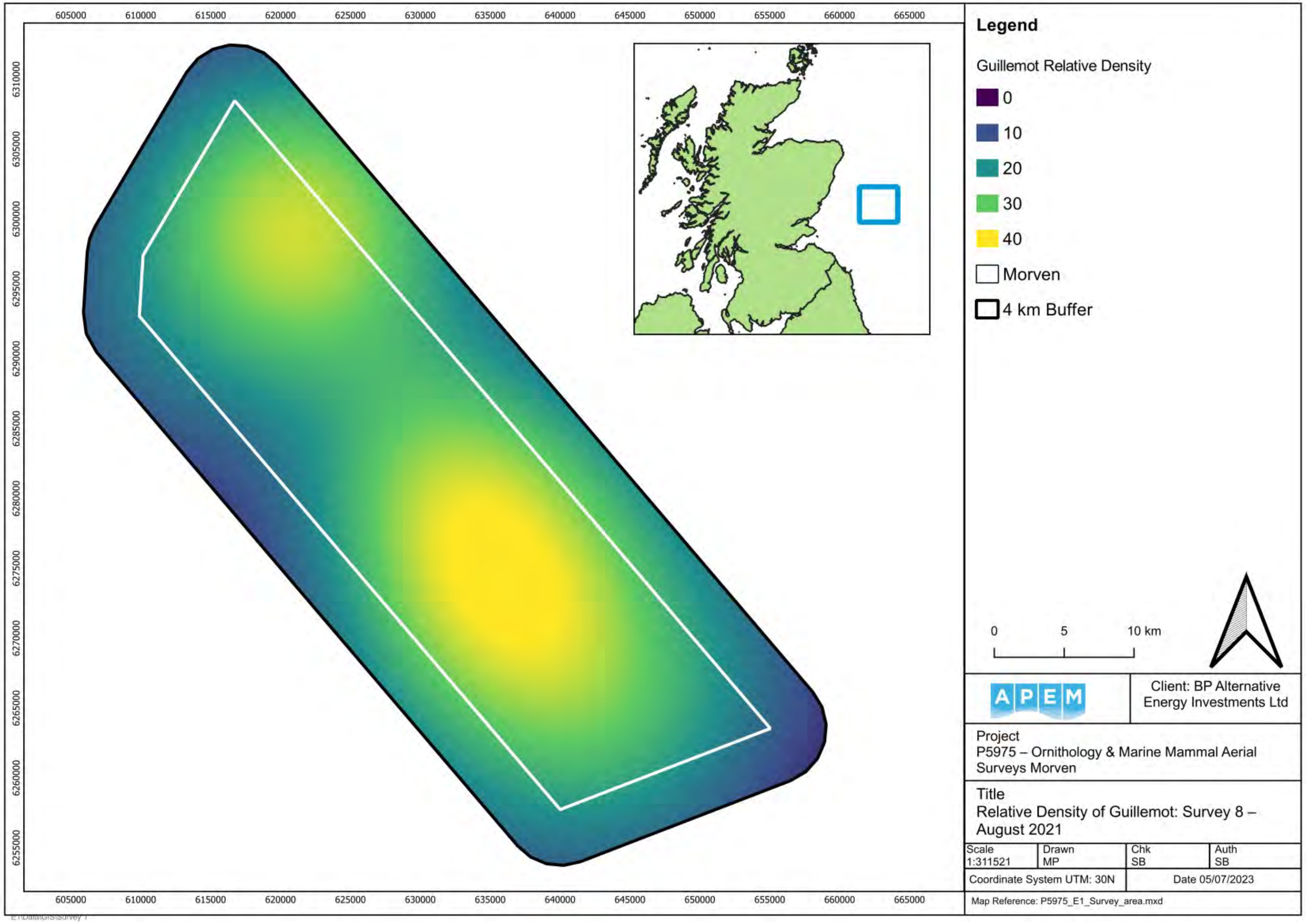


Figure 71 Relative density of guillemot in August 2021 (Survey 08).

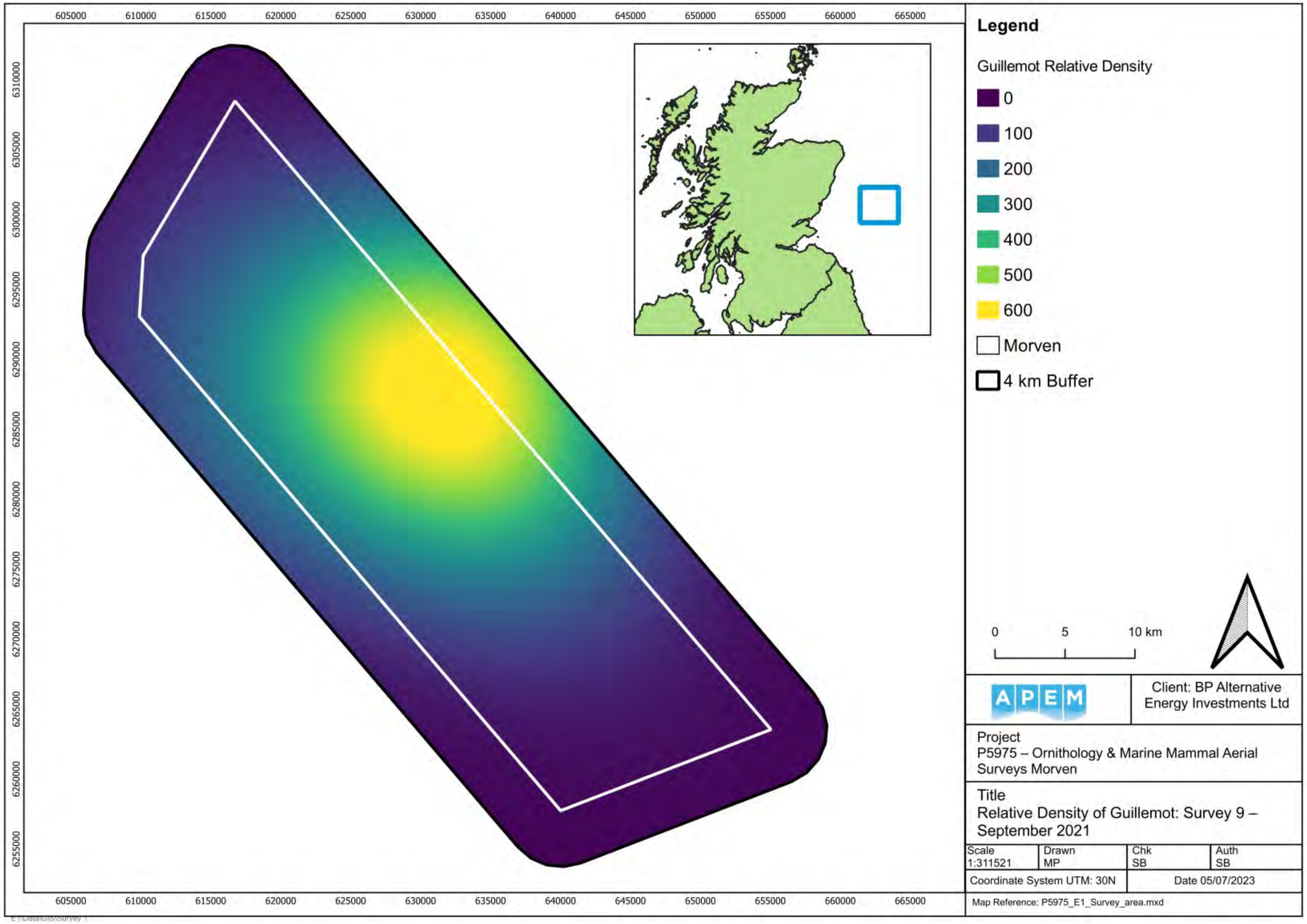


Figure 72 Relative density of guillemot in September 2021 (Survey 09).

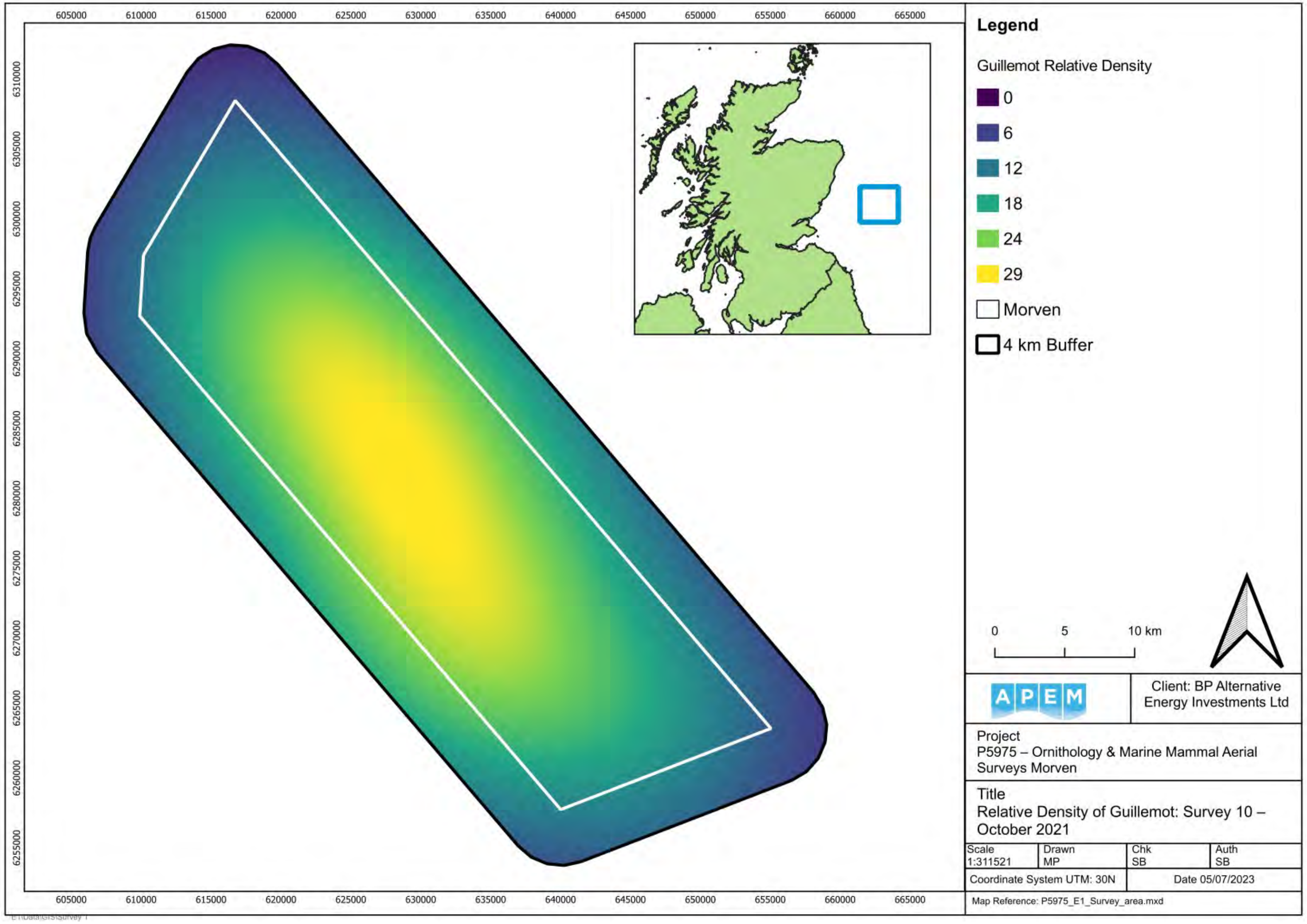


Figure 73 Relative density of guillemot in October 2021 (Survey 10).

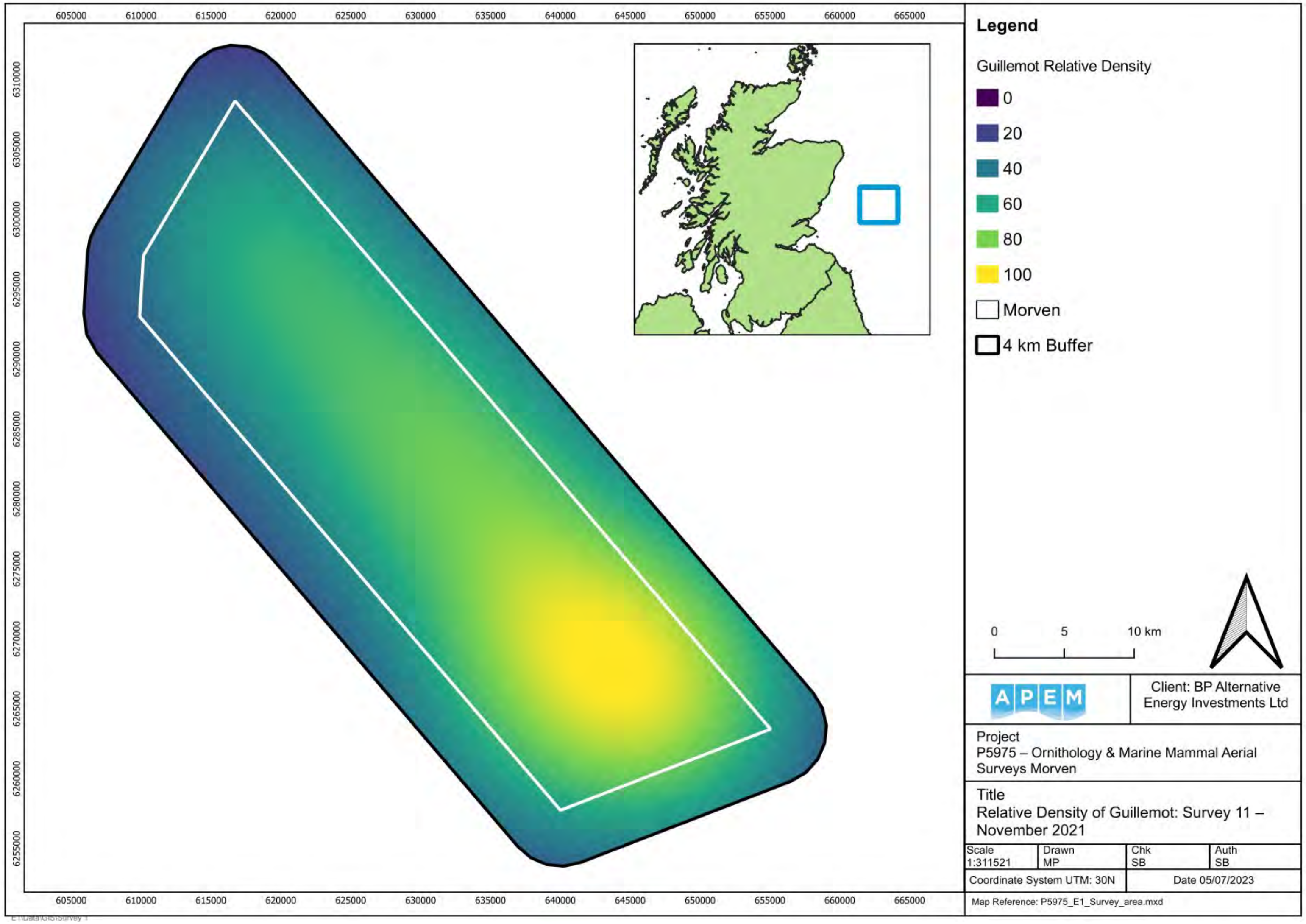


Figure 74 Relative density of guillemot in November 2021 (Survey 11).

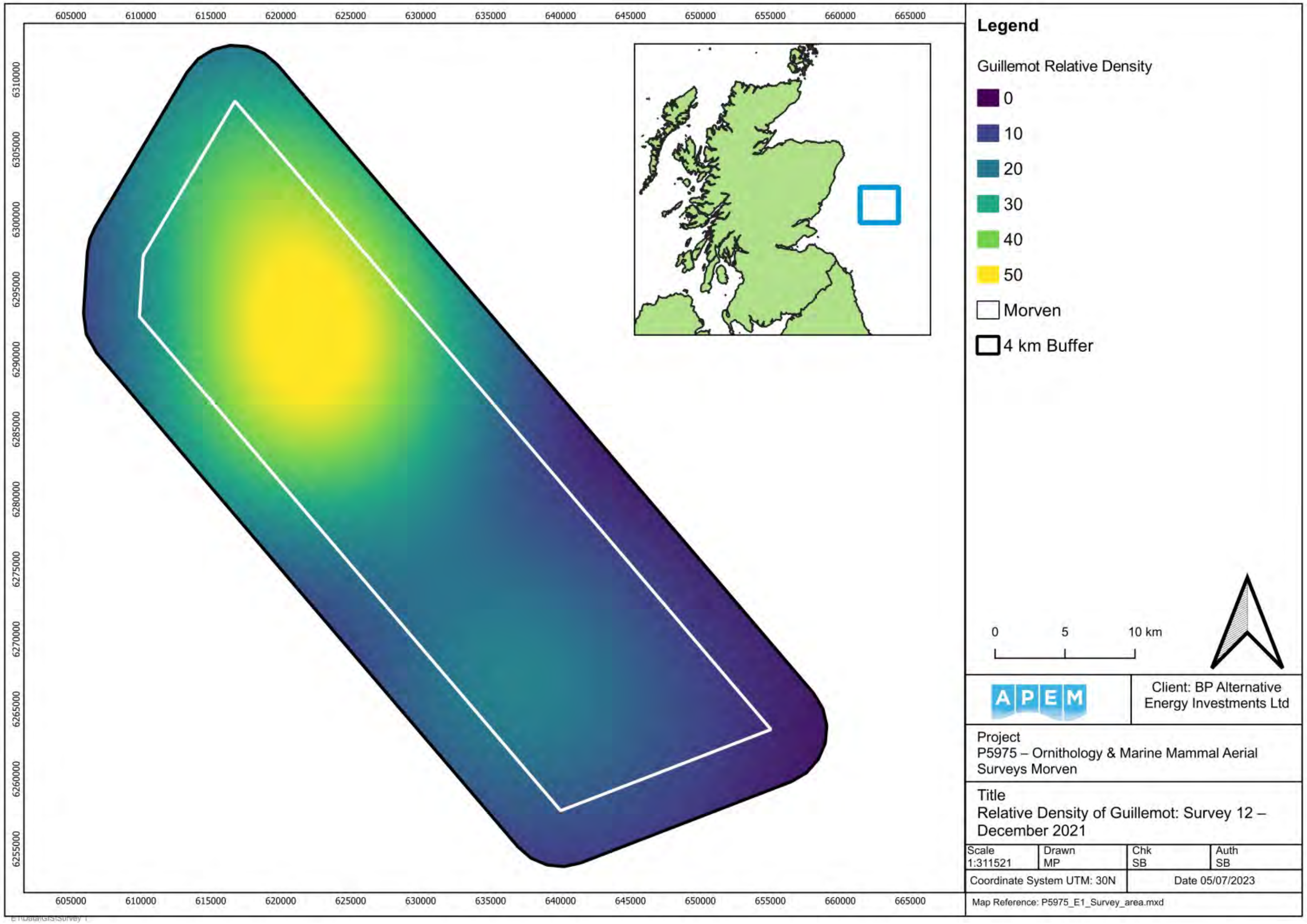


Figure 75 Relative density of guillemot in December 2021 (Survey 12).

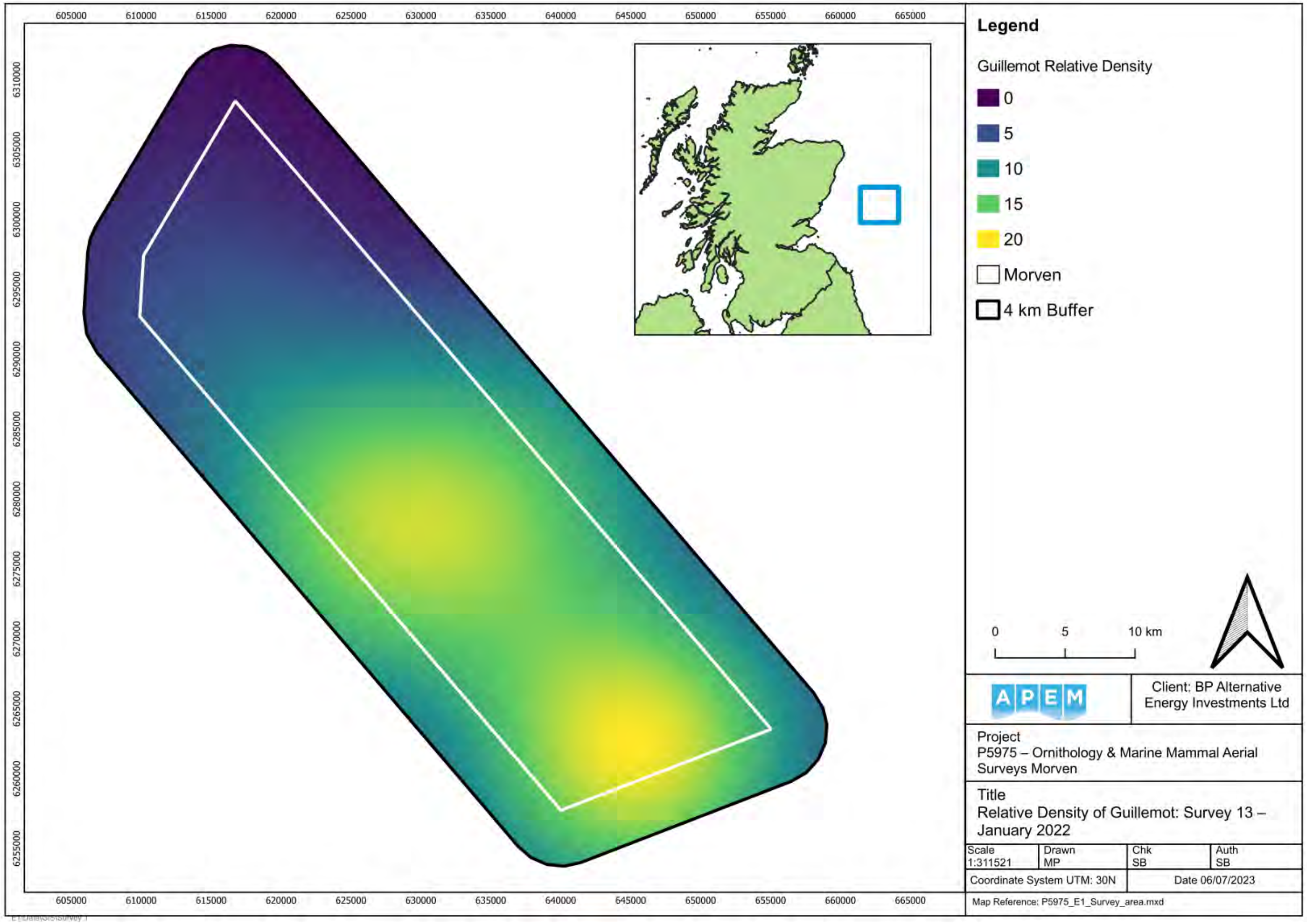


Figure 76 Relative density of guillemot in January 2022 (Survey 13).

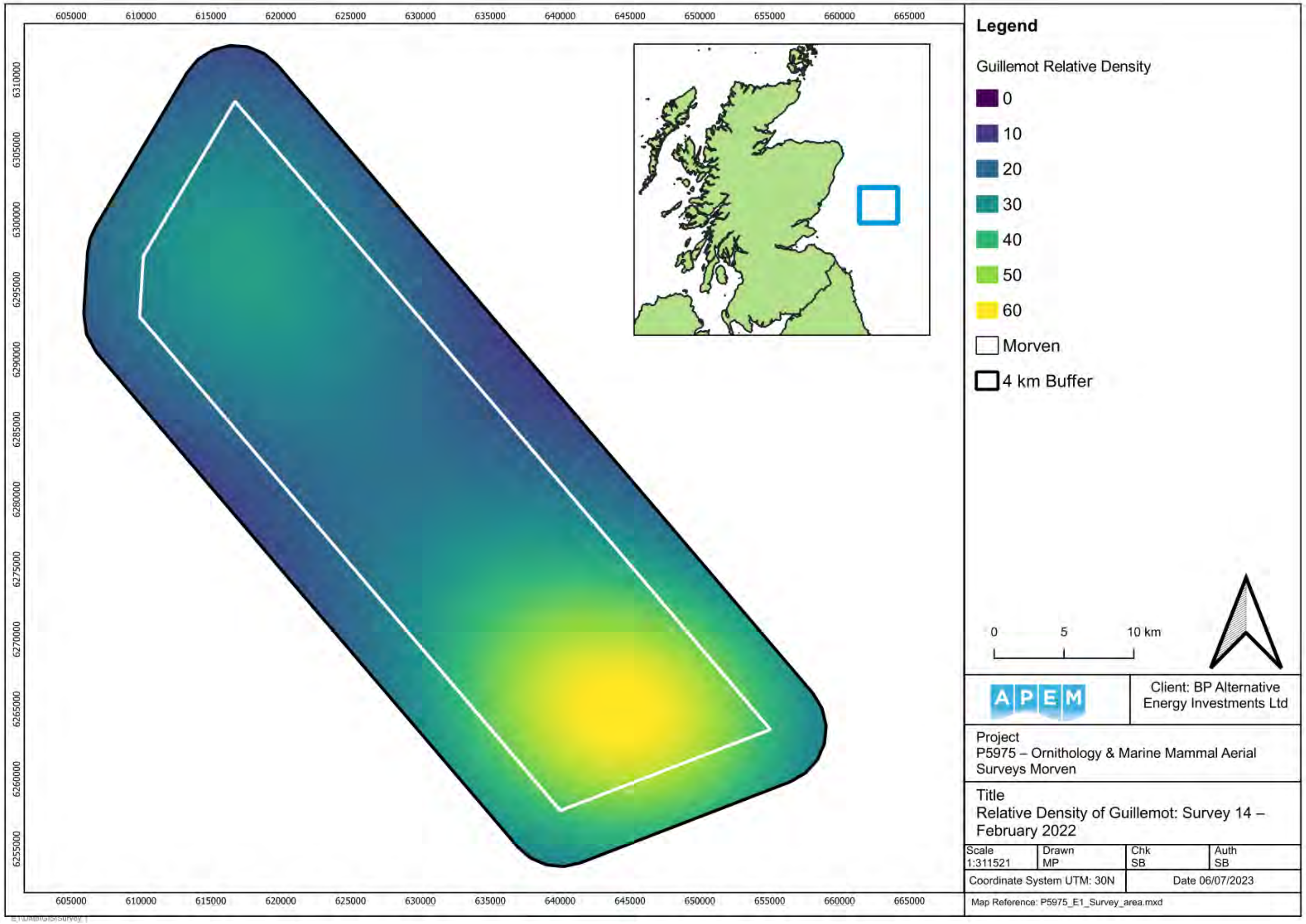


Figure 77 Relative density of guillemot in February 2022 (Survey 14).

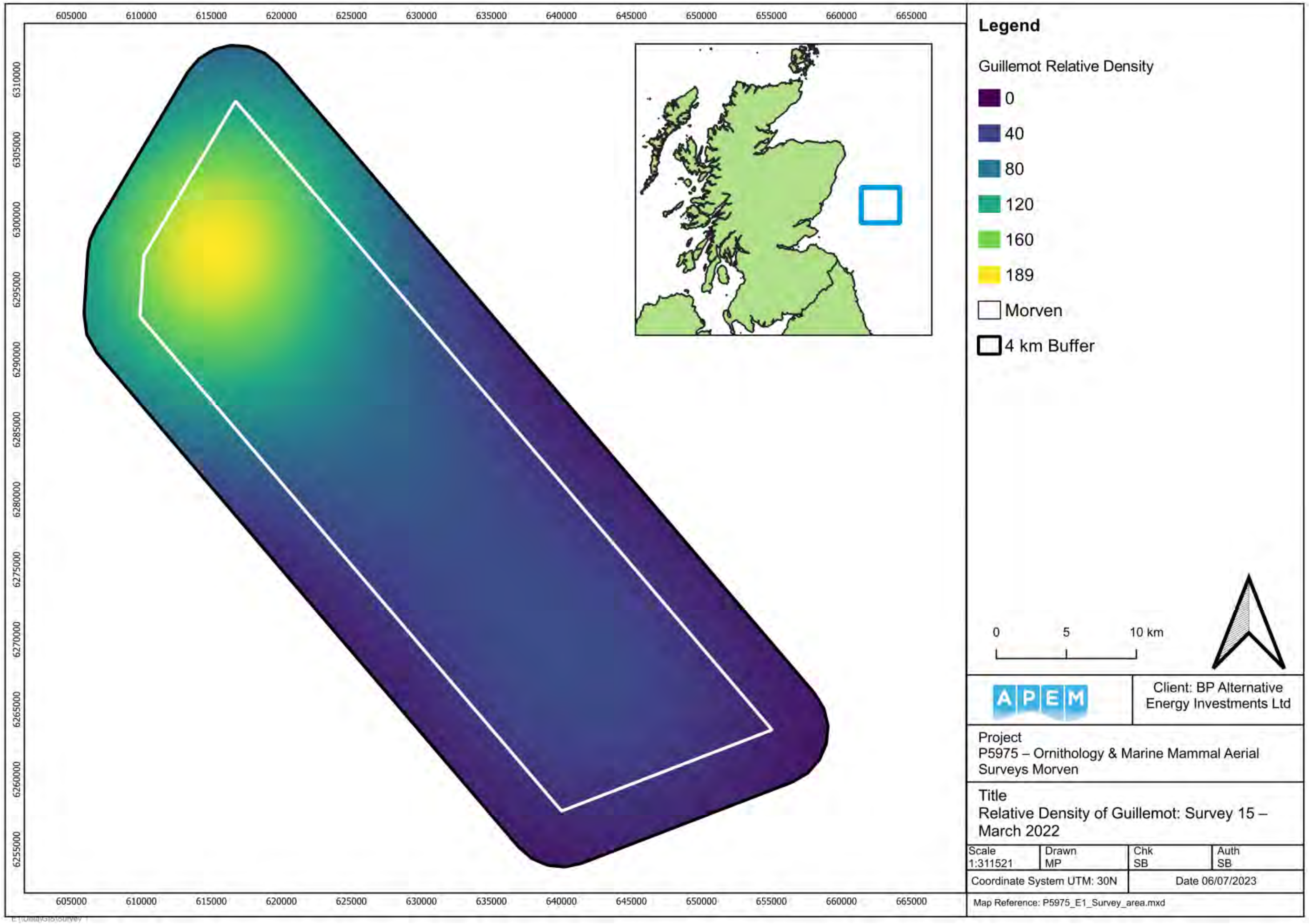
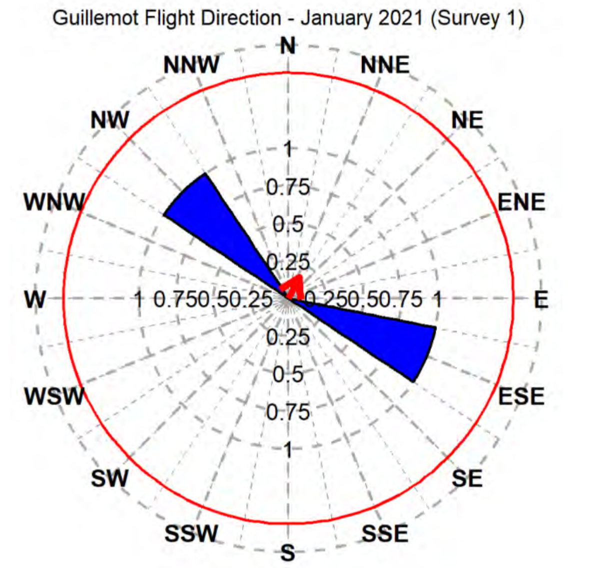
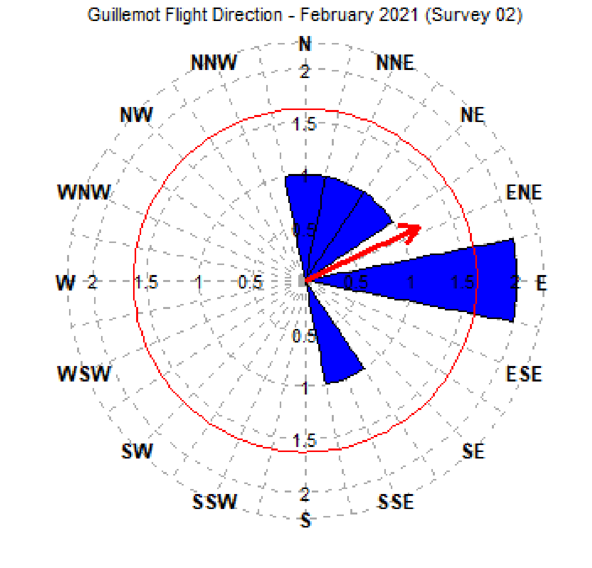


Figure 78 Relative density of guillemot in March 2022 (Survey 15).



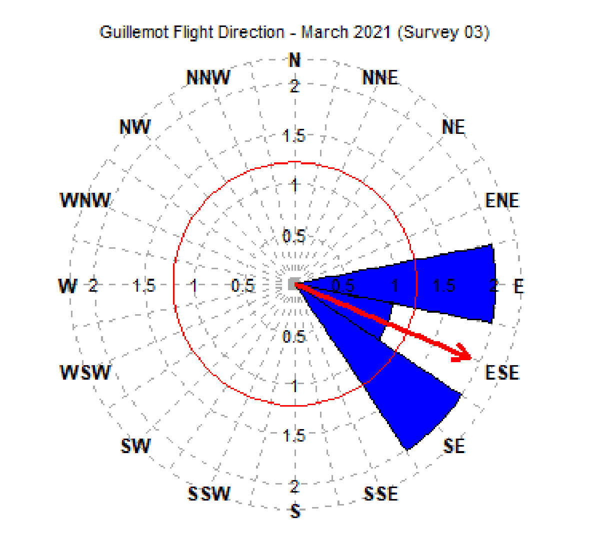
Number of Observations	2
Mean Vector (µ)	27.712
Length of Mean Vector (r)	0.158
Rayleigh Test (Z)	0.050
Rayleigh Test (p)	0.962

Figure 79a January 2021 (Survey 01)



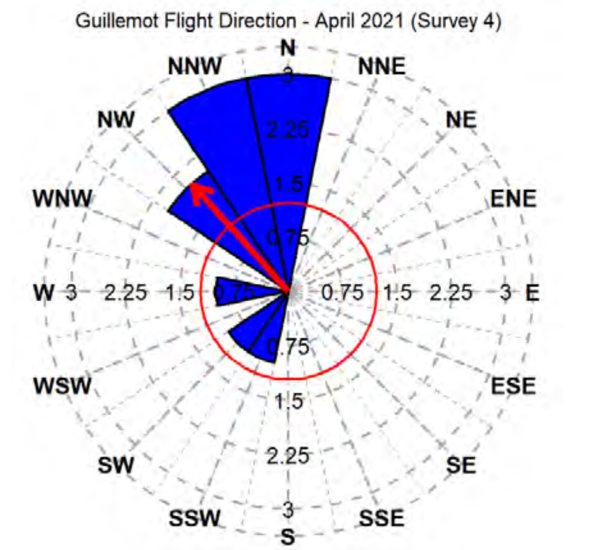
Number of Observations	6
Mean Vector (µ)	65.98
Length of Mean Vector (r)	0.588
Rayleigh Test (Z)	2.073
Rayleigh Test (p)	0.125

Figure 79b February 2021 (Survey 02)



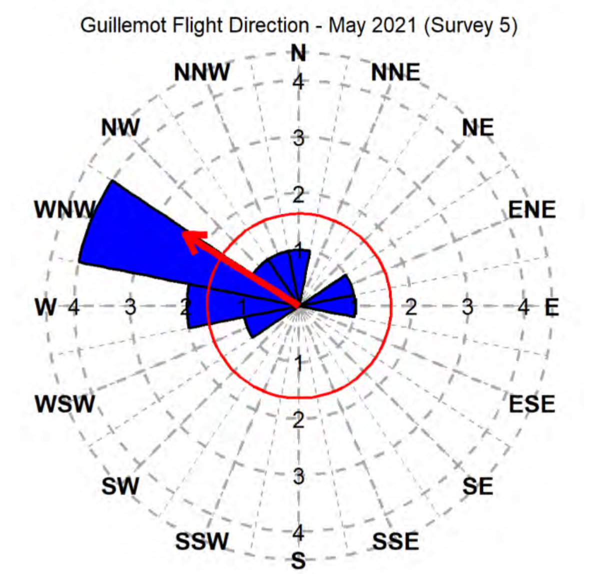
Number of Observations	5
Mean Vector (µ)	113.979
Length of Mean Vector (r)	0.943
Rayleigh Test (Z)	4.447
Rayleigh Test (p)	0.004

Figure 79a March 2021 (Survey 03)



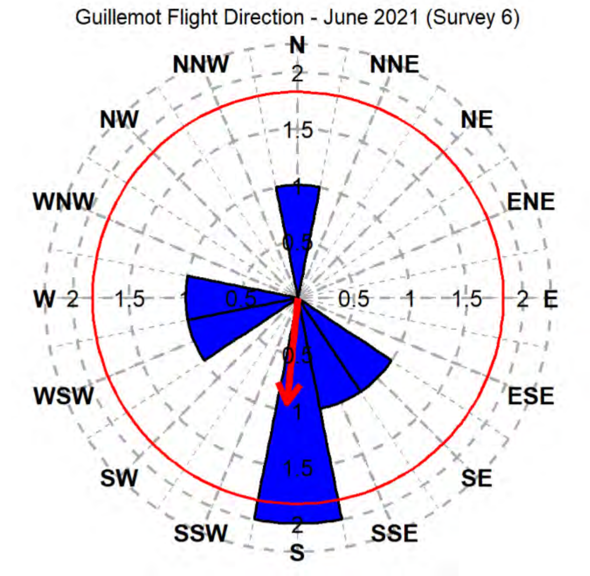
Number of Observations	13
Mean Vector (µ)	321.669
Length of Mean Vector (r)	0.614
Rayleigh Test (Z)	4.901
Rayleigh Test (p)	0.005

Figure 79c April 2021 (Survey 04)



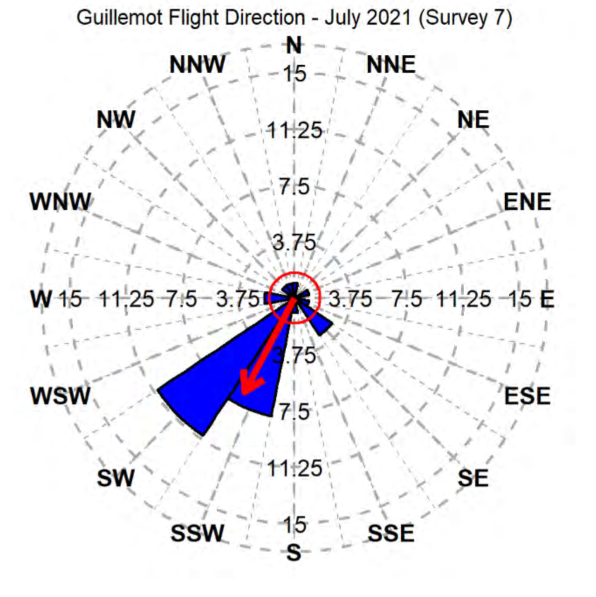
Number of Observations	12
Mean Vector (µ)	302.620
Length of Mean Vector (r)	0.599
Rayleigh Test (Z)	4.303
Rayleigh Test (p)	0.011

Figure 79d May 2021 (Survey 05)



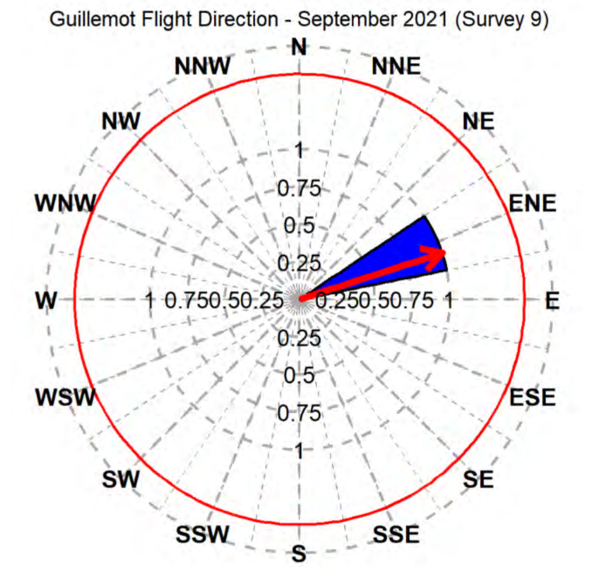
Number of Observations	7
Mean Vector (µ)	186.507
Length of Mean Vector (r)	0.468
Rayleigh Test (Z)	1.533
Rayleigh Test (p)	0.222

Figure 79e June 2021 (Survey 06)



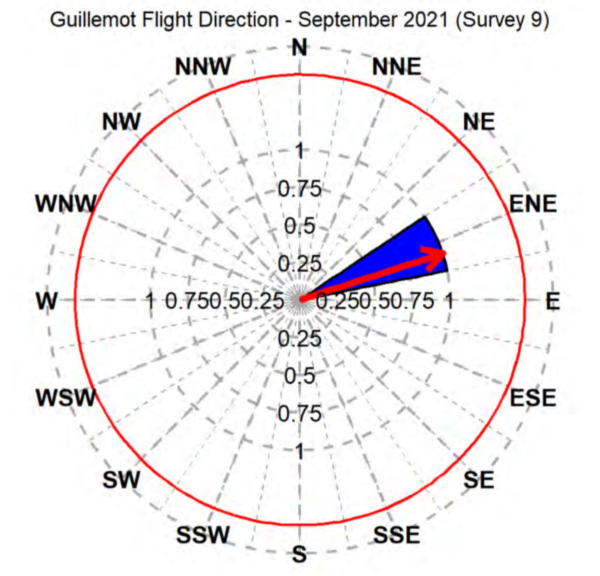
Number of Observations	30
Mean Vector (µ)	208.998
Length of Mean Vector (r)	0.643
Rayleigh Test (Z)	12.421
Rayleigh Test (p)	<0.001

Figure 79f July 2021 (Survey 07)



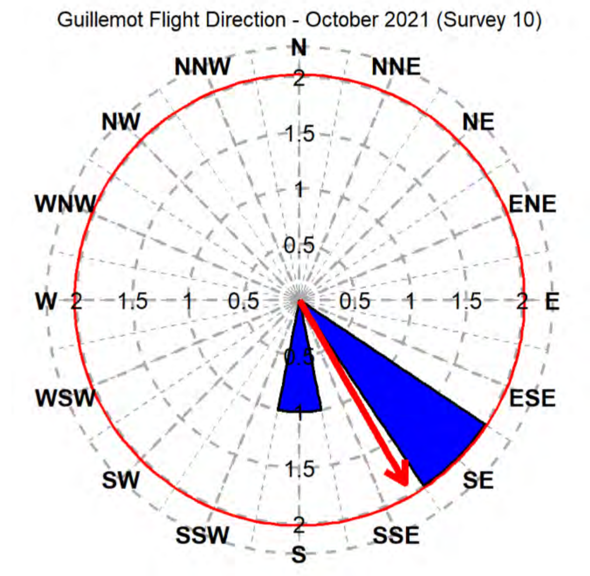
Number of Observations	1
Mean Vector (µ)	72.150
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

Figure 79f August 2021 (Survey 08)



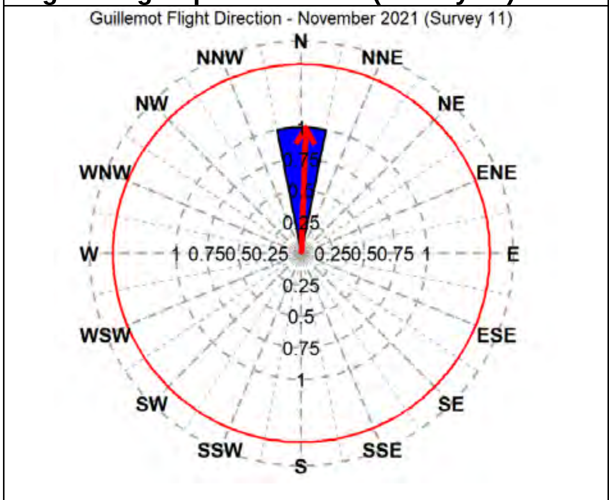
Number of Observations	1
Mean Vector (µ)	72.150
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

Figure 79g September 2021 (Survey 09)



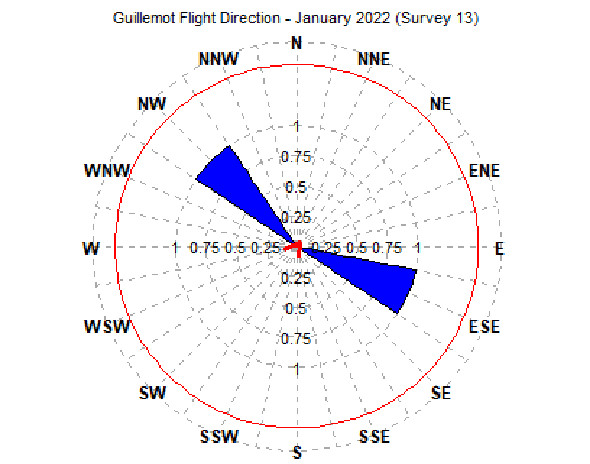
Number of Observations	3
Mean Vector (µ)	150.883
Length of Mean Vector (r)	0.945
Rayleigh Test (Z)	2.679
Rayleigh Test (p)	0.055

Figure 79h October 2021 (Survey 10)



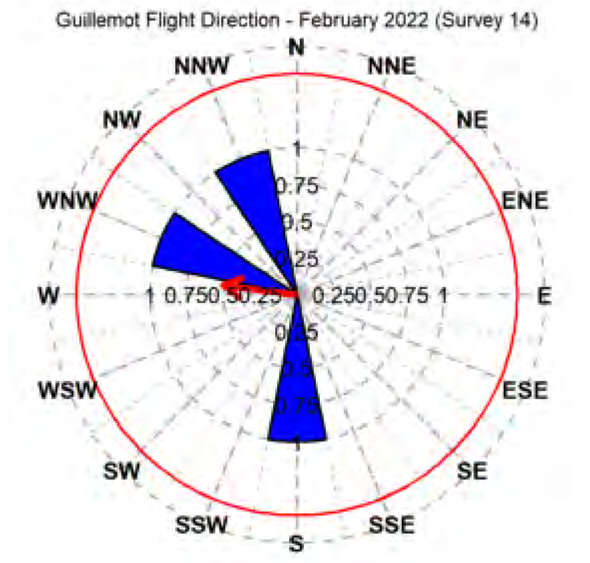
Number of Observations	1
Mean Vector (µ)	2.428
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

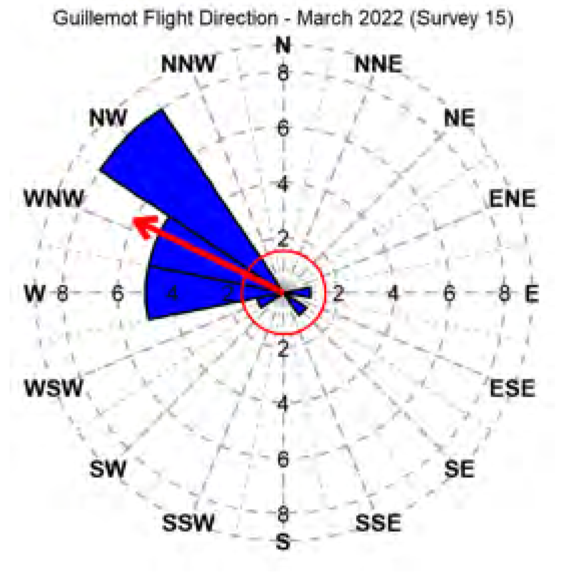
Figure 79i November 2021 (Survey 11)



Number of Observations	2
Mean Vector (µ)	35.444
Length of Mean Vector (r)	0.037
Rayleigh Test (Z)	0.003
Rayleigh Test (p)	0.998

Figure 79j January 2022 (Survey 13)





Number of Observations	3	Number of Observations	21
Mean Vector (μ)	277.444	Mean Vector (μ)	296.026
Length of Mean Vector (r)	0.502	Length of Mean Vector (r)	0.746
Rayleigh Test (Z)	0.758	Rayleigh Test (Z)	11.691
Rayleigh Test (p)	0.511	Rayleigh Test (p)	<0.001
Figure 79k February 2022 (Survey 14)		**Figure 79l March 2022 (Survey 15)**	

Figure 79 Summary of flight directions of guillemots recorded in the Array Project.

4.19 Razorbill – *Alca torda*

Razorbills were recorded in all months. Peak numbers were recorded in July - 1,140 individuals, resulting in an abundance estimate of 9,347 within the Array Project (Table 23).

These were recorded throughout the Array Project in January, May, and June 2021, and February 2022. In the center of the Array Project in September 2021, south in March 2021, and west in January 2022. Razorbill were recorded in the north of the Array Project in February, April, July, August, October, November, and December 2021, and March 2022 (Figure 80 - Figure 94).

Only a few razorbills were recorded as flying, they were recorded flying in a significantly significant direction in July 2021 (Figure 95).

Table 23 Raw counts, abundance and density estimates of razorbill in the Array Project.

Survey	Raw Count	Sitting	Flying	Abundance	Lower CL	Upper CL	Precision	Density
Jan-21	33	31	2	268	179	374	0.17	0.19
Feb-21	90	89	1	735	572	906	0.11	0.52
Mar-21	10	10	-	83	33	141	0.32	0.06
Apr-21	14	11	3	112	48	192	0.27	0.10
May-21	20	20	-	163	74	261	0.22	0.11
Jun-21	195	190	5	1,606	1,326	1,902	0.07	1.13
Jul-21	1,142	1,129	13	9,363	8,297	10,511	0.03	6.60
Aug-21	16	16	-	131	57	222	0.25	0.09
Sep-21	81	81	-	666	460	896	0.11	0.47
Oct-21	6	6	-	48	16	88	0.41	0.03
Nov-21	16	16	-	133	75	208	0.25	0.09
Dec-21	26	26	-	213	123	304	0.20	0.15
Jan-22	9	9	-	73	32	122	0.33	0.05
Feb-22	8	8	-	65	24	114	0.35	0.05
Mar-22	12	10	2	97	41	179	0.29	0.07

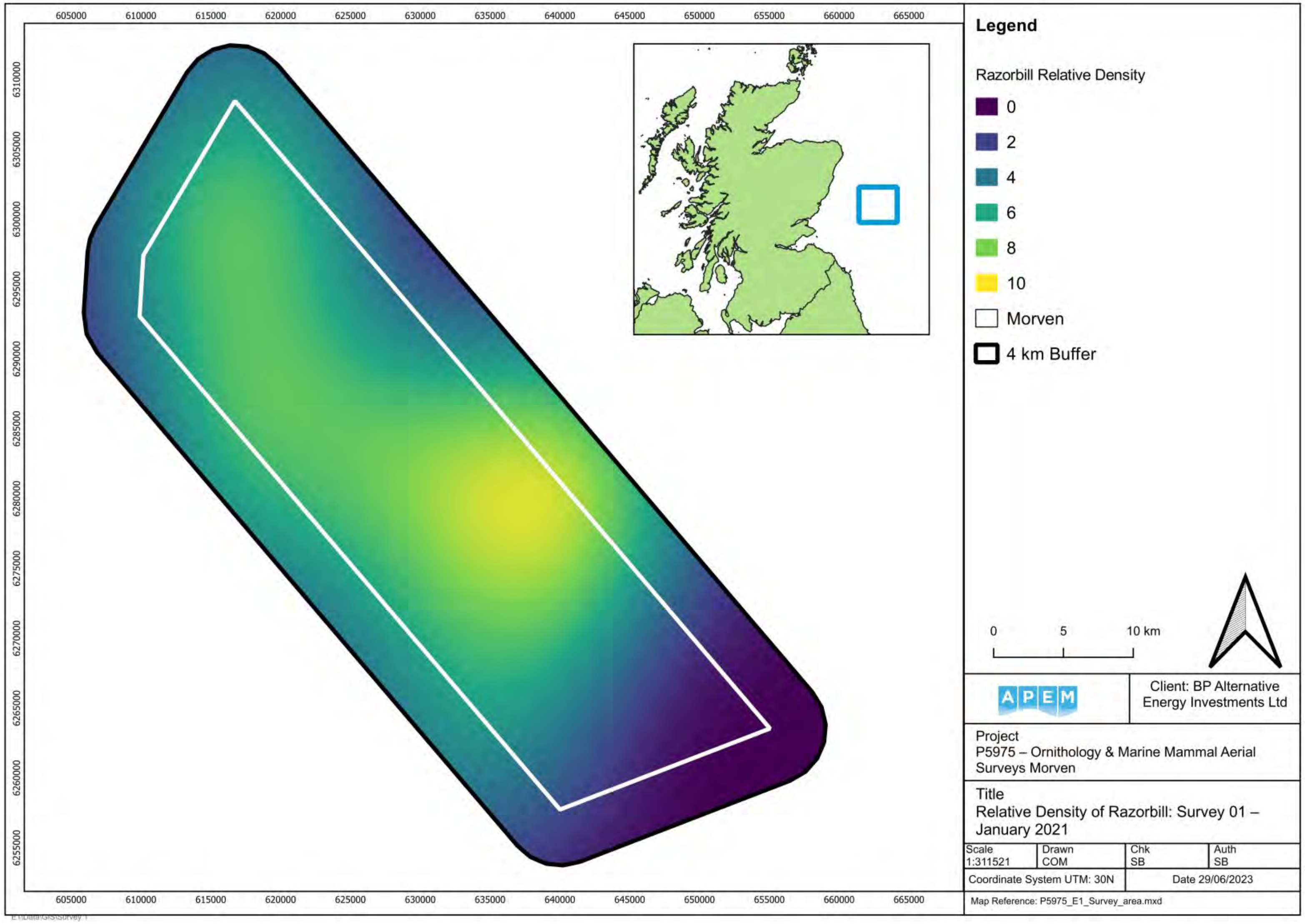


Figure 80 Relative density of razorbill in January 2021 (Survey 01).

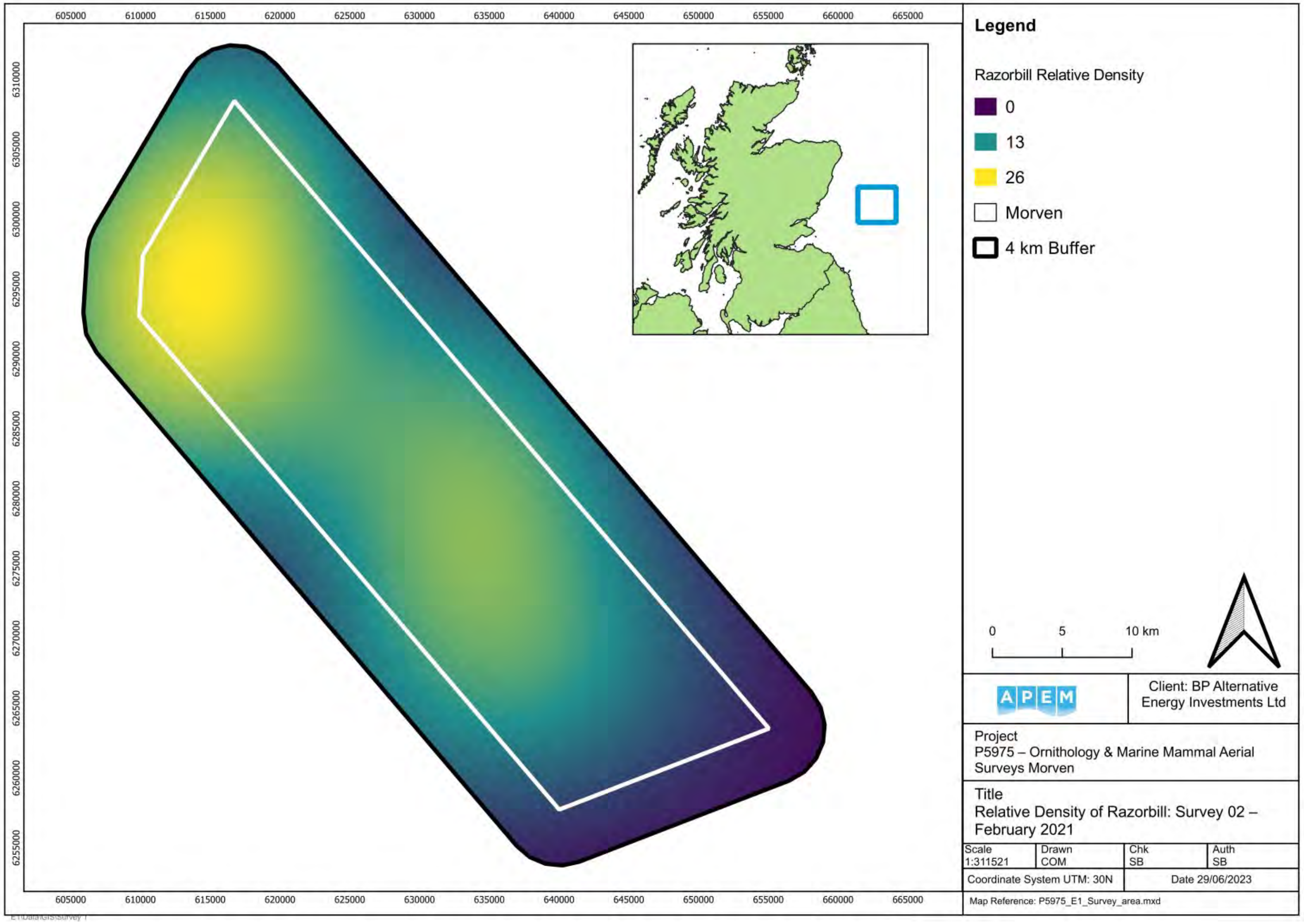


Figure 81 Relative density of razorbill in February 2021 (Survey 02).

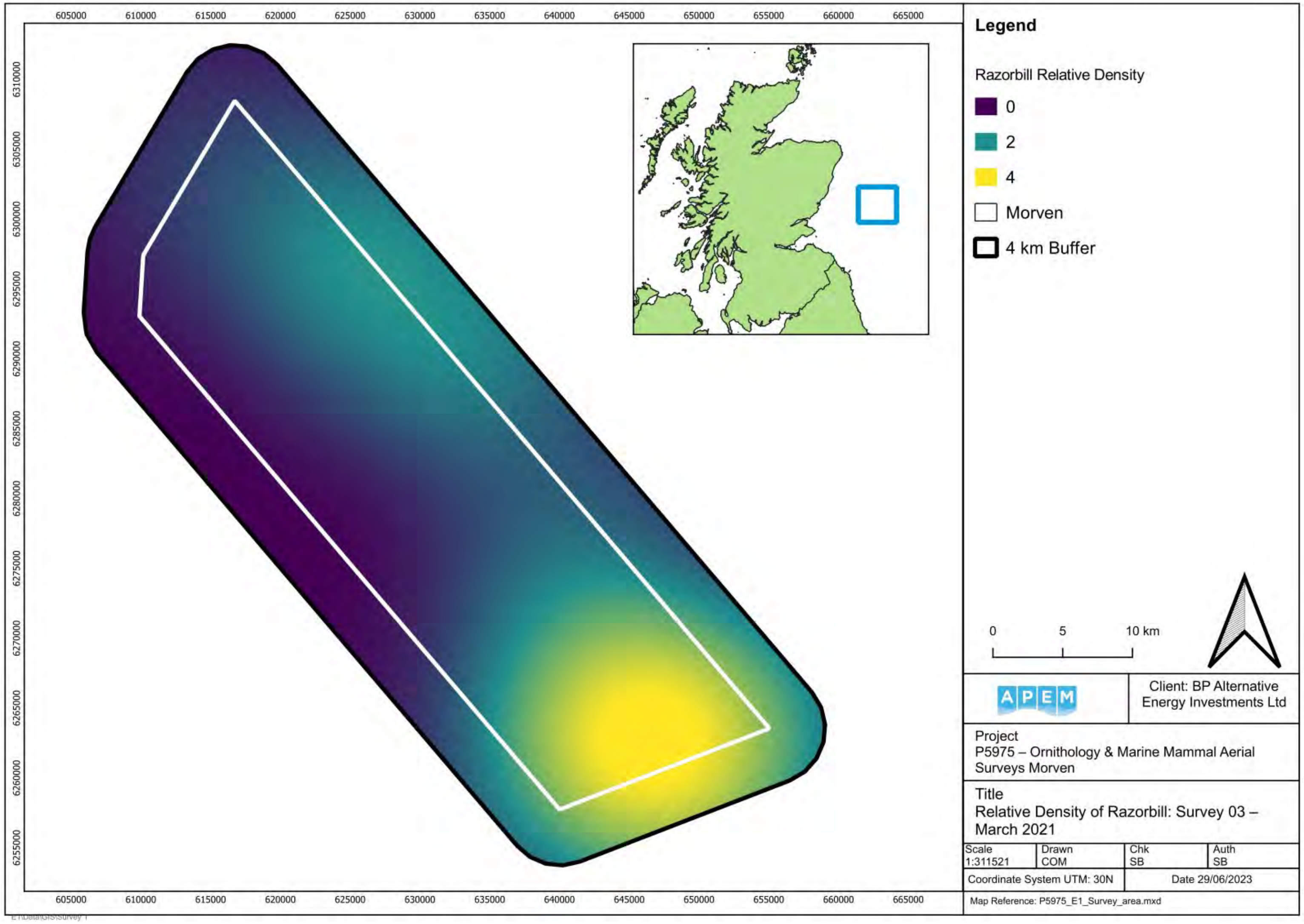


Figure 82 Relative density of razorbill in March 2021 (Survey 03).

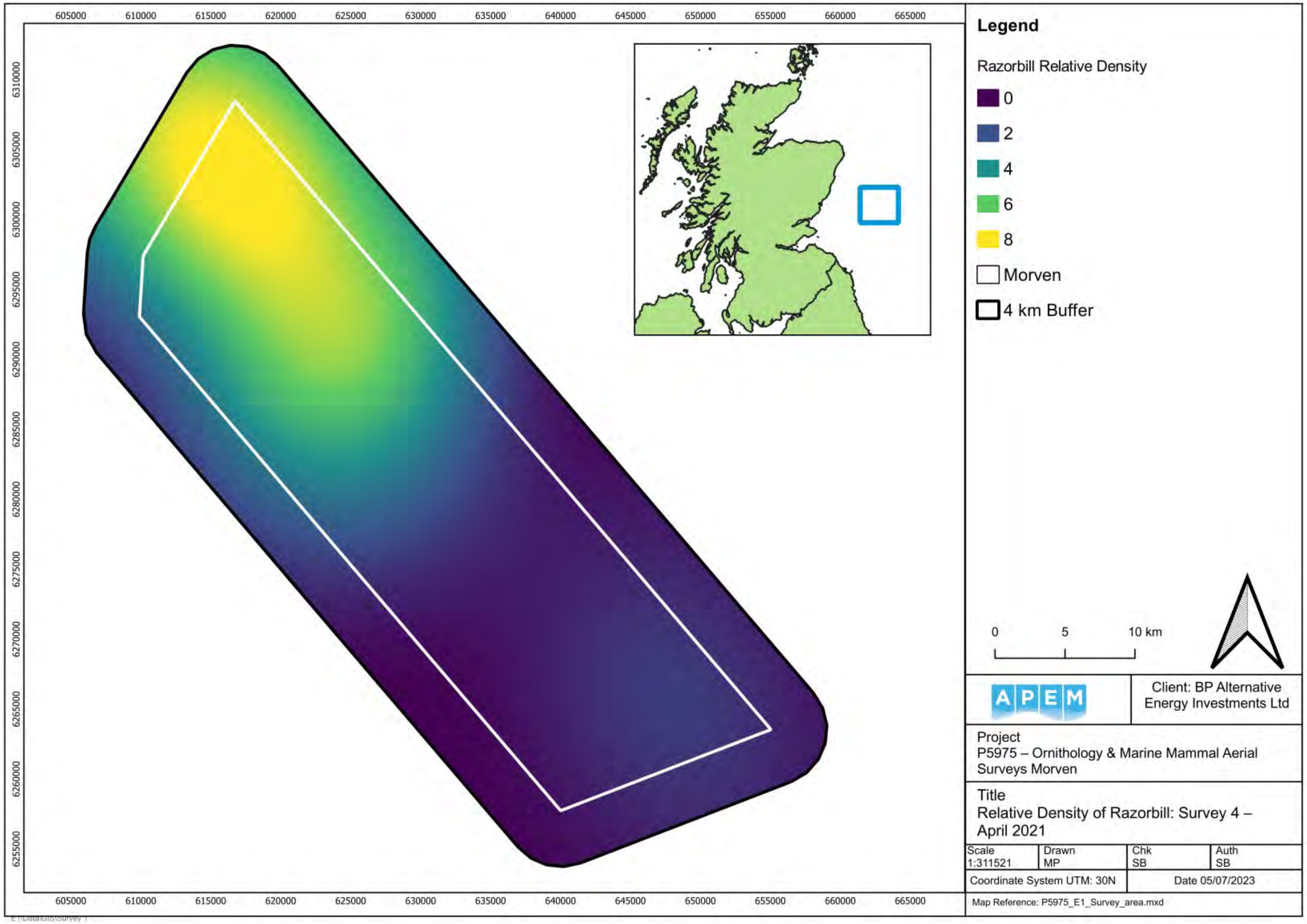


Figure 83 Relative density of razorbill in April 2021 (Survey 04).

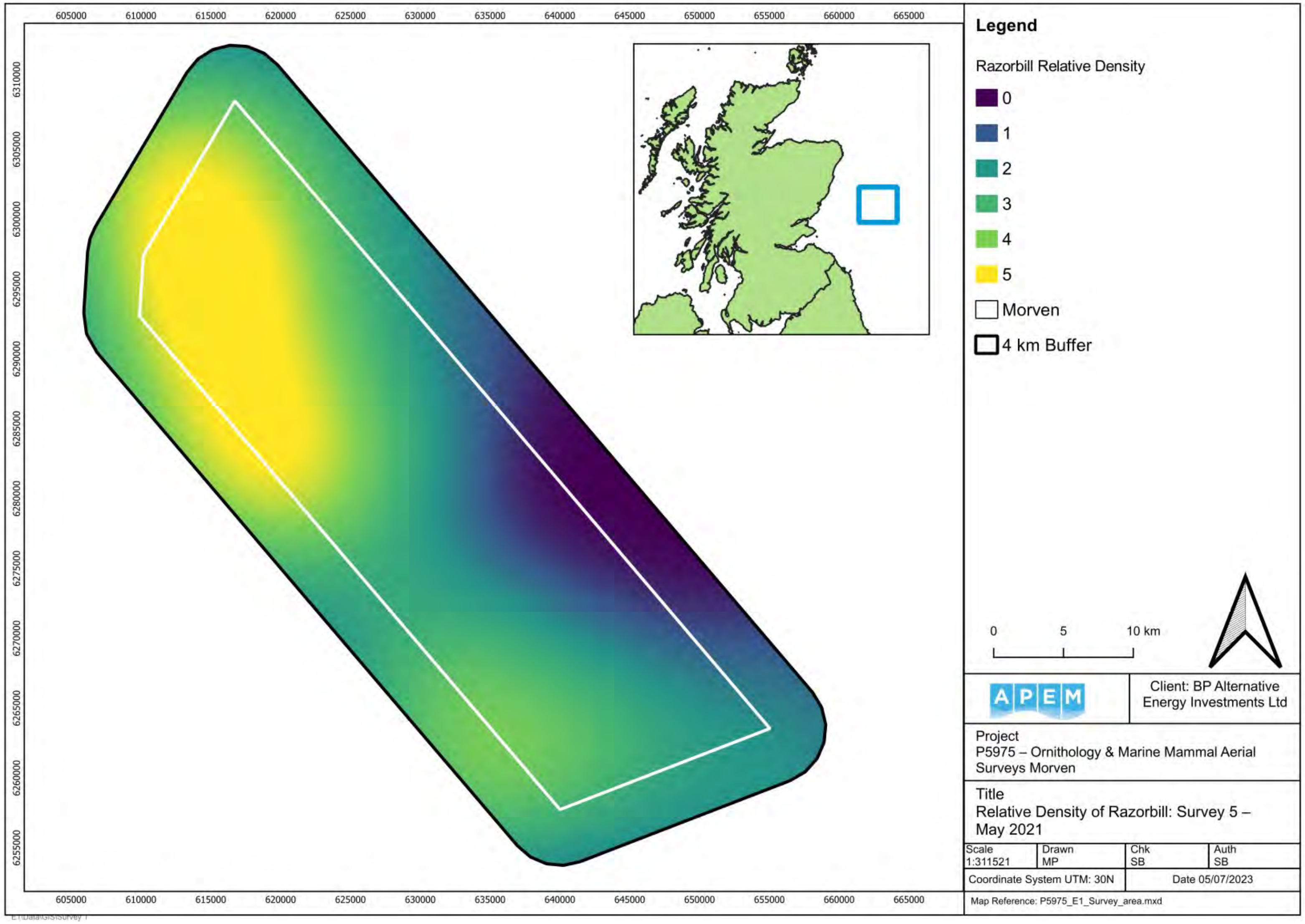


Figure 84 Relative density of razorbill in May 2021 (Survey 05).

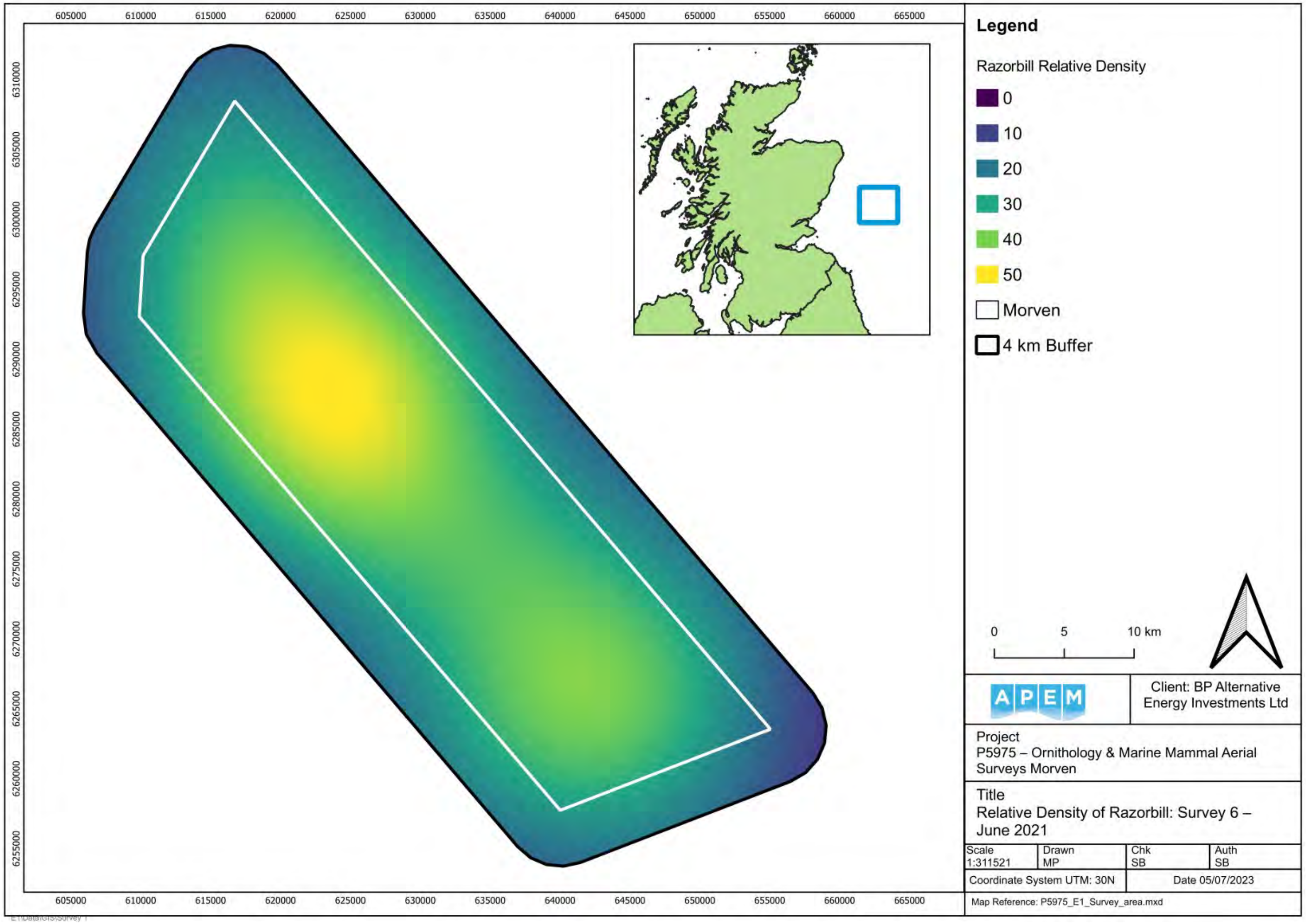


Figure 85 Relative density of razorbill in June 2021 (Survey 06).

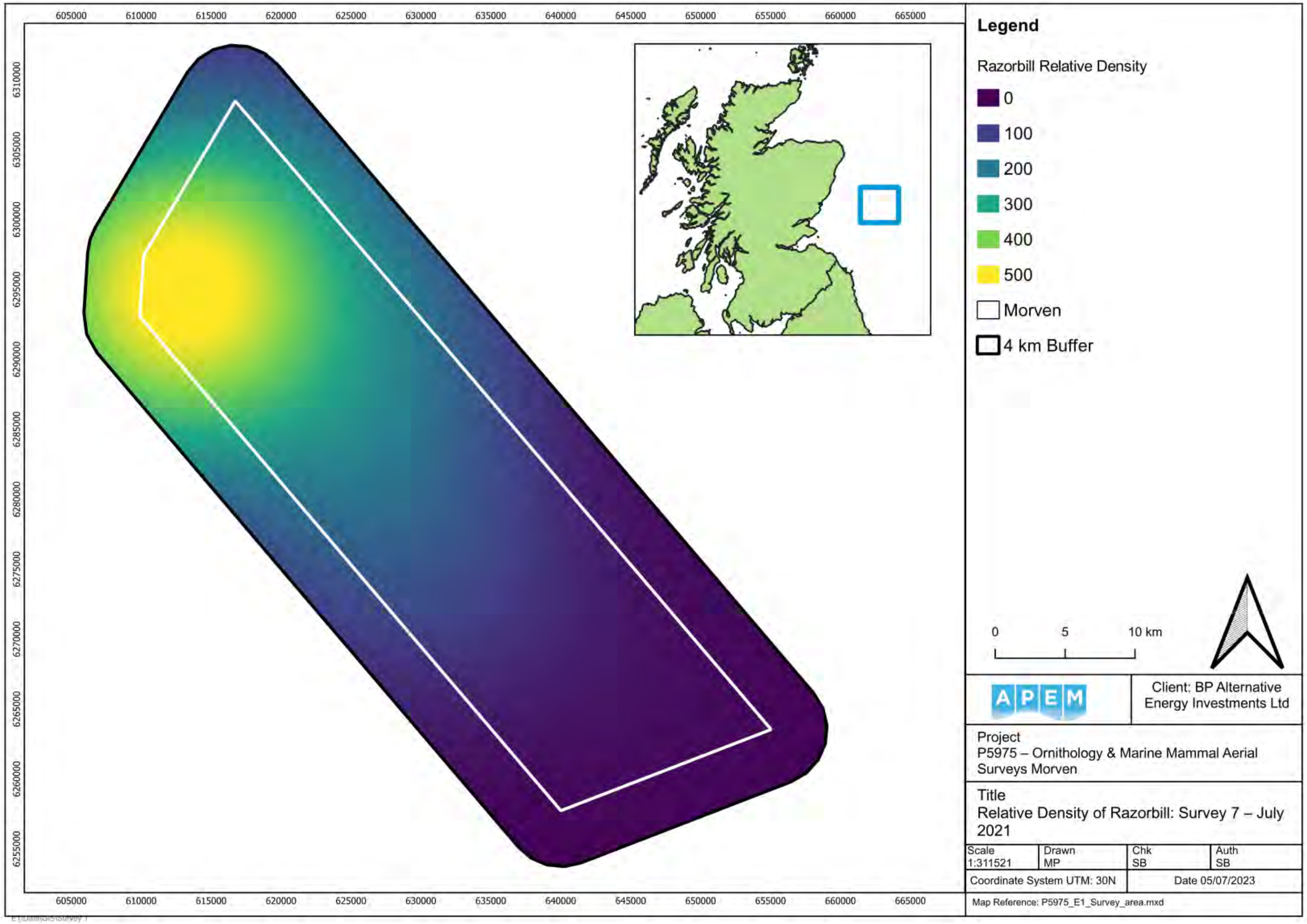


Figure 86 Relative density of razorbill in July 2021 (Survey 07).

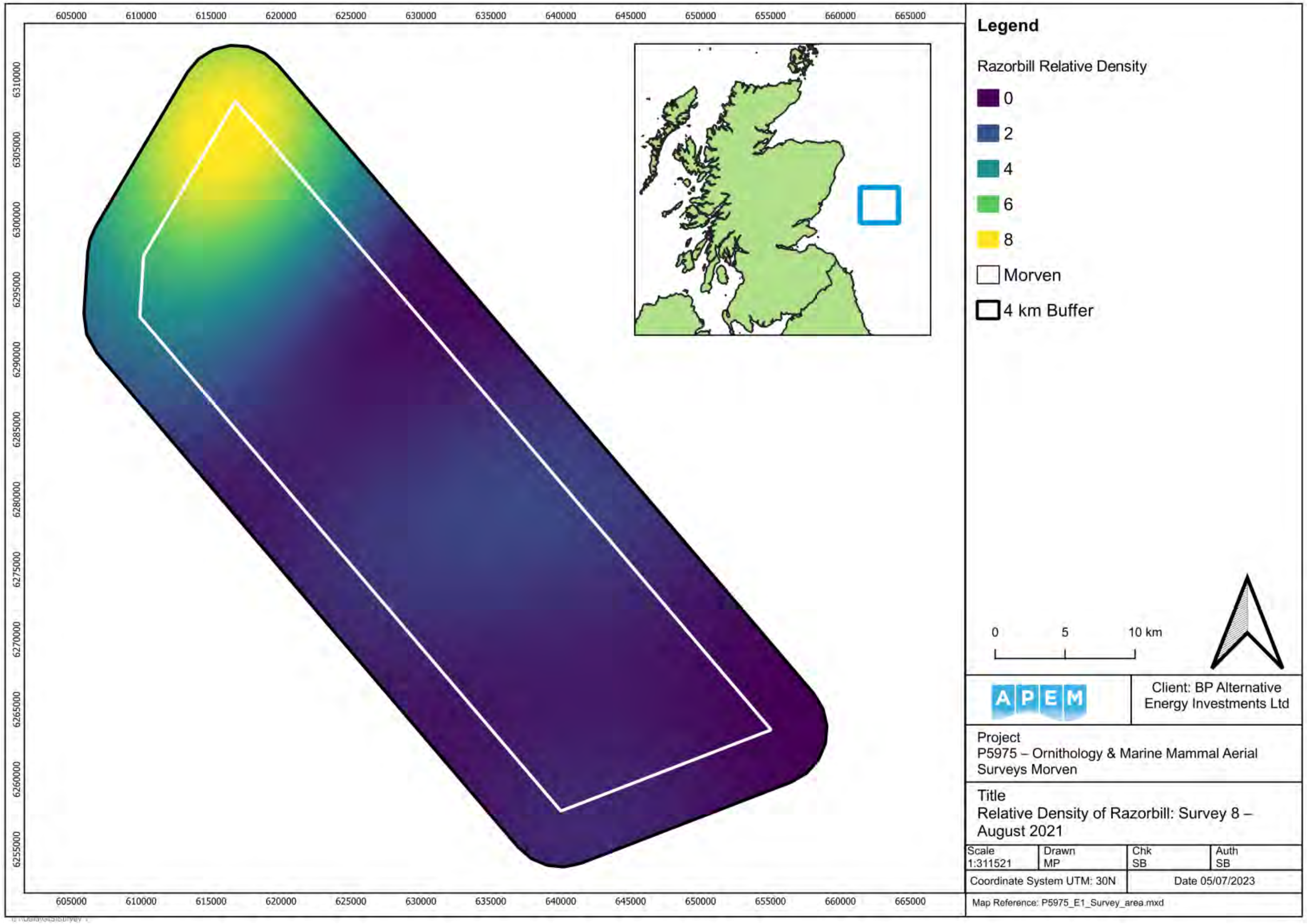


Figure 87 Relative density of razorbill in August 2021 (Survey 08).

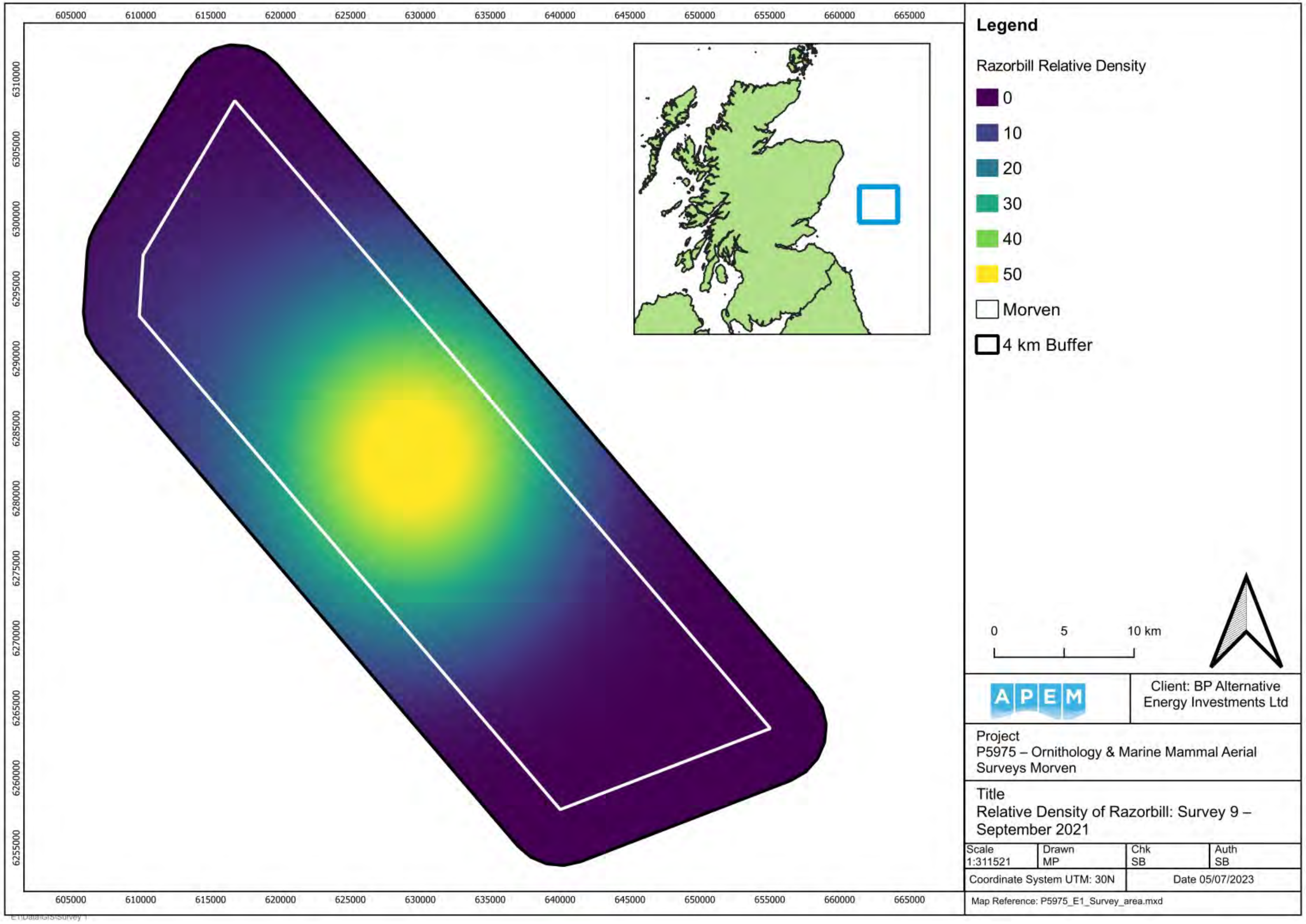


Figure 88 Relative density of razorbill in September 2021 (Survey 09).

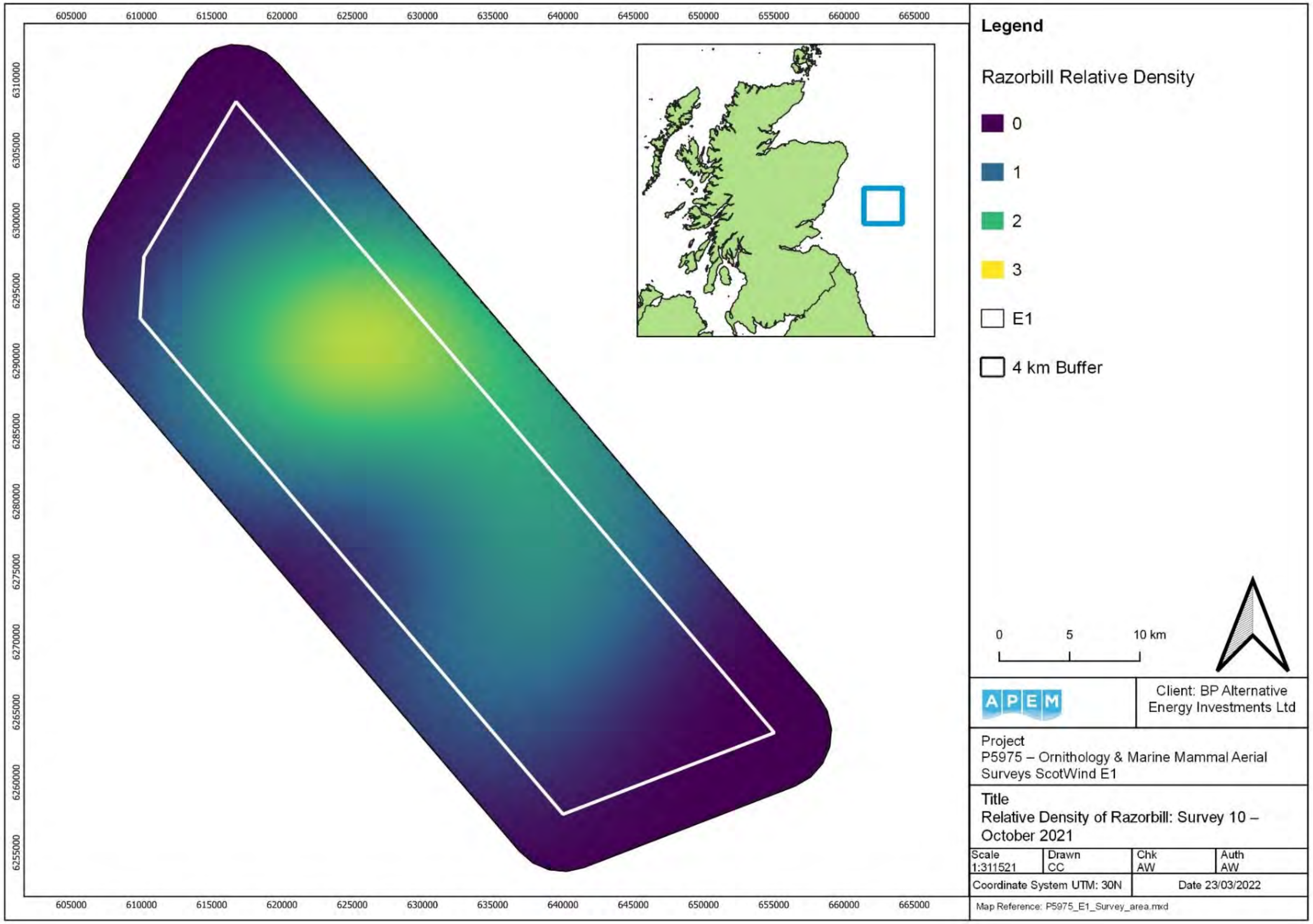


Figure 89 Relative density of razorbill in October 2021 (Survey 10).

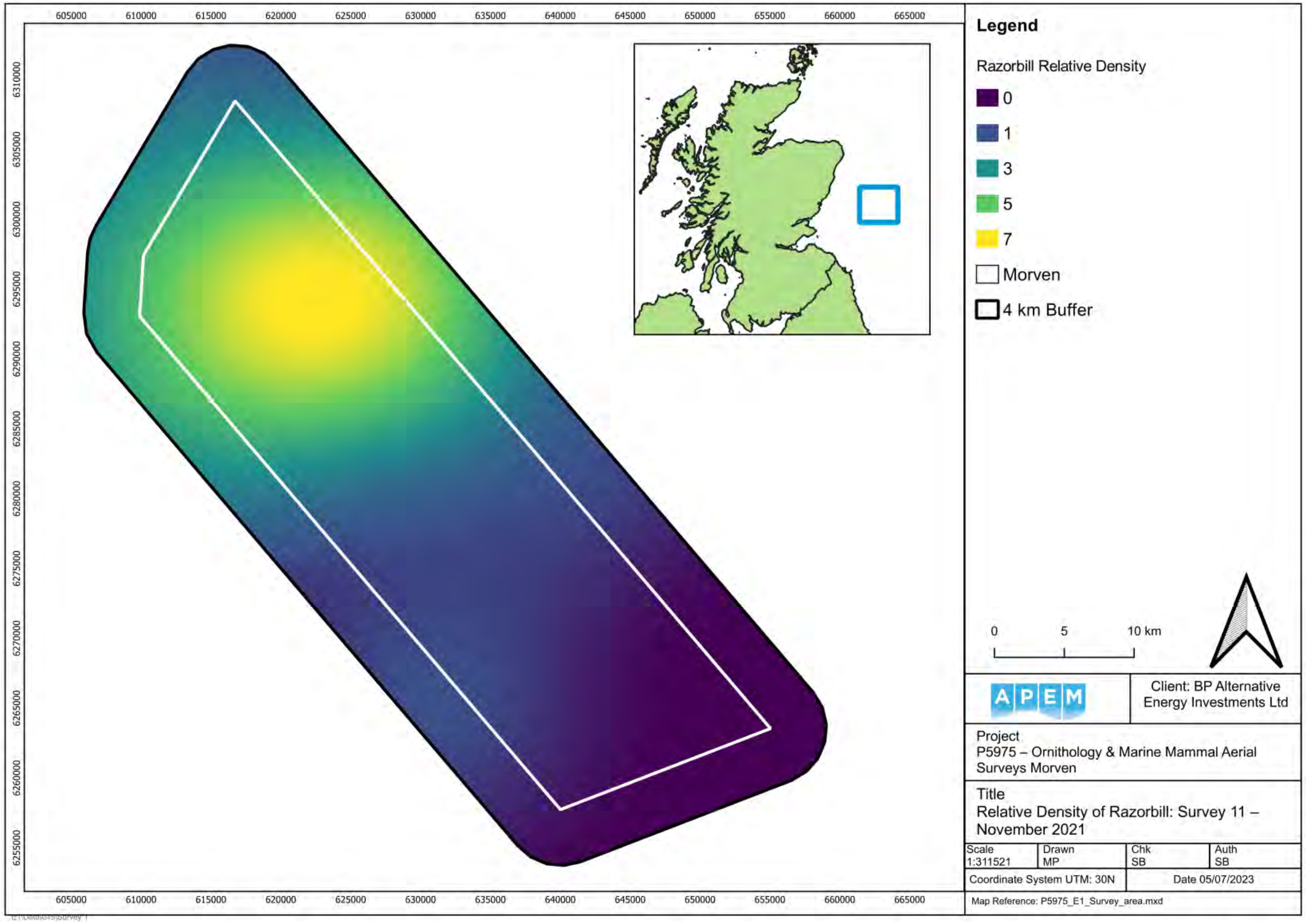


Figure 90 Relative density of razorbill in November 2021 (Survey 11).

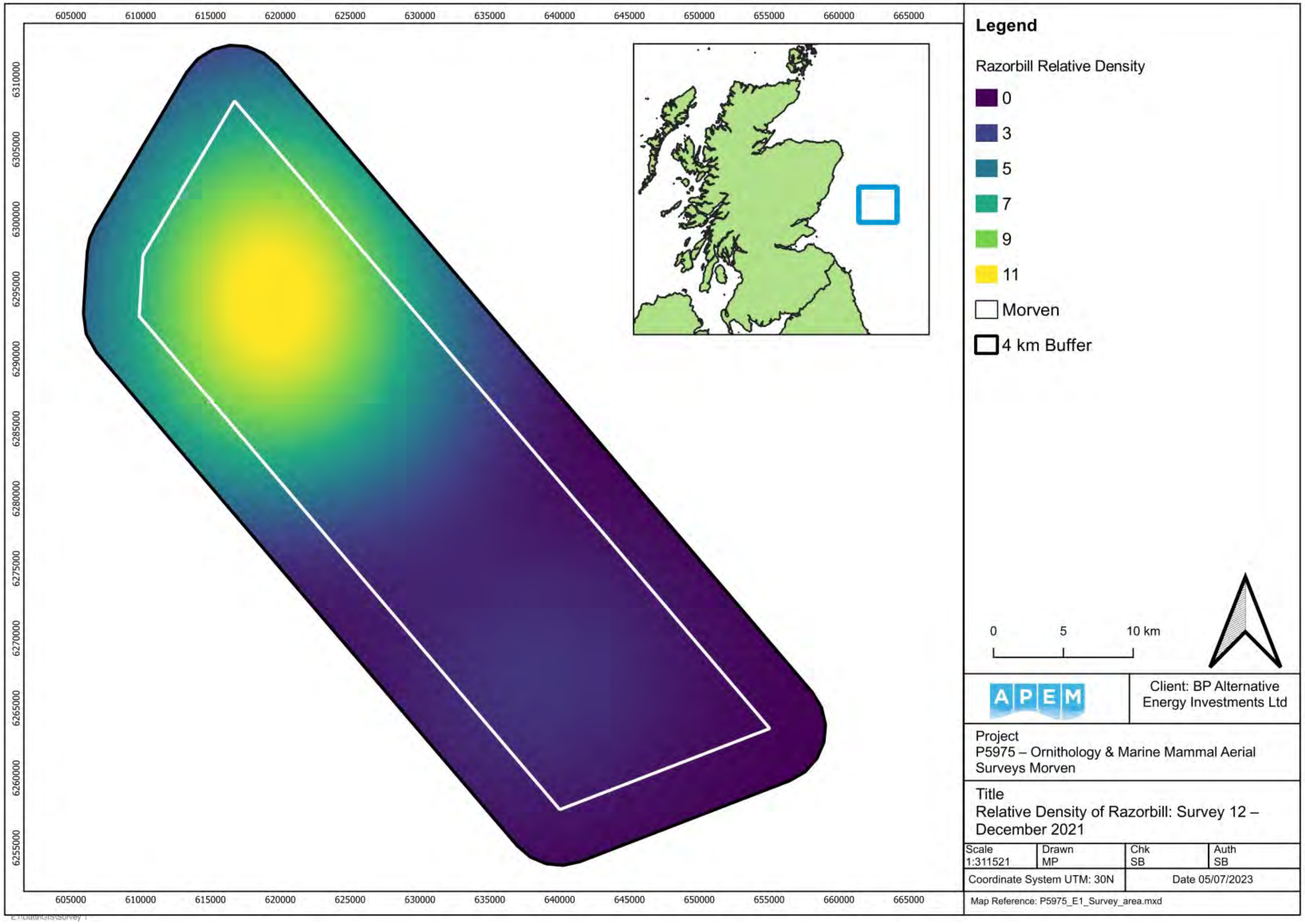


Figure 91 Relative density of razorbill in December 2021 (Survey 12).

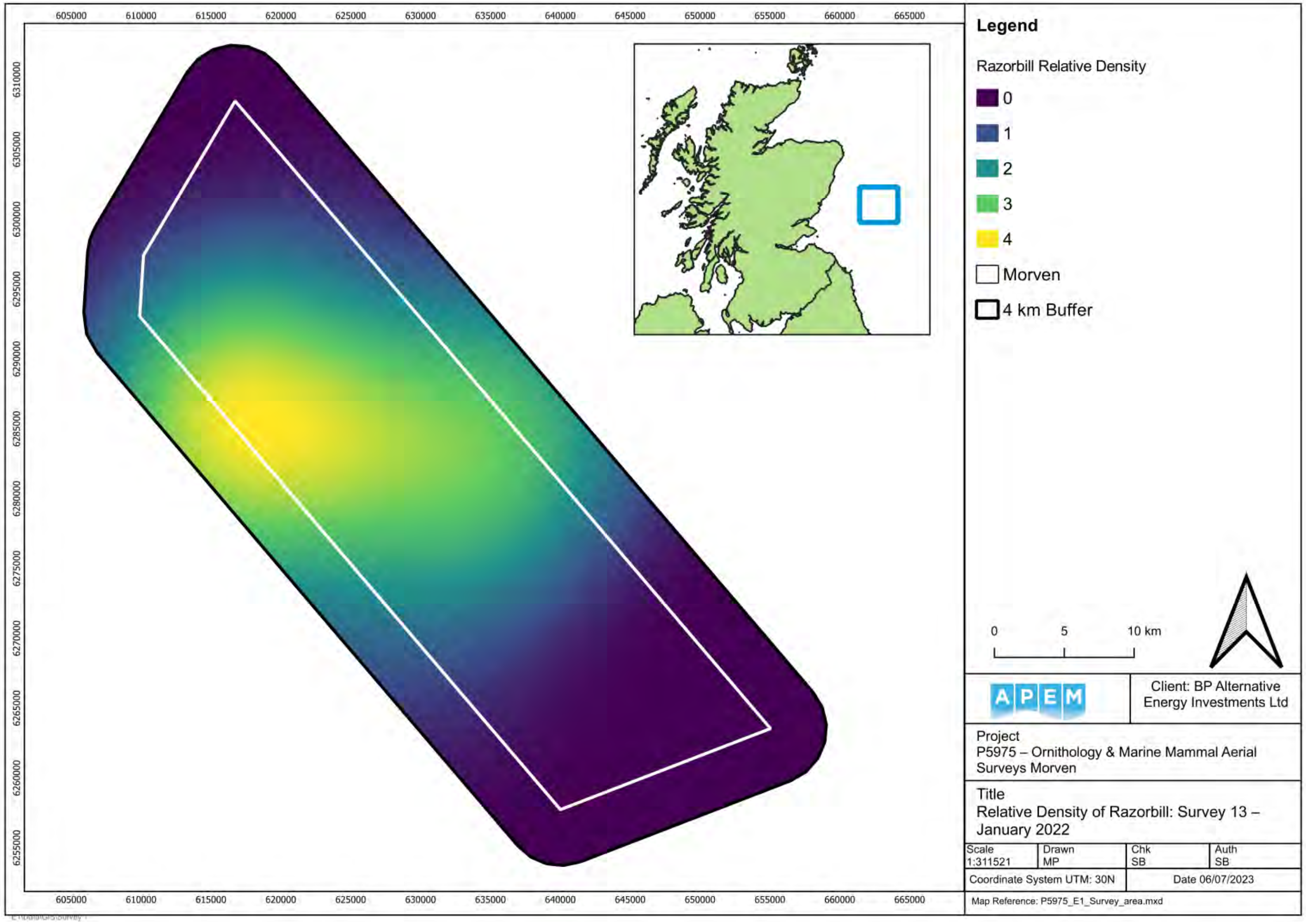


Figure 92 Relative density of razorbill in January 2022 (Survey 13).

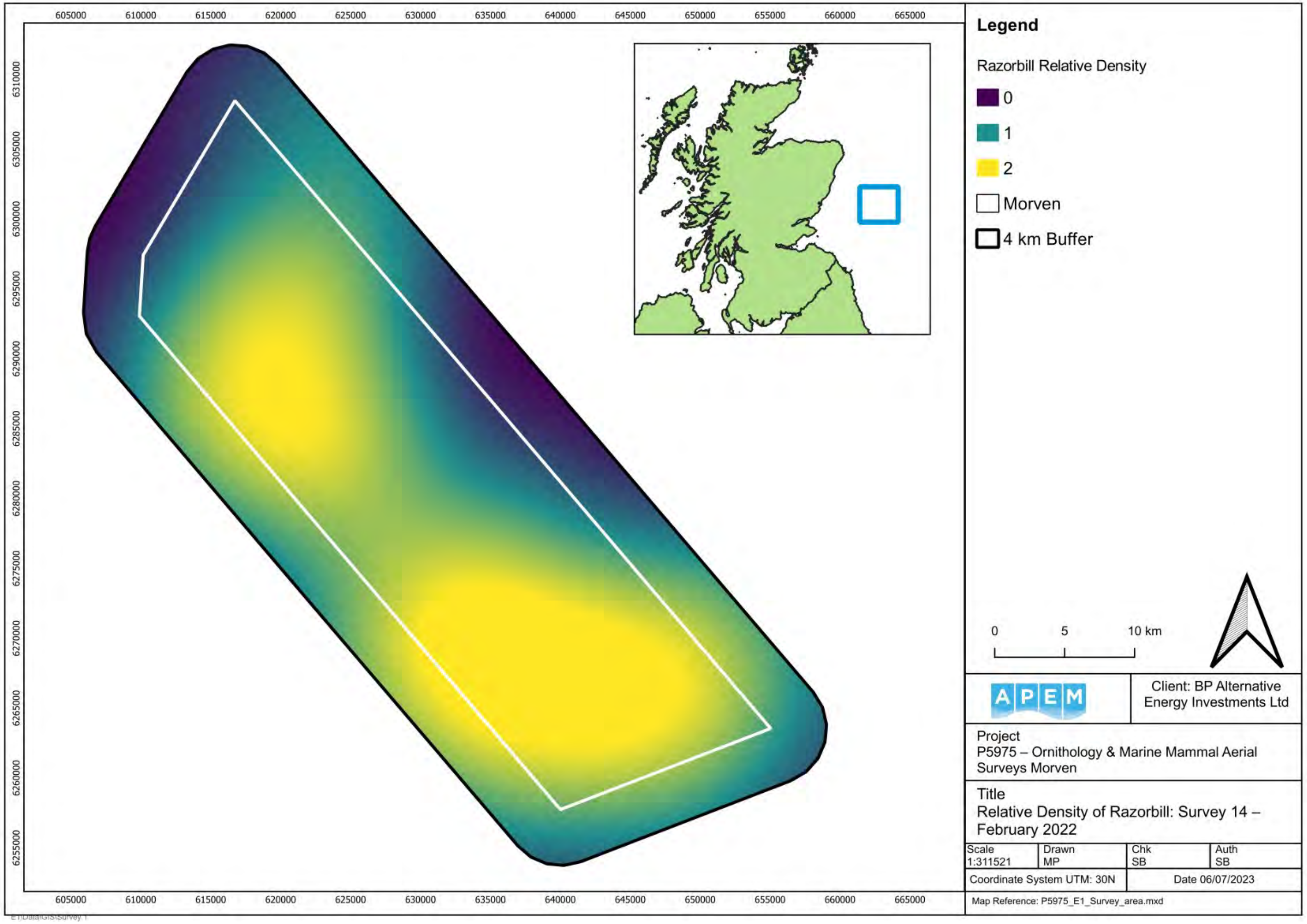


Figure 93 Relative density of razorbill in February 2022 (Survey 14).

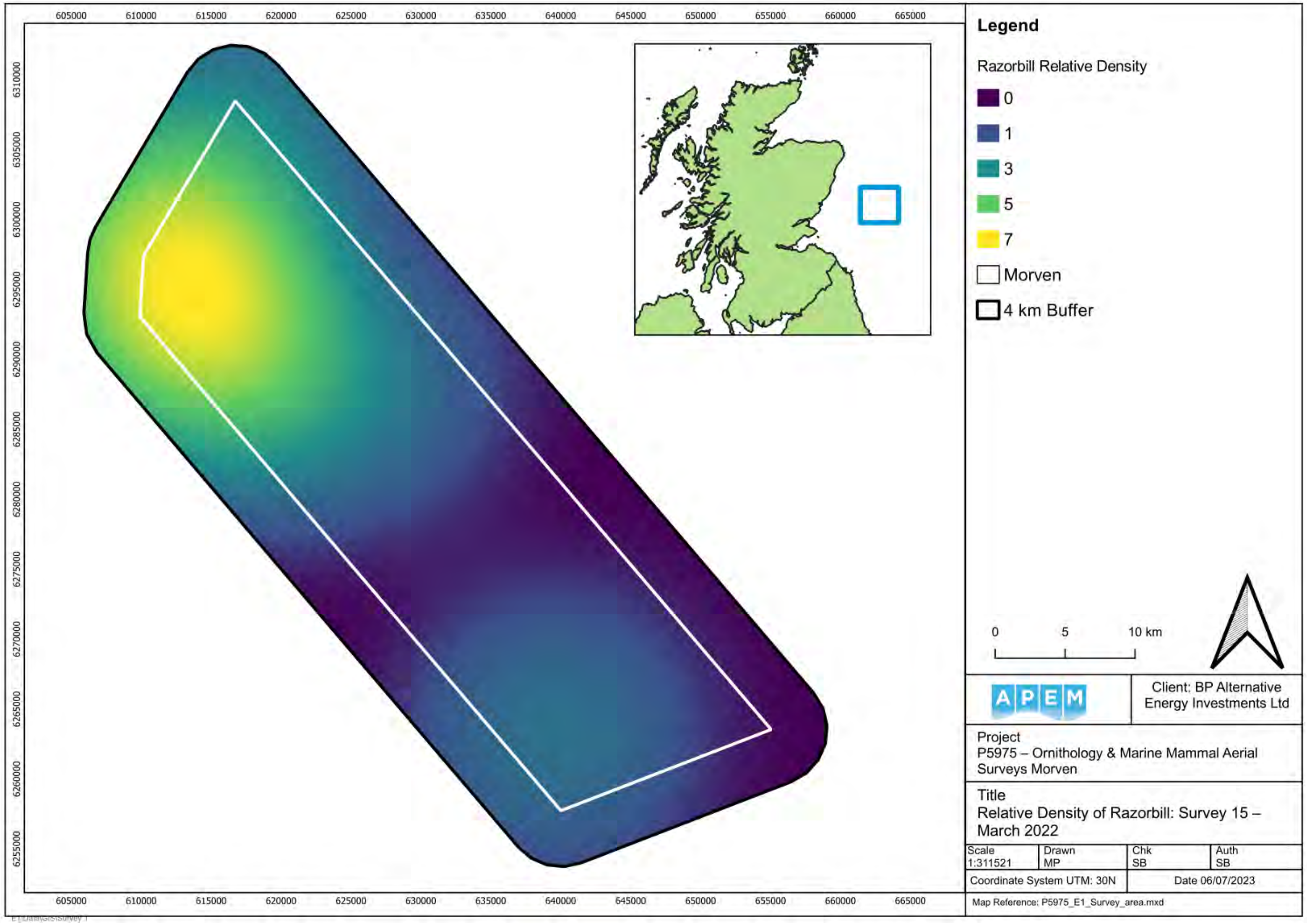
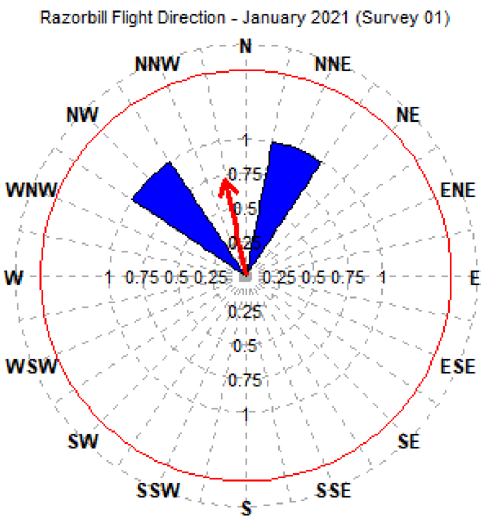
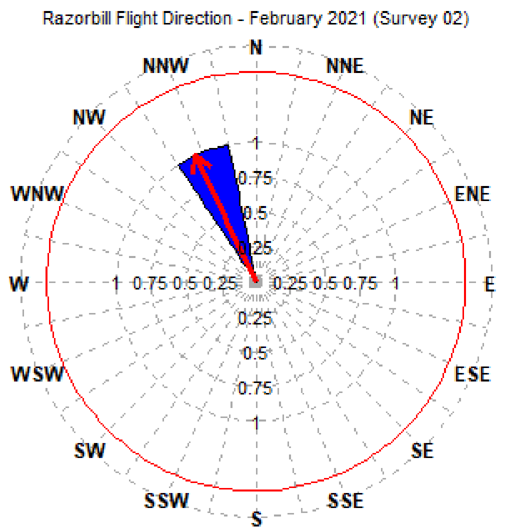


Figure 94 Relative density of razorbill in March 2022 (Survey 15).



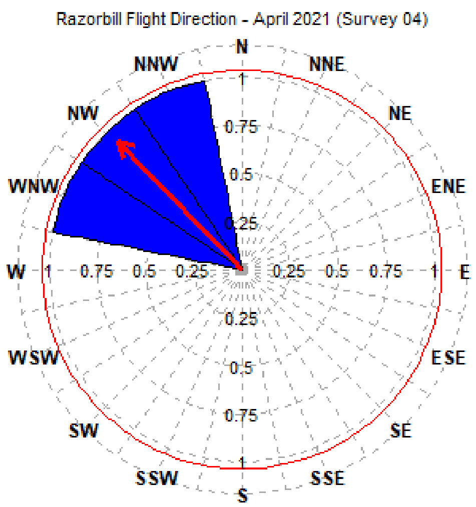
Number of Observations	2
Mean Vector (µ)	348.523
Length of Mean Vector (r)	0.714
Rayleigh Test (Z)	1.019
Rayleigh Test (p)	0.419

Figure 95a January 2021 (Survey 01)



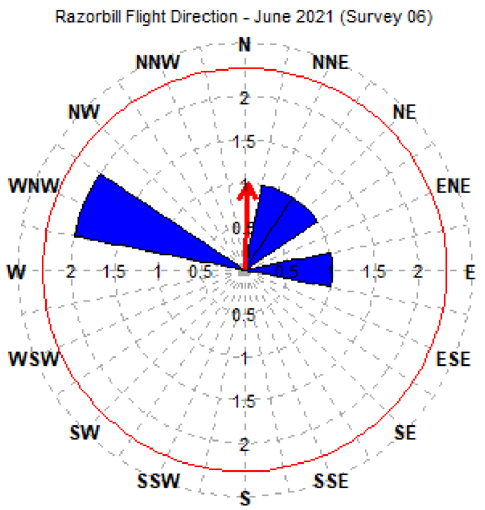
Number of Observations	4
Mean Vector (µ)	26.000
Length of Mean Vector (r)	0.592
Rayleigh Test (Z)	1.404
Rayleigh Test (p)	0.261

Figure 95b February 2021 (Survey 02)



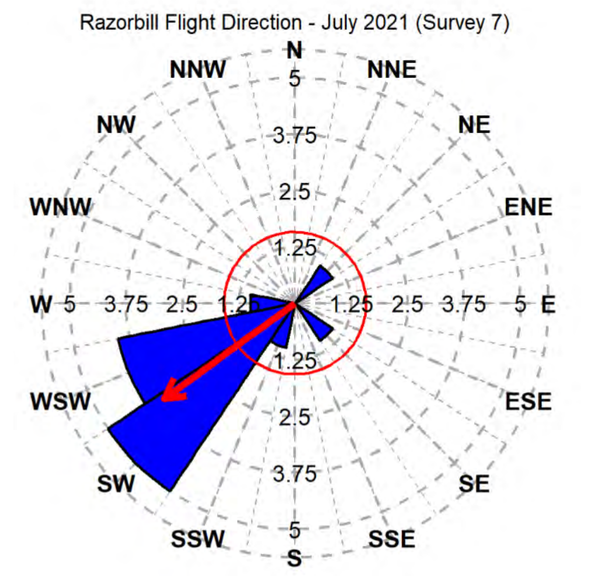
Number of Observations	3
Mean Vector (µ)	316.324
Length of Mean Vector (r)	0.921
Rayleigh Test (Z)	2.543
Rayleigh Test (p)	0.067

Figure 95d April 2021 (Survey 04)



Number of Observations	5
Mean Vector (µ)	2.216
Length of Mean Vector (r)	0.493
Rayleigh Test (Z)	1.213
Rayleigh Test (p)	0.313

Figure 95d June 2021 (Survey 06)



Number of Observations	13
Mean Vector (µ)	234.623
Length of Mean Vector (r)	0.718
Rayleigh Test (Z)	6.700
Rayleigh Test (p)	<0.001
Figure 95c July 2021 (Survey 07)	

Figure 95 Summary of flight directions of razorbills recorded in the Array Project.

4.20 Guillemot / Razorbill – Unidentified

Unidentified guillemots / razorbills were recorded in all months during the first 15 months of surveys. Peak numbers were recorded in July - 790 individuals, resulting in an abundance estimate of 6,477 within the Array Project (Table 24).

These were throughout the Array Project in February 2021, in the east in April 2021, west in June 2021, and in the north and south in August 2021. Guillemot / Razorbill were recorded in the north in January, July, and December 2021, and March 2022, in the south in March, October, and November 2021, and February 2022, and in the center of the Array Project in May, and September 2021, and January 2022 (Figure 96 - Figure 110).

Guillemots / razorbills showed no significant direction of flight (P>0.05) (Figure 111).

Table 24 Raw counts, abundance and density estimates of unidentified guillemot / razorbill in the Array Project.

Survey	Raw Count	Sitting	Flying	Abundance	Lower CL	Upper CL	Precision	Density
Jan-21	203	203	-	203	1,651	1,391	1,911	0.07
Feb-21	60	60	-	490	367	621	0.13	0.35
Mar-21	35	34	1	290	190	406	0.17	0.20
Apr-21	12	9	3	96	40	168	0.29	0.09
May-21	21	19	2	172	98	261	0.22	0.12
Jun-21	64	64	-	527	346	725	0.13	0.37
Jul-21	454	452	2	3,722	3,124	4,395	0.05	2.62
Aug-21	31	31	-	254	164	361	0.18	0.18
Sep-21	121	120	1	994	715	1,298	0.09	0.7
Oct-21	49	49	-	394	281	514	0.14	0.28
Nov-21	71	71	-	590	432	739	0.12	0.42
Dec-21	203	200	3	1,667	1,379	1,962	0.07	1.17
Jan-22	28	28	-	227	146	308	0.19	0.16
Feb-22	103	103	-	836	682	999	0.10	0.59
Mar-22	52	52	-	422	308	552	0.14	0.30

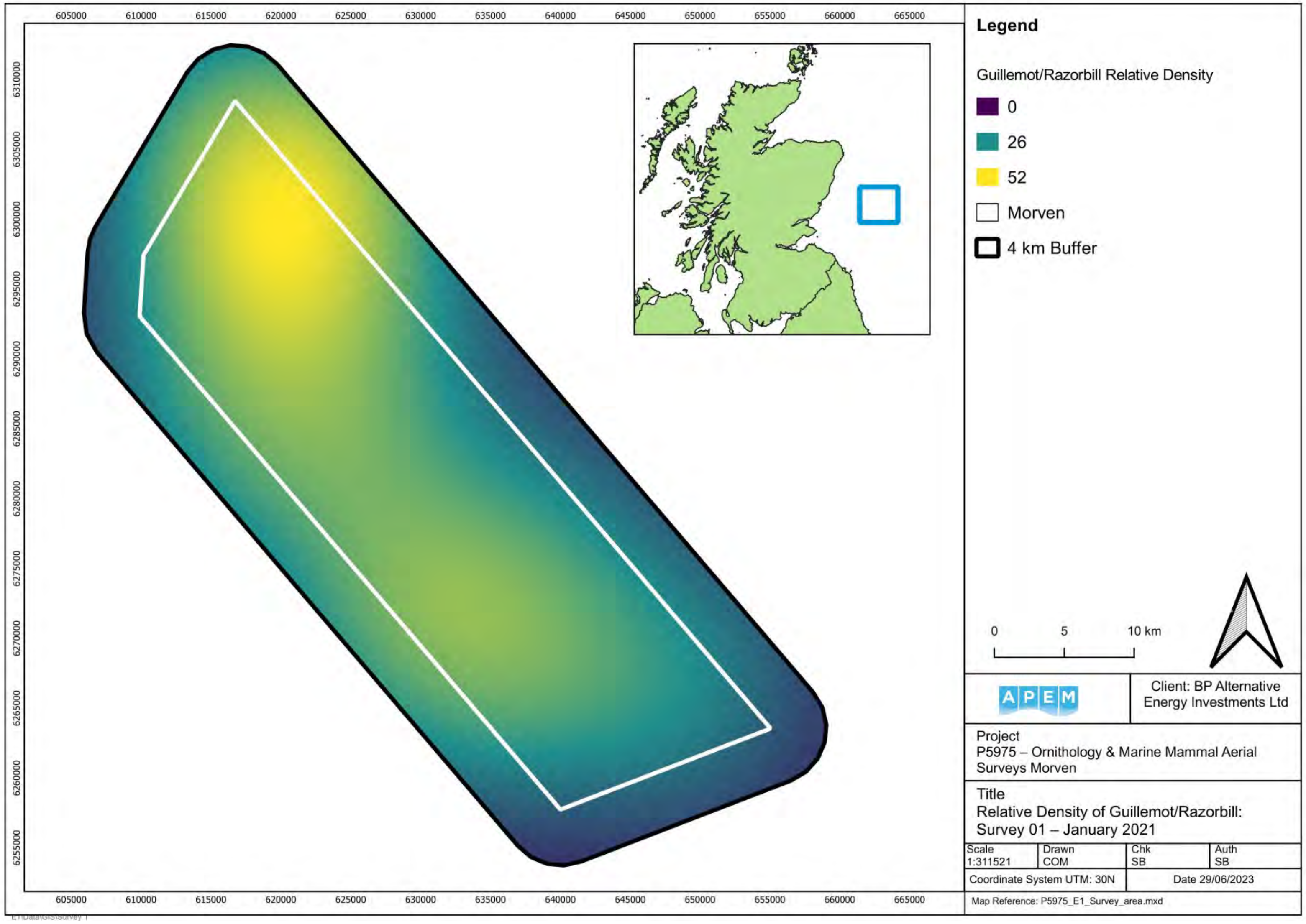


Figure 96 Relative density of guillemot / razorbill in January 2021 (Survey 01).

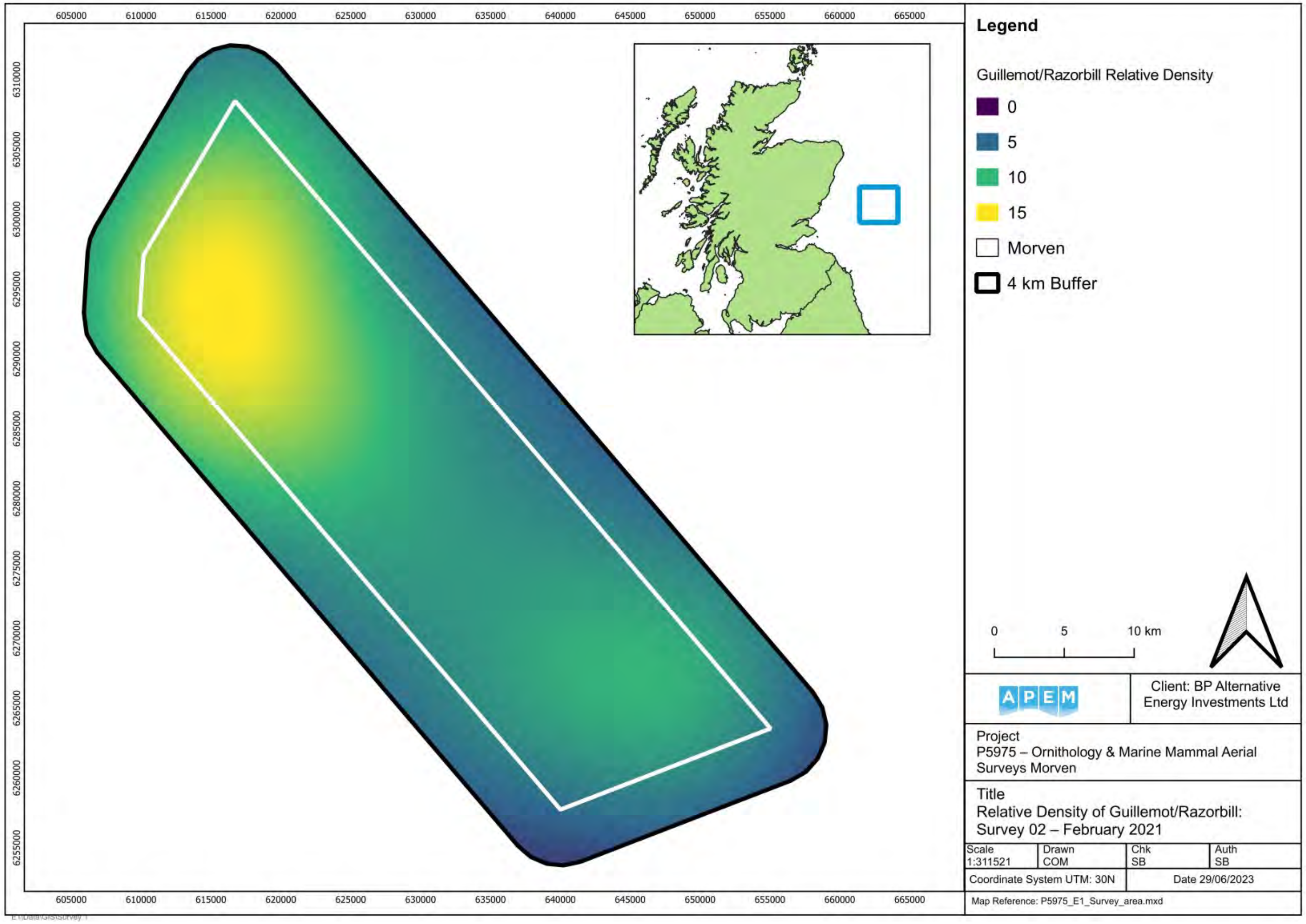


Figure 97 Relative density of guillemot / razorbill in February 2021 (Survey 02).

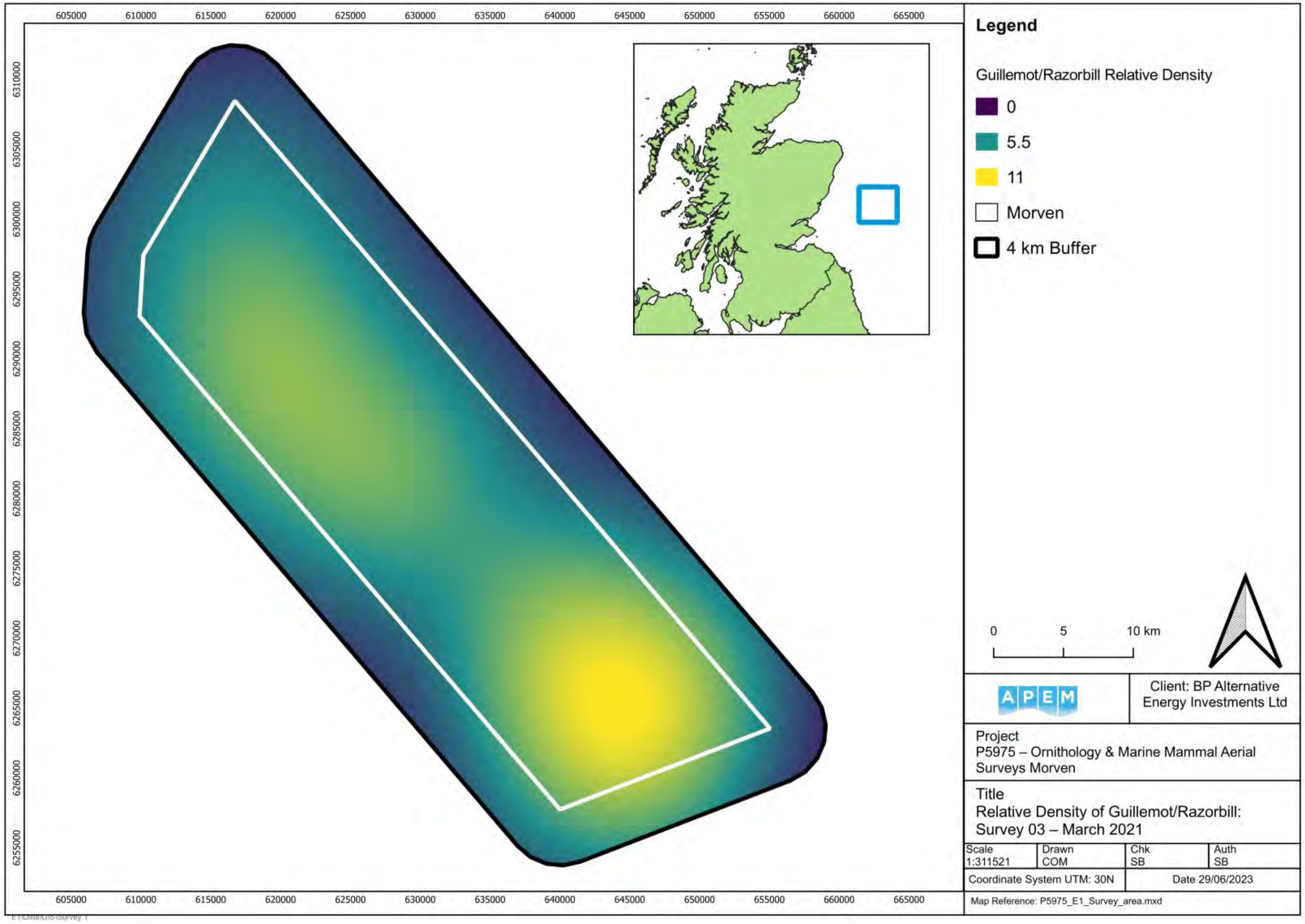


Figure 98 Relative density of guillemot / razorbill in March 2021 (Survey 03).

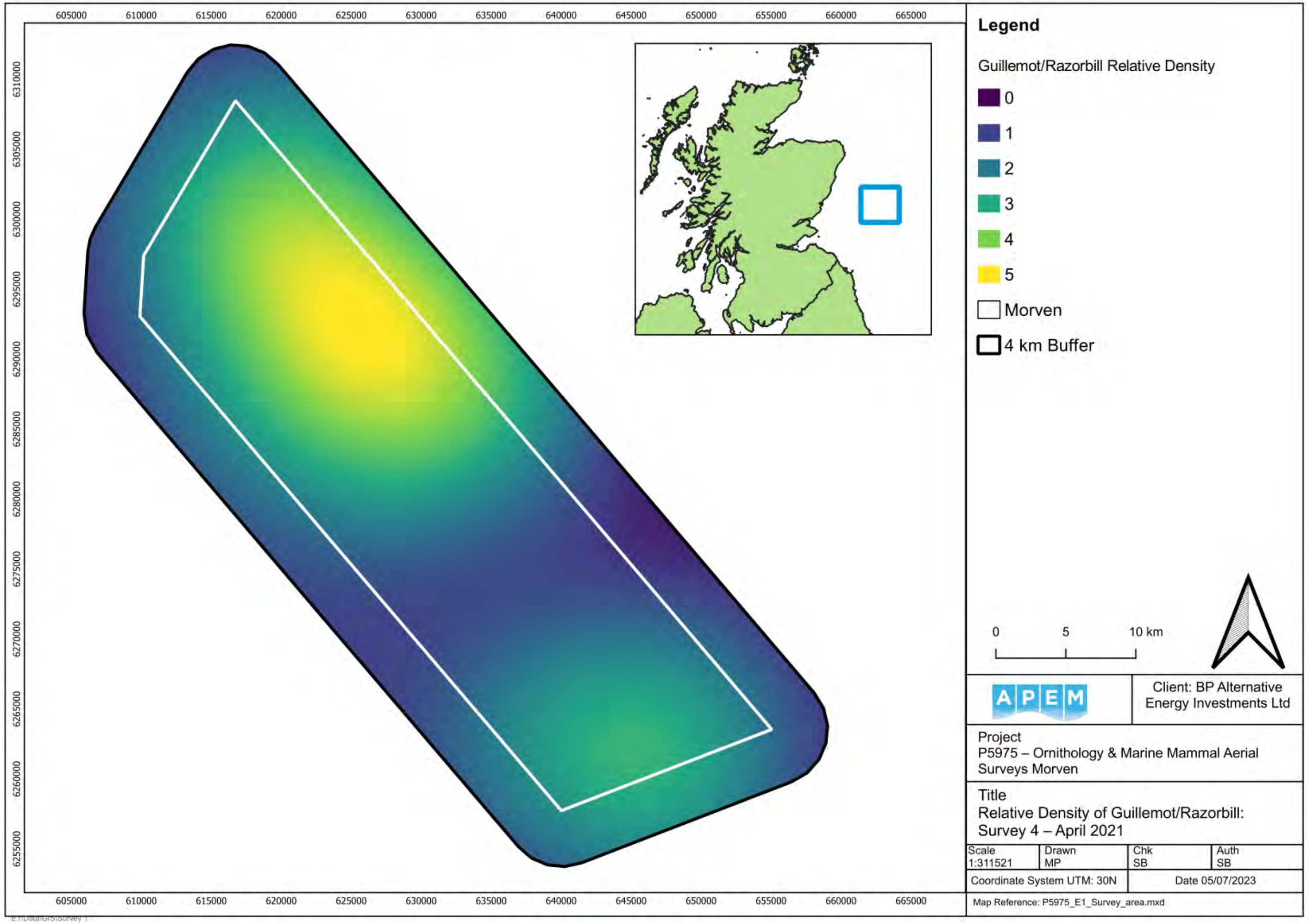


Figure 99 Relative density of guillemot / razorbill in April 2021 (Survey 04).

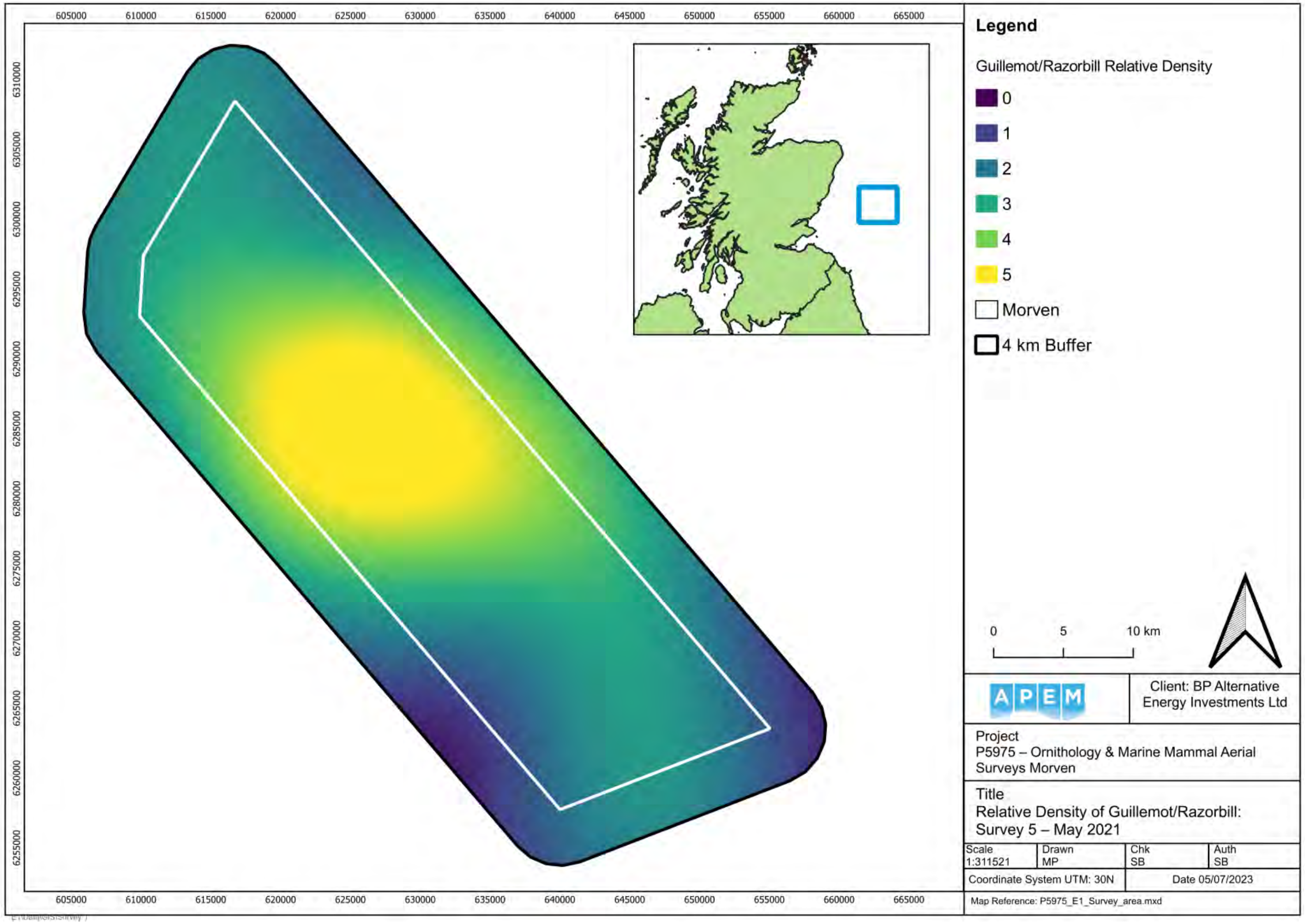


Figure 100 Relative density of guillemot / razorbill in May 2021 (Survey 05).

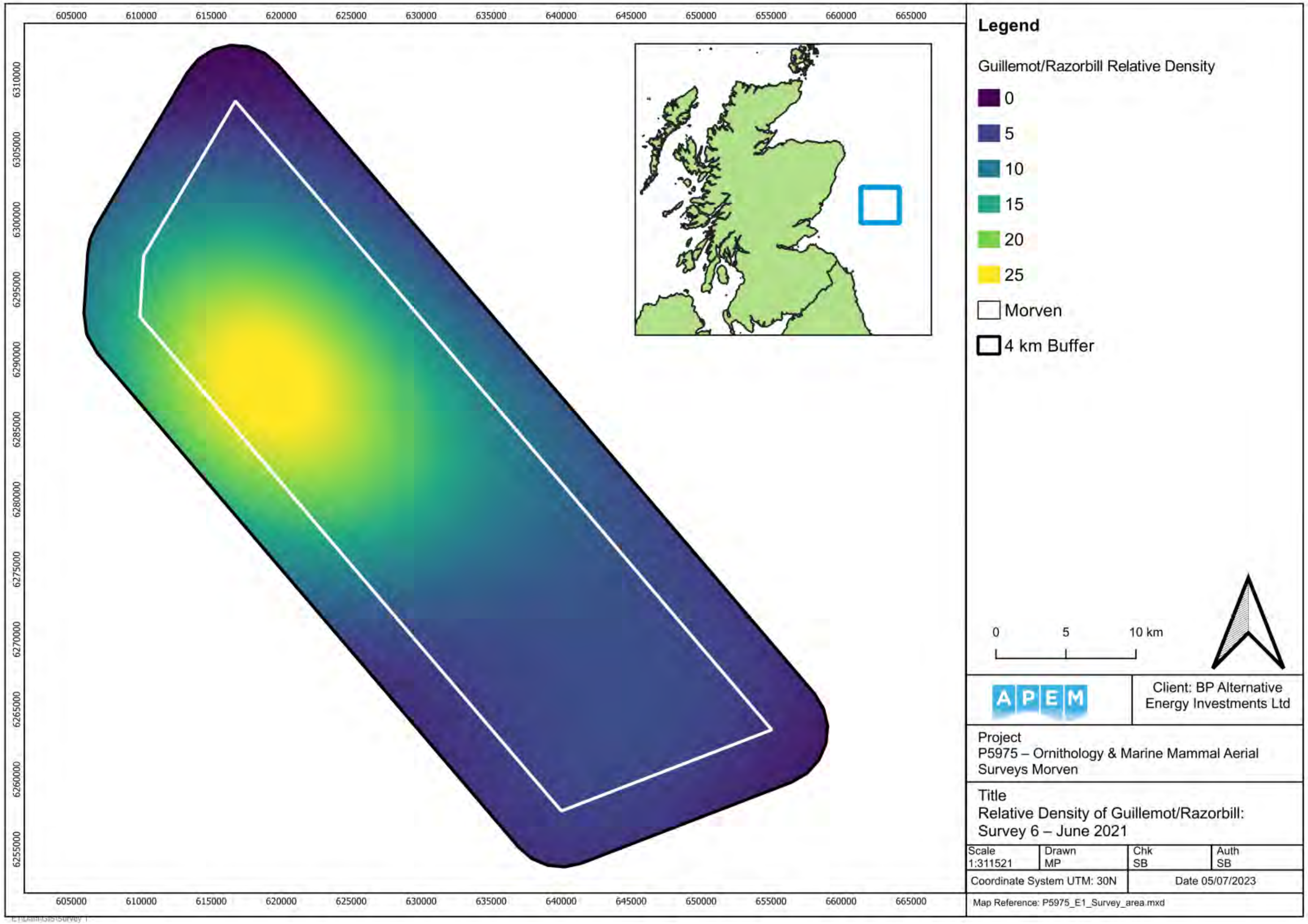


Figure 101 Relative density of guillemot / razorbill in June 2021 (Survey 06).

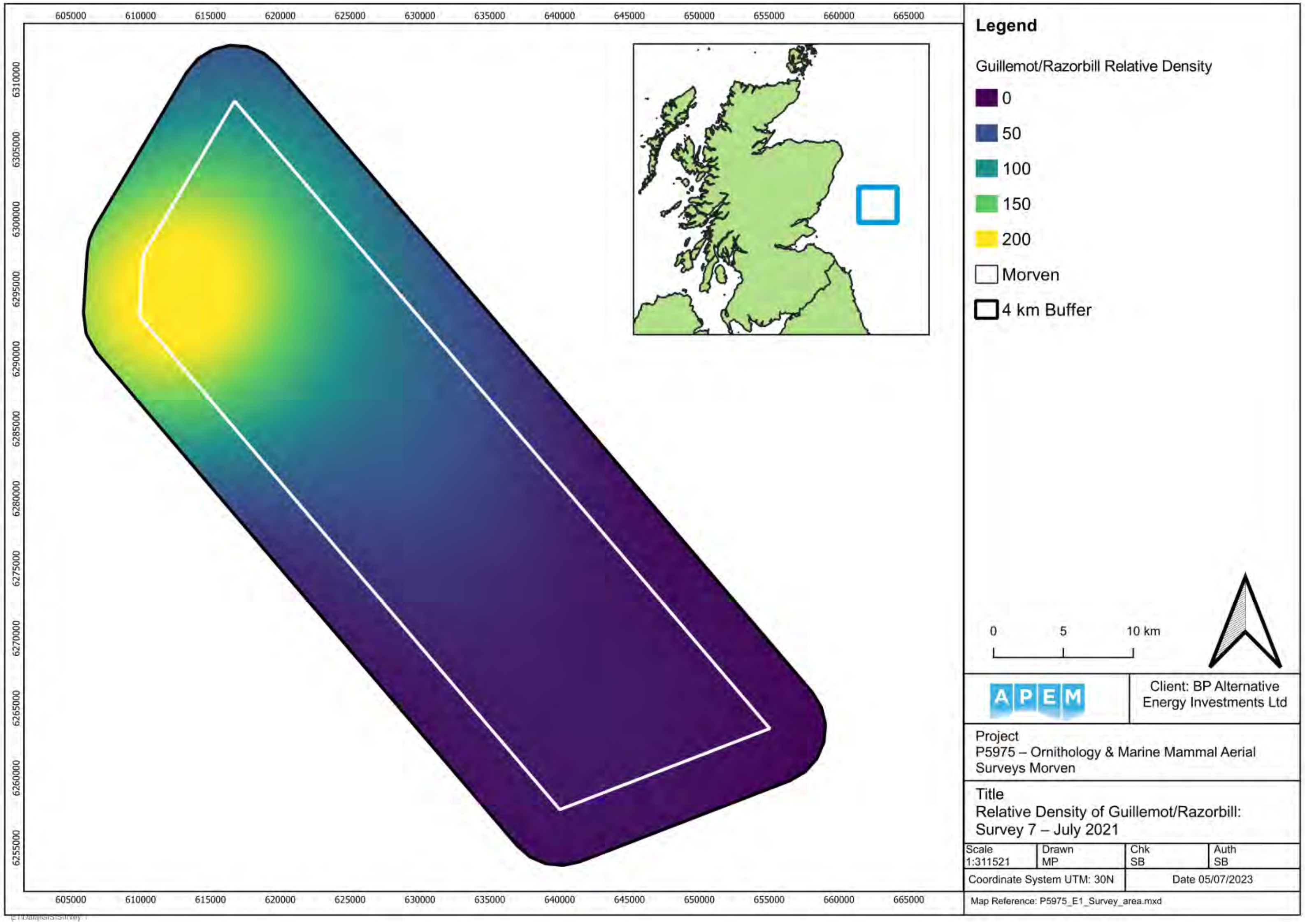


Figure 102 Relative density of guillemot / razorbill in July 2021 (Survey 07).

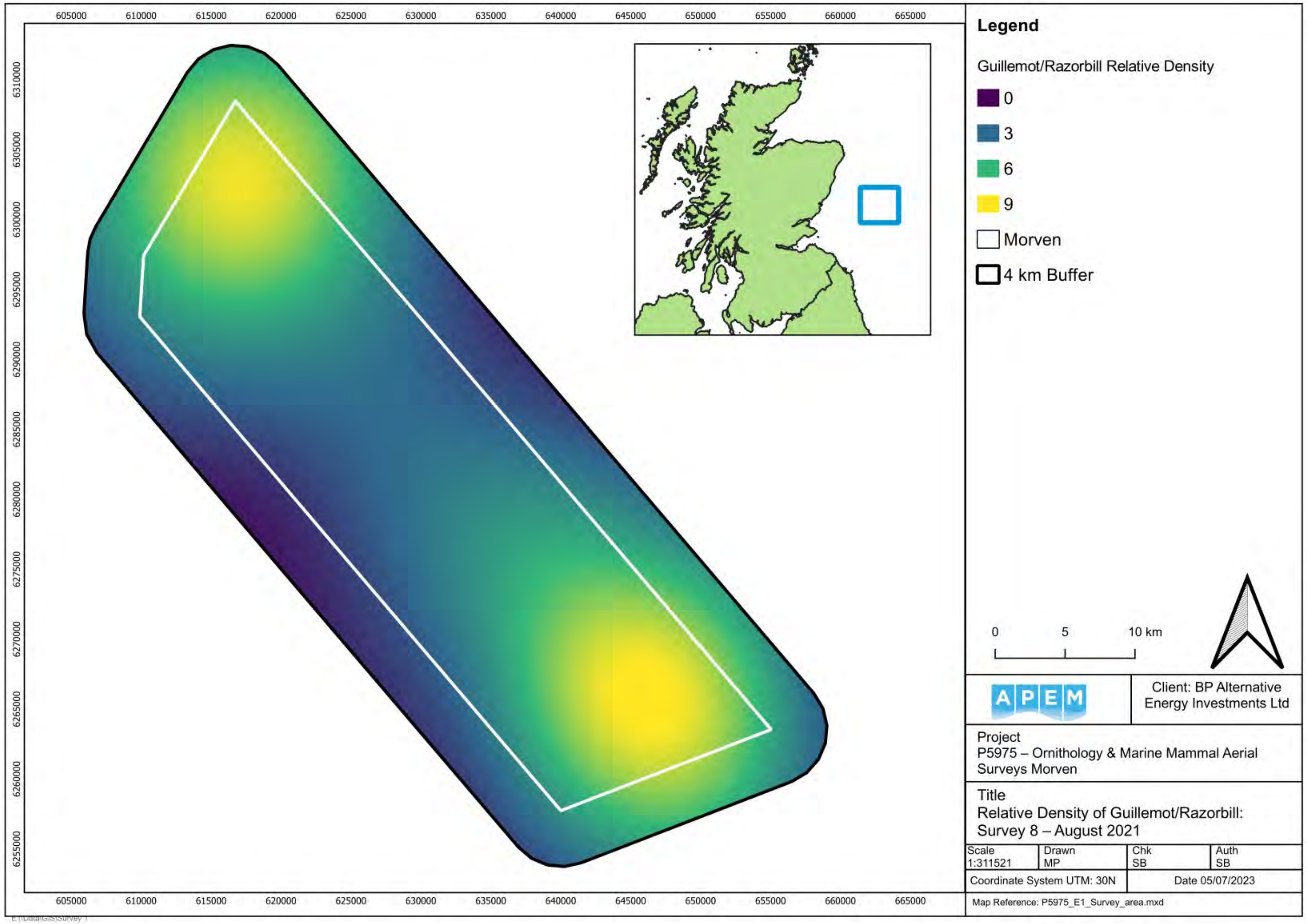


Figure 103 Relative density of guillemot / razorbill in August 2021 (Survey 08).

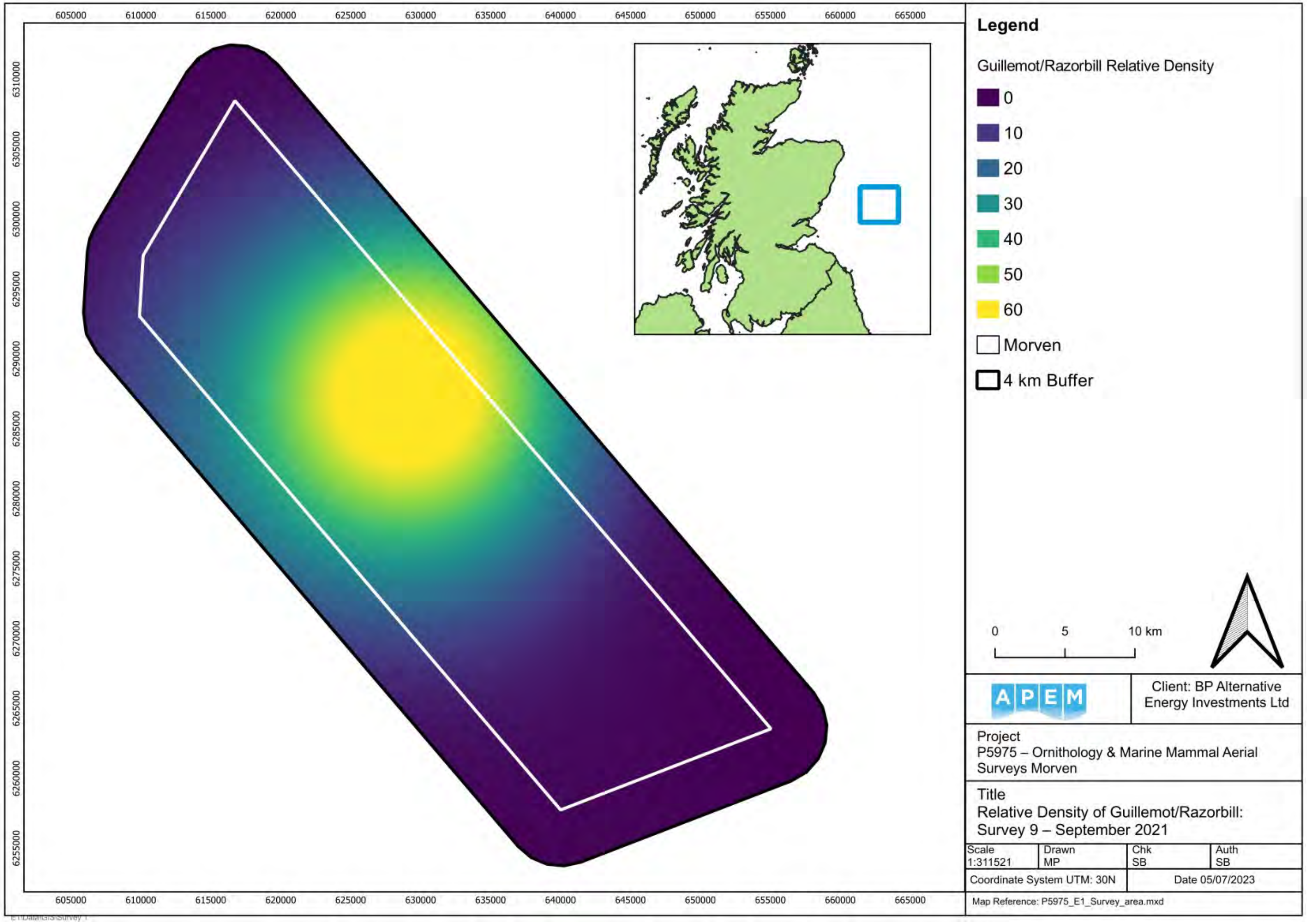


Figure 104 Relative density of guillemot / razorbill in September 2021 (Survey 09).

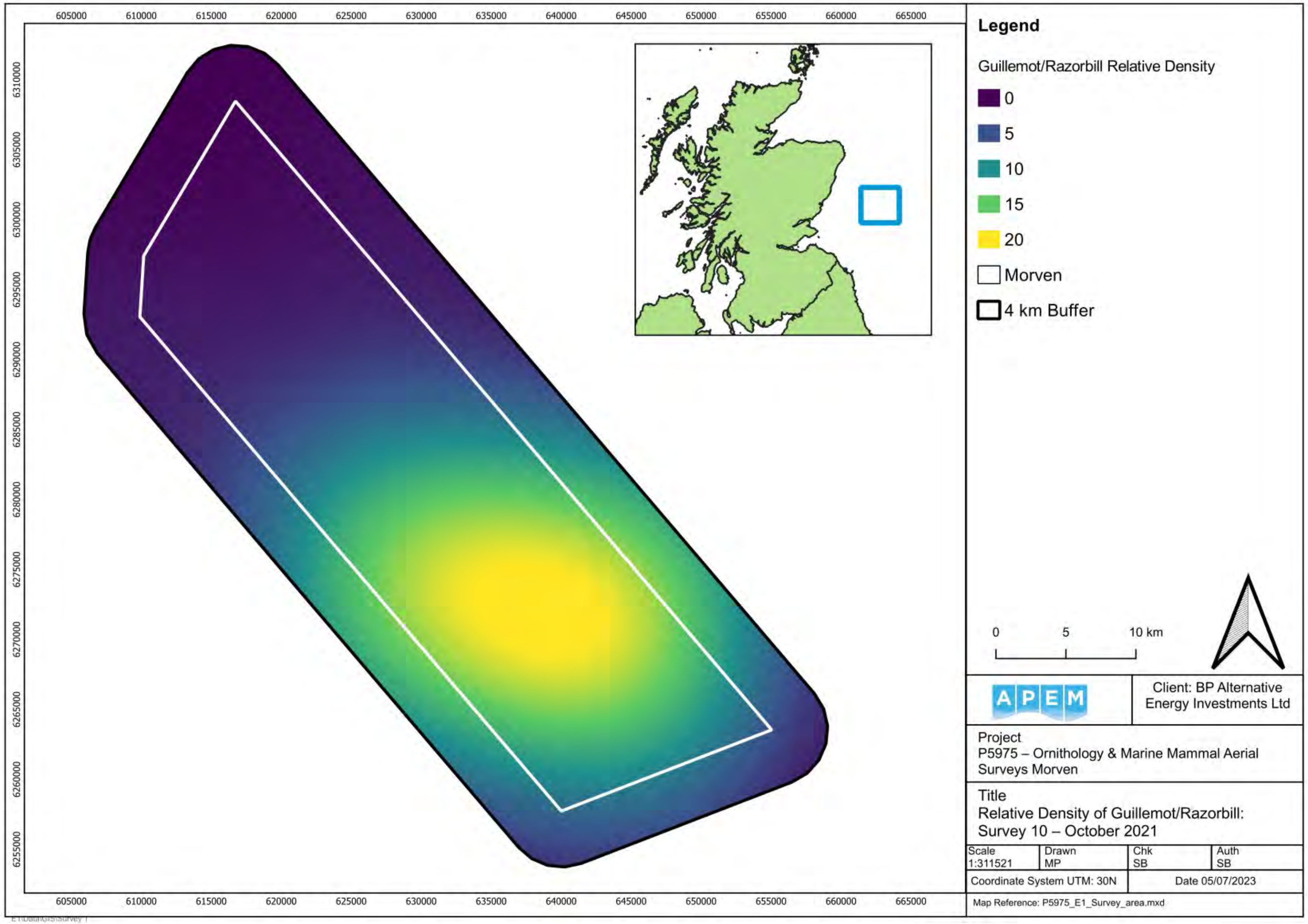


Figure 105 Relative density of guillemot / razorbill in October 2021 (Survey 10).

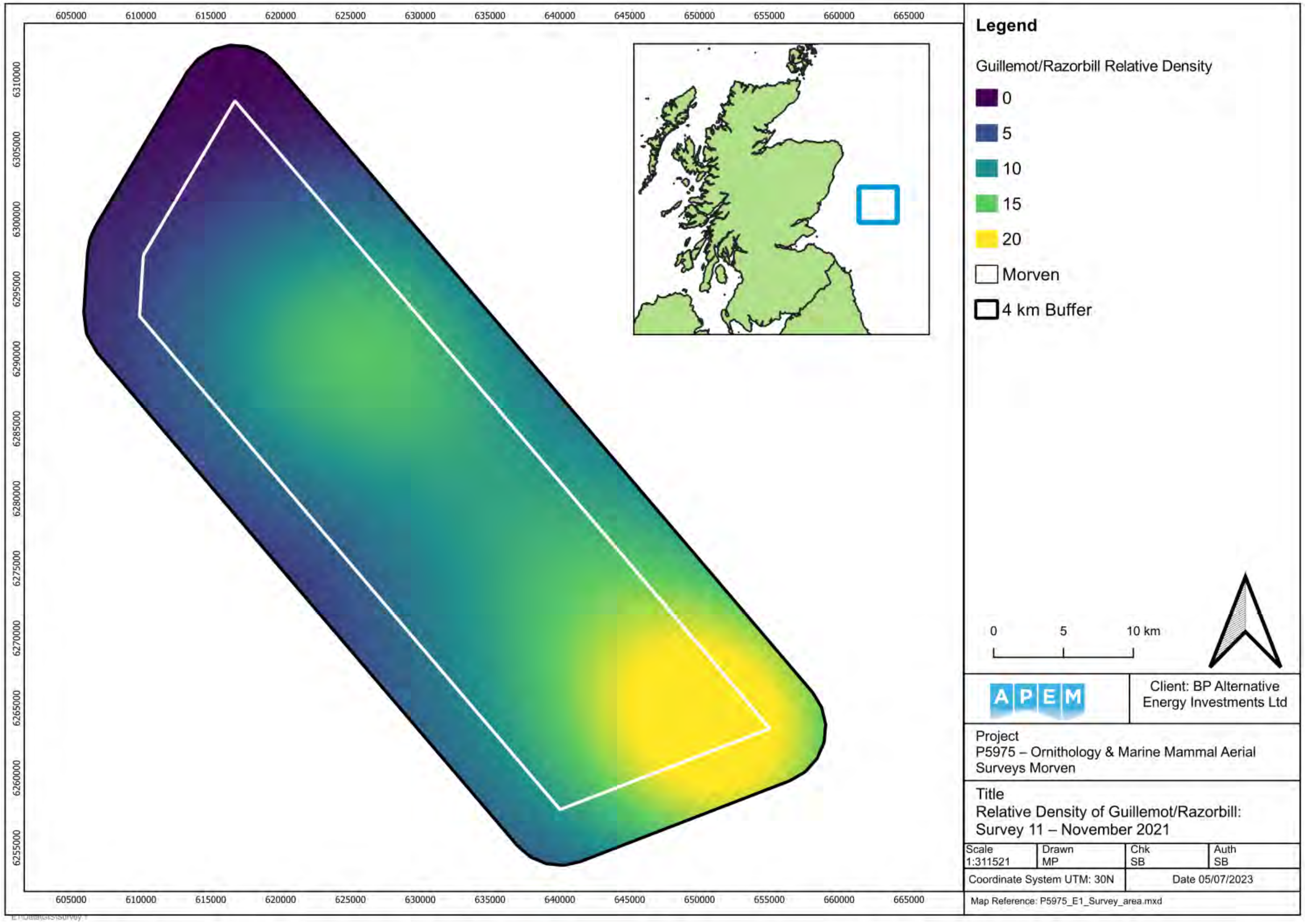


Figure 106 Relative density of guillemot / razorbill in November 2021 (Survey 11).

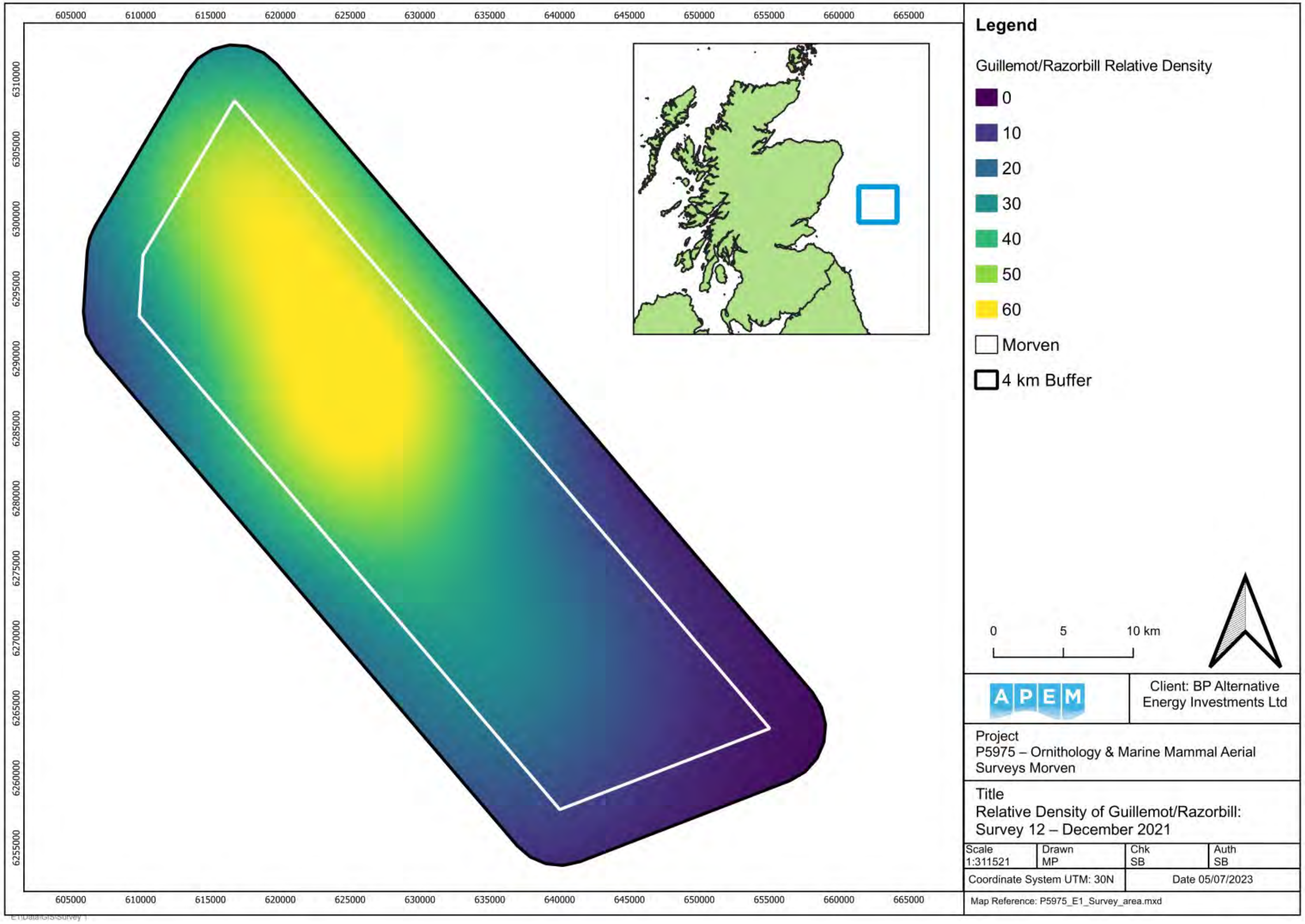


Figure 107 Relative density of guillemot / razorbill in December 2021 (Survey 12).

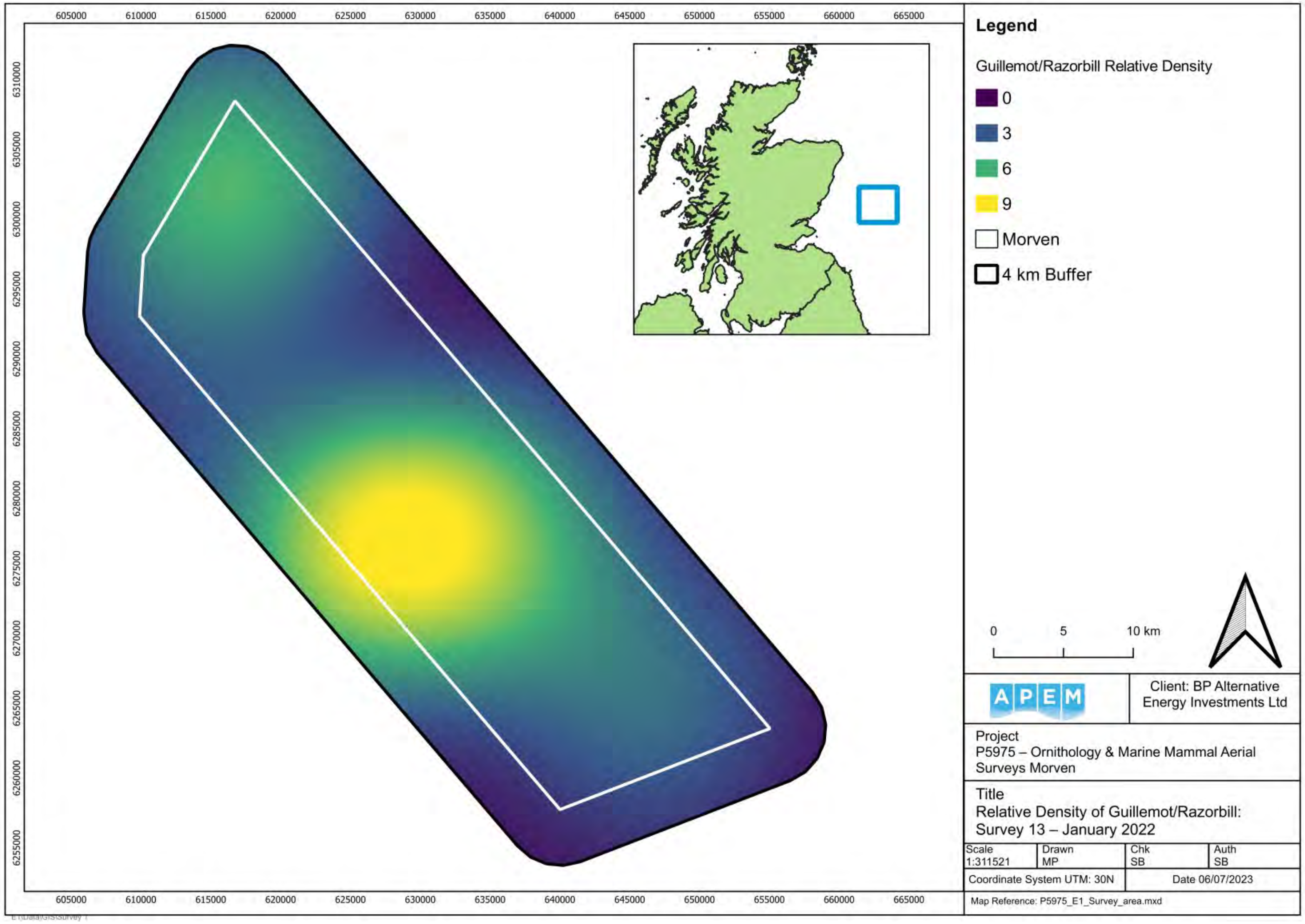


Figure 108 Relative density of guillemot / razorbill in January 2022 (Survey 13).

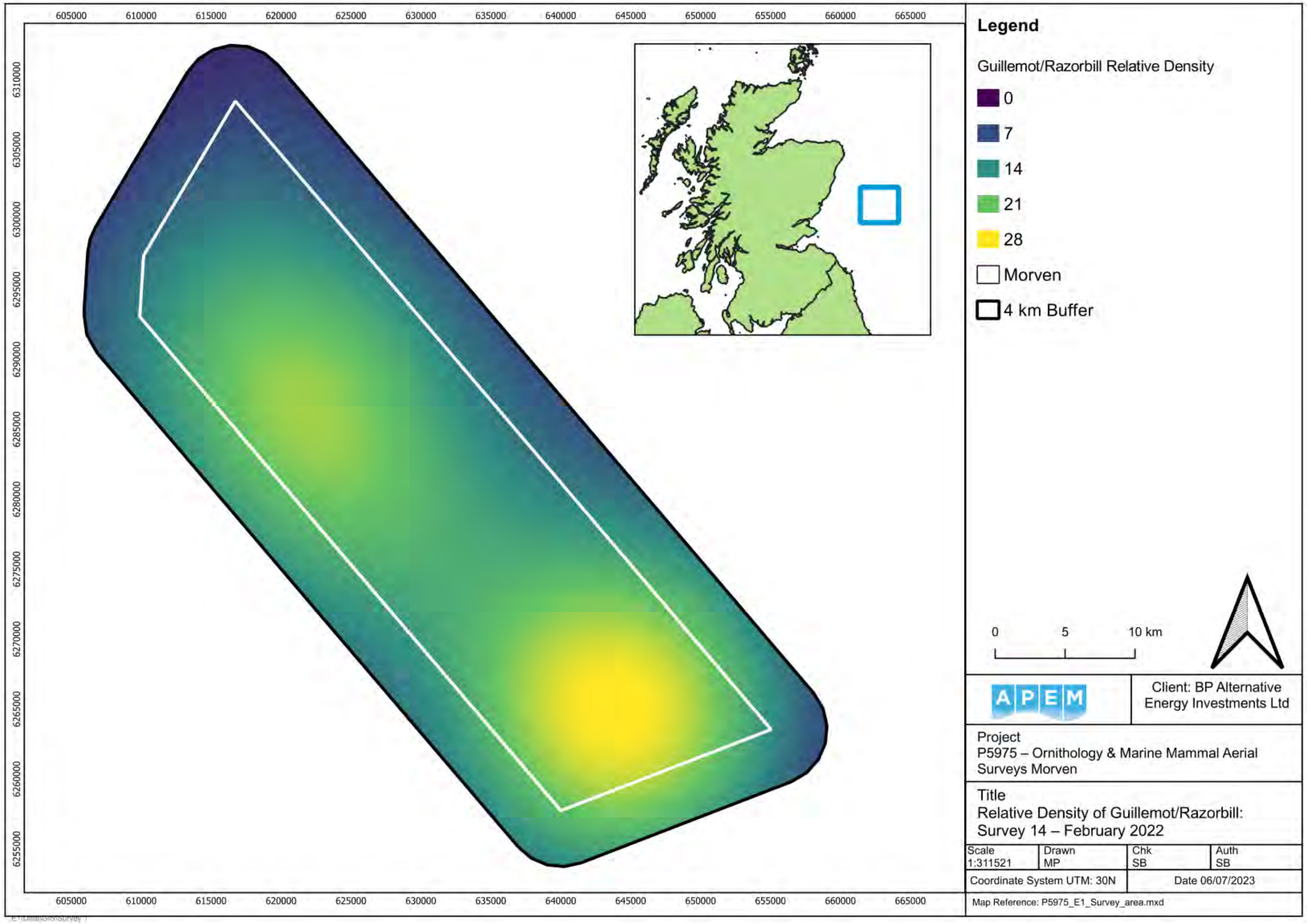


Figure 109 Relative density of guillemot / razorbill in February 2022 (Survey 14).

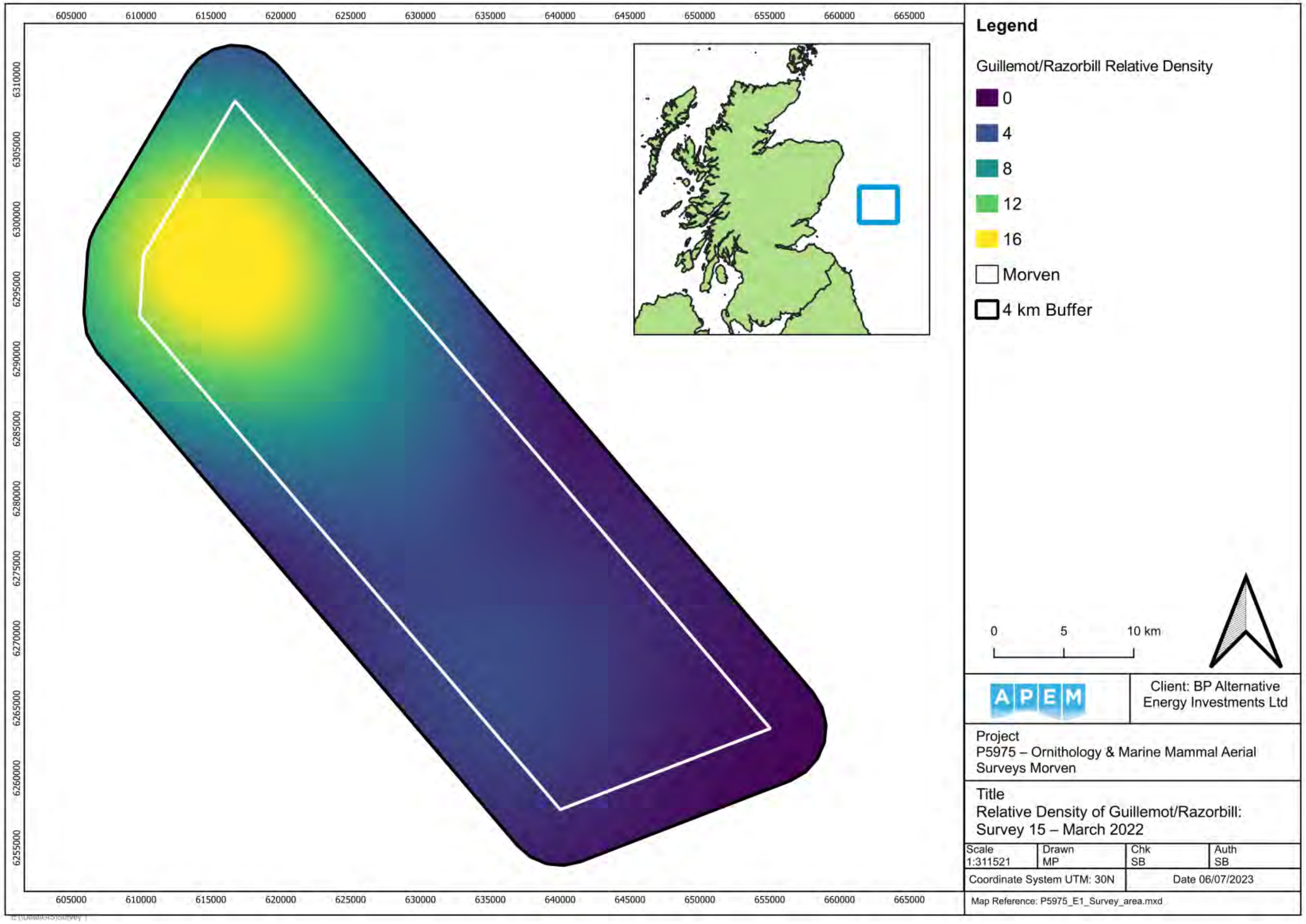
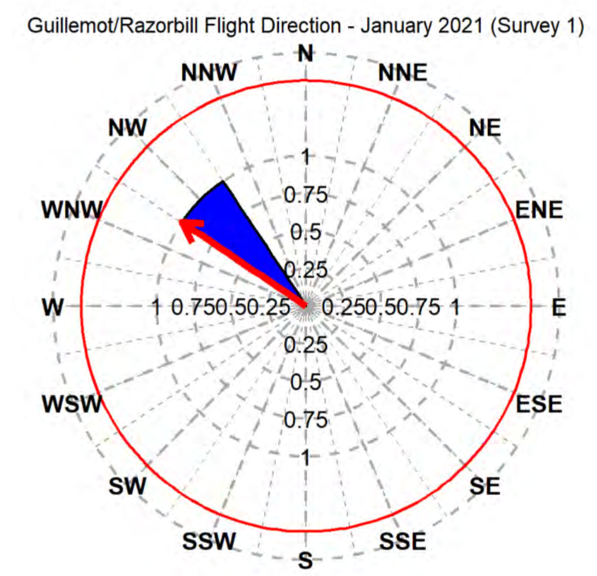
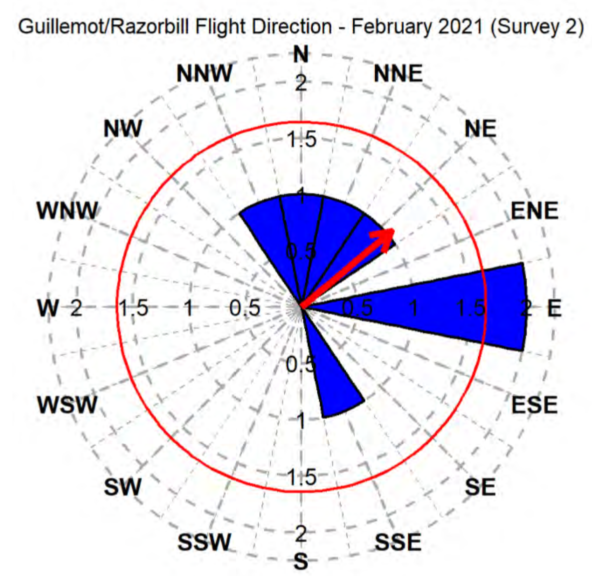


Figure 110 Relative density of guillemot / razorbill in March 2022 (Survey 15).



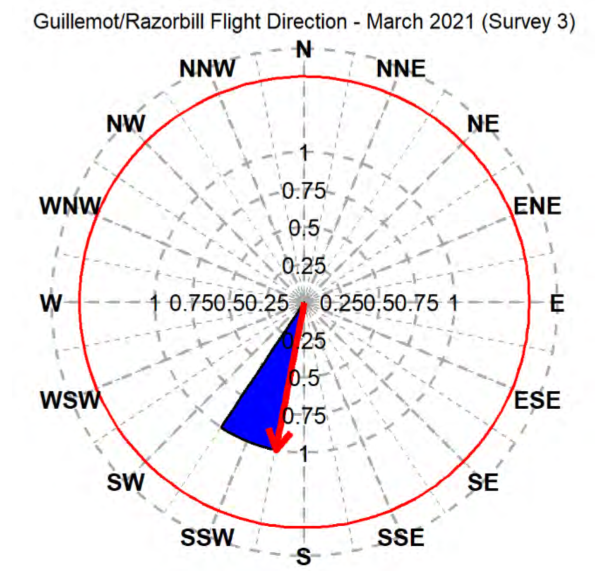
Number of Observations	1
Mean Vector (µ)	304.060
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

Figure 111a January 2021 (Survey 01)



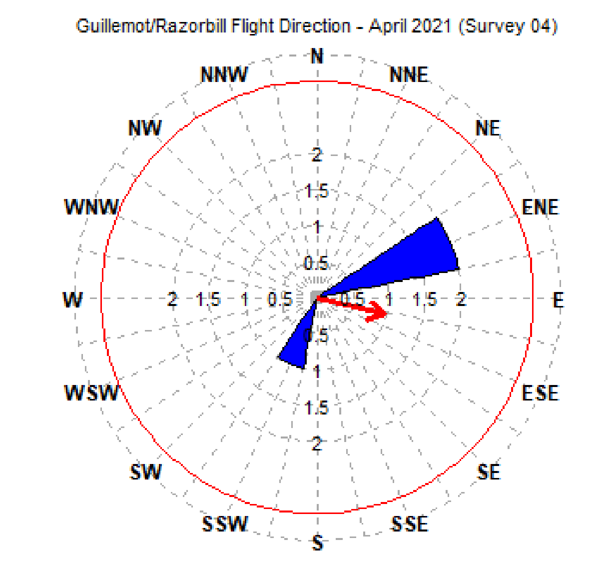
Number of Observations	7
Mean Vector (µ)	50.067
Length of Mean Vector (r)	0.521
Rayleigh Test (Z)	1.900
Rayleigh Test (p)	0.151

Figure 111b February 2021 (Survey 02)



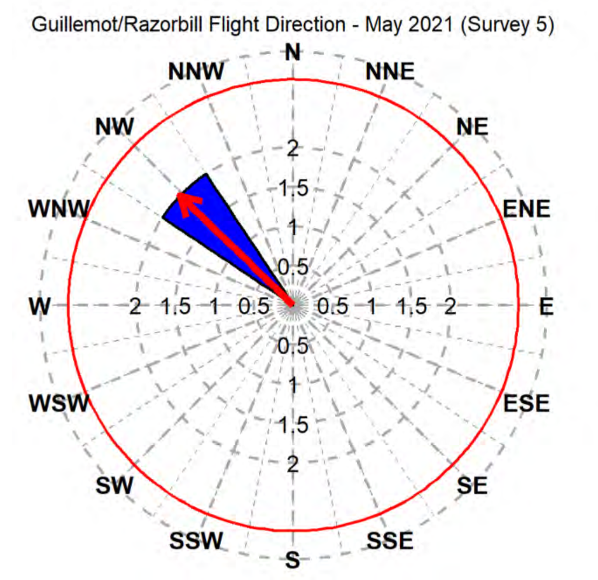
Number of Observations	1
Mean Vector (µ)	191.749
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

Figure 111c March 2021 (Survey 03)



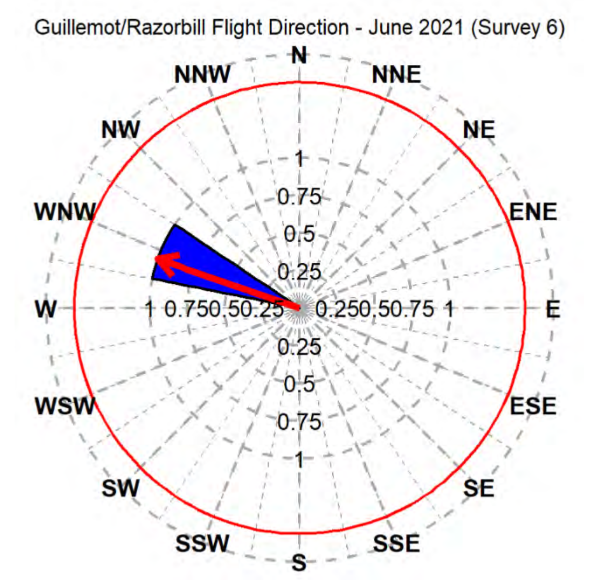
Number of Observations	3
Mean Vector (µ)	104.787
Length of Mean Vector (r)	0.484
Rayleigh Test (Z)	0.702
Rayleigh Test (p)	0.538

Figure 111d April 2021 (Survey 04)



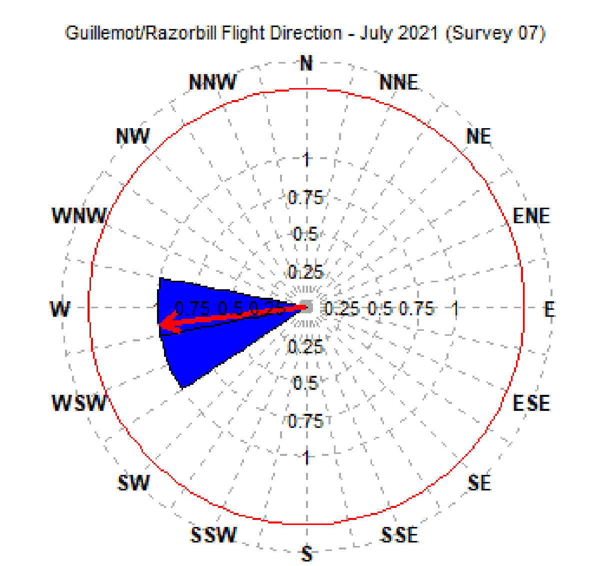
Number of Observations	2
Mean Vector (µ)	314.936
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	2.000
Rayleigh Test (p)	0.137

Figure 111e May 2021 (Survey 05)



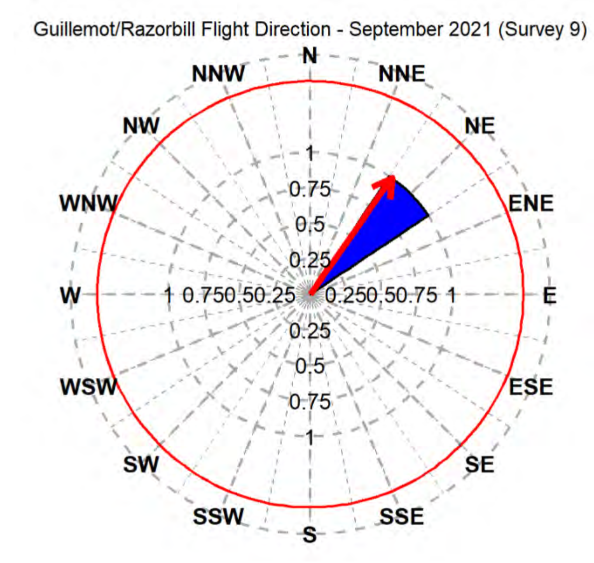
Number of Observations	1
Mean Vector (µ)	289.340
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

Figure 111f June 2021 (Survey 06)



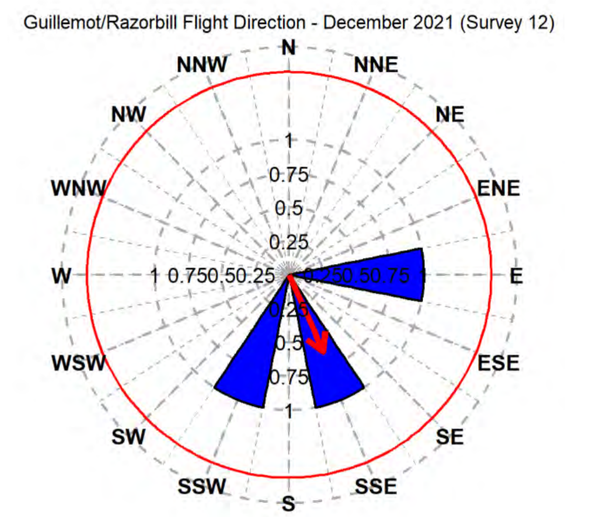
Number of Observations	2
Mean Vector (µ)	263.365
Length of Mean Vector (r)	0.979
Rayleigh Test (Z)	1.915
Rayleigh Test (p)	0.154

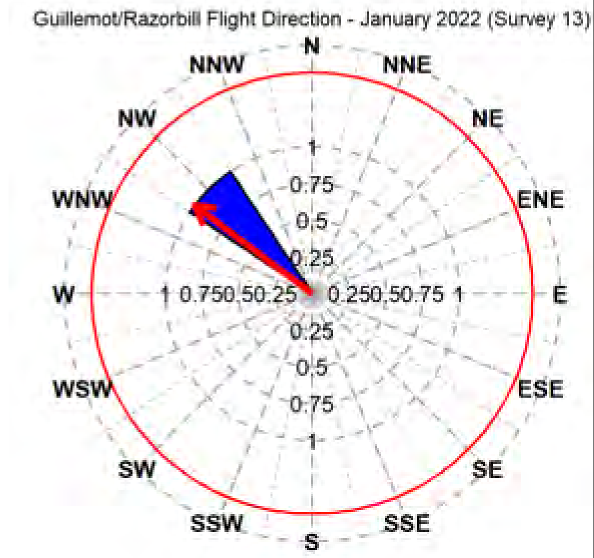
Figure 111g July 2021 (Survey 07)



Number of Observations	1
Mean Vector (µ)	35.666
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

Figure 111h September 2021 (Survey 09)





Number of Observations	3	Number of Observations	1
Mean Vector (μ)	156.266	Mean Vector (μ)	307.581
Length of Mean Vector (r)	0.620	Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.155	Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.347	Rayleigh Test (p)	0.512
Figure 111i December 2021 (Survey 12)		**Figure 111 January 2022 (Survey 13)**	

Figure 111 Summary of flight directions of unidentified guillemots / razorbills recorded in the Array Project.

4.21 Black Guillemot – *Cepphus grylle*

An individual black guillemot was recorded in May 2021 in the east of the Array Project (Figure 103), resulting in an abundance estimate of eight within the Array Project (Table 25).

Table 25 Raw counts, abundance and density estimates of black guillemot in the Array Project.

Survey	Raw Count	Sitting	Flying	Abundance	Lower CL	Upper CL	Precision	Density
May-21	1	1	-	8	1	25	1.00	0.01

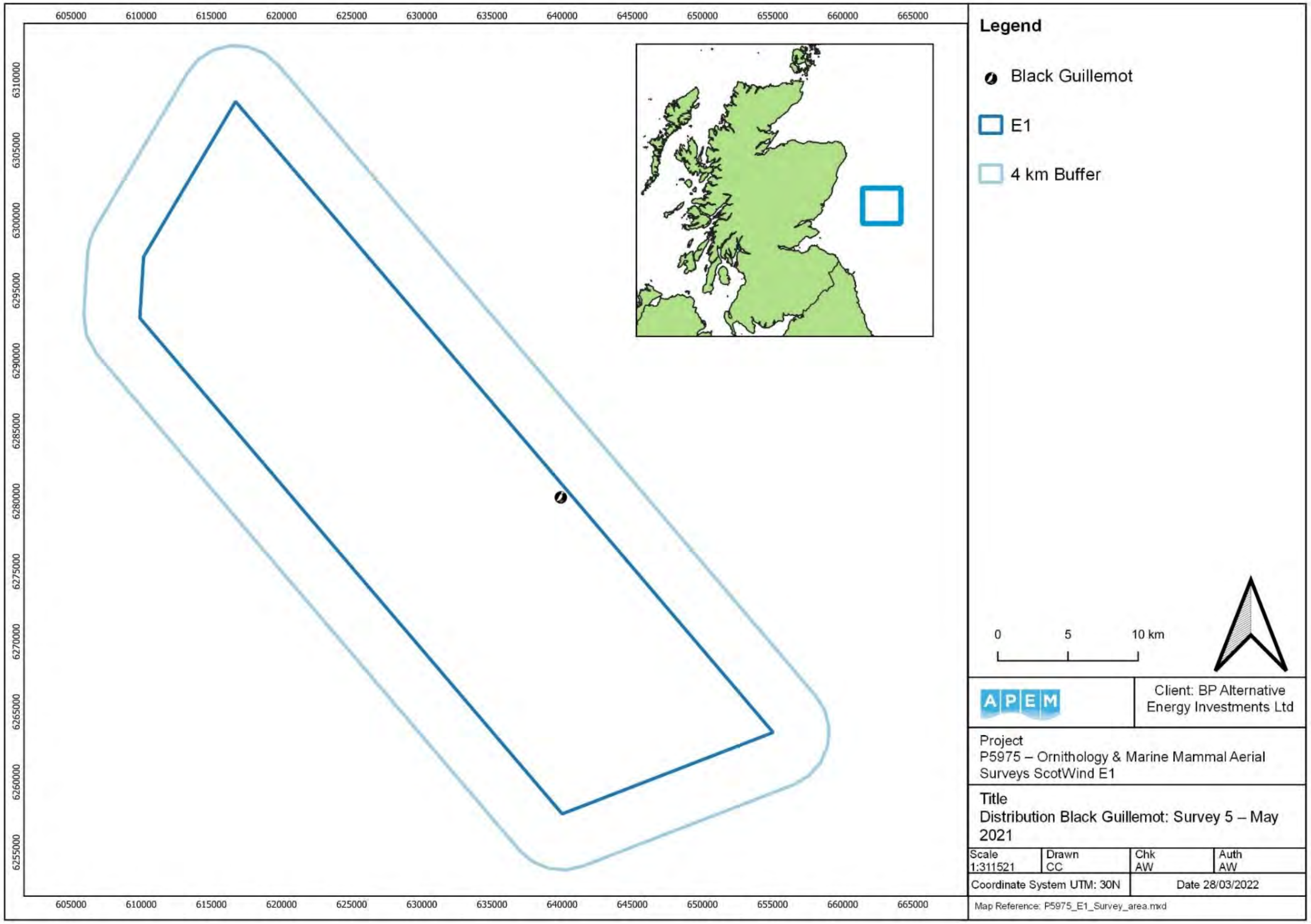


Figure 112 Location of a black guillemot in May 2021 (Survey 05).

4.22 Puffin – *Fratercula arctica*

Puffins were recorded in all months except January and March 2022. Peak numbers were in September - 290 individuals, resulting in an abundance estimate of 2,383 within the Array Project (Table 26).

These were throughout the Array Project in April, and November 2021, in the south in January, and May 2021, and March 2022, and in the southeast in June 2021. Puffin were recorded in the north in August, October, and December 2021, and February 2022, and in the west in March, July, and September 2021 (Figure 113 - Figure 137).

Puffin were not recorded flying in a significant direction (p>0.05: Figure 138).

Table 26 Raw counts, abundance and density estimates of puffin in the Array Project.

Survey	Raw Count	Sitting	Flying	Abundance	Lower CL	Upper CL	Precision	Density
Jan-21	9	9	-	73	33	130	0.33	0.05
Feb-21	12	12	-	98	49	163	0.29	0.07
Mar-21	53	53	-	439	323	579	0.14	0.31
Apr-21	30	19	11	240	128	359	0.18	0.22
May-21	64	64	-	523	351	702	0.13	0.37
Jun-21	46	46	-	379	255	527	0.15	0.27
Jul-21	46	41	5	377	246	517	0.15	0.27
Aug-21	79	79	-	648	435	911	0.11	0.46
Sep-21	291	291	-	2,391	1,964	2,810	0.06	1.68
Oct-21	8	8	-	64	24	113	0.35	0.05
Nov-21	4	4	-	33	8	66	0.50	0.02
Dec-21	7	7	-	57	16	107	0.38	0.04
Feb-22	1	1	-	8	1	24	1.00	0.01

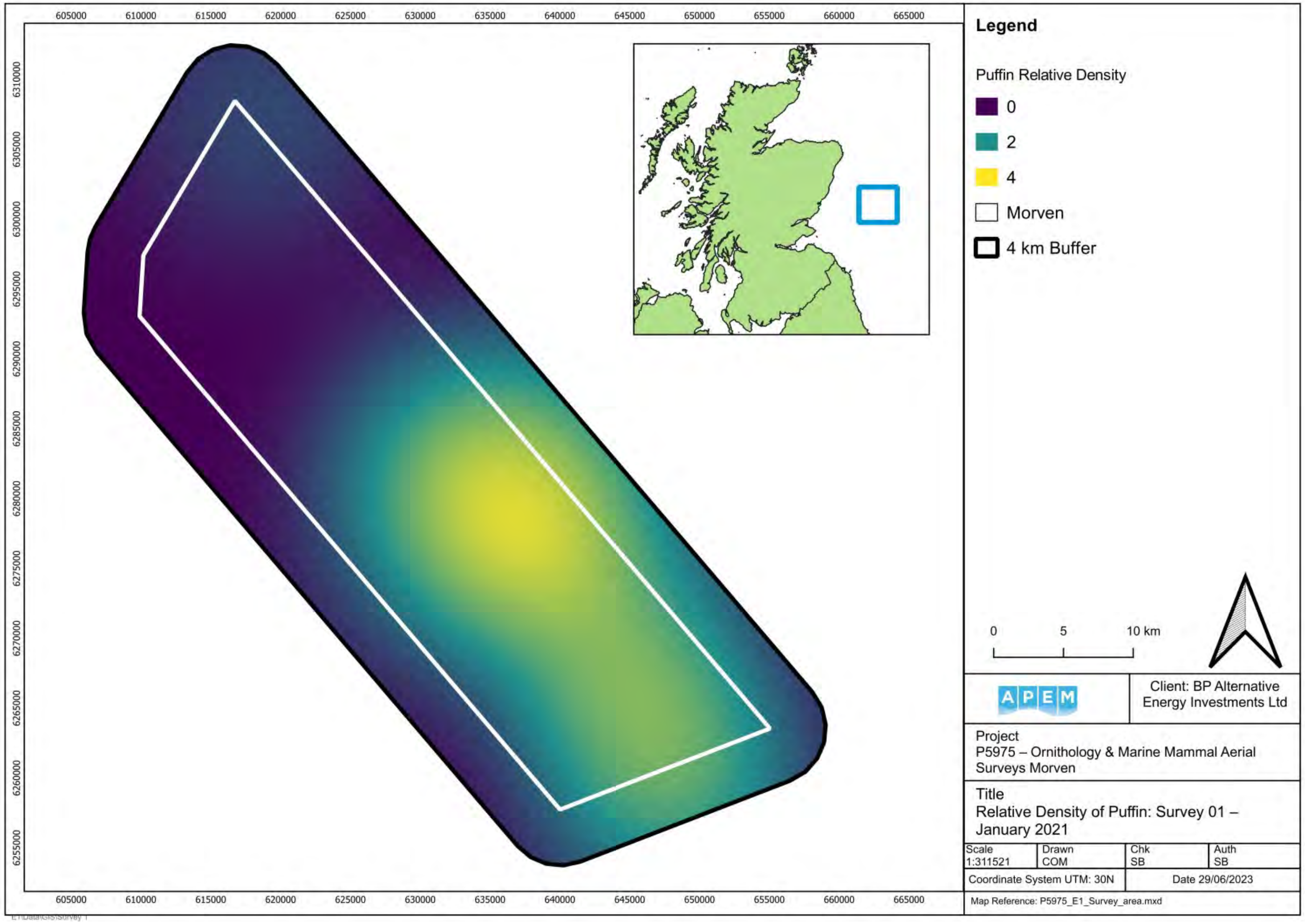


Figure 113 Distribution of puffins in January 2021 (Survey 01).

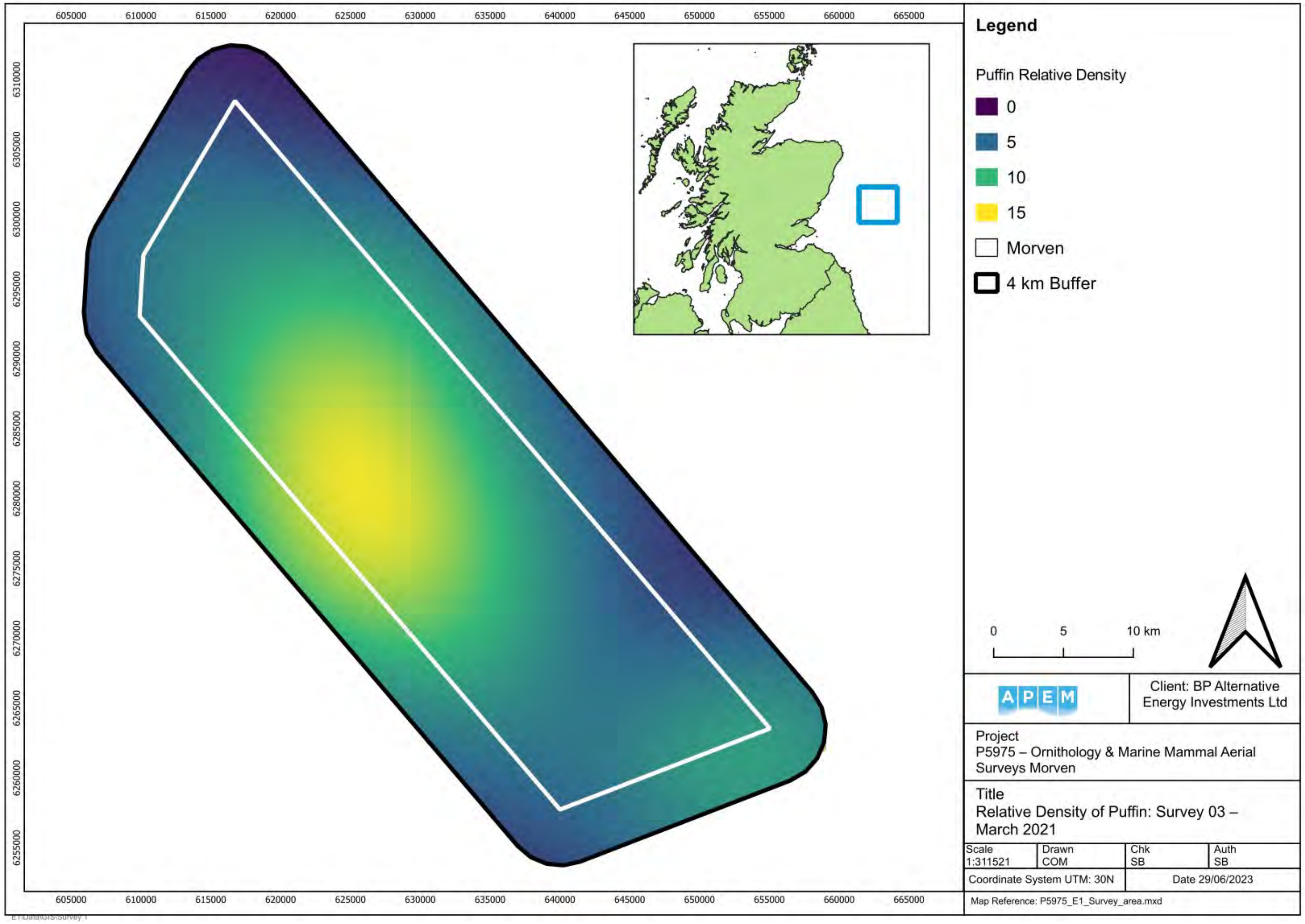


Figure 114 Relative density of puffin in March 2021 (Survey 03).

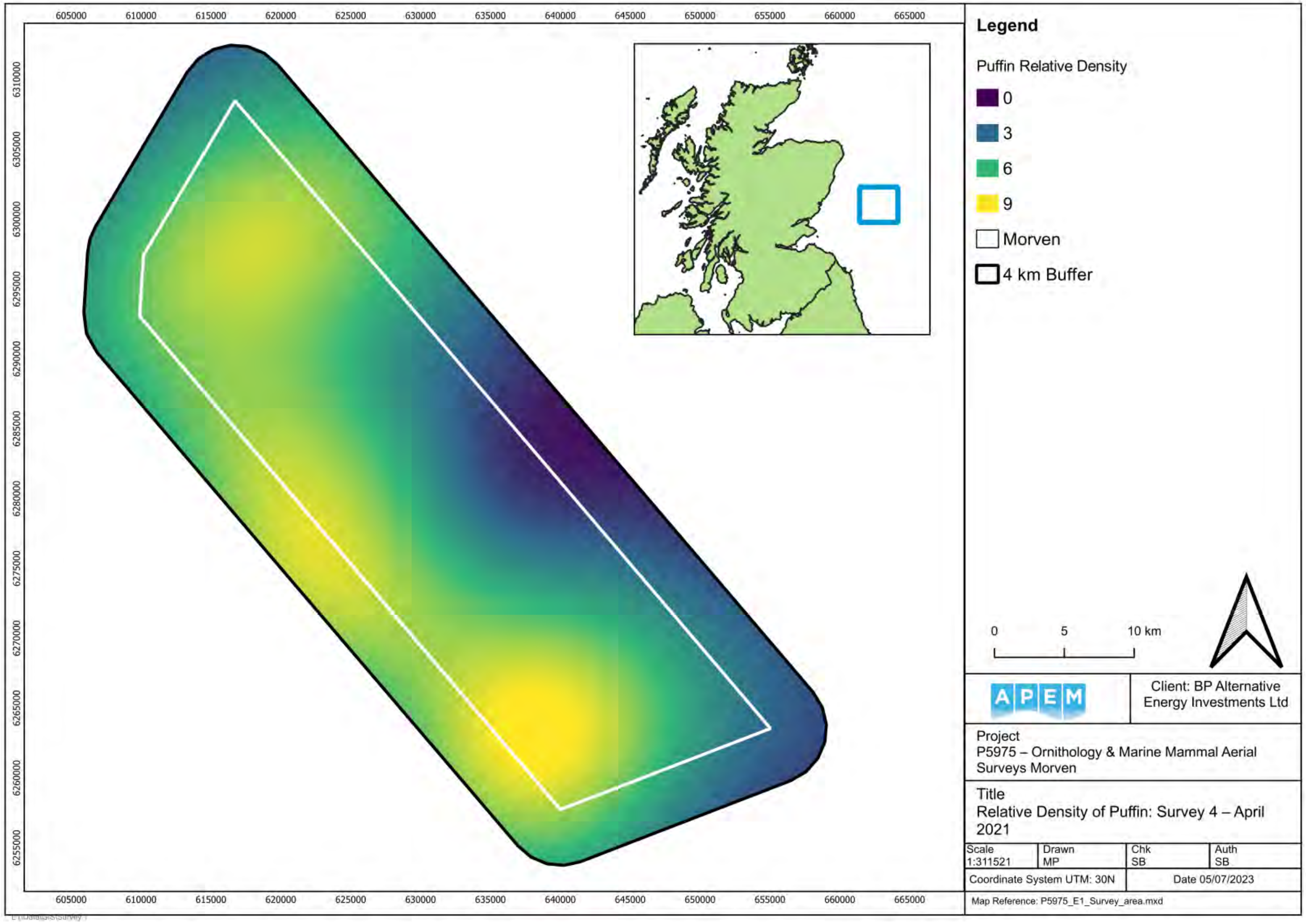


Figure 115 Relative density of puffin in April 2021 (Survey 04).

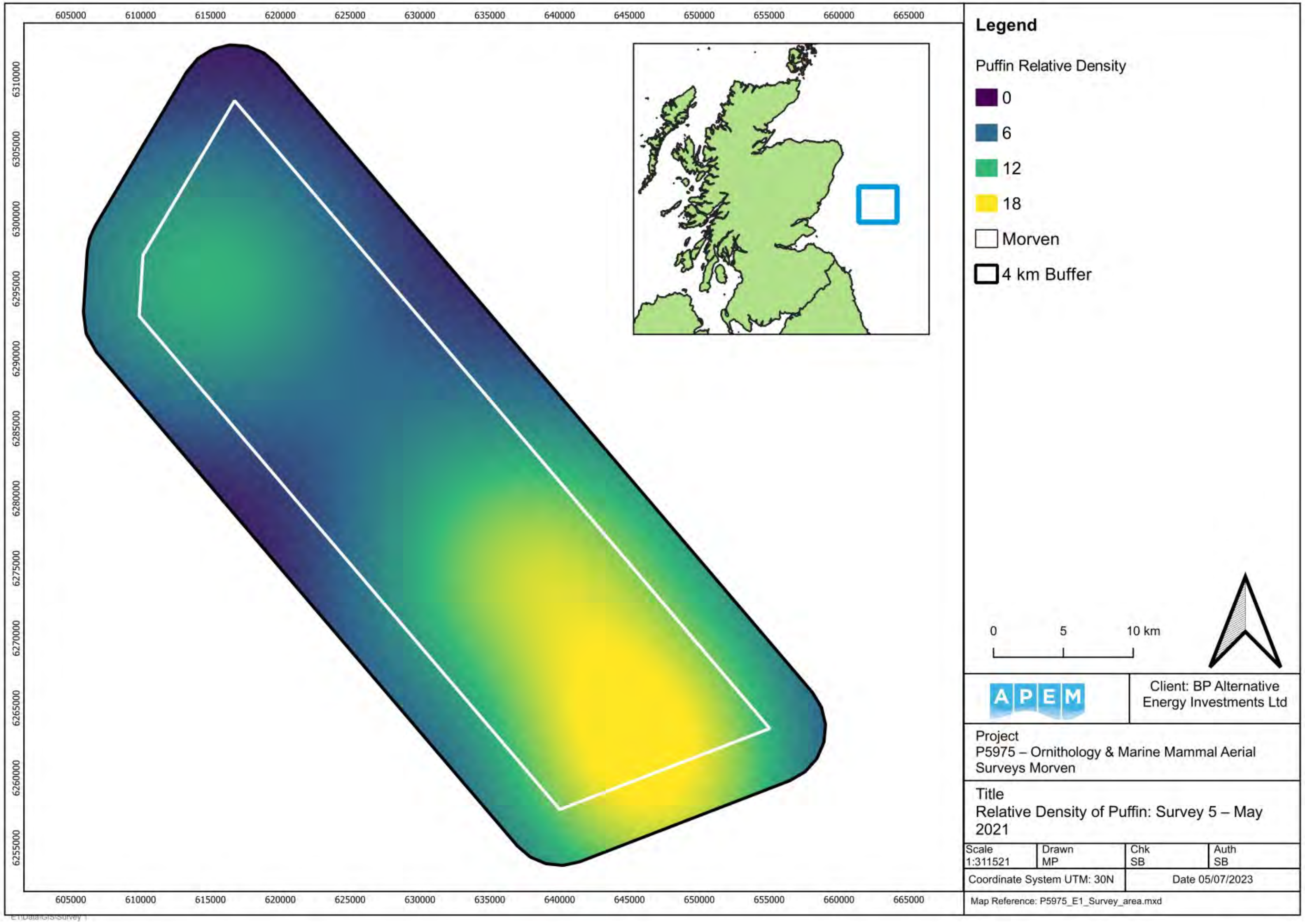


Figure 116 Relative density of puffin in May 2021 (Survey 05).

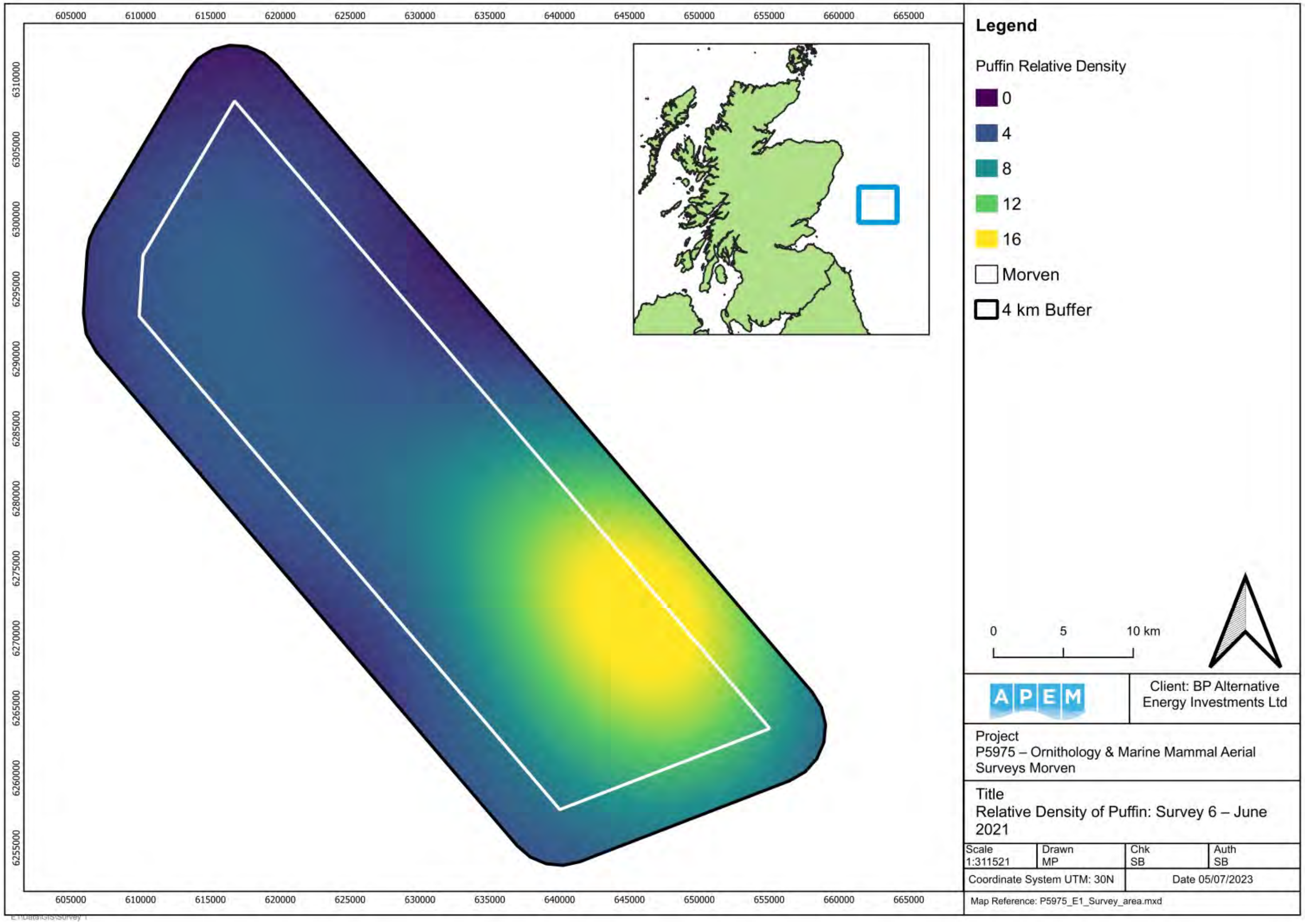


Figure 117 Relative density of puffin in June 2021 (Survey 06).

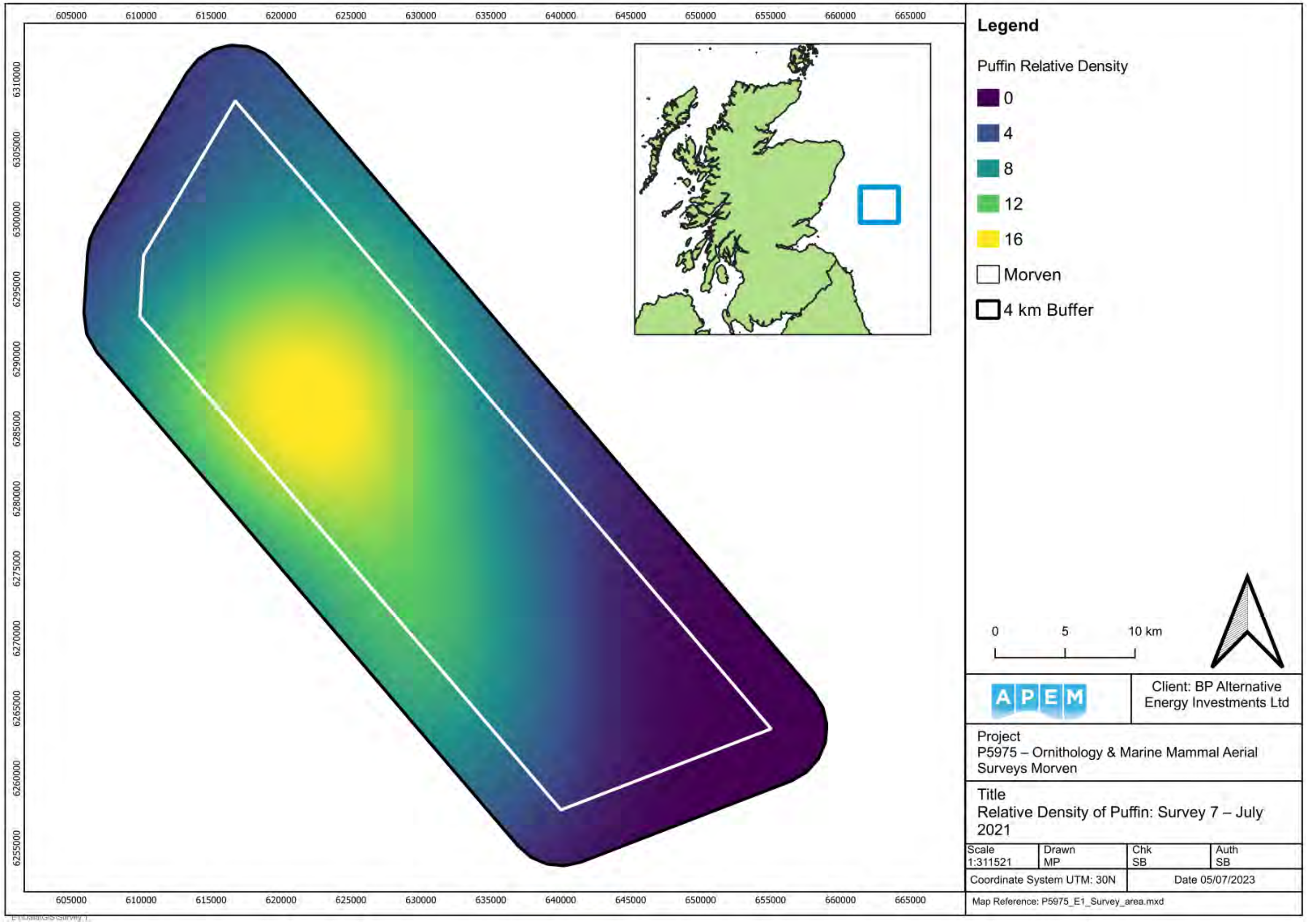


Figure 118 Relative density of puffin in July 2021 (Survey 07).

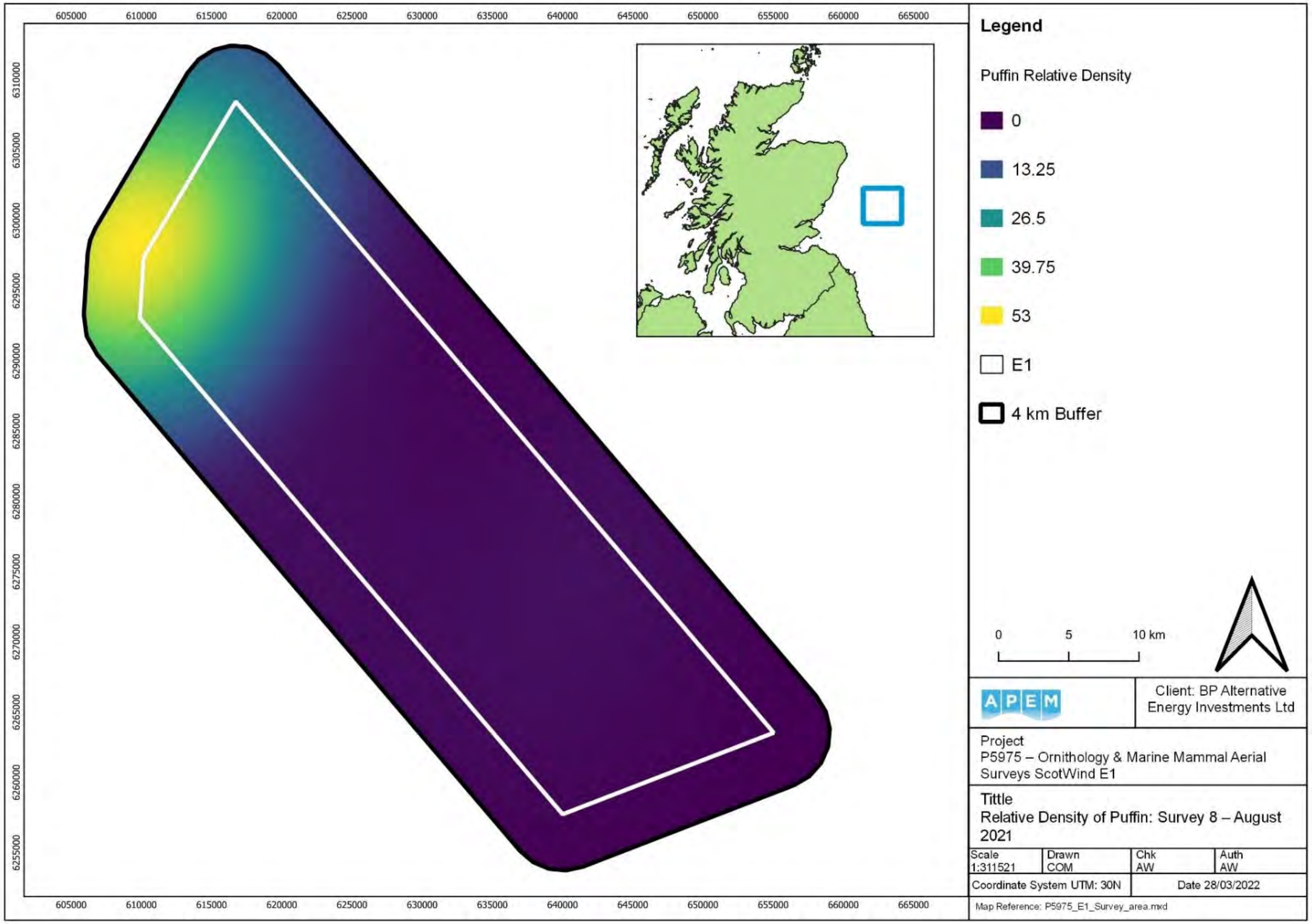


Figure 119 Relative density of puffin in August 2021 (Survey 08).

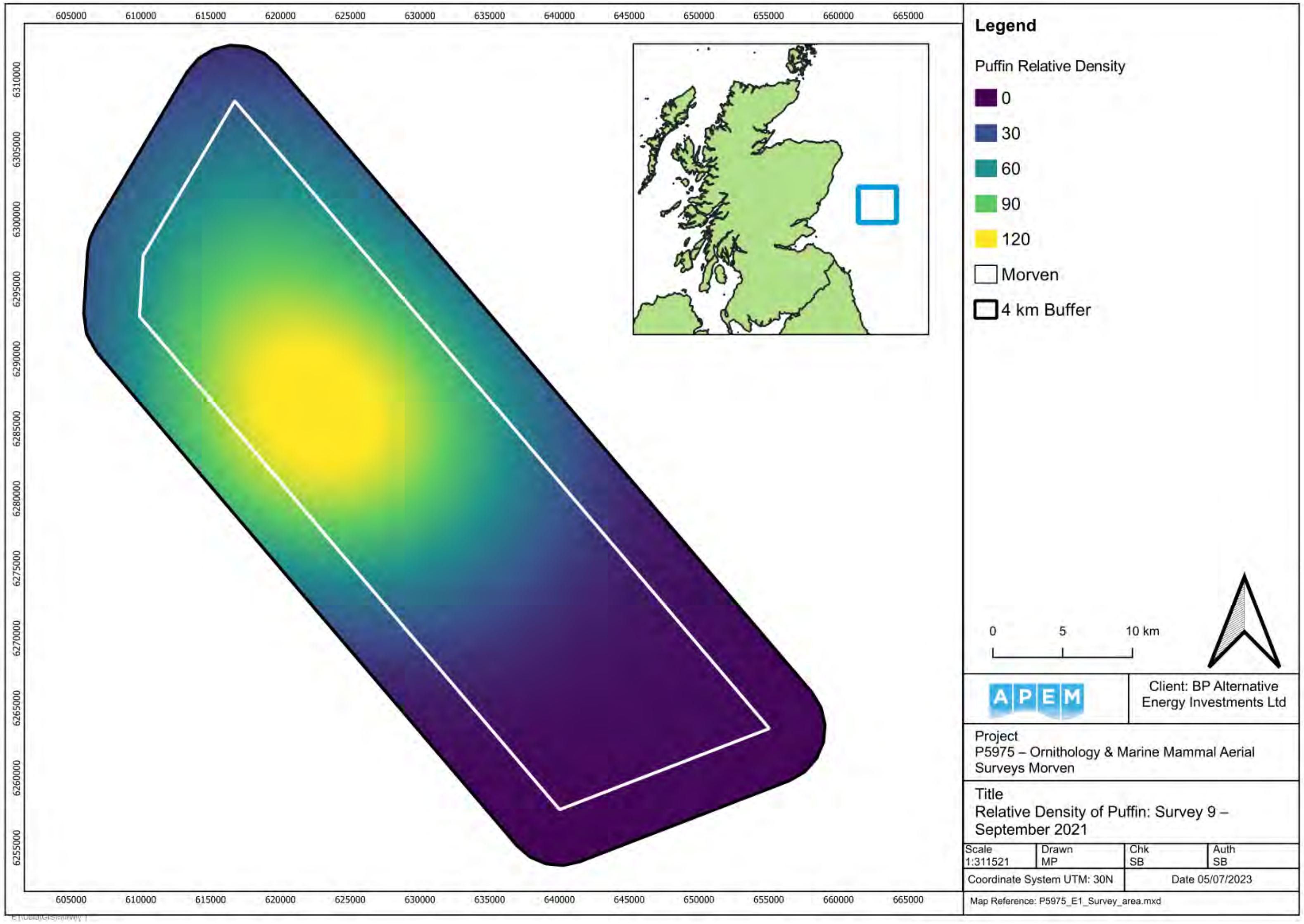


Figure 120 Relative density of puffin in September 2021 (Survey 09).

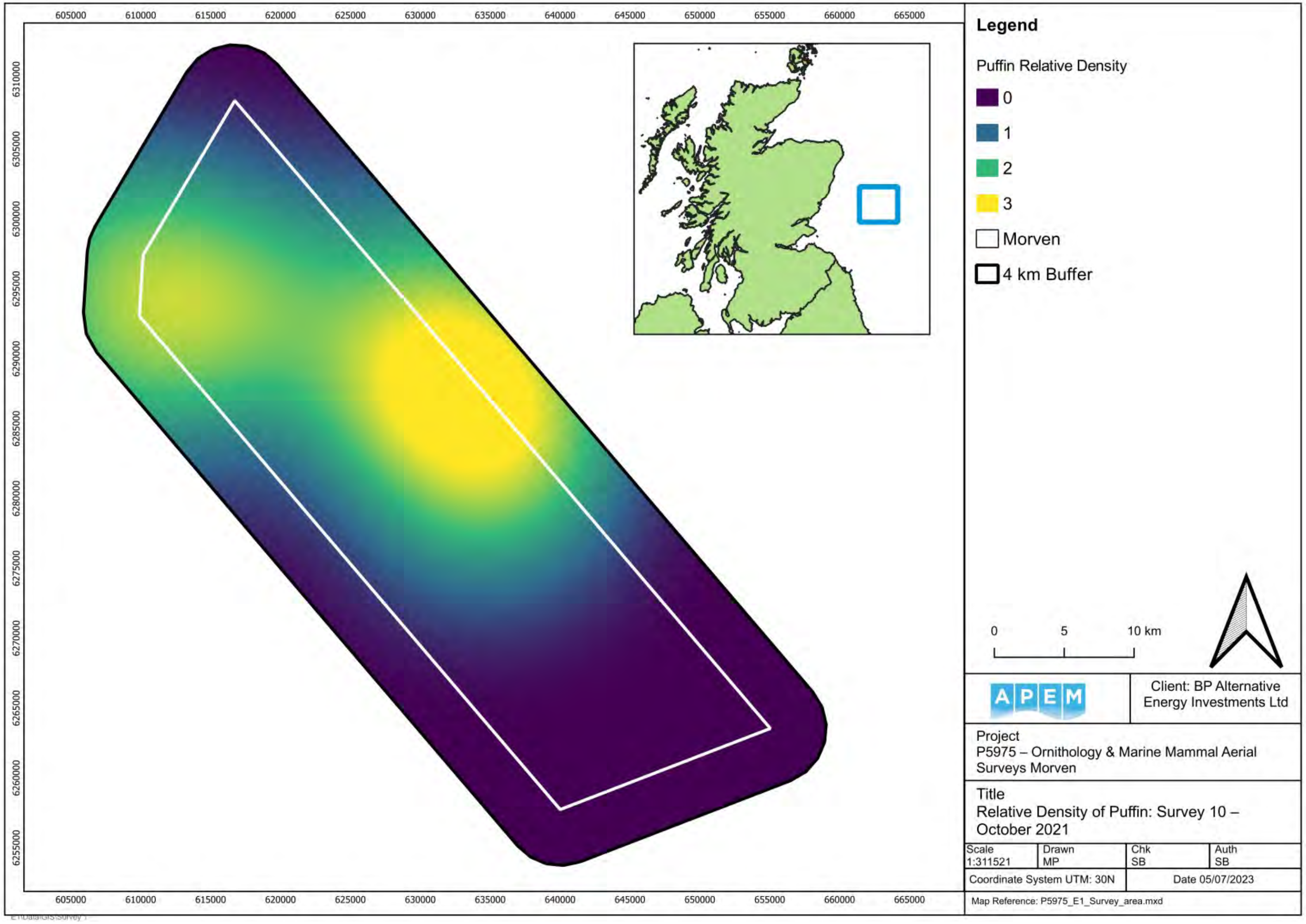


Figure 121 Relative density of puffin in October 2021 (Survey 10).

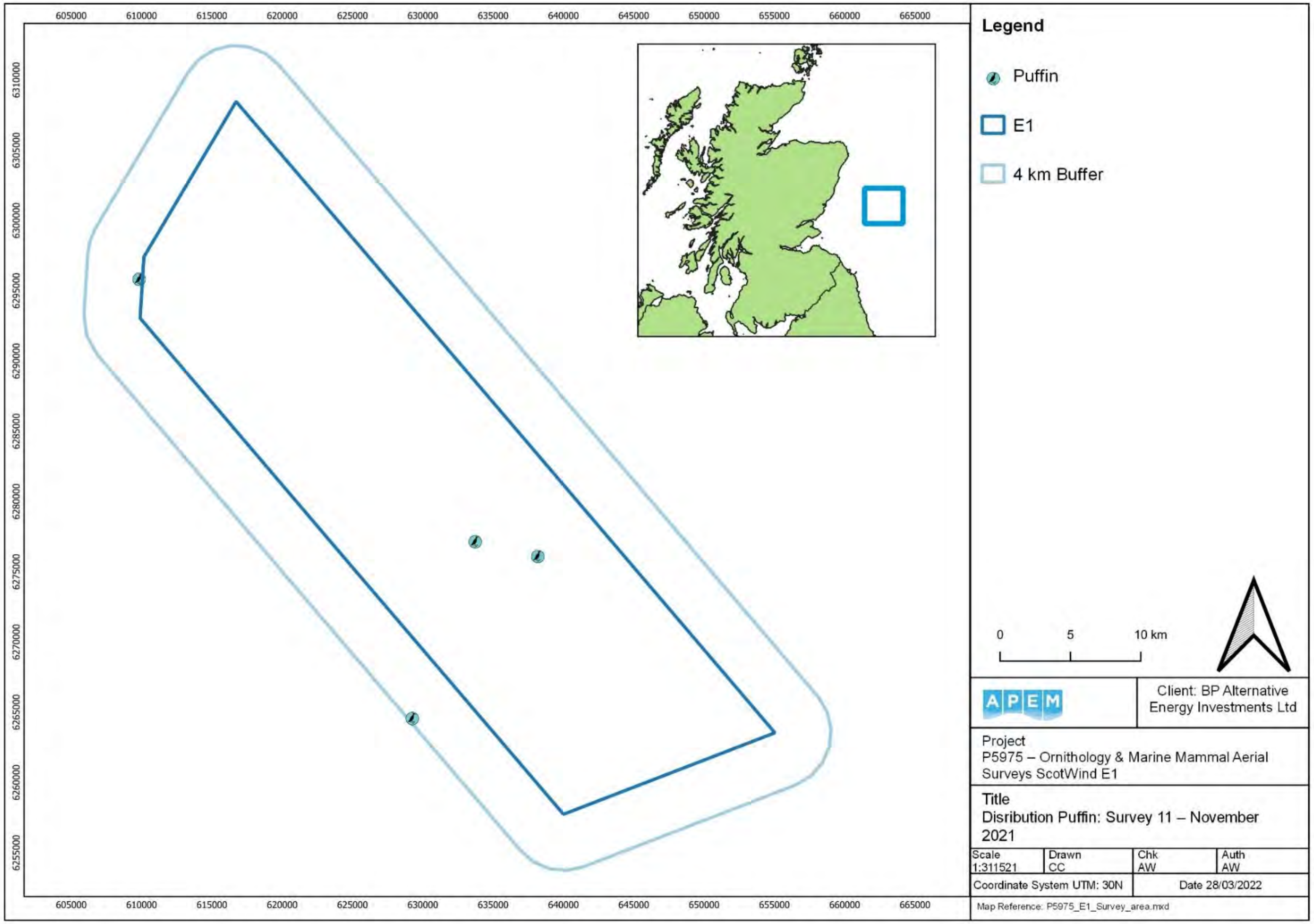


Figure 122 Distribution of puffins in November 2021 (Survey 11).

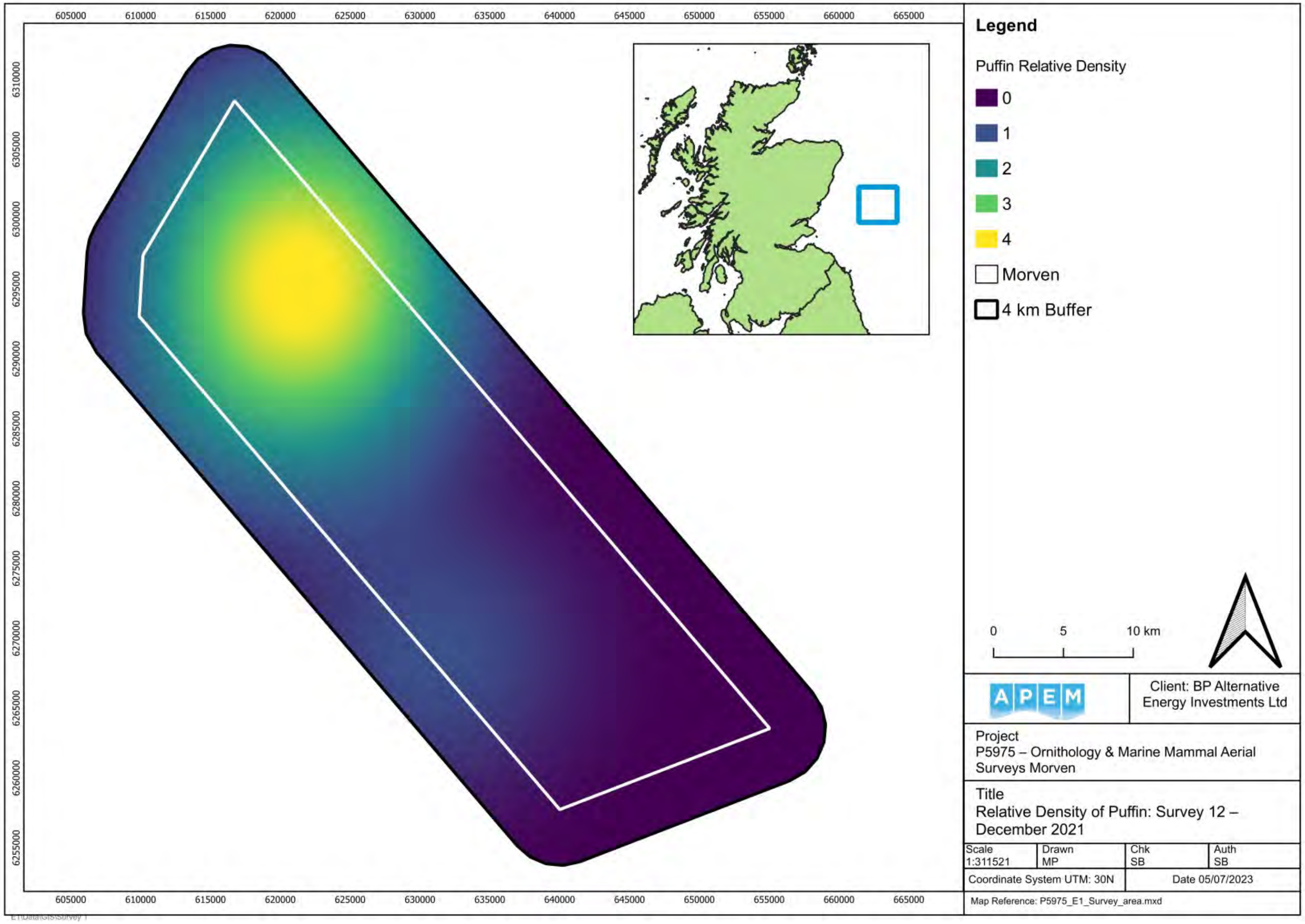


Figure 123 Distribution of puffins in December 2021 (Survey 12).

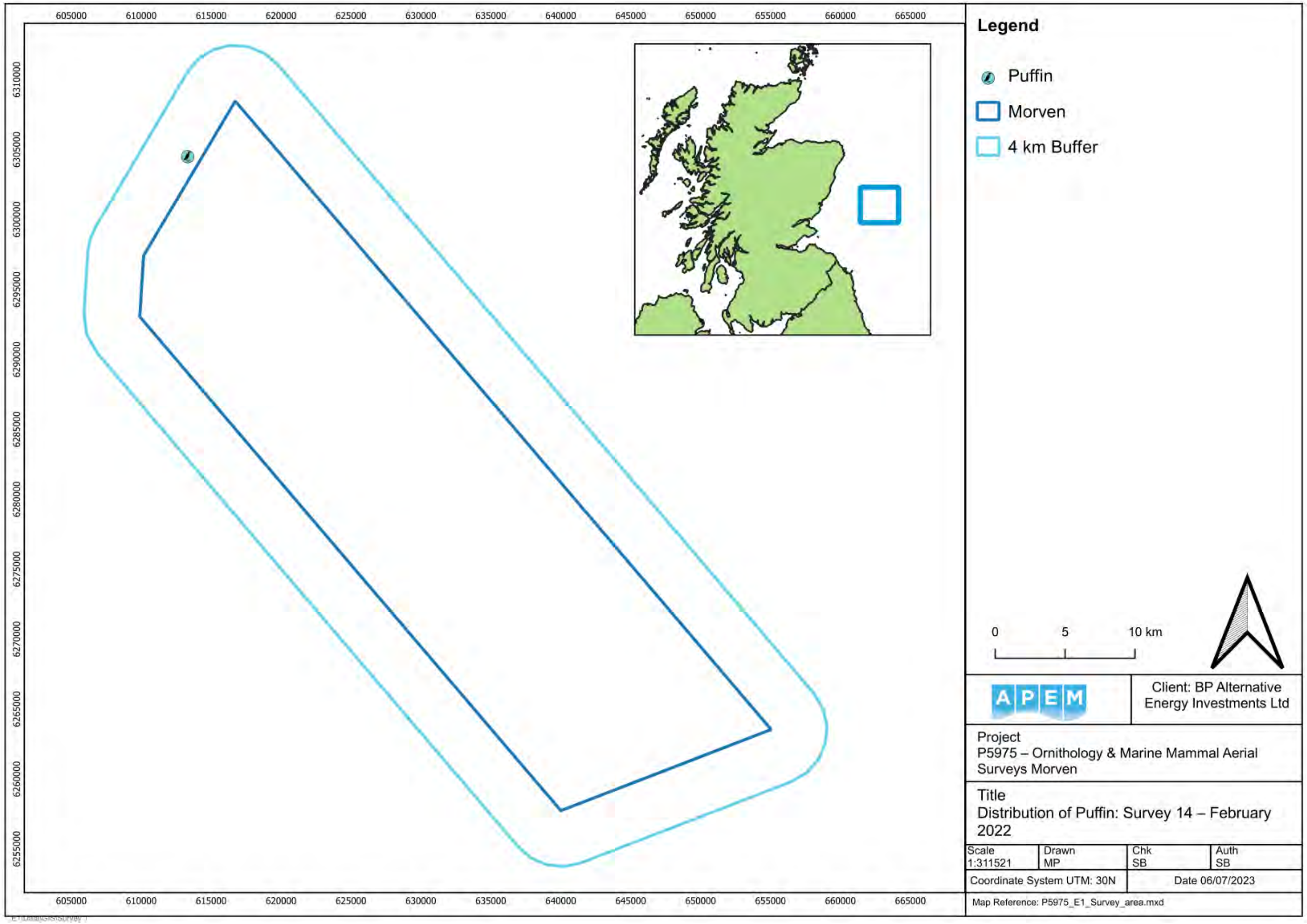


Figure 124 Distribution of puffins in February 2022 (Survey 14).

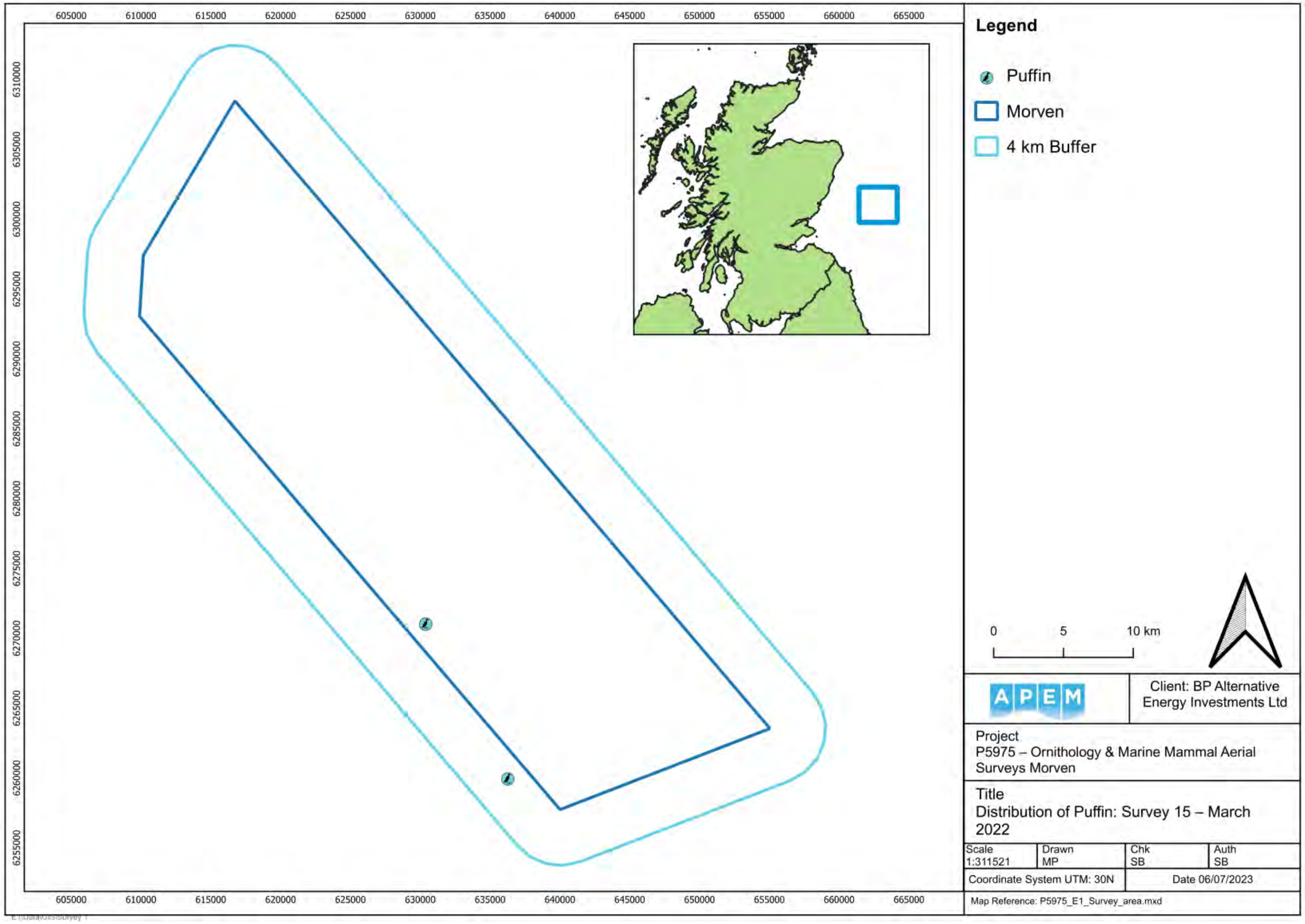
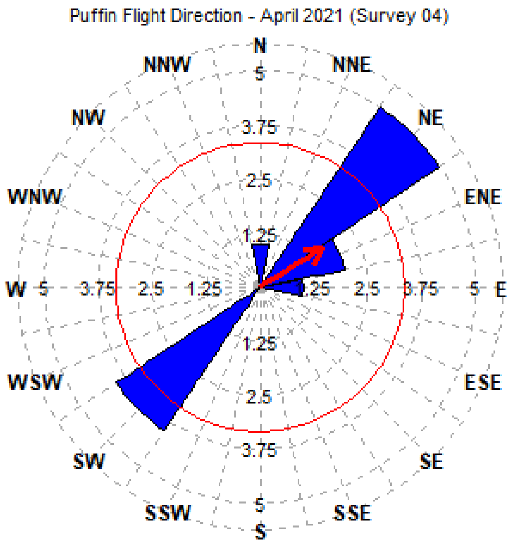
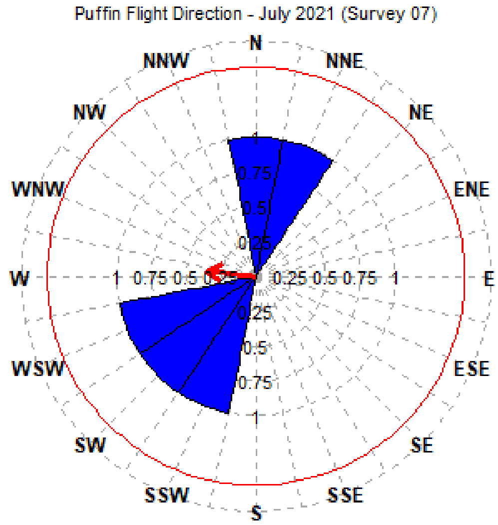


Figure 125 Distribution of puffins in March 2022 (Survey 15).





Number of Observations	13	Number of Observations	5
Mean Vector (µ)	58.716	Mean Vector (µ)	276.029
Length of Mean Vector (r)	0.338	Length of Mean Vector (r)	0.358
Rayleigh Test (Z)	1.488	Rayleigh Test (Z)	0.641
Rayleigh Test (p)	0.229	Rayleigh Test (p)	0.551
Error! Reference source not found.**a April 2021 (Survey 04)**		Error! Reference source not found.**b July 2021 (Survey 06)**	

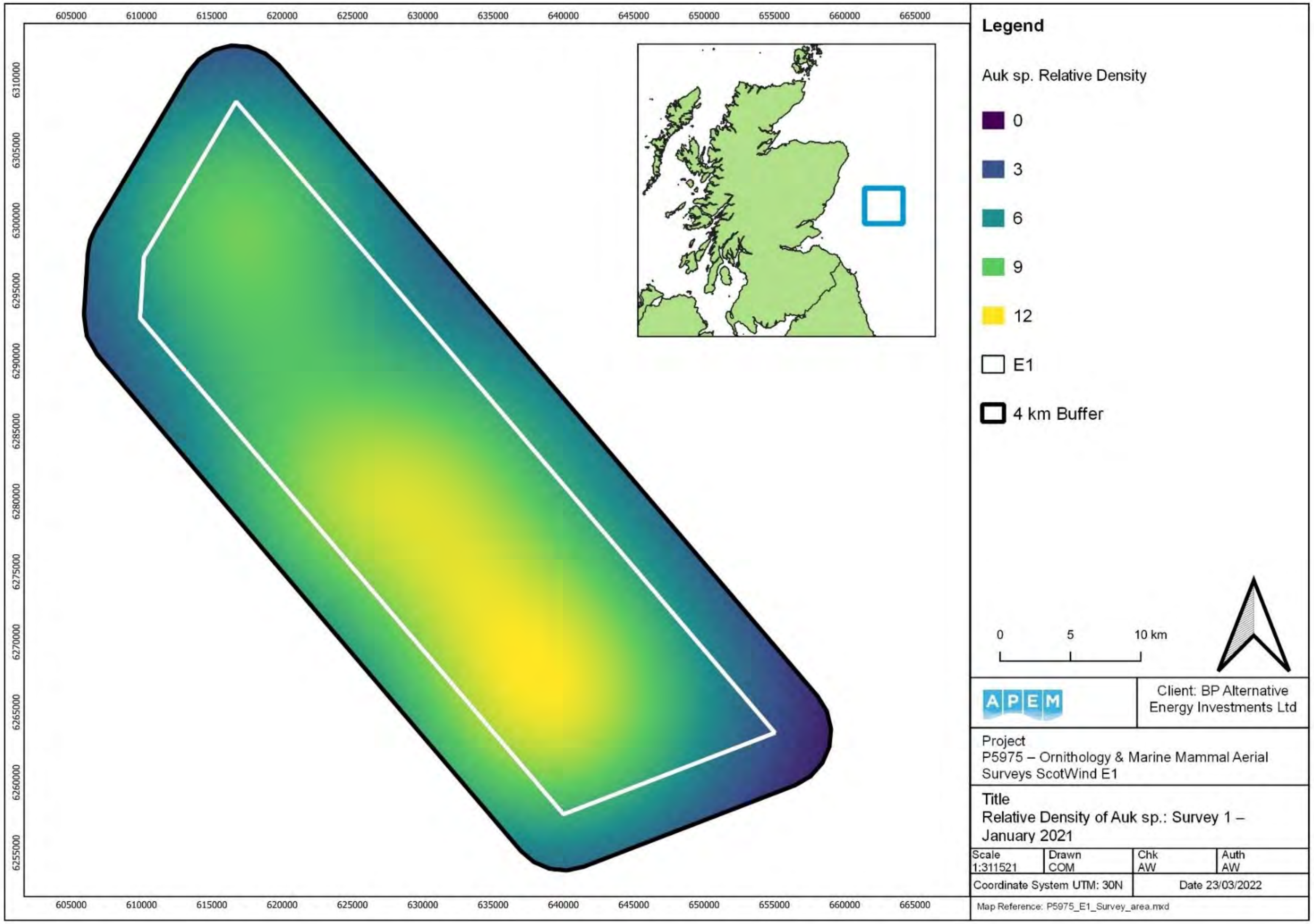


Figure 126 Relative density of unidentified auk in January 2021 (Survey 01).

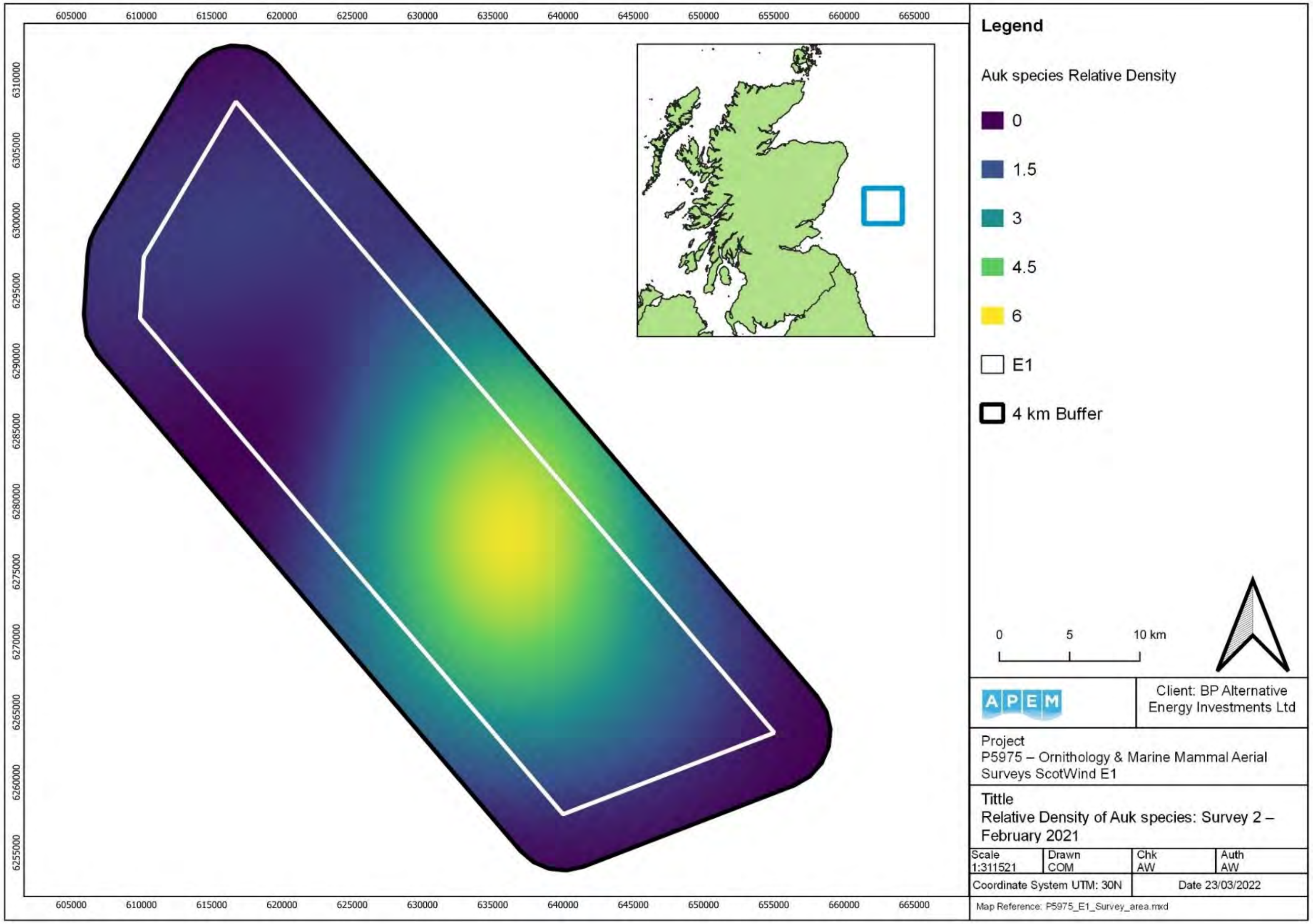


Figure 127 Relative density of unidentified auk in February 2021 (Survey 02).

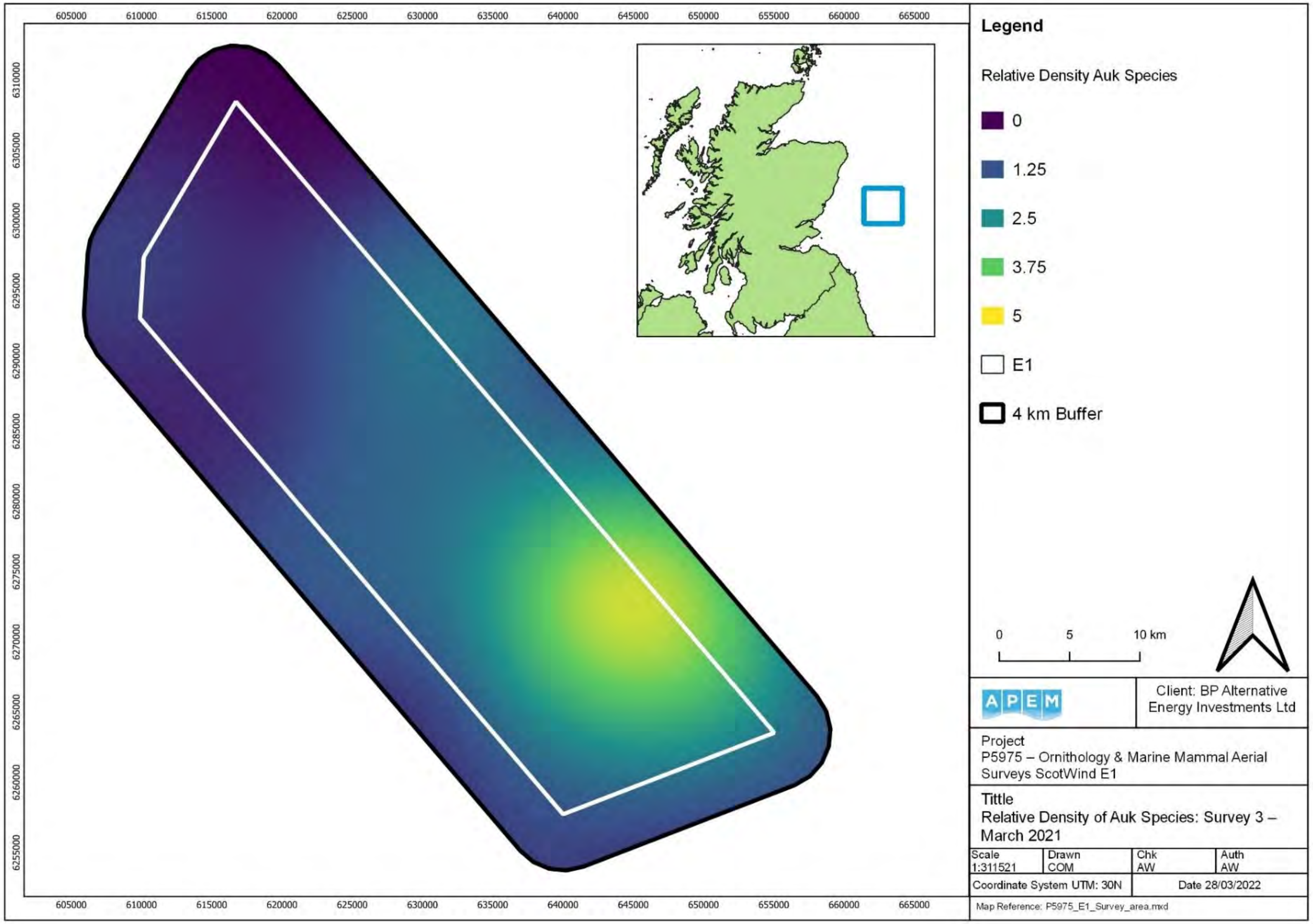


Figure 128 Relative density of unidentified auk in March 2021 (Survey 03).

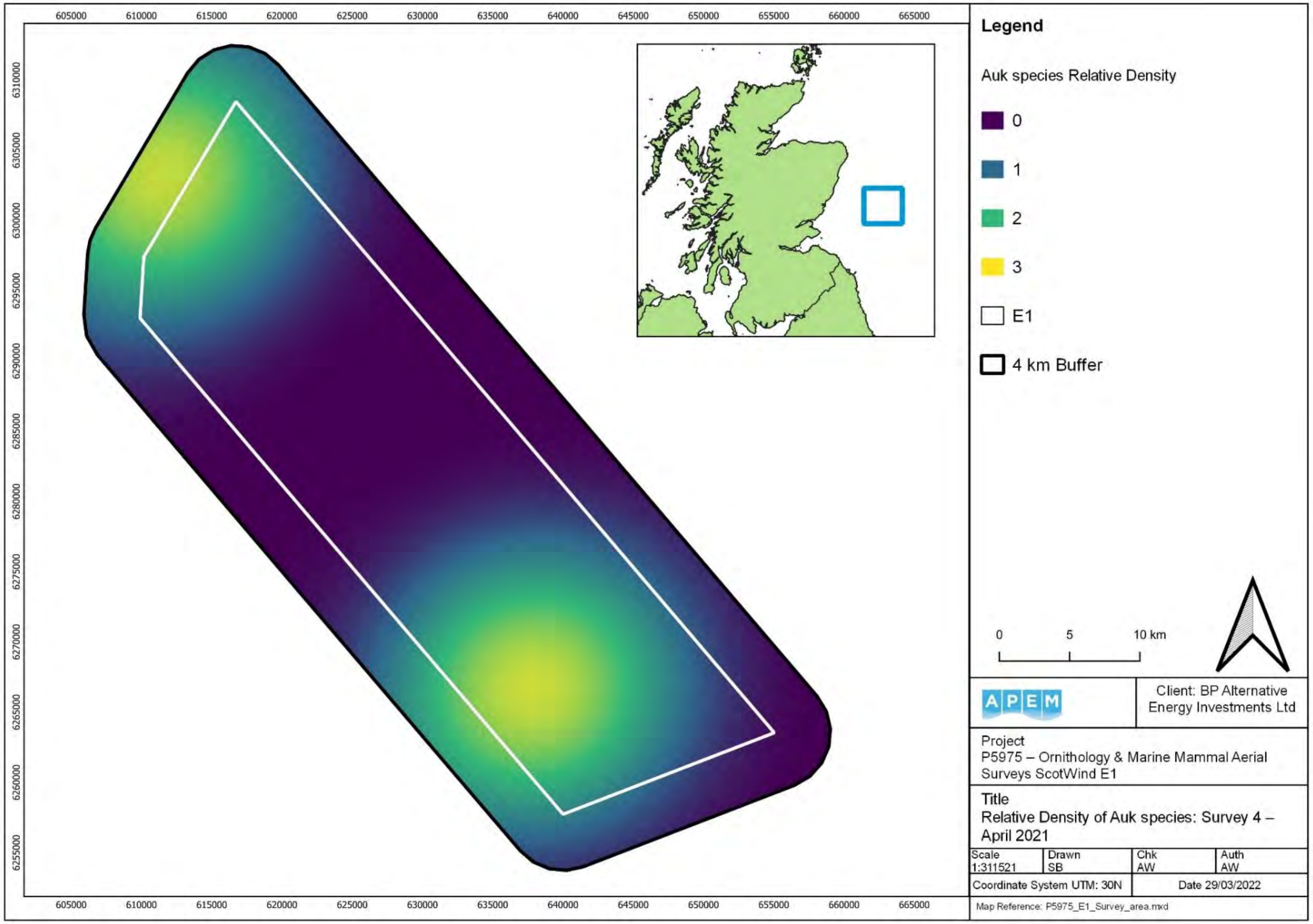


Figure 129 Relative density of unidentified auk in April 2021 (Survey 04).

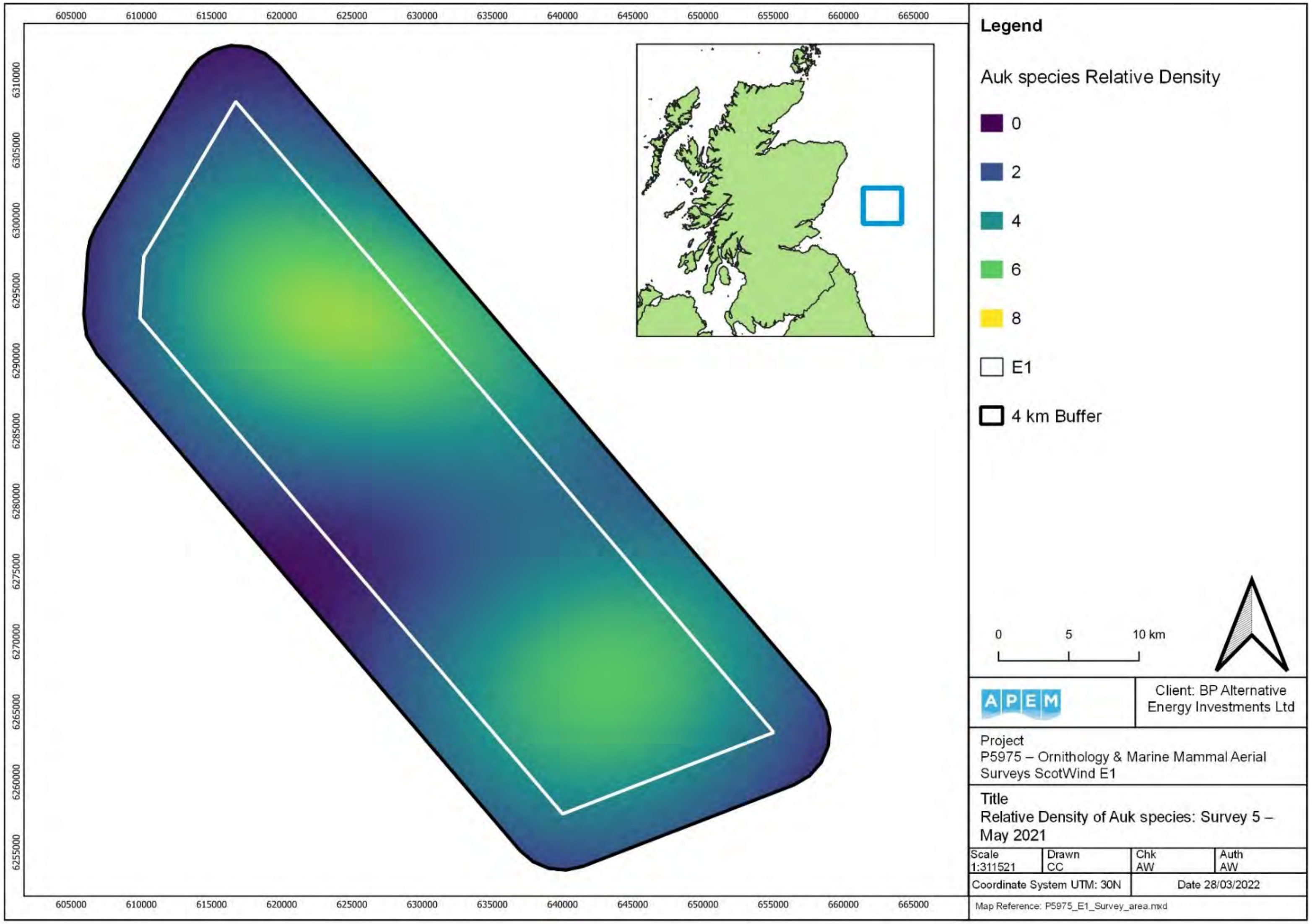


Figure 130 Relative density of unidentified auk in May 2021 (Survey 05).

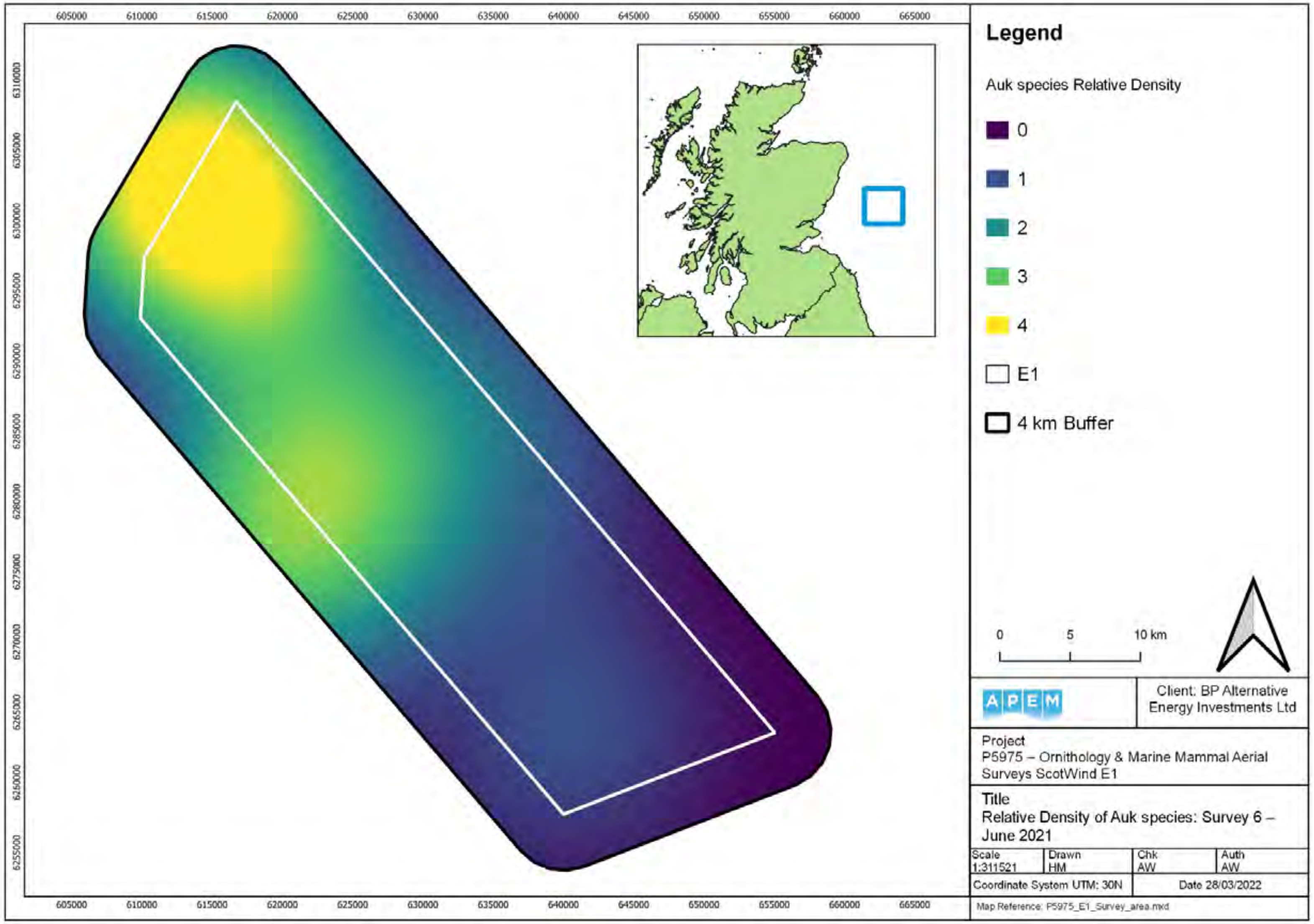


Figure 131 Relative density of unidentified auk in June 2021 (Survey 06).

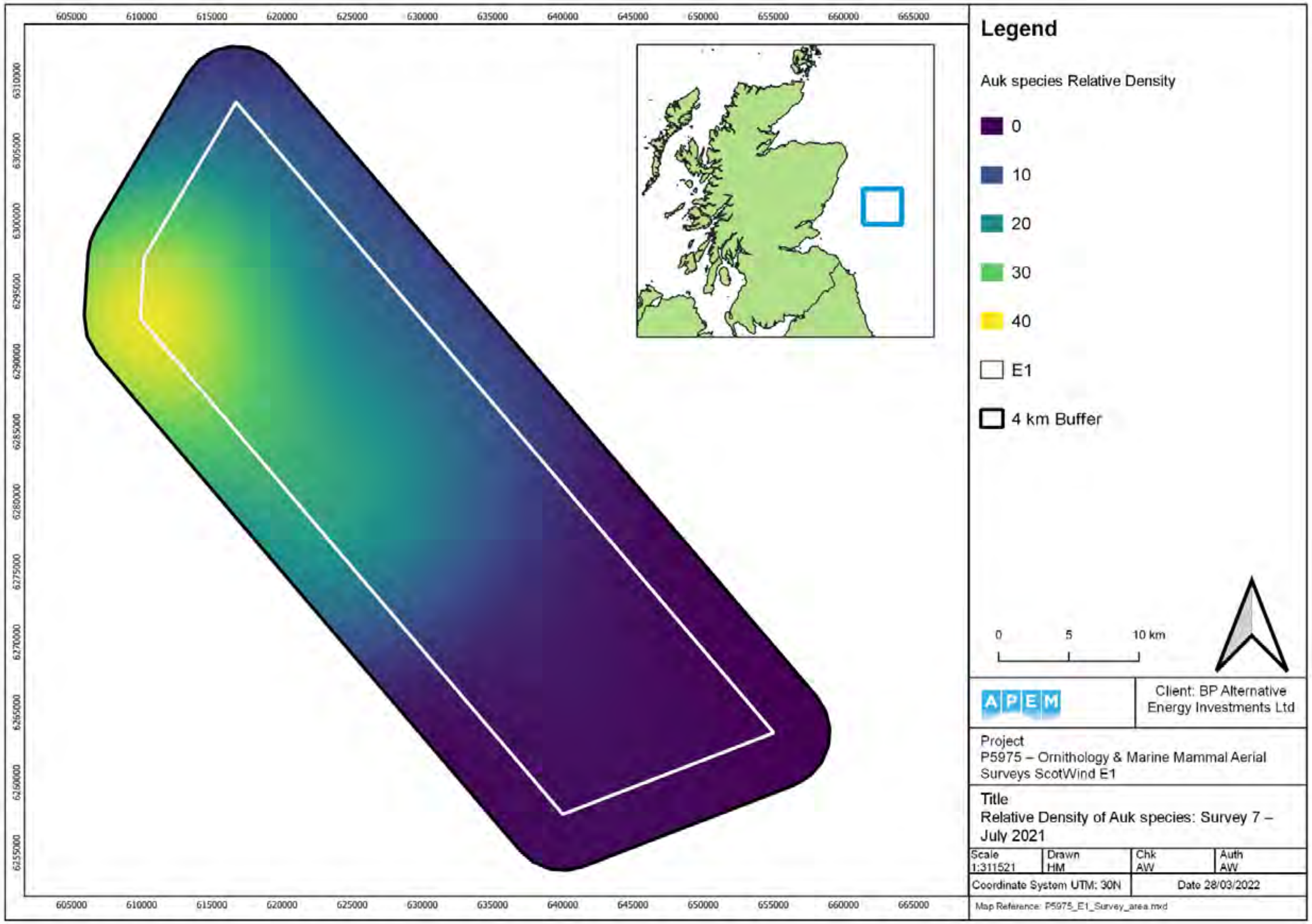


Figure 132 Relative density of unidentified auk in July 2021 (Survey 07).

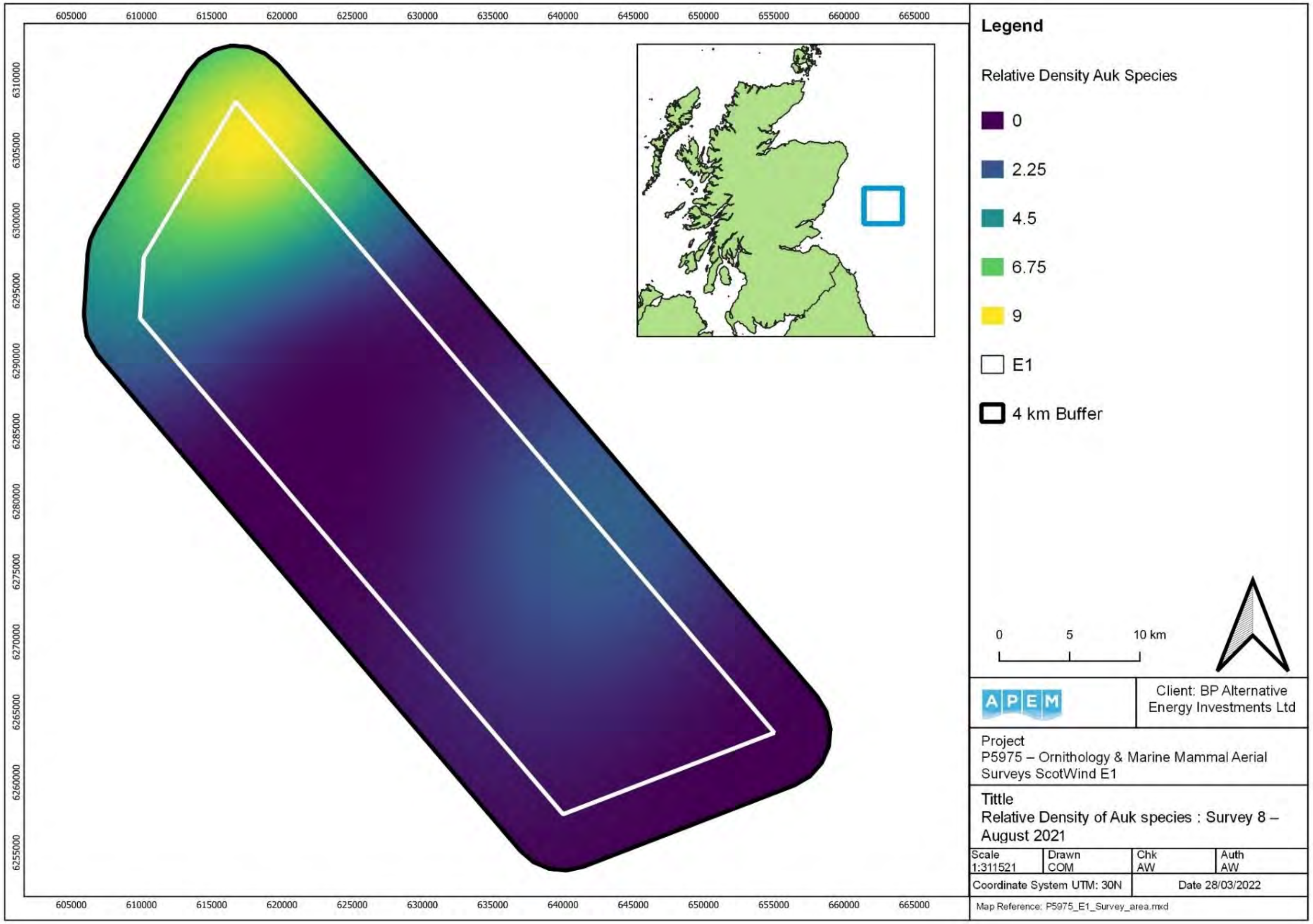


Figure 133 Relative density of unidentified auk in August 2021 (Survey 08).

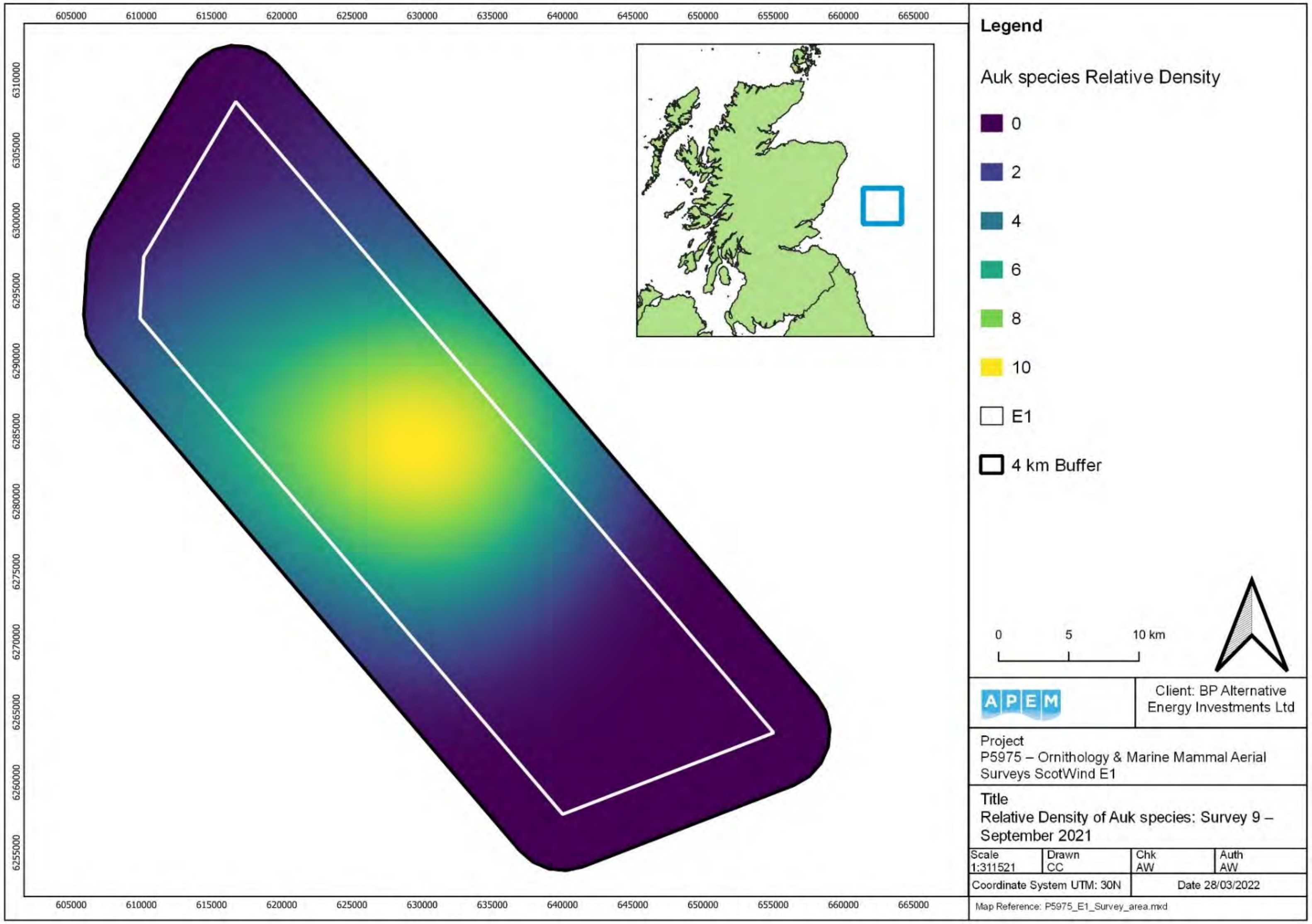


Figure 134 Relative density of unidentified auk in September 2021 (Survey 09).

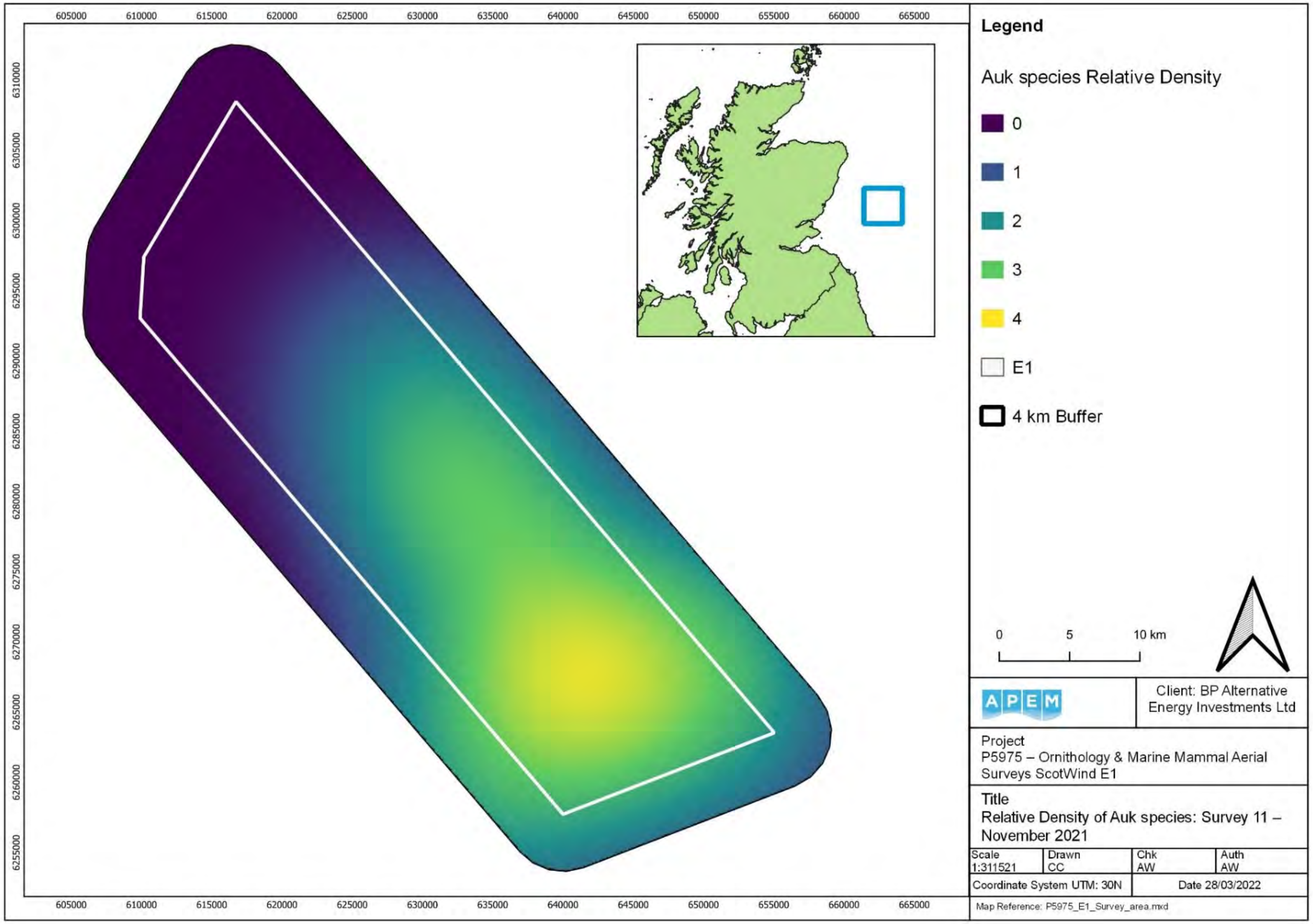


Figure 135 Relative density of unidentified auk in November 2021 (Survey 11).

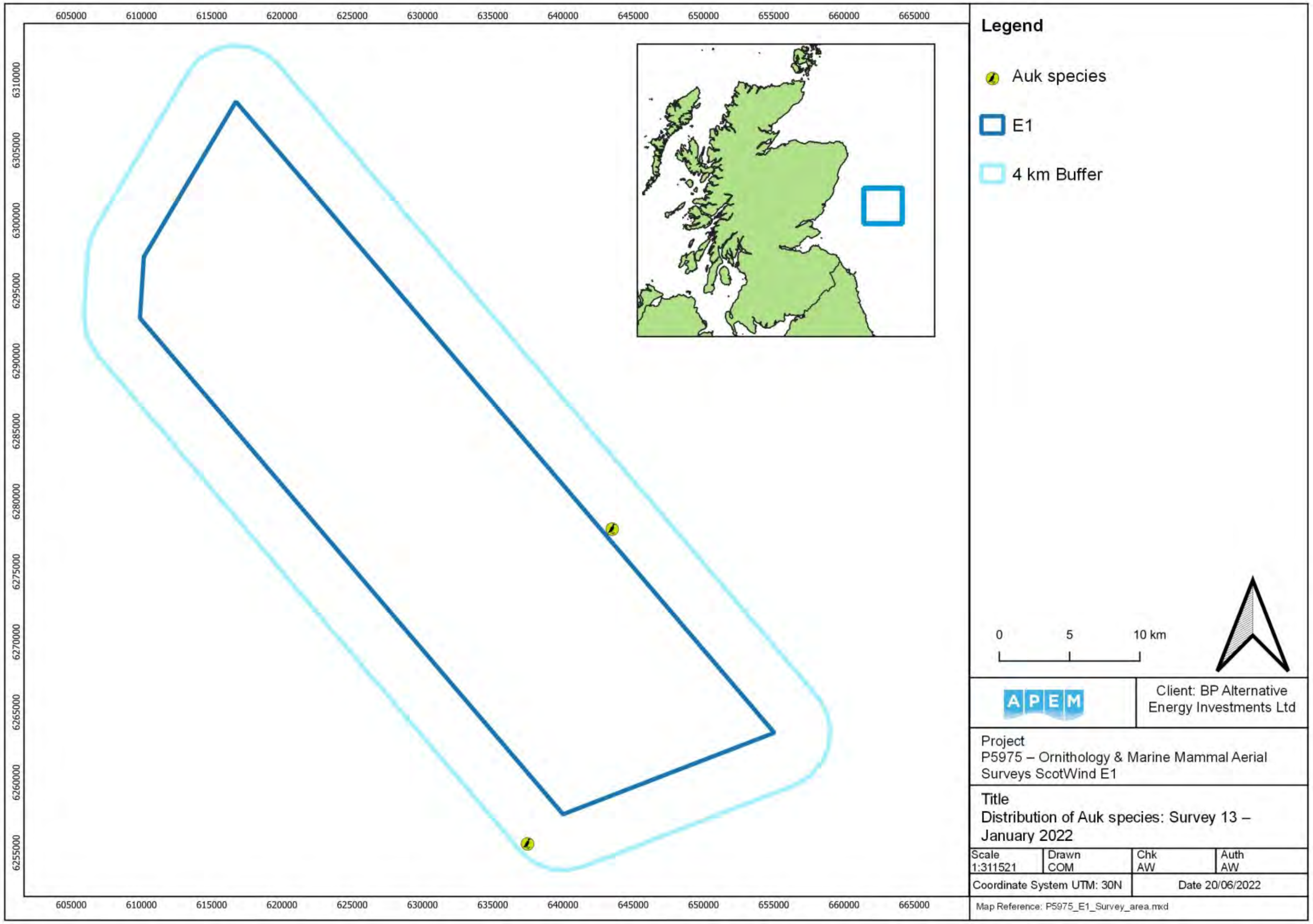


Figure 136 Distribution of unidentified auks in January 2022 (Survey 13).

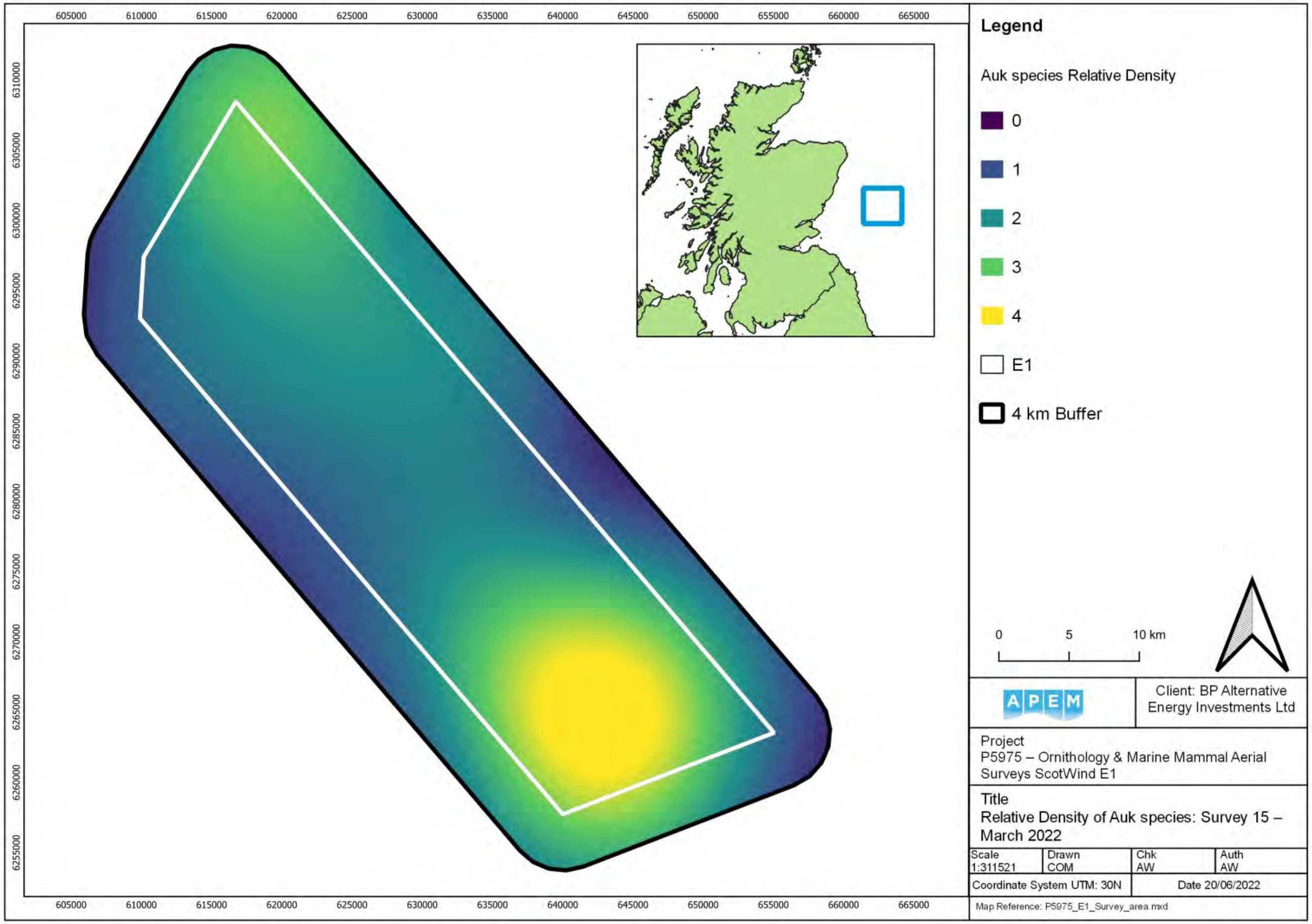
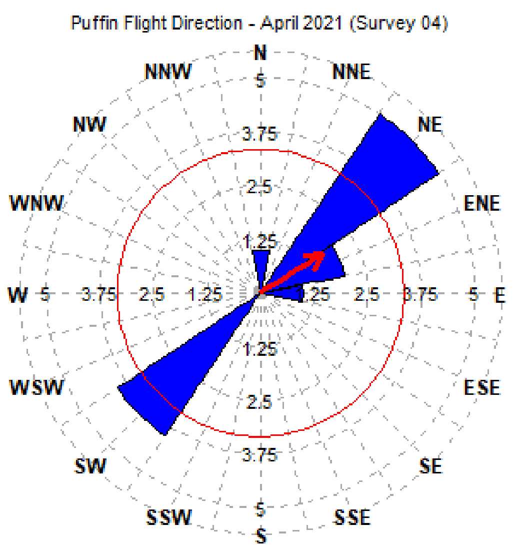
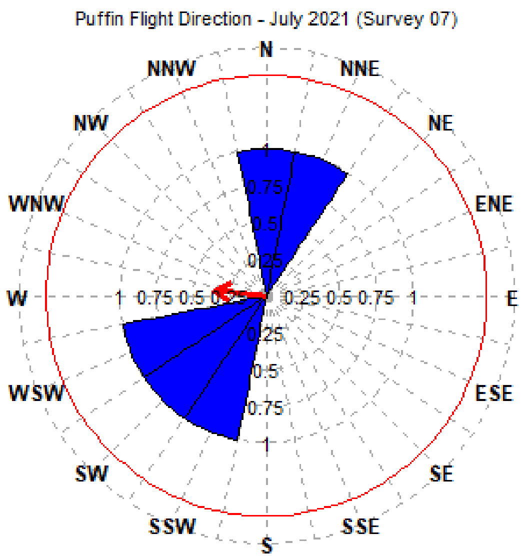


Figure 137 Relative density of unidentified auk in March 2022 (Survey 15).





Number of Observations	13	Number of Observations	5
Mean Vector (µ)	58.716	Mean Vector (µ)	276.029
Length of Mean Vector (r)	0.338	Length of Mean Vector (r)	0.358
Rayleigh Test (Z)	1.488	Rayleigh Test (Z)	0.641
Rayleigh Test (p)	0.229	Rayleigh Test (p)	0.551
Figure 138a April 2021 (Survey 04)		**Figure 138b July 2021 (Survey 07)**	

Figure 138 Summary of flight directions of puffin recorded in the Array Project.

4.23 Unidentified Auk species

Unidentified auks were recorded in all months except October and December 2021, and February 2022. Peak numbers were recorded in July, with 90 individuals, resulting in an abundance estimate of 738 within the Array Project (Table 27).

These were found throughout the Array Project in January, and April 2021, in the southern half in February, March, and November 2021, and January, and March 2022; northern half in May, June, and July 2021; north in August; and central in February, and September 2021 (Figure 138 - Figure 150).

No significant flight direction was recorded in unidentified auk species (p>0.05; Figure 151).

Table 27 Raw counts, abundance and density estimates of unidentified auk in the Array Project.

Survey	Raw Count	Sitting	Flying	Abundance	Lower CL	Upper CL	Precision	Density
Jan-21	27	27	-	220	138	309	0.19	0.15
Feb-21	13	13	-	106	57	163	0.28	0.07
Mar-21	11	12	-	91	41	149	0.30	0.06
Apr-21	5	3	2	40	8	88	0.45	0.04
May-21	19	19	-	155	74	253	0.23	0.11
Jun-21	12	12	-	99	49	173	0.29	0.07
Jul-21	90	90	-	738	492	1,033	0.11	0.52
Aug-21	18	18	-	148	57	263	0.24	0.1
Sep-21	19	19	-	156	82	238	0.23	0.11
Nov-21	10	10	-	83	33	150	0.32	0.06
Jan-22	2	2	-	16	2	41	0.71	0.01
Mar-22	10	10	-	80	32	128	0.32	0.07

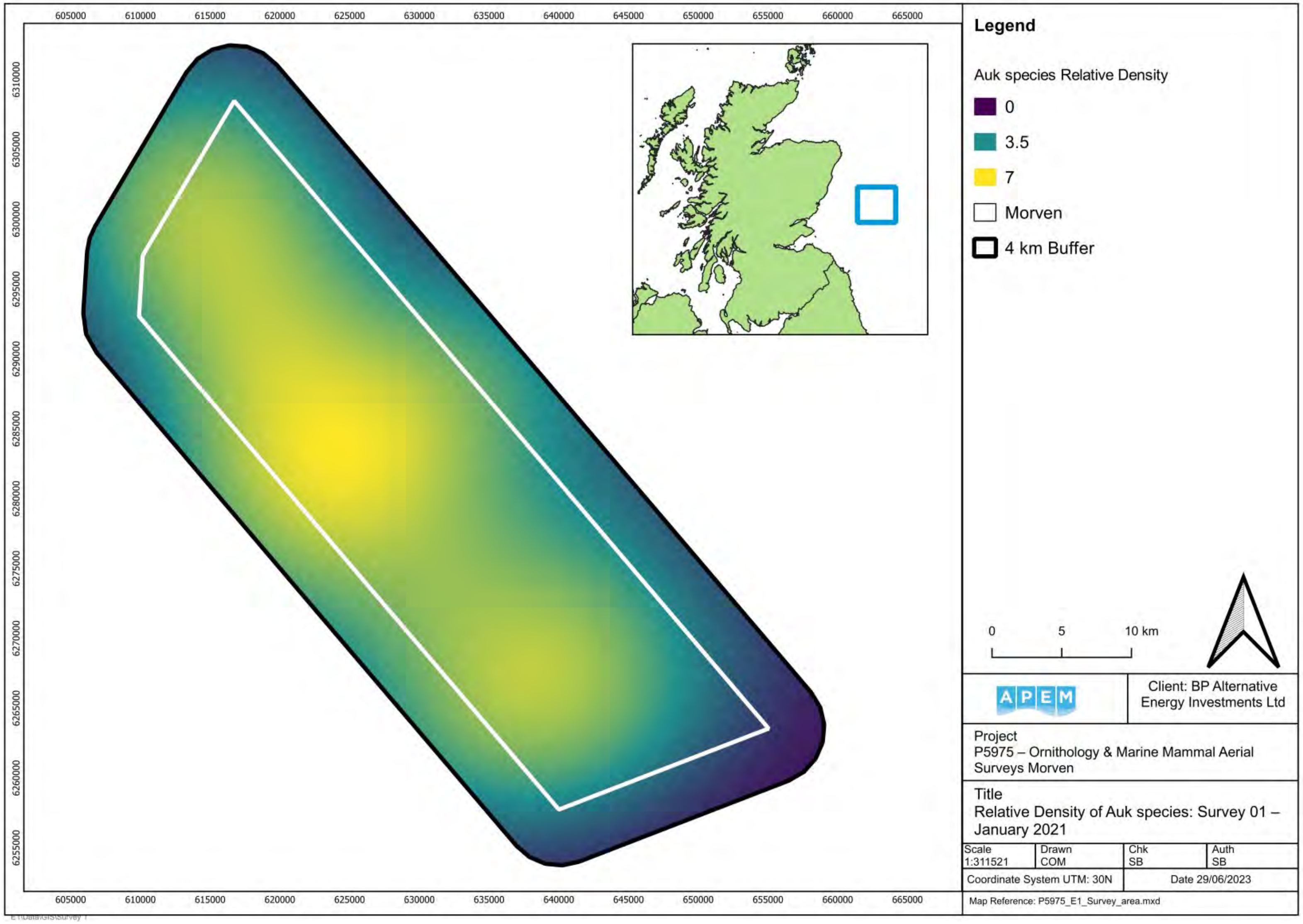


Figure 138 Relative density of unidentified auk in January 2021 (Survey 01).

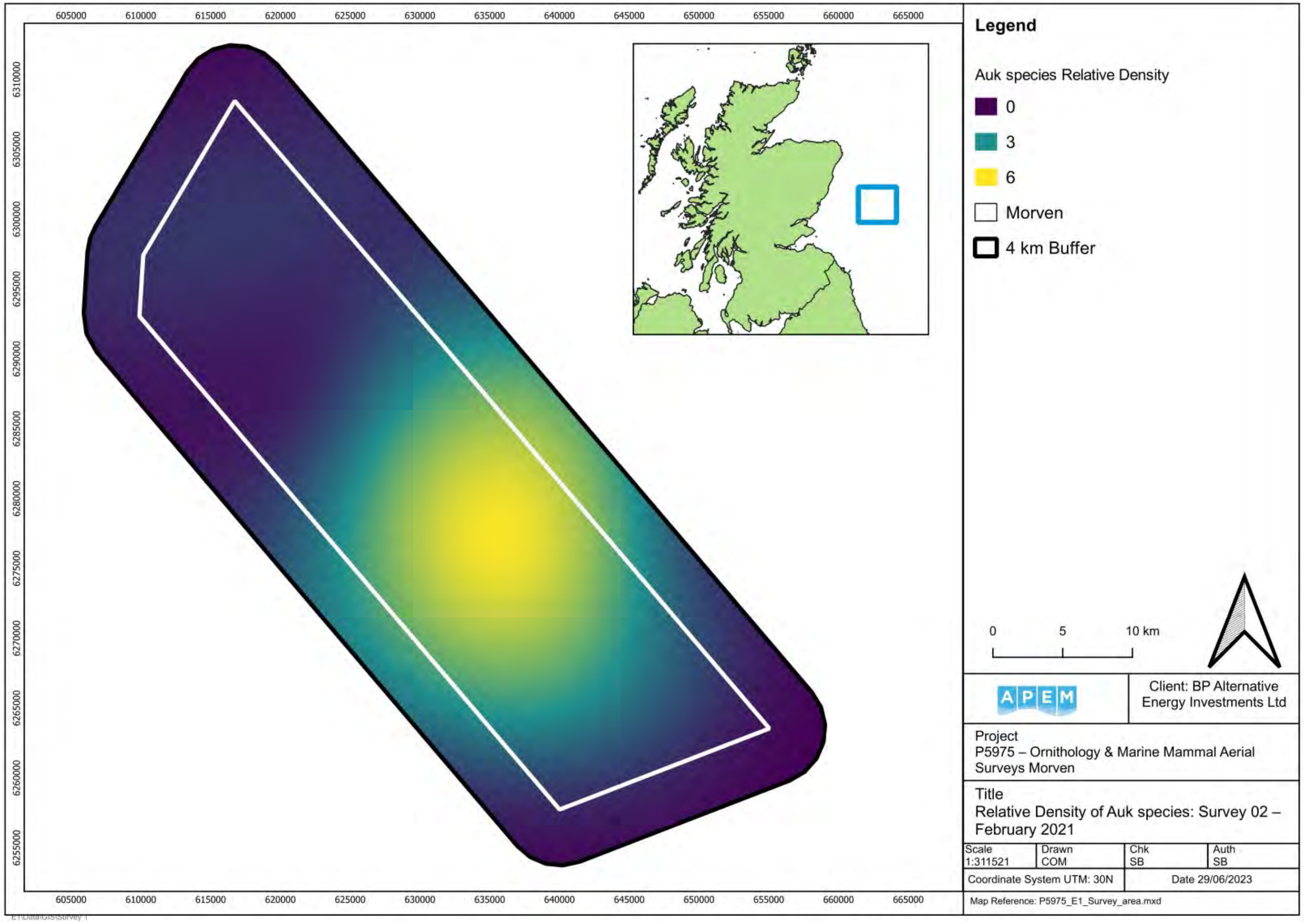


Figure 139 Relative density of unidentified auk in February 2021 (Survey 02).

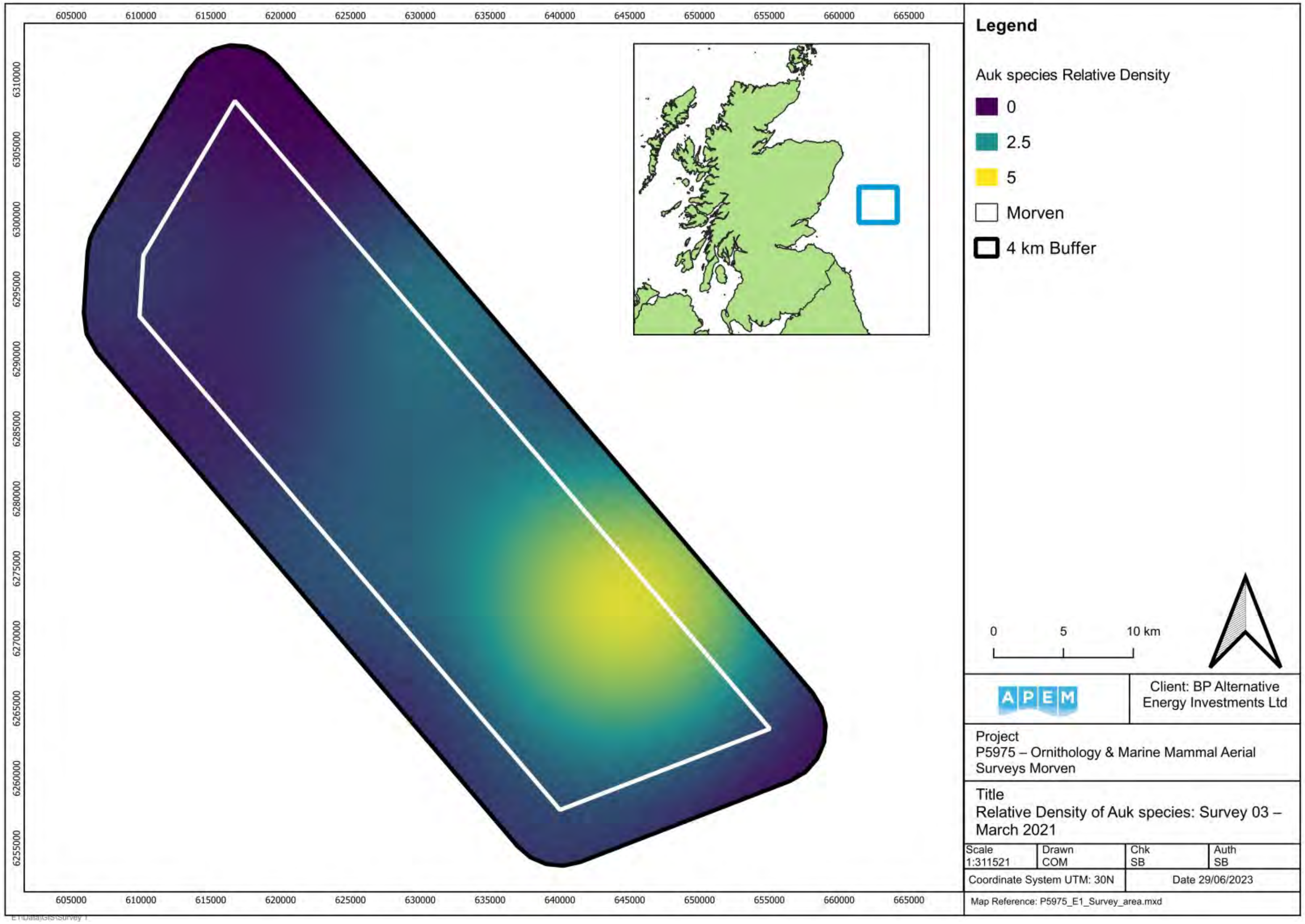


Figure 140 Relative density of unidentified auk in March 2021 (Survey 03).

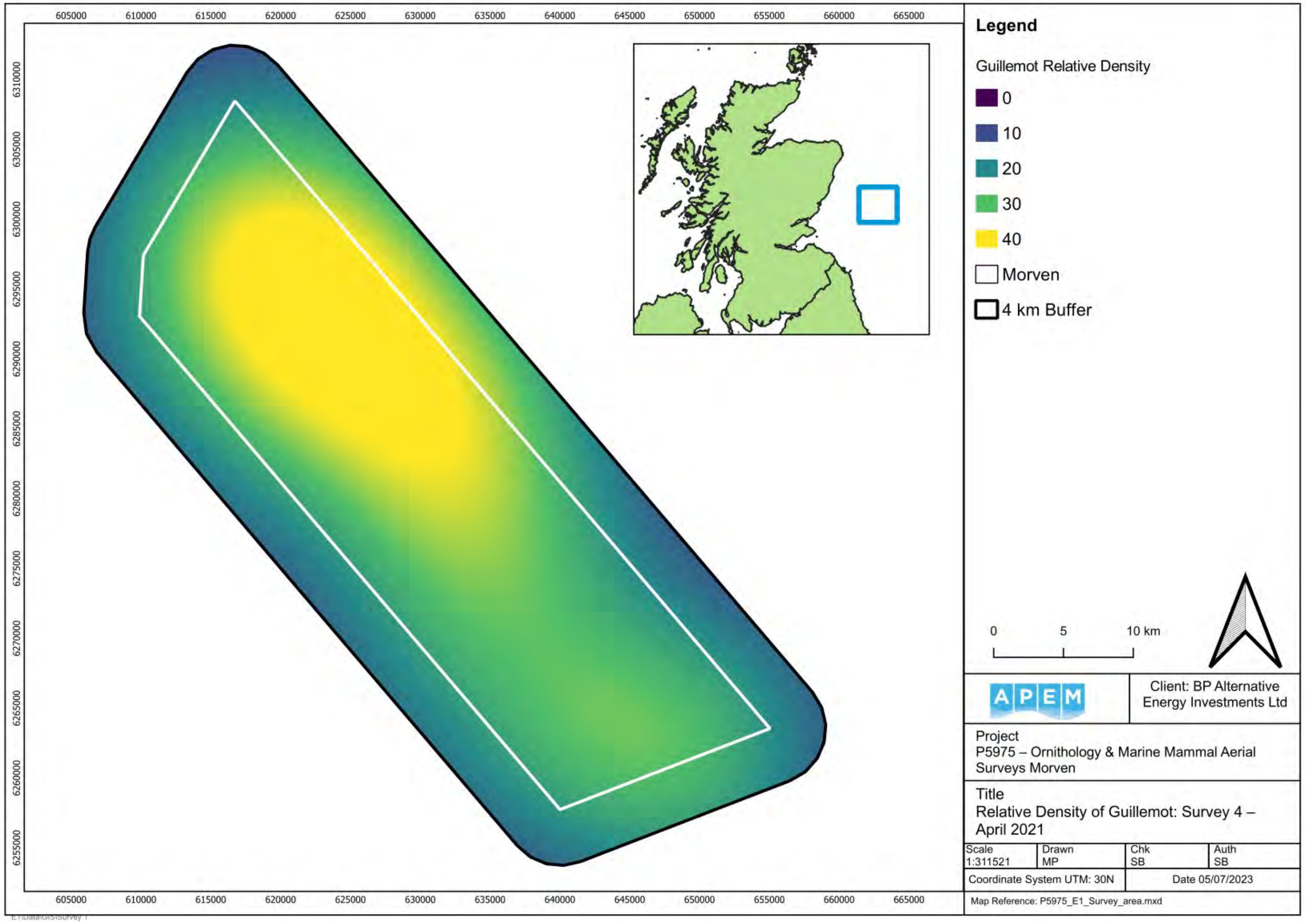


Figure 141 Relative density of unidentified auk in April 2021 (Survey 04).

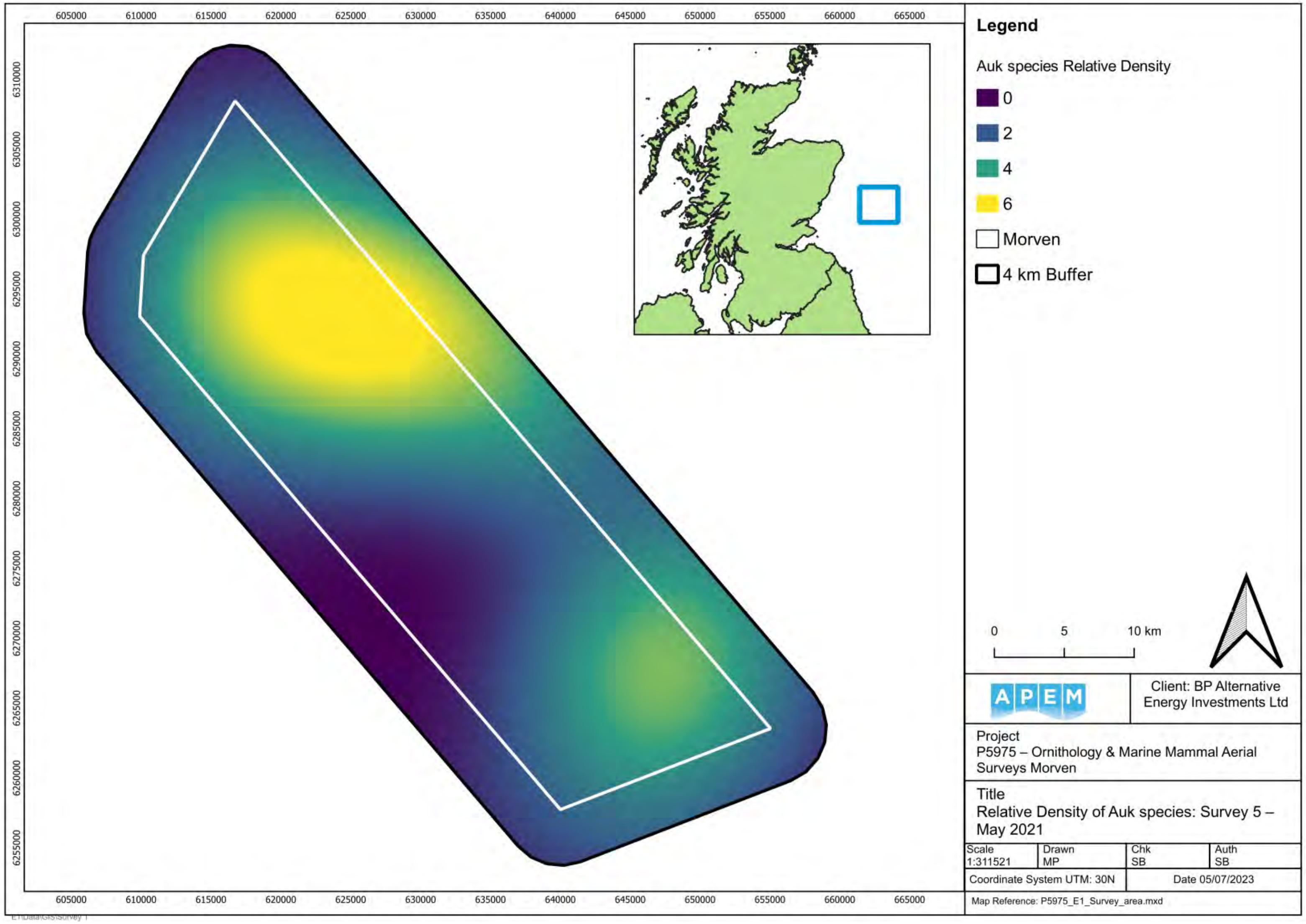


Figure 142 Relative density of unidentified auk in May 2021 (Survey 05).

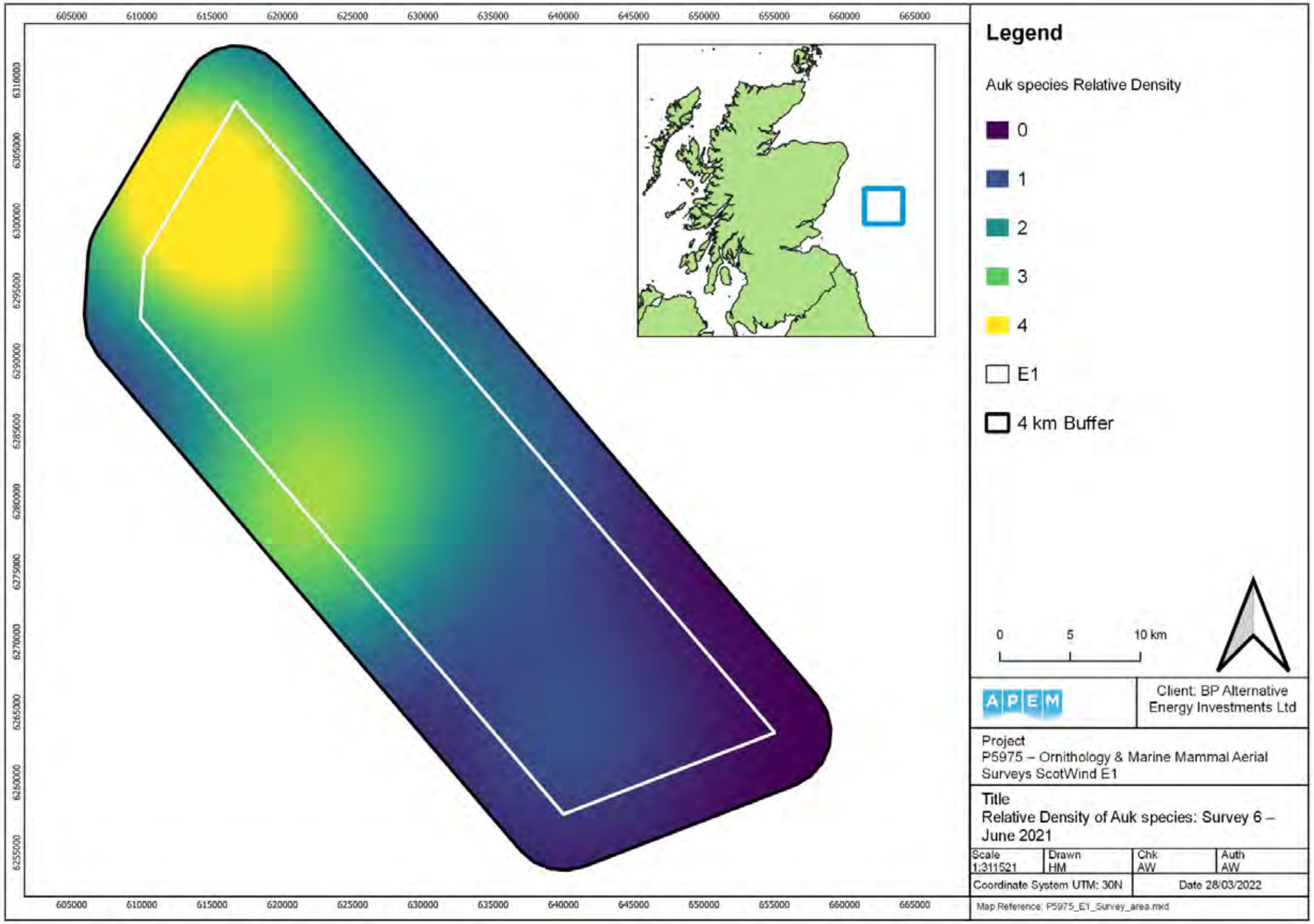


Figure 143 Relative density of unidentified auk in June 2021 (Survey 06).

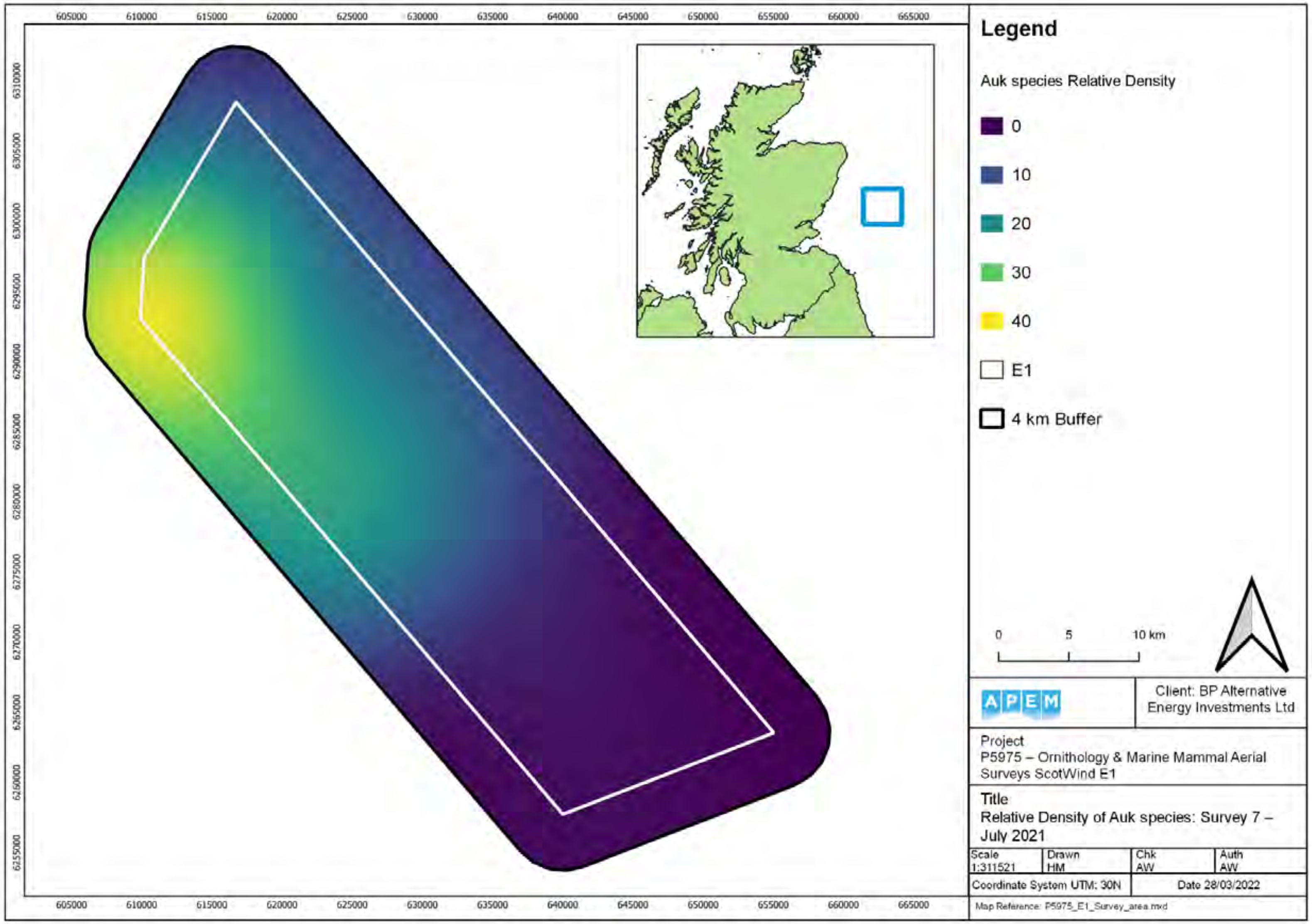


Figure 144 Relative density of unidentified auk in July 2021 (Survey 07).

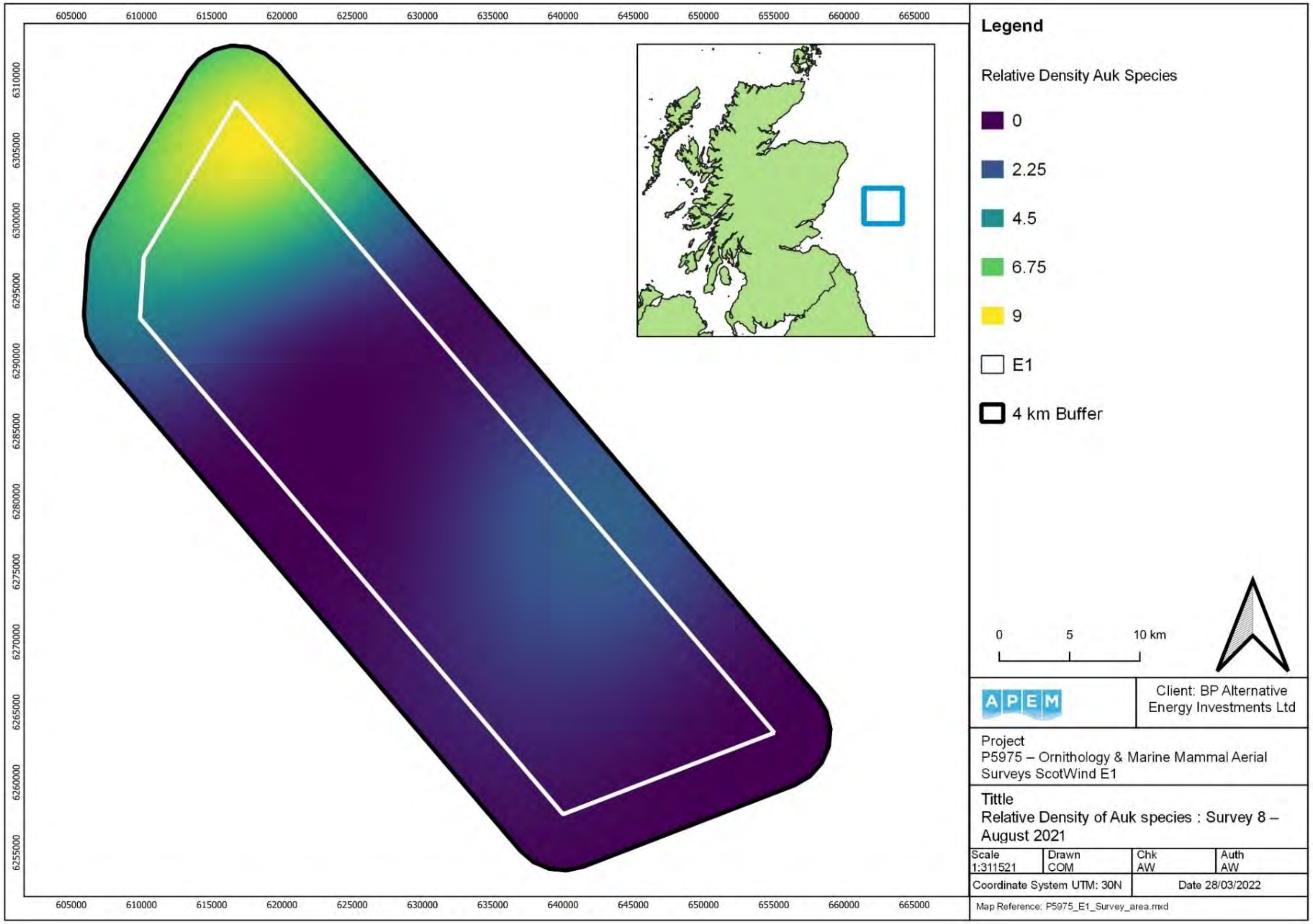


Figure 145 Relative density of unidentified auk in August 2021 (Survey 08).

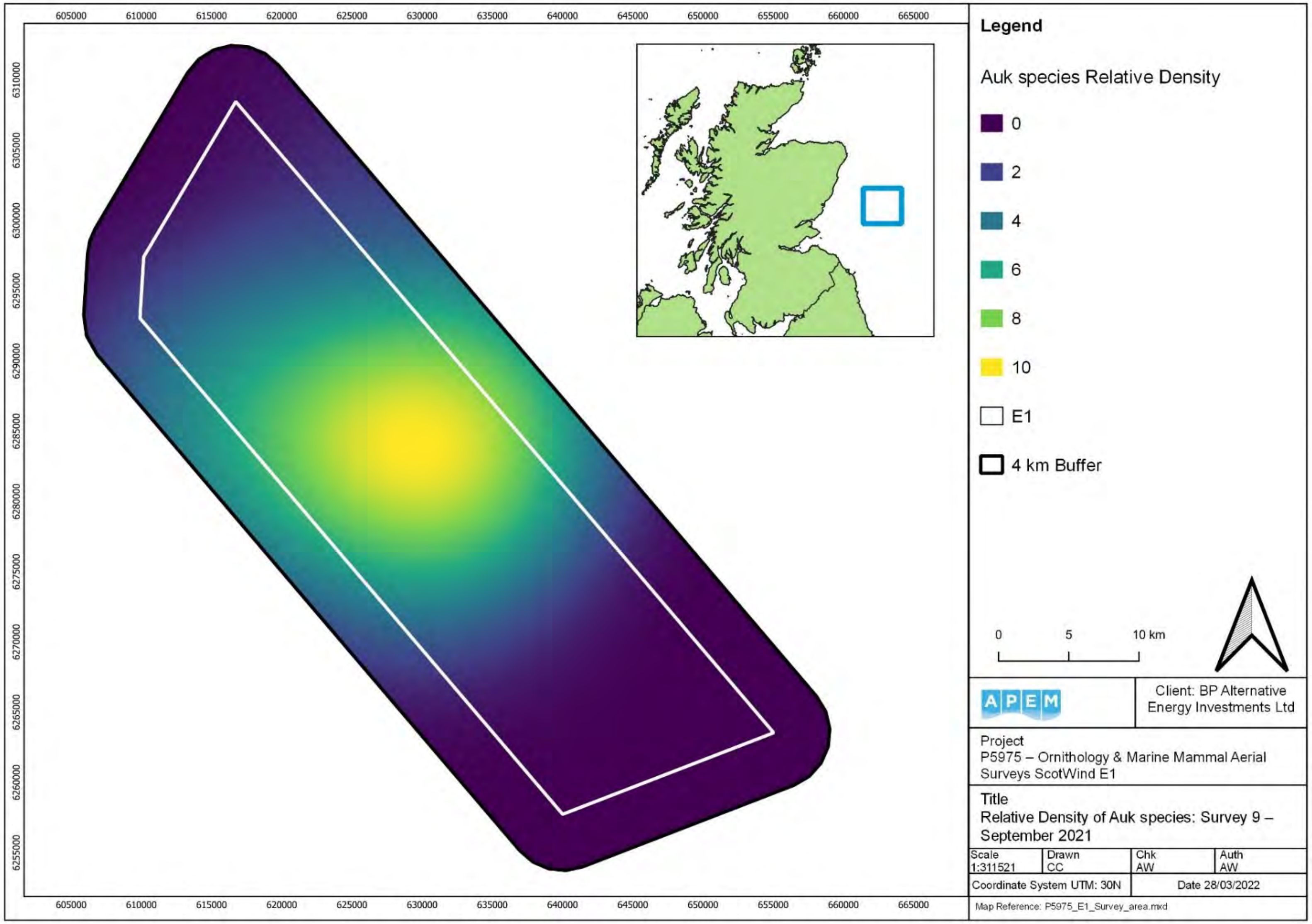


Figure 146 Relative density of unidentified auk in September 2021 (Survey 09).

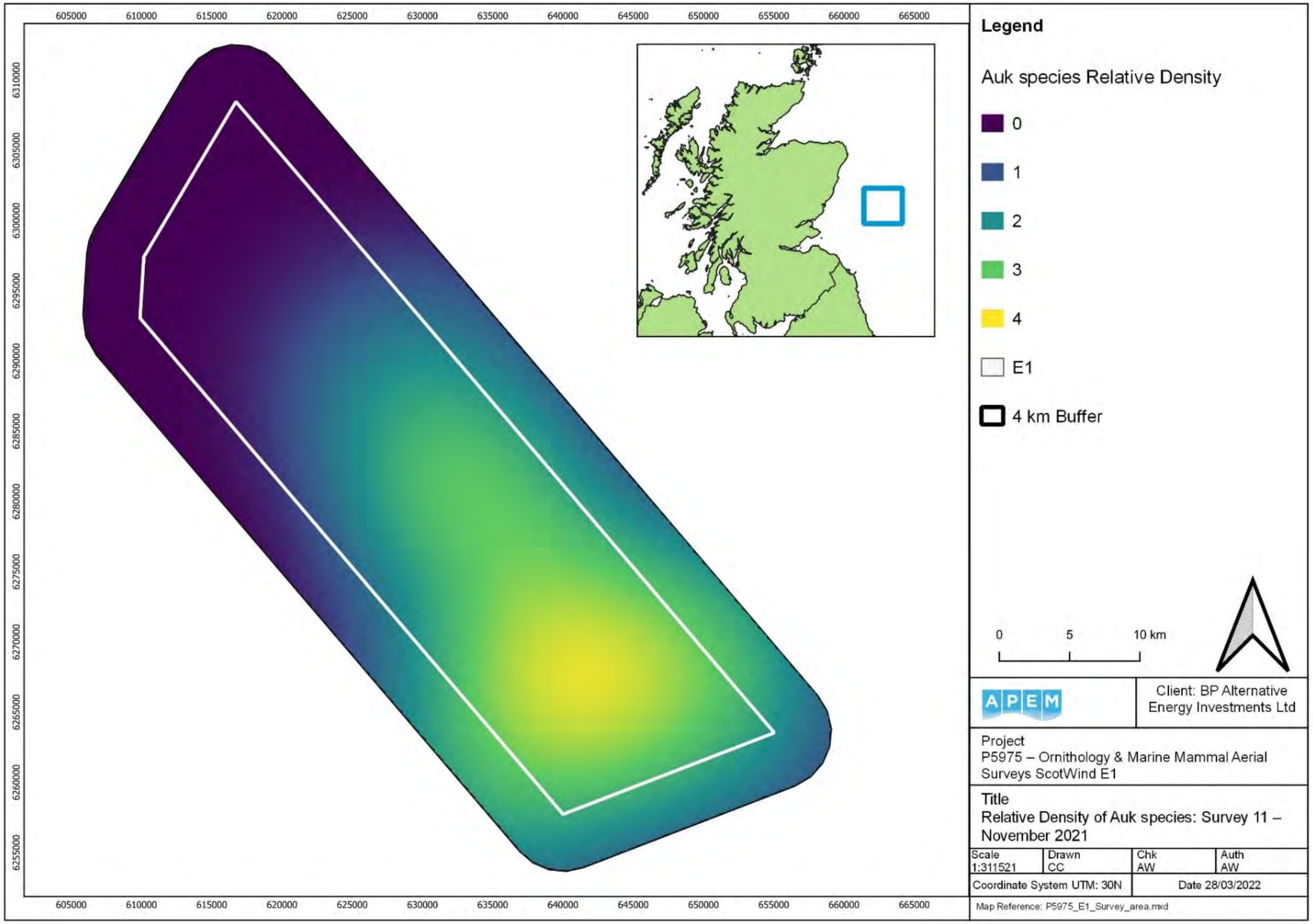


Figure 147 Relative density of unidentified auk in November 2021 (Survey 11).

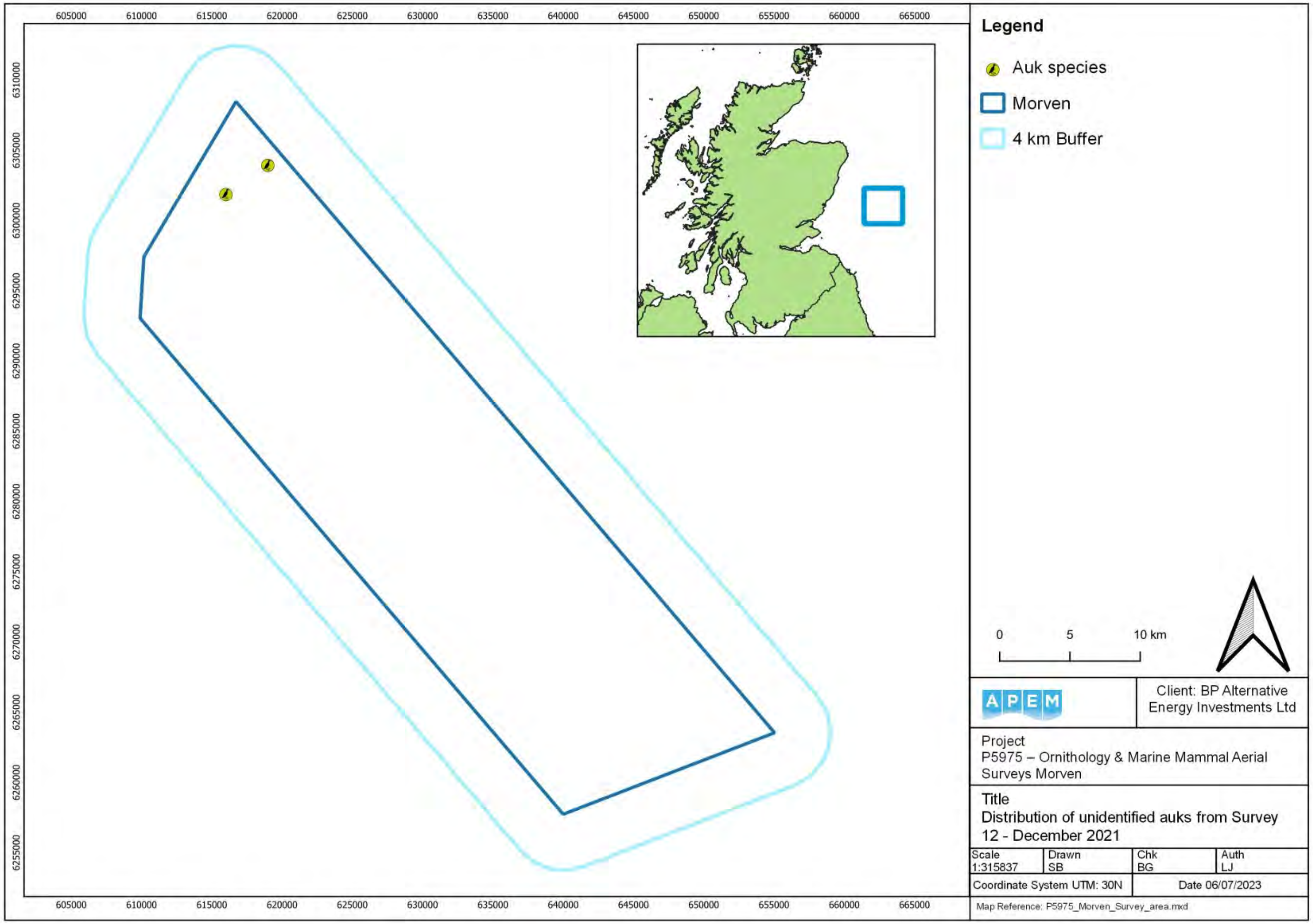


Figure 148 Relative density of unidentified auk in December 2021 (Survey 12).

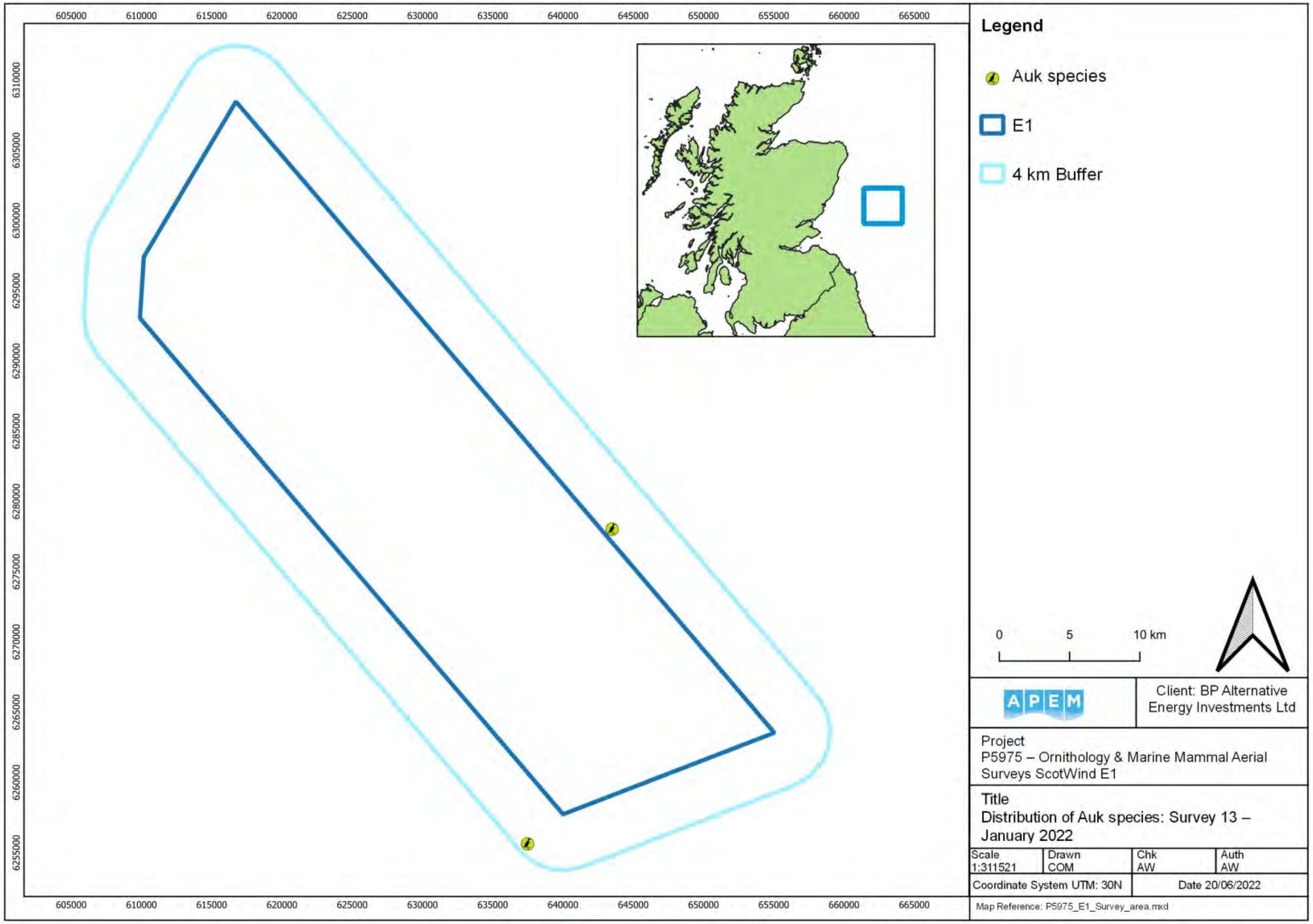


Figure 149 Distribution of unidentified auks in January 2022 (Survey 13).

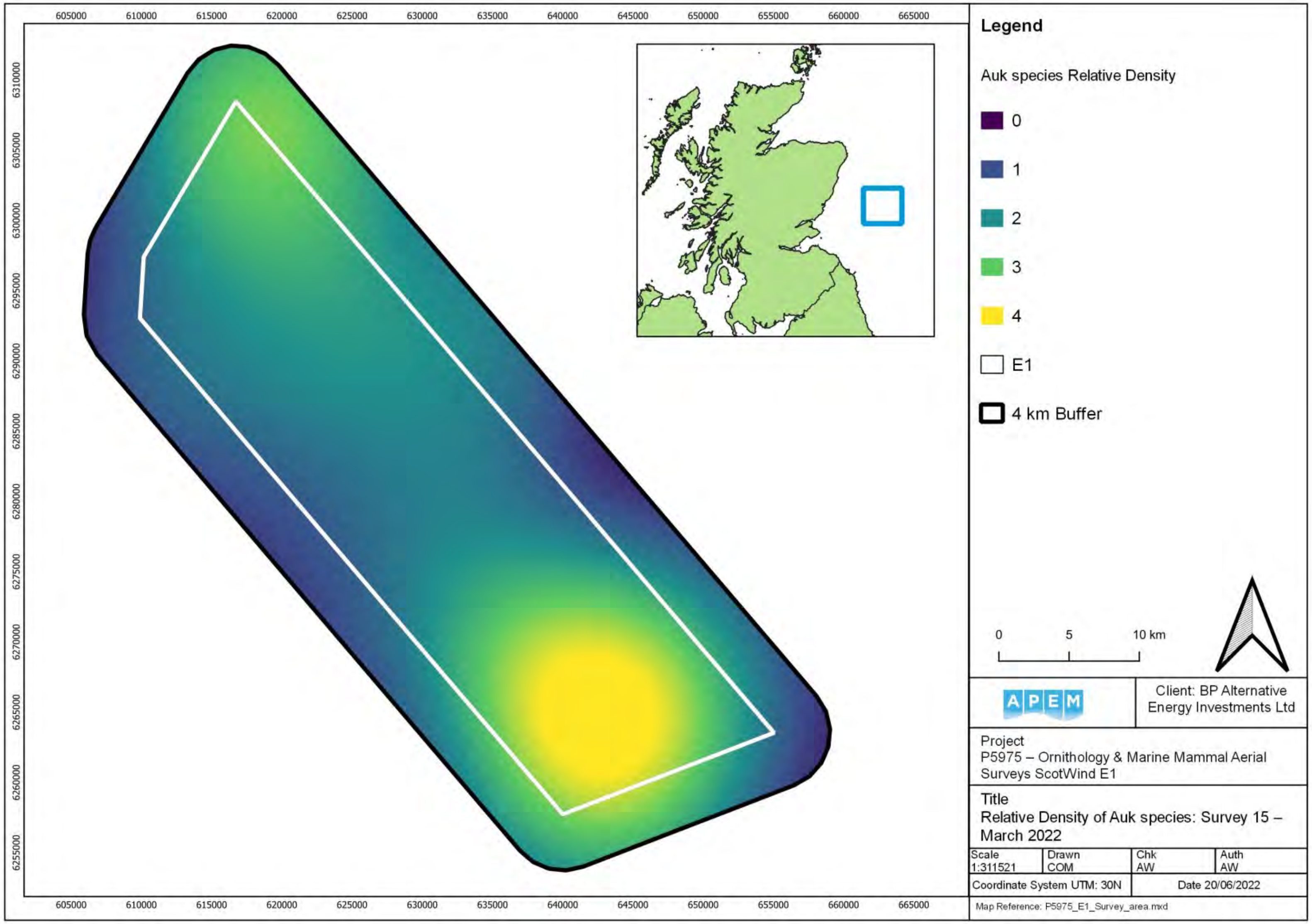
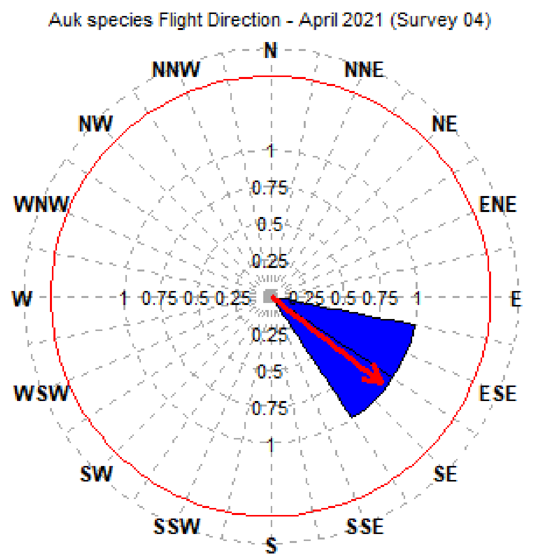


Figure 150 Relative density of unidentified auk in March 2022 (Survey 15).



Number of Observations	2
Mean Vector (µ)	128.161
Length of Mean Vector (r)	0.953
Rayleigh Test (Z)	1.817
Rayleigh Test (p)	0.174

Figure 151 Summary of flight directions of unidentified auk species recorded in the Array Project.

4.24 Red-throated – Diver *Gavia stellata*

An individual red-throated diver was recorded in May 2021 in the north of the Array Project (Figure 126), resulting in an abundance estimate of eight within the Array Project (Table 28).

No significant flight direction was recorded in red-throated diver (p>0.05).

.

Table 28 Raw counts, abundance and density estimates of red-throated diver in the Array Project.

Survey	Raw Count	Sitting	Flying	Abundance	Lower CL	Upper CL	Precision	Density
May-21	1	-	1	8	1	25	1.00	0.01

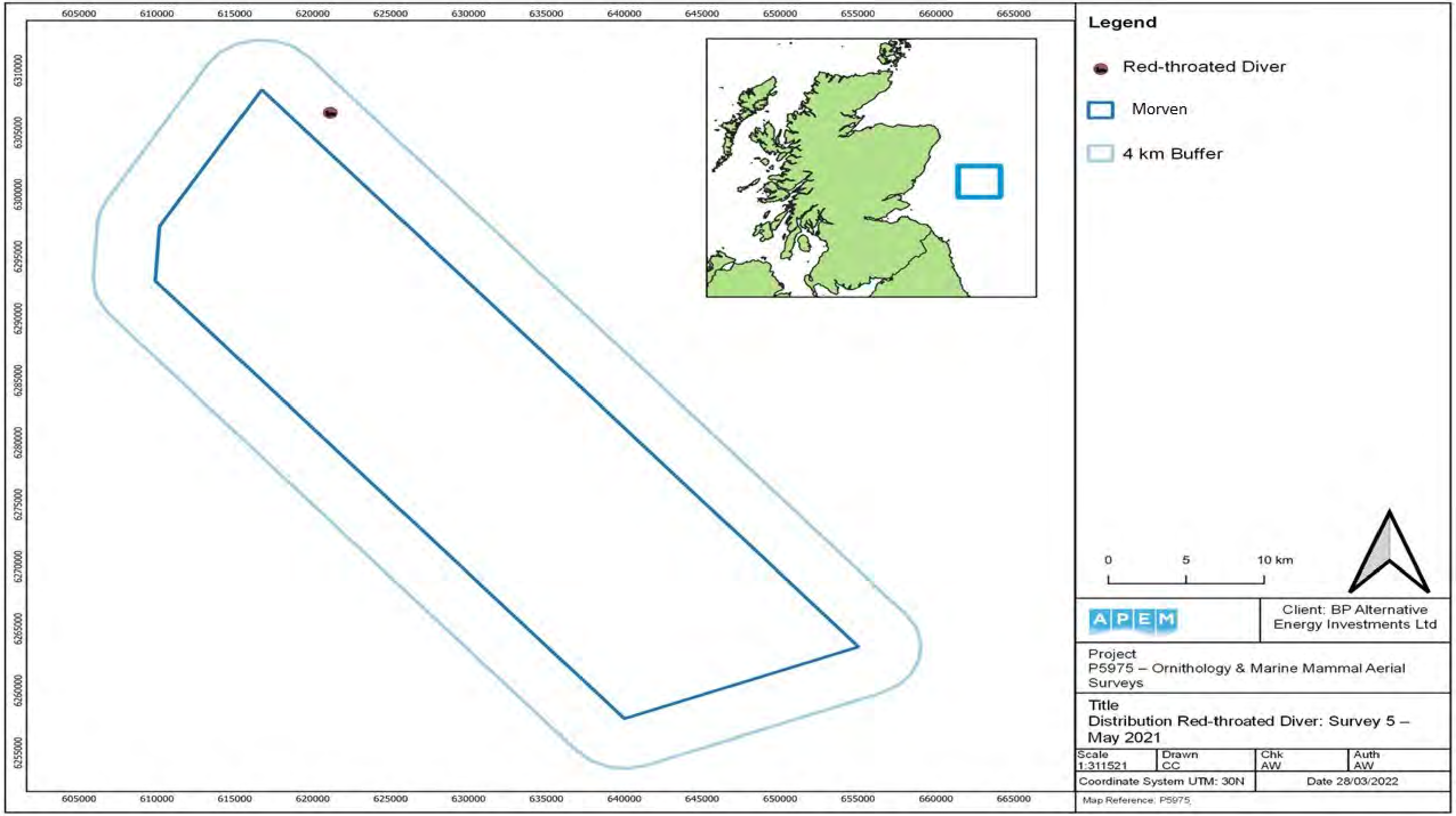


Figure 152 Location of a red-throated divers in May 2021 (Survey 05).

4.25 Divers – Unidentified

One unidentified diver was recorded in March 2021 in the northwest of the Array Project (Figure 128), resulting in an abundance estimate of eight within the Array Project (Table 29).

No significant flight direction was recorded in unidentified diver species (p>0.05).

Table 29 Raw counts, abundance and density estimates of unidentified diver in the Array Project.

Survey	Raw Count	Sitting	Flying	Abundance	Lower CL	Upper CL	Precision	Density
Mar-21	1	-	1	8	1	25	1.00	0.01

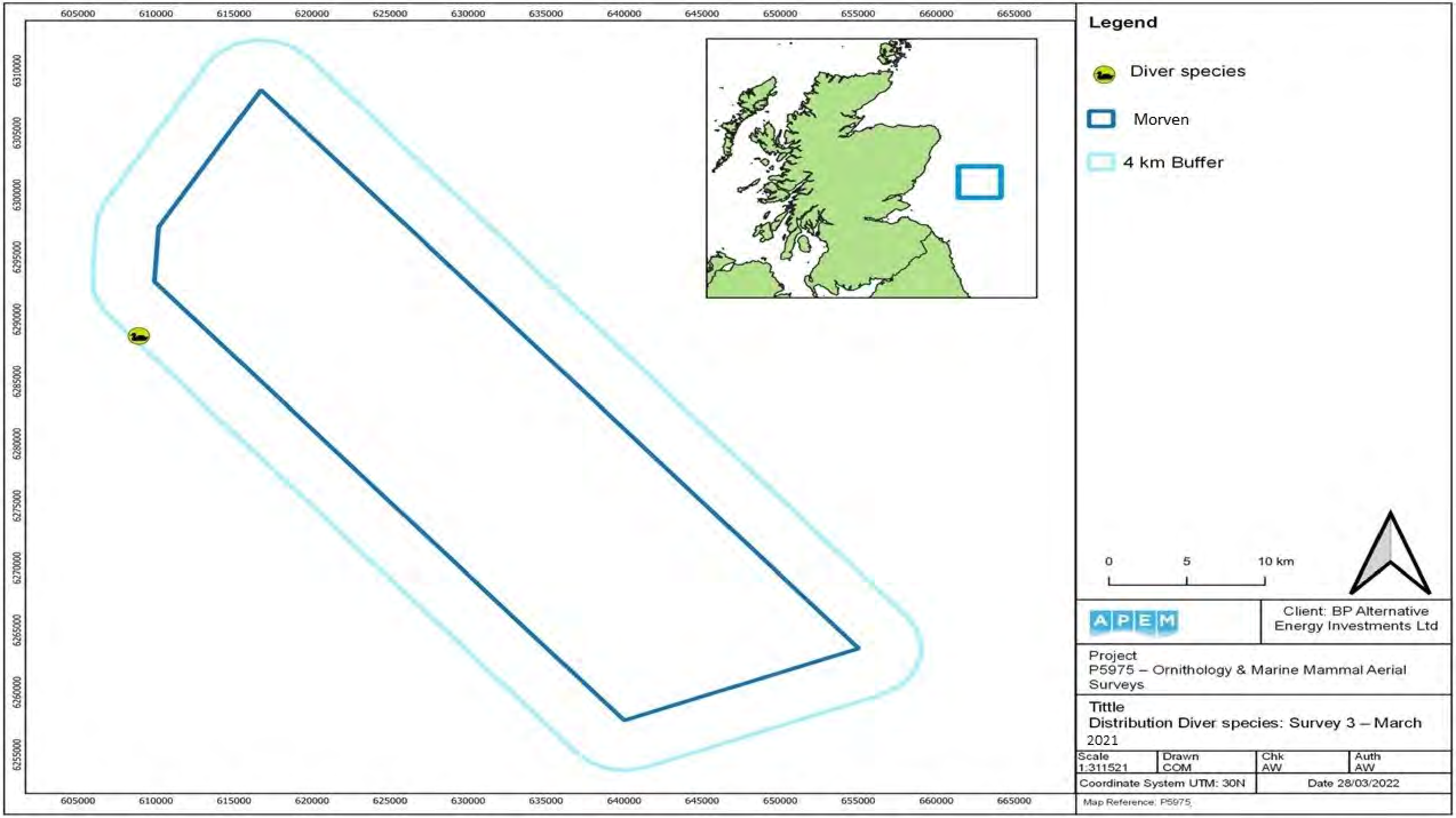


Figure 153 Location of an unidentified diver in March 2021 (Survey 03).

4.26 Storm Petrels – Unidentified

A single unidentified storm petrels was recorded in June and August 2021, with two individuals recorded in October, resulting in an abundance estimate of 16 within the Array Project (Table 30).

These were found throughout the Array Project – north in June (Figure 154); west in August (Figure 155) and southern half in October (Figure 156).

No significant flight direction was recorded in unidentified storm petrel species (p>0.05).

Table 30 Raw counts, abundance and density estimates of unidentified storm petrel in the Array Project.

Survey	Raw Count	Sitting	Flying	Abundance	Lower CL	Upper CL	Precision	Density
Jun-21	1	1	-	8	1	25	1.00	0.01
Aug-21	1	-	1	8	1	33	1.00	0.01
Oct-21	2	2	-	16	2	48	0.71	0.01

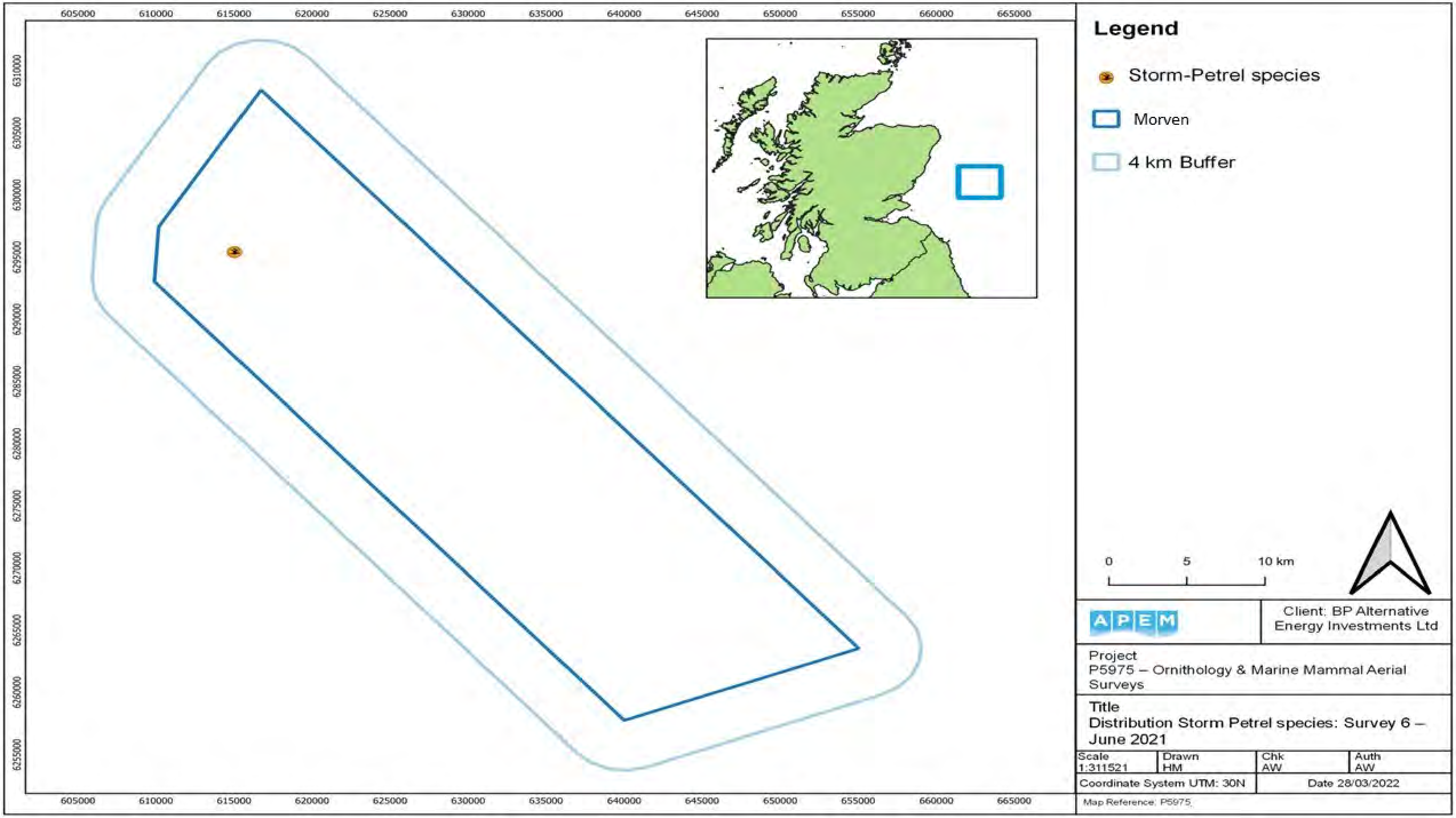


Figure 154 Location of an unidentified storm petrel in June 2021 (Survey 06).

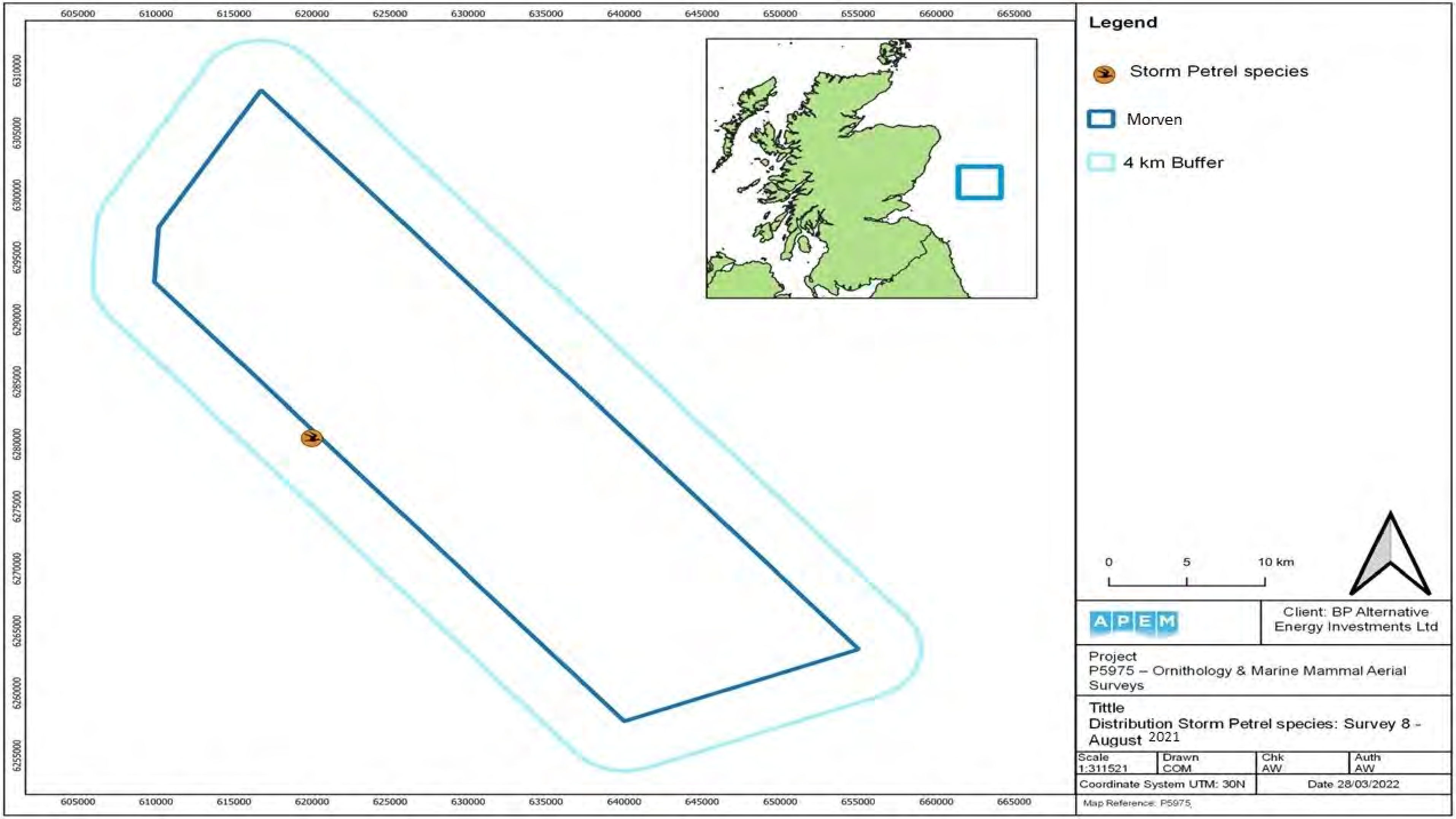


Figure 155 Location of an unidentified storm petrel in August 2021 (Survey 08).

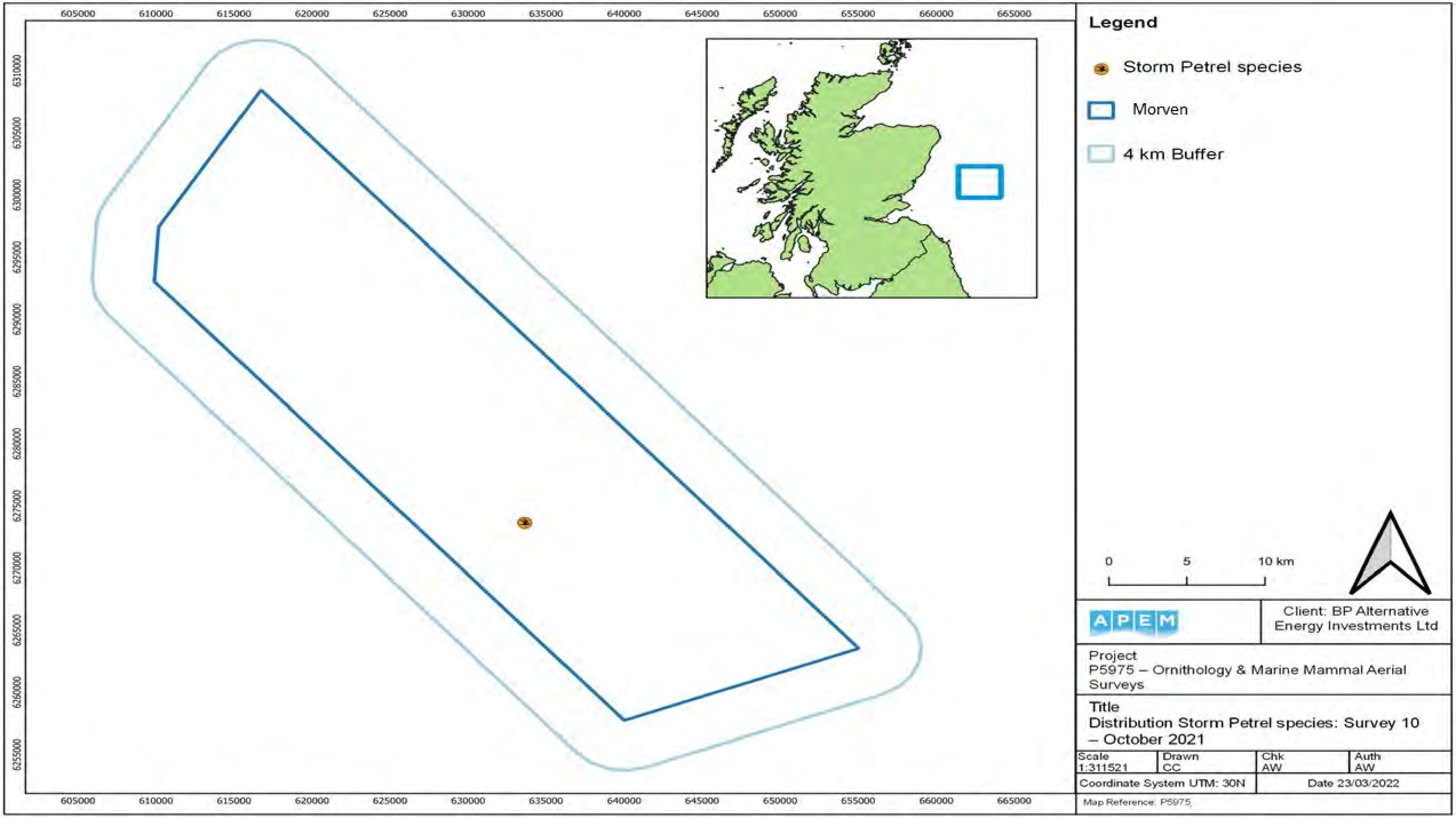


Figure 156 Location of unidentified storm petrels in October 2021 (Survey 10).

4.27 Fulmar – *Fulmarus glacialis*

Fulmars were recorded in all months during the 15 months of surveys. Peak numbers were in November with 185 individuals, resulting in an abundance estimate of 1,537 within the Array Project (Table 31).

These were throughout the Array Project – north in January 2022, February 2021 and 2022 (Figure 158), April (Figure 160), and December (Figure 168); west in June (Figure 162); south in July (Figure 163), August (Figure 164), September (Figure 165), and October (Figure 166); north half in March (Figure 159) and November (Figure 167); and both north and south in January 2021 (Figure 157), May (Figure 161) and March 2022.

Fulmars were recorded flying in a significant south-westerly direction in January 2021. In February and December 2021, and March 2022 fulmar were recorded flying in a significant south-easterly direction, Fulmars were recorded flying north-west in April and August and west in May ($p<0.05$). In all other months, fulmar showed no significant preference of direction ($p>0.05$) (Figure 172).

Table 31 Raw counts, abundance and density estimates of fulmar in the Array Project.

Survey	Raw Count	Sitting	Flying	Abundance	Lower CL	Upper CL	Precision	Density
Jan-21	23	7	16	187	114	268	0.21	0.13
Feb-21	18	6	12	147	82	229	0.24	0.1
Mar-21	24	3	21	199	116	298	0.20	0.14
Apr-21	40	17	23	324	218	445	0.16	0.23
May-21	36	24	12	294	139	515	0.17	0.21
Jun-21	12	3	9	99	49	156	0.29	0.07
Jul-21	40	30	10	328	139	697	0.16	0.23
Aug-21	159	93	66	1,304	1,091	1,510	0.08	0.92
Sep-21	50	35	15	411	238	641	0.14	0.29
Oct-21	127	68	59	1,021	739	1,382	0.09	0.72
Nov-21	185	111	74	1,537	1,271	1,819	0.07	1.08
Dec-21	91	10	81	747	558	961	0.10	0.53
Jan-22	10	-	10	80	32	136	0.32	0.07
Feb-22	50	17	33	406	292	520	0.14	0.29
Mar-22	11	3	8	88	40	144	0.30	0.08

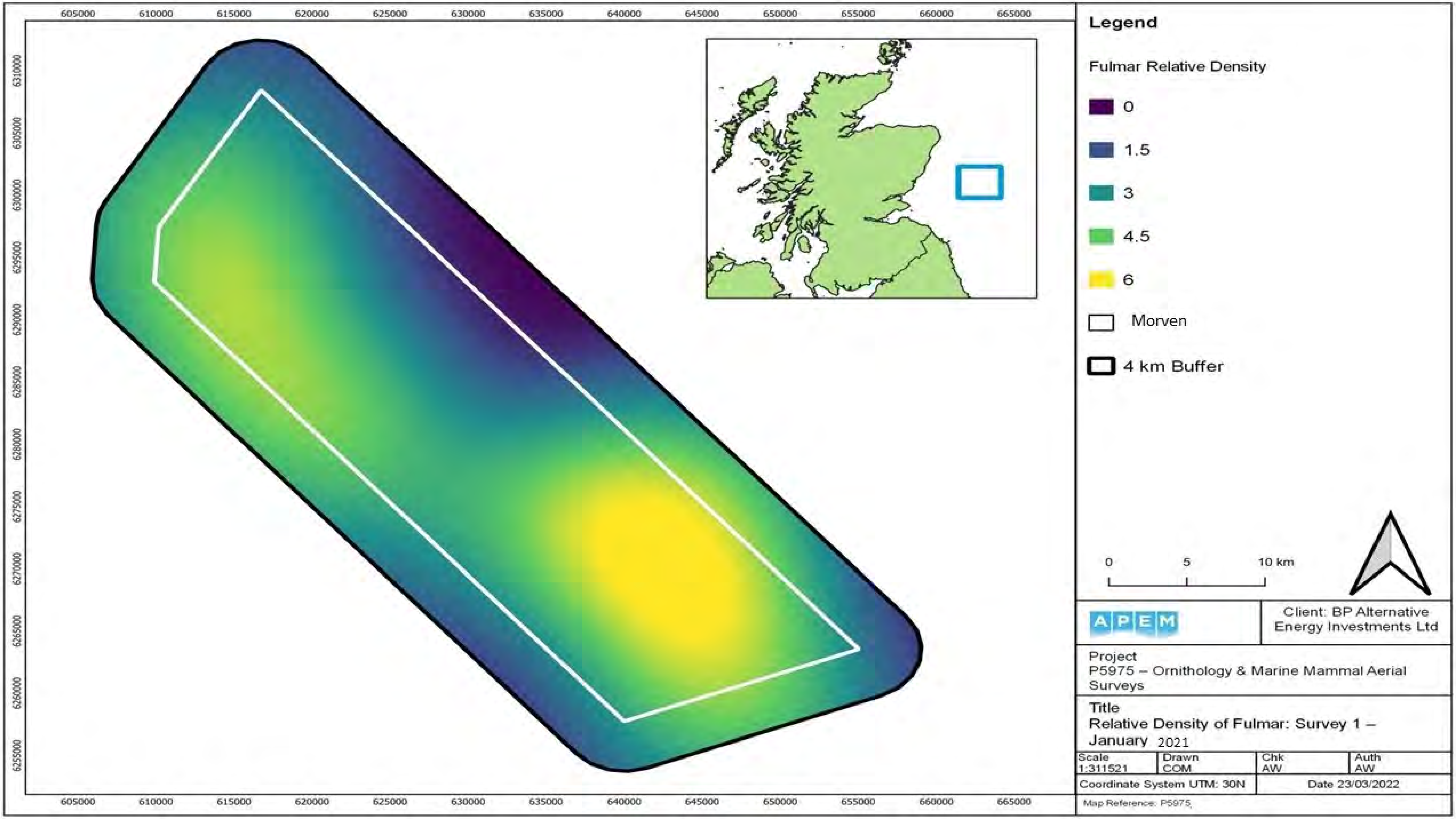


Figure 157 Relative density of fulmar in January 2021 (Survey 01).

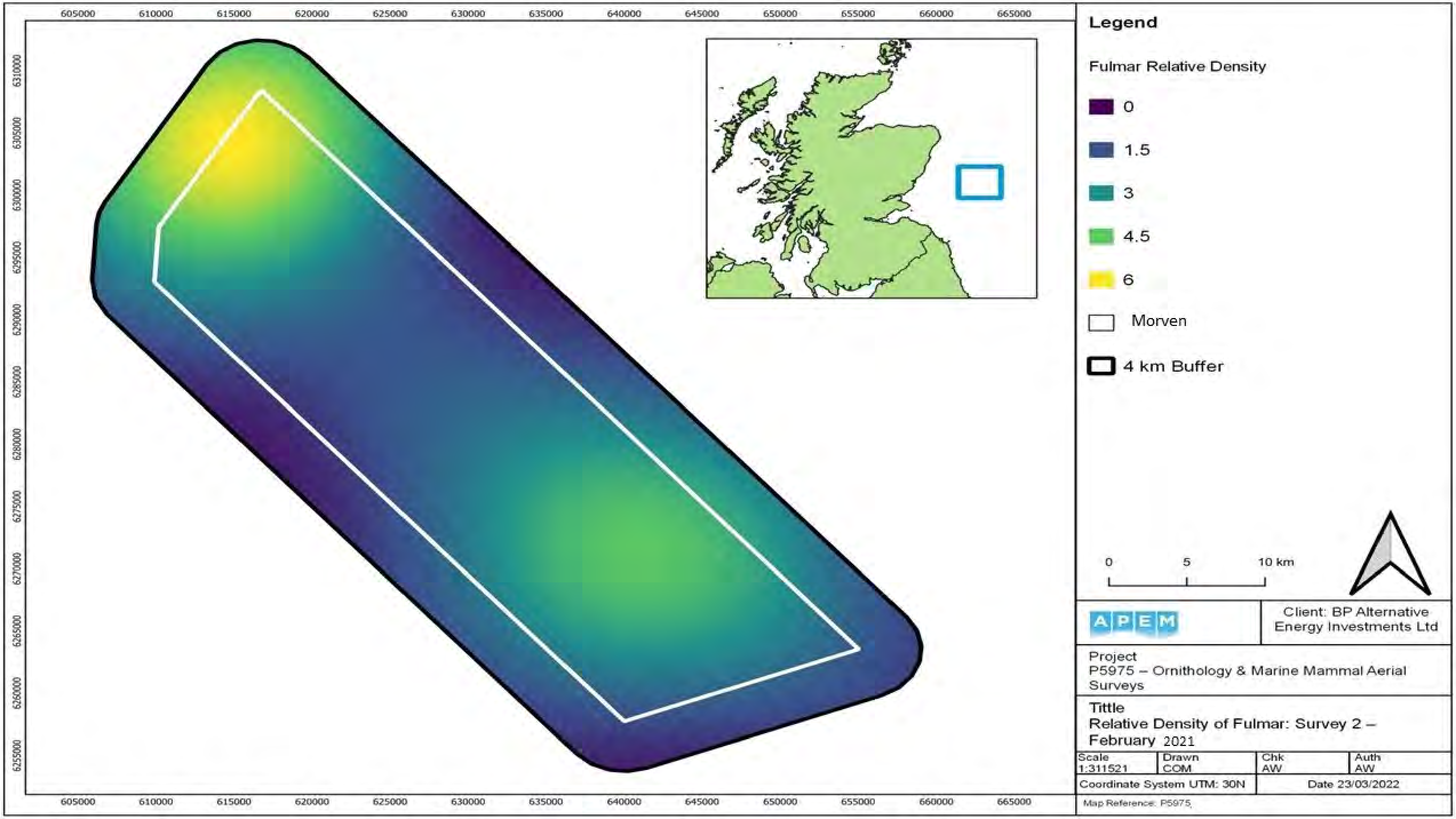


Figure 158 Relative density of fulmar in February 2021 (Survey 02).

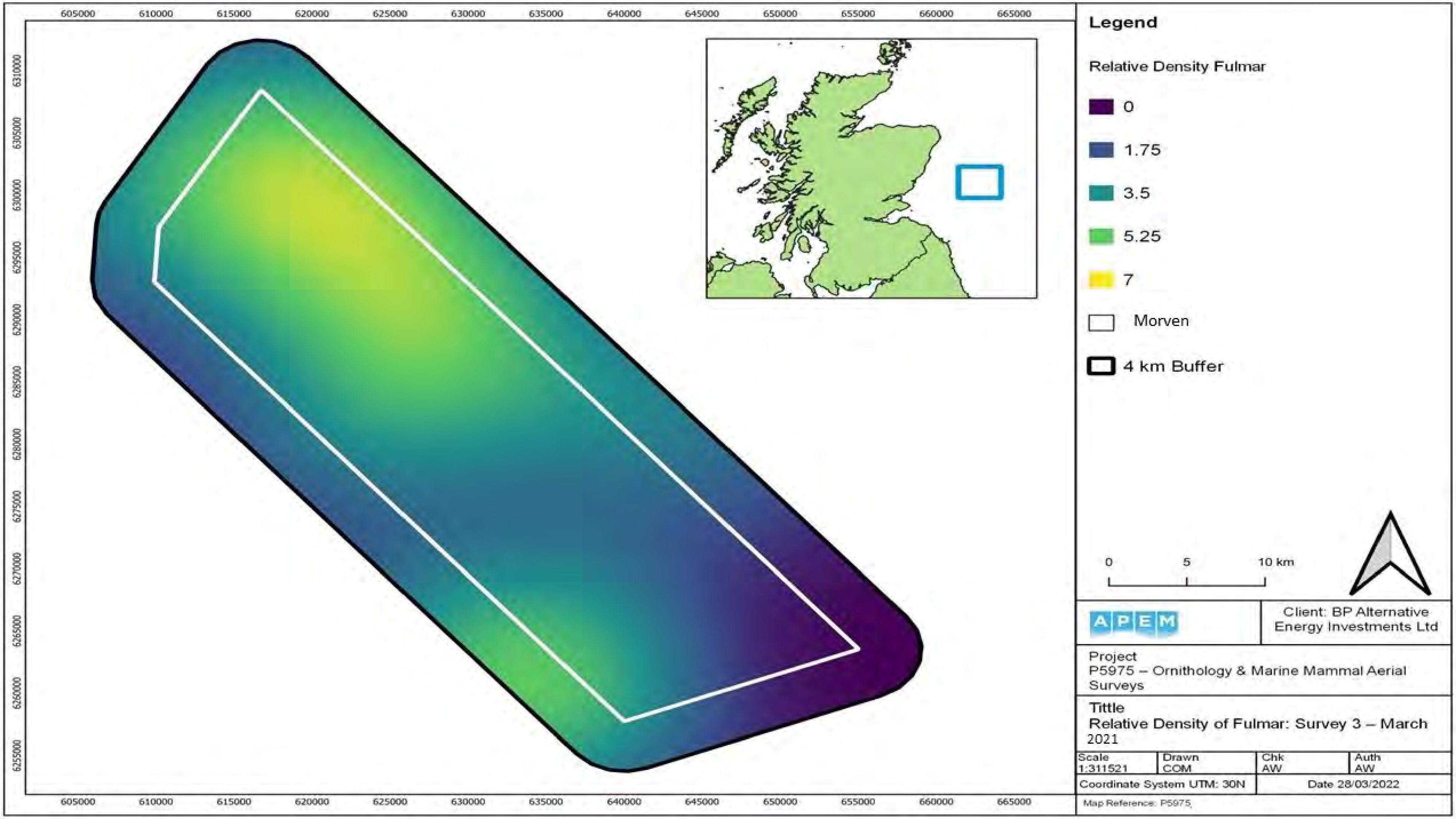


Figure 159 Relative density of fulmar in March 2021 (Survey 03).

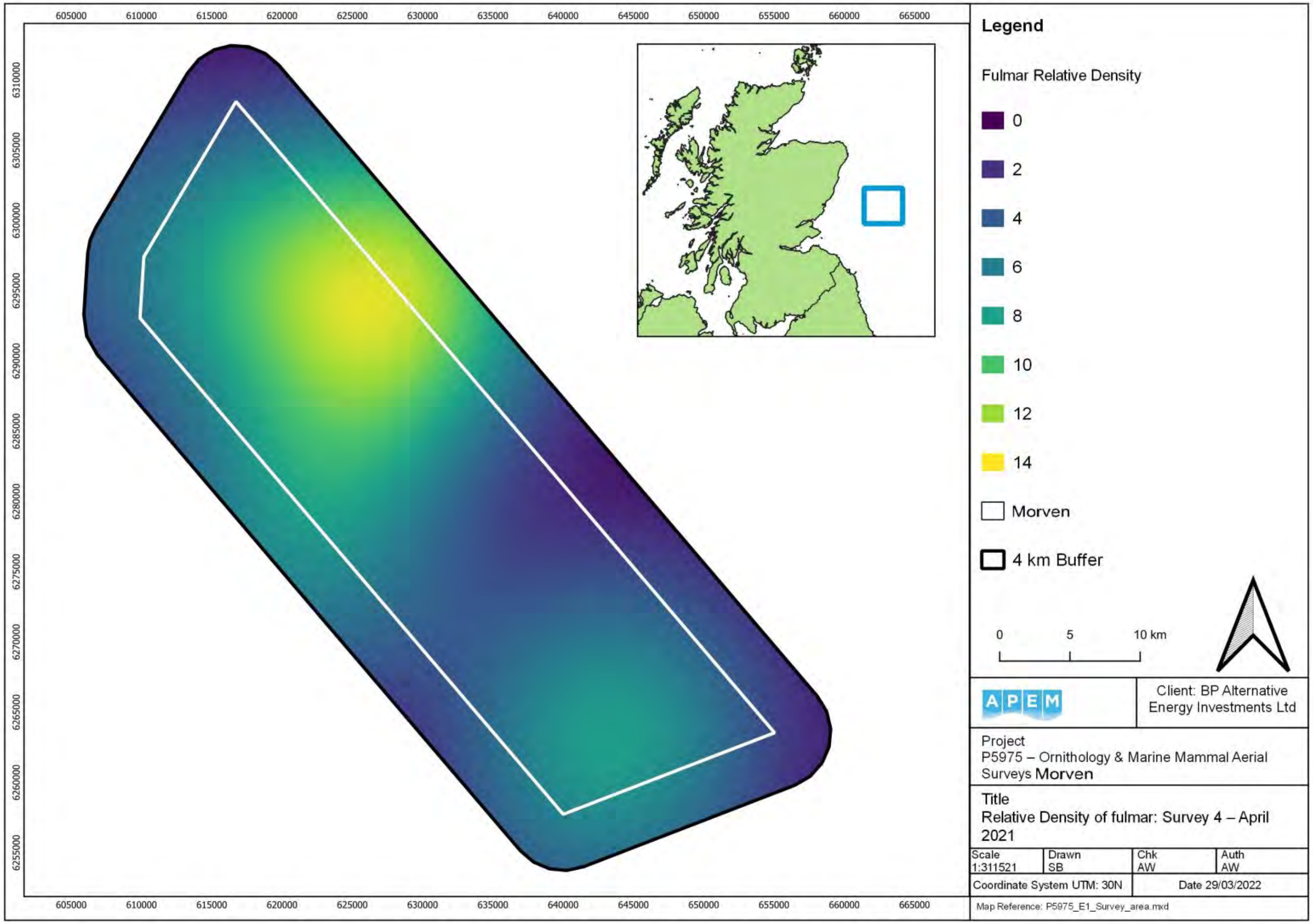


Figure 160 Relative density of fulmar in April 2021 (Survey 04).

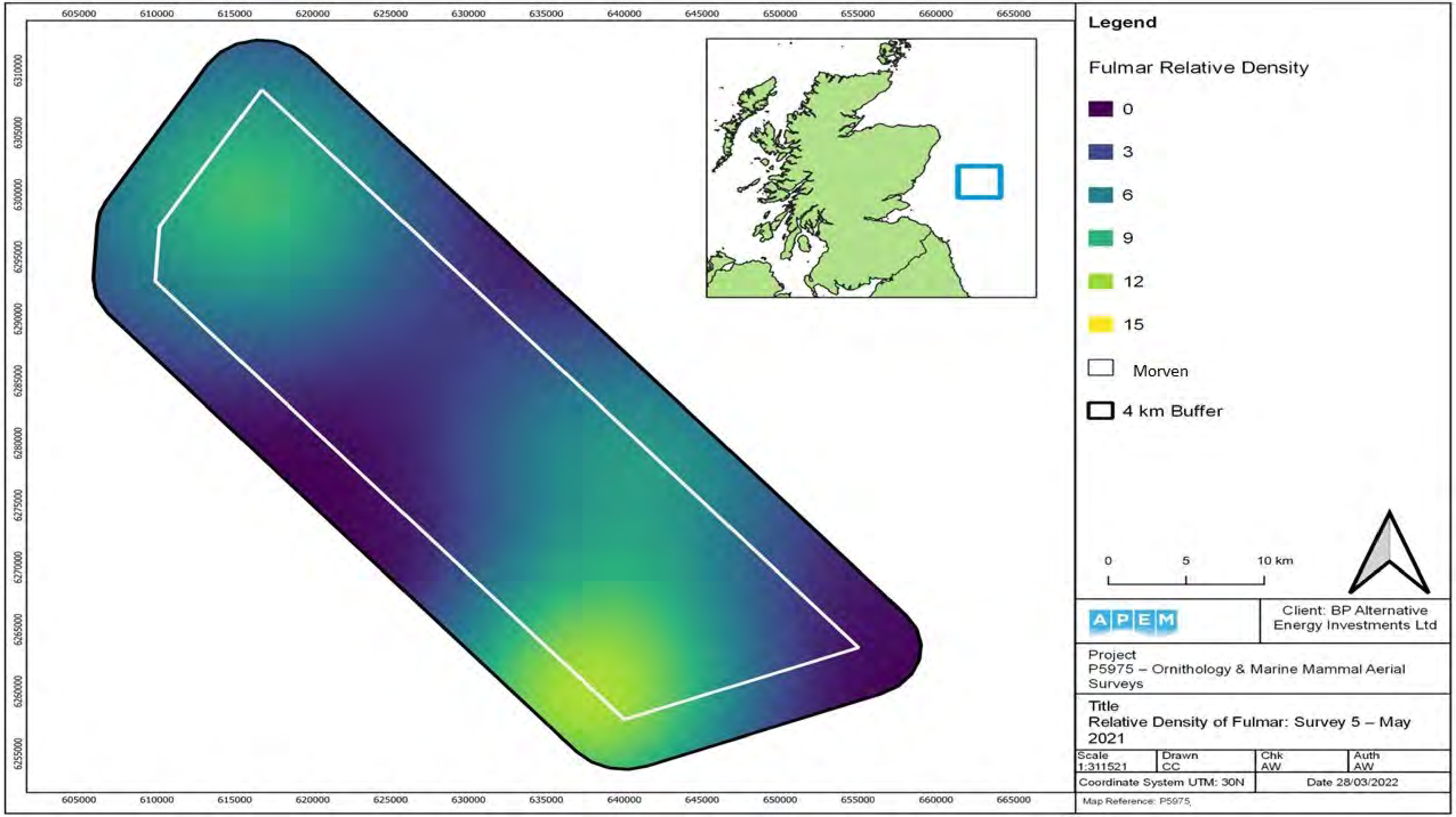


Figure 161 Relative density of fulmar in May 2021 (Survey 05).

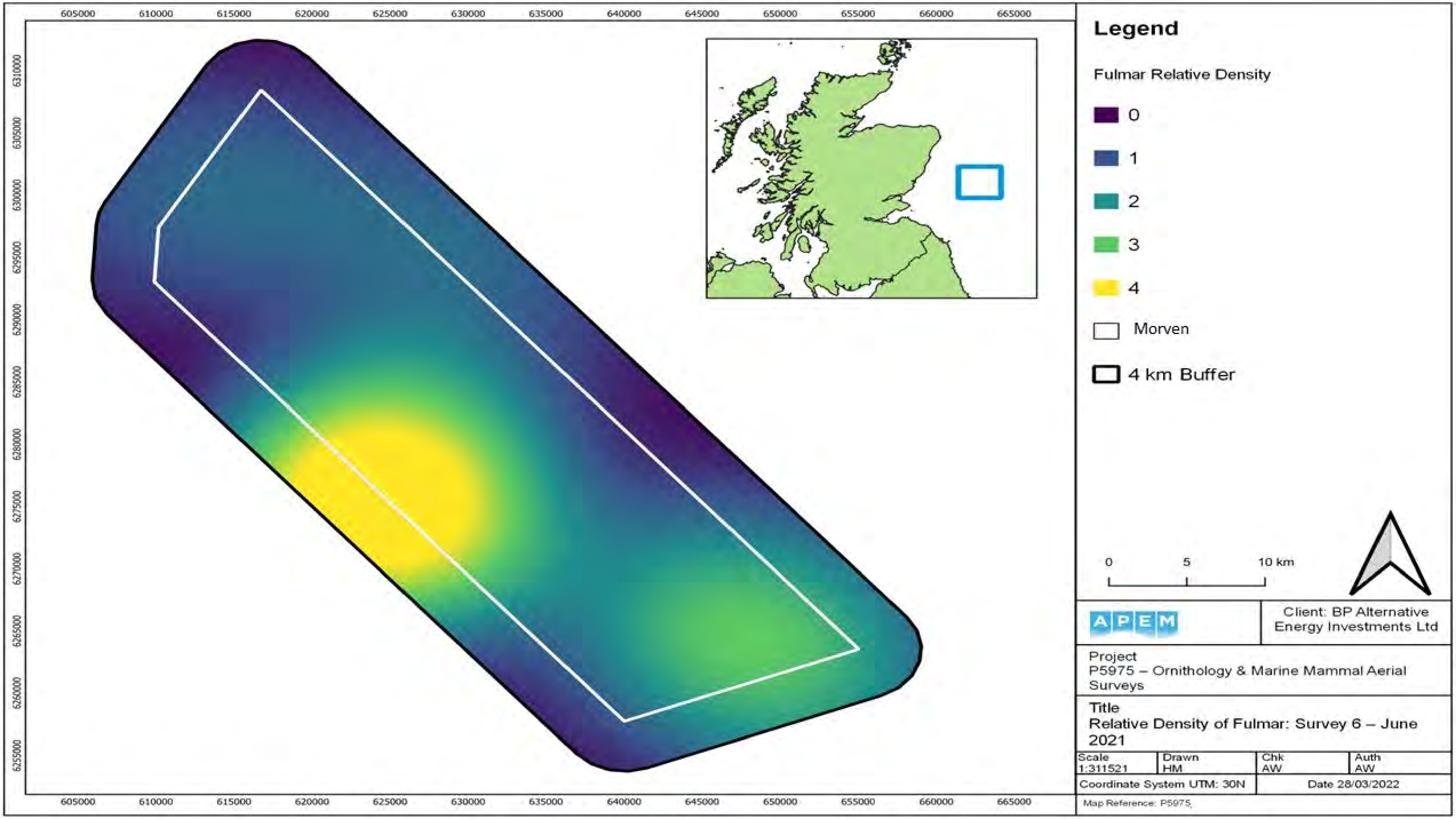


Figure 162 Relative density of fulmar in June 2021 (Survey 06).

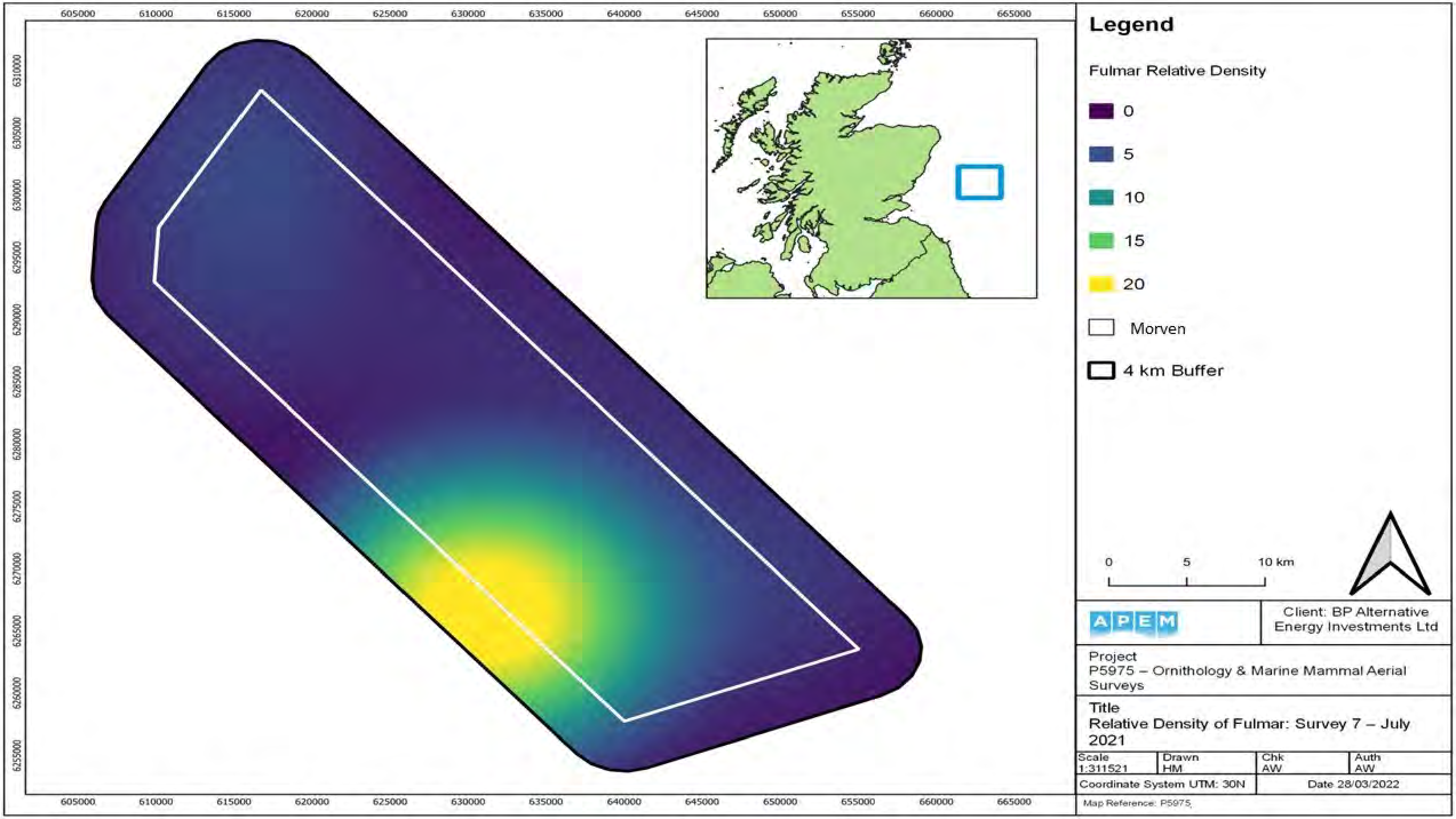


Figure 163 Relative density of fulmar in July 2021 (Survey 07).

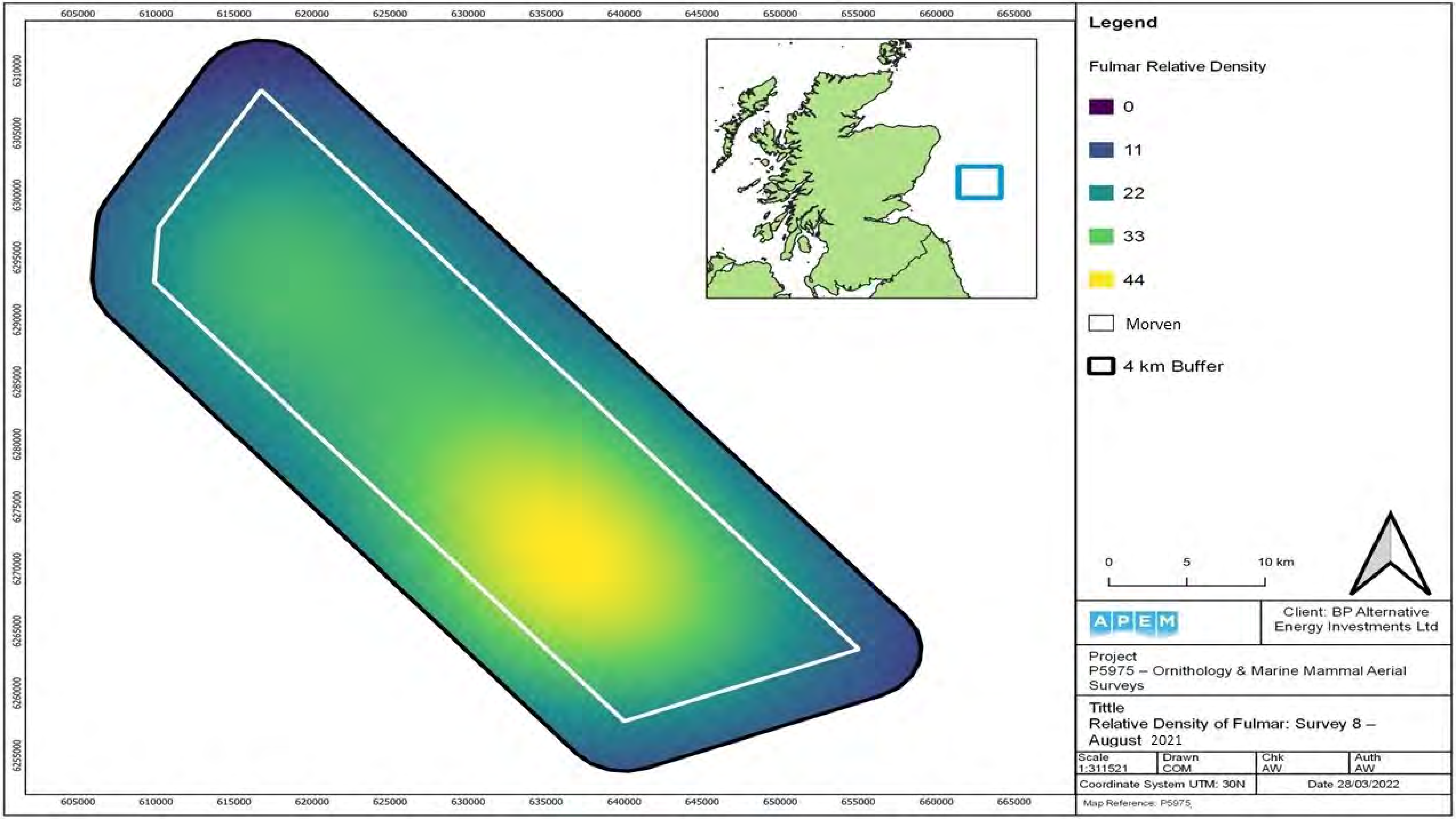


Figure 164 Relative density of fulmar in August 2021 (Survey 08).

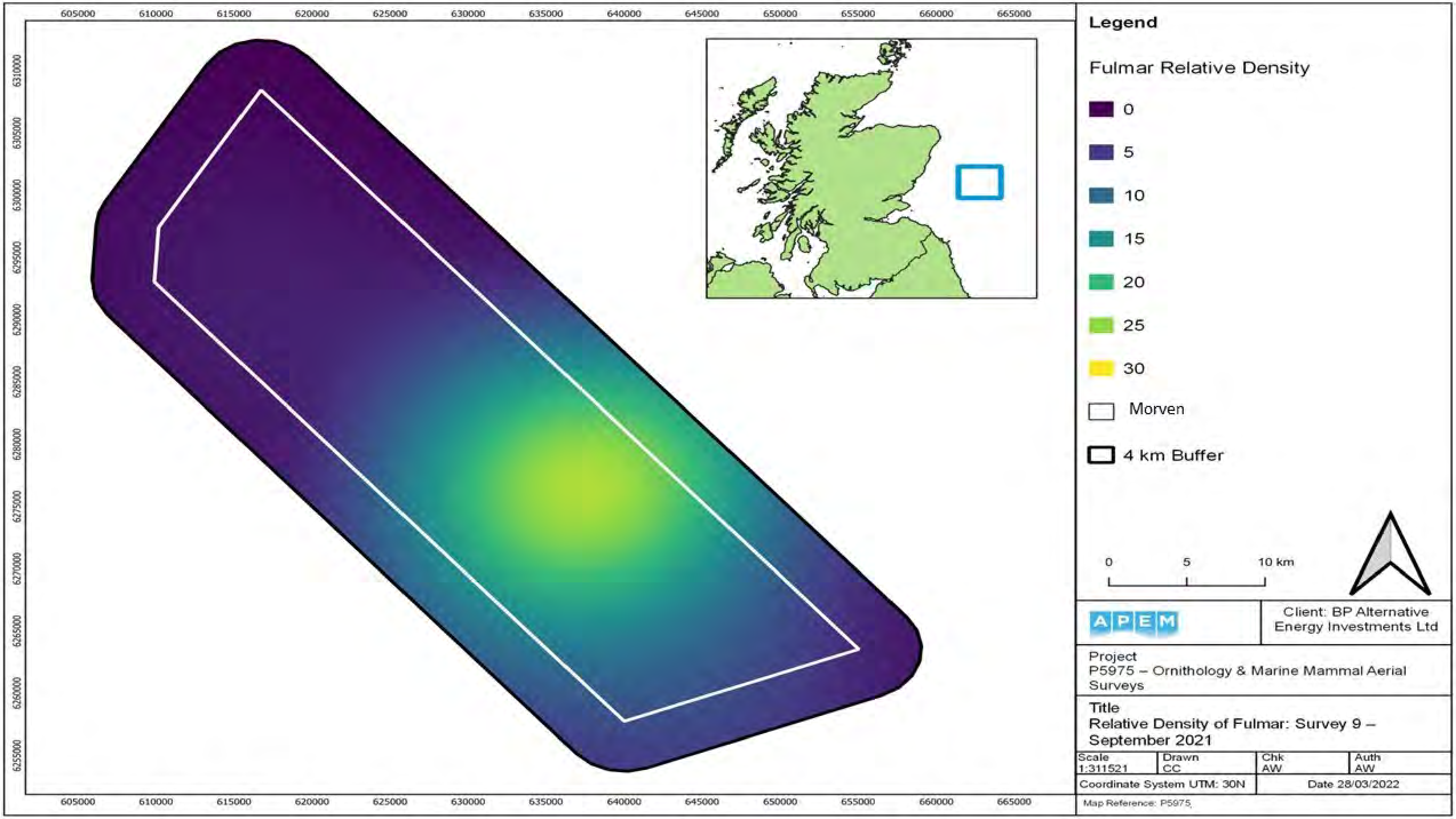


Figure 165 Relative density of fulmar in September 2021 (Survey 09).

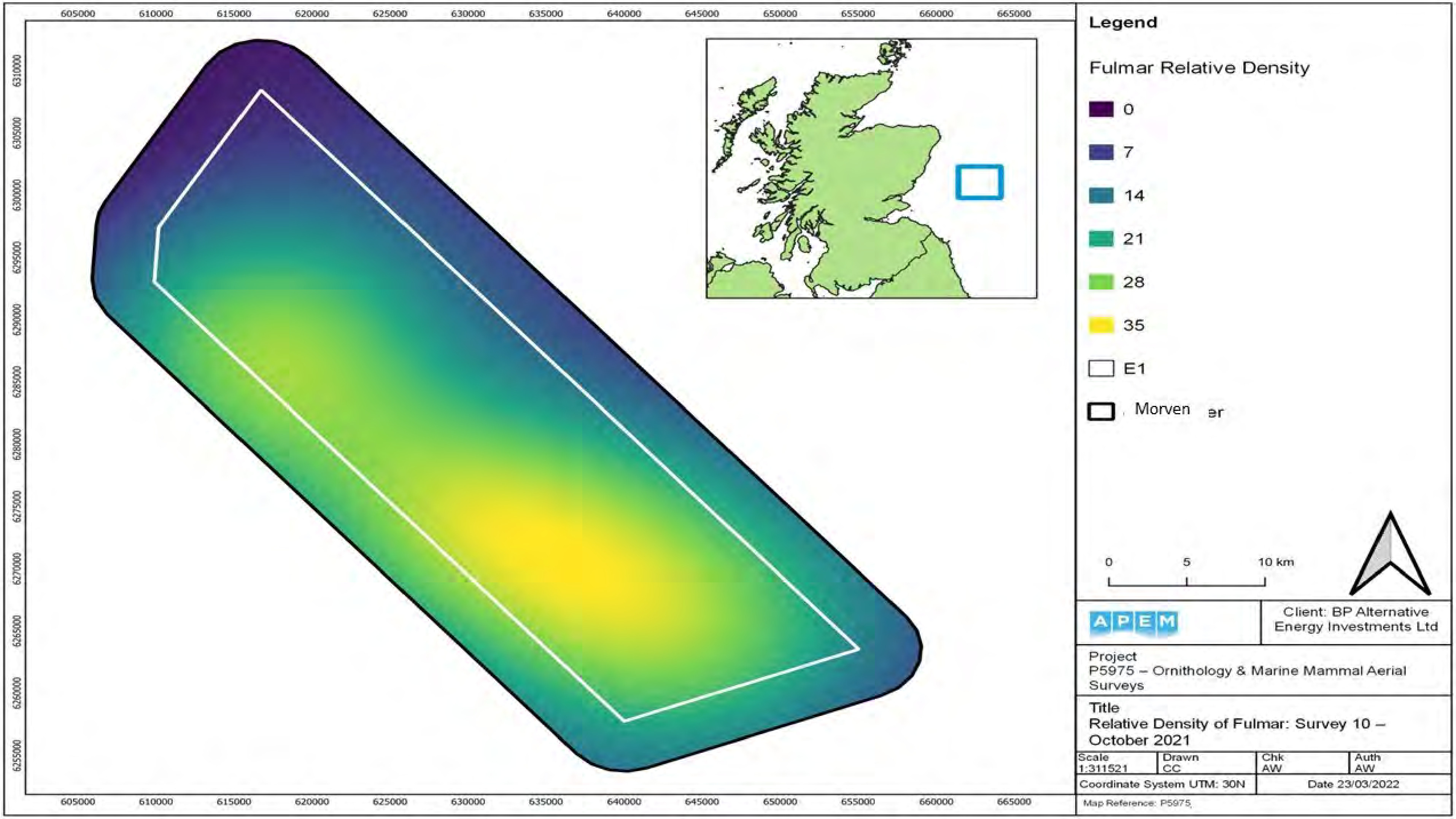


Figure 166 Relative density of fulmar in October 2021 (Survey 10).

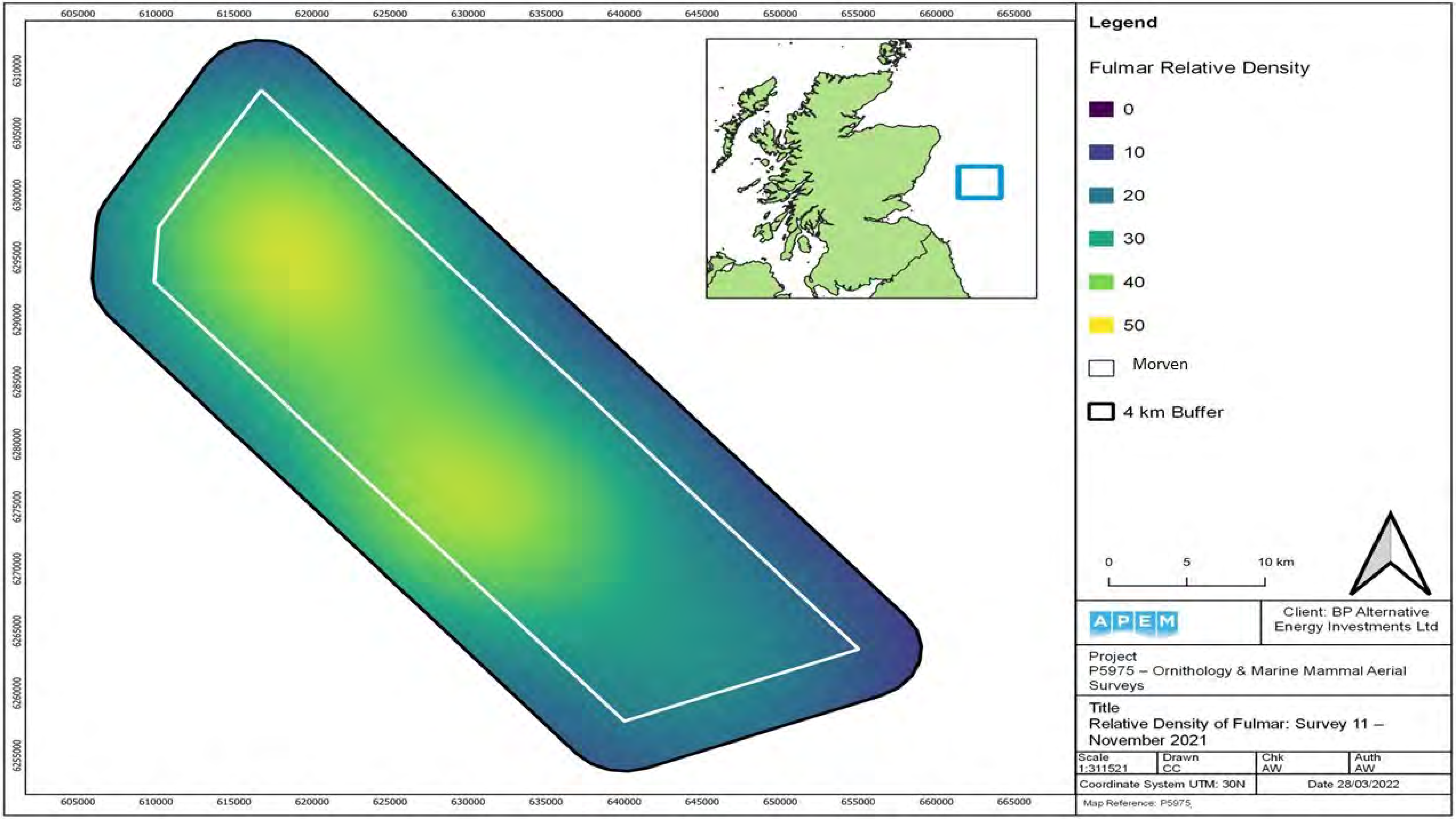


Figure 167 Relative density of fulmar in November 2021 (Survey 11).

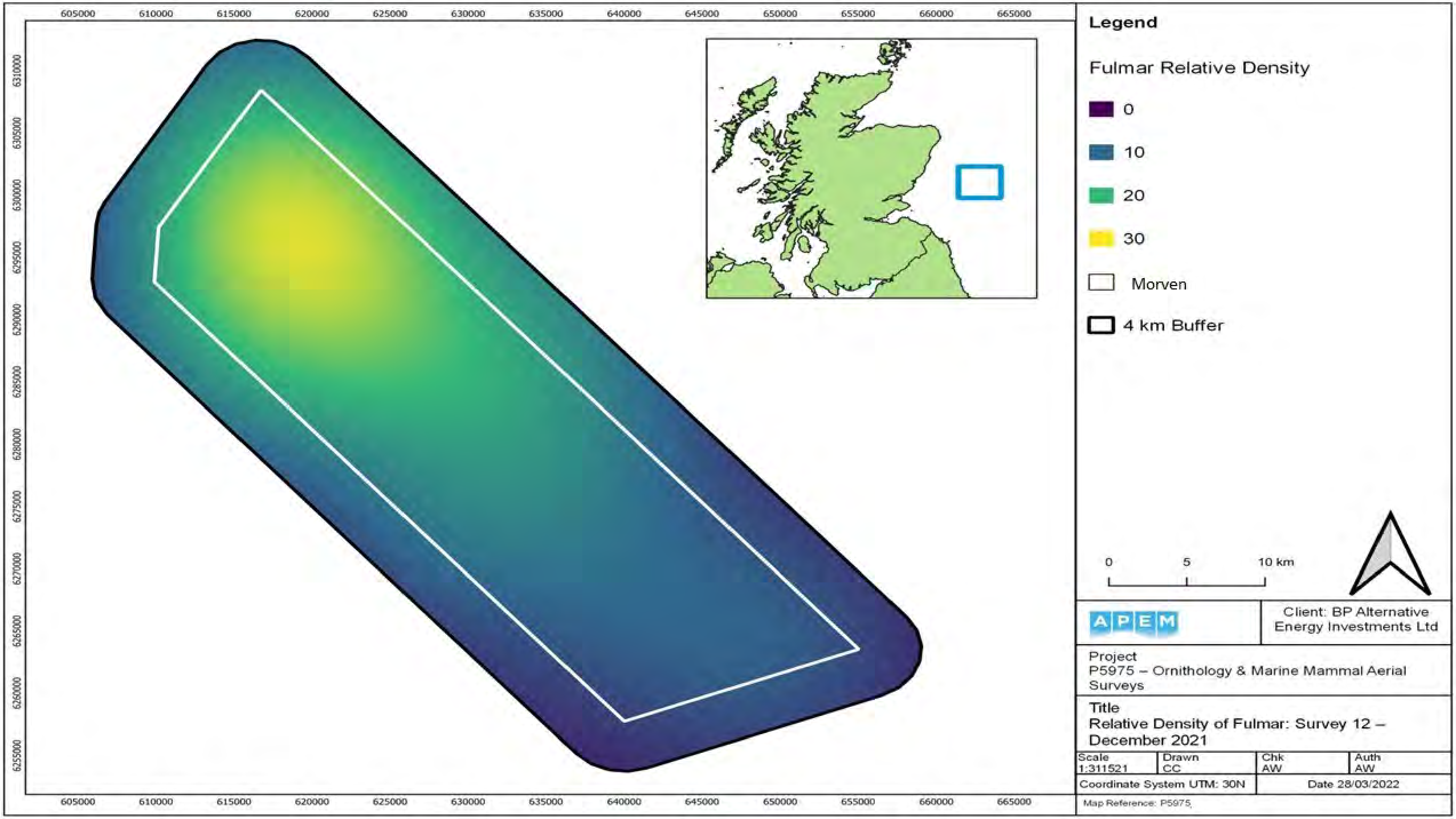


Figure 168 Relative density of fulmar in December 2021 (Survey 12).

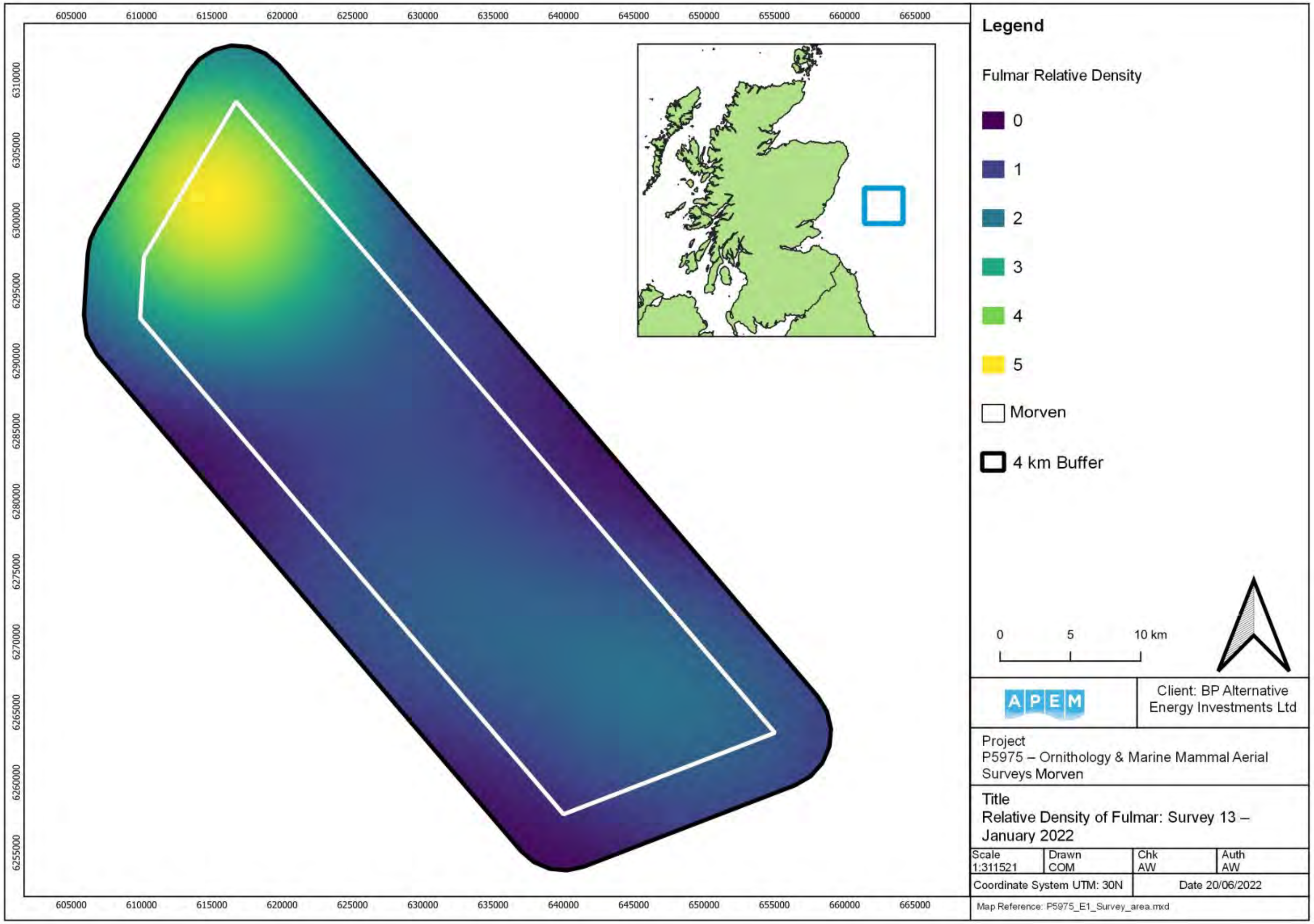


Figure 169 Relative density of fulmar in January 2022 (Survey 13).

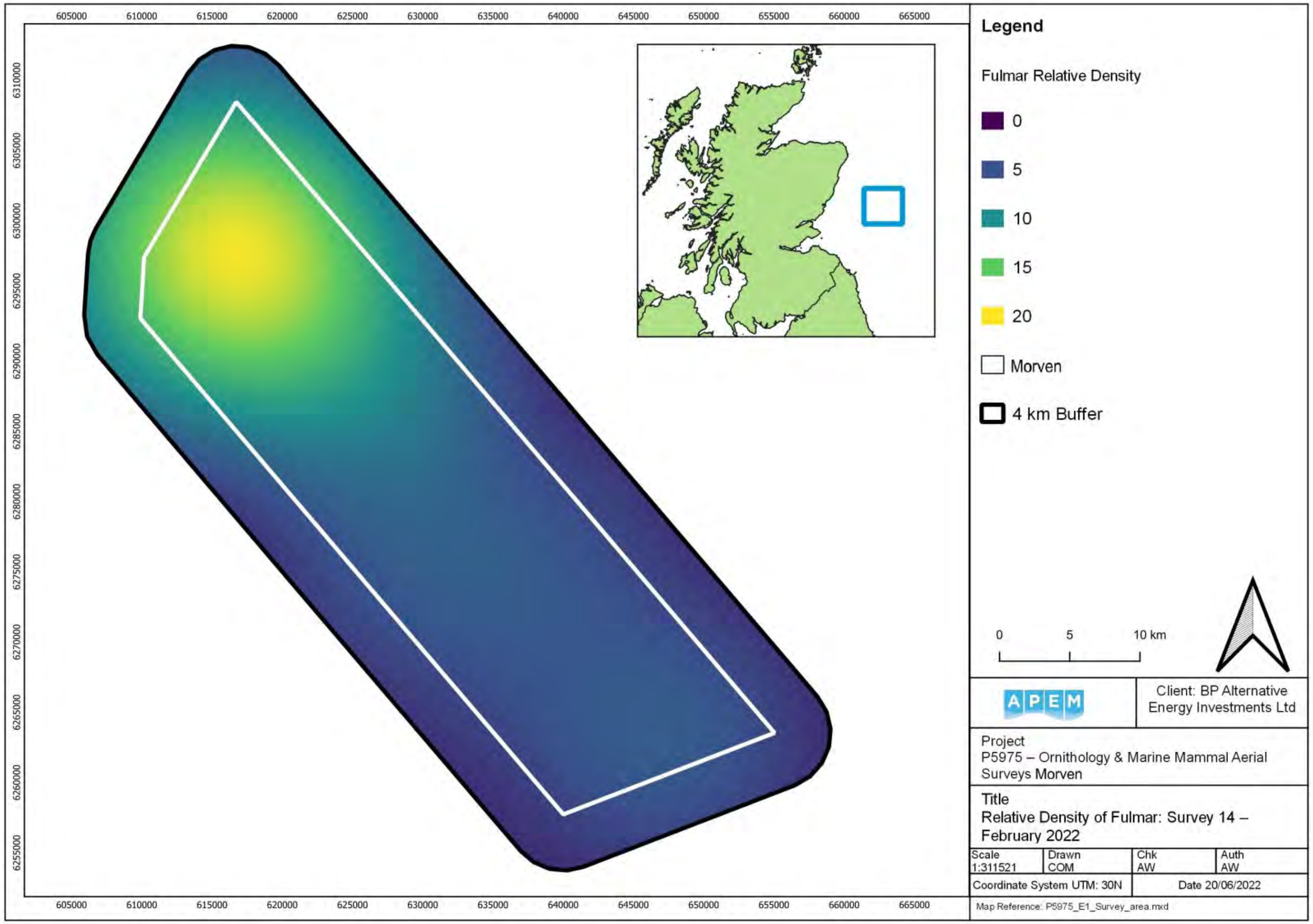


Figure 170 Relative density of fulmar in February 2022 (Survey 14).

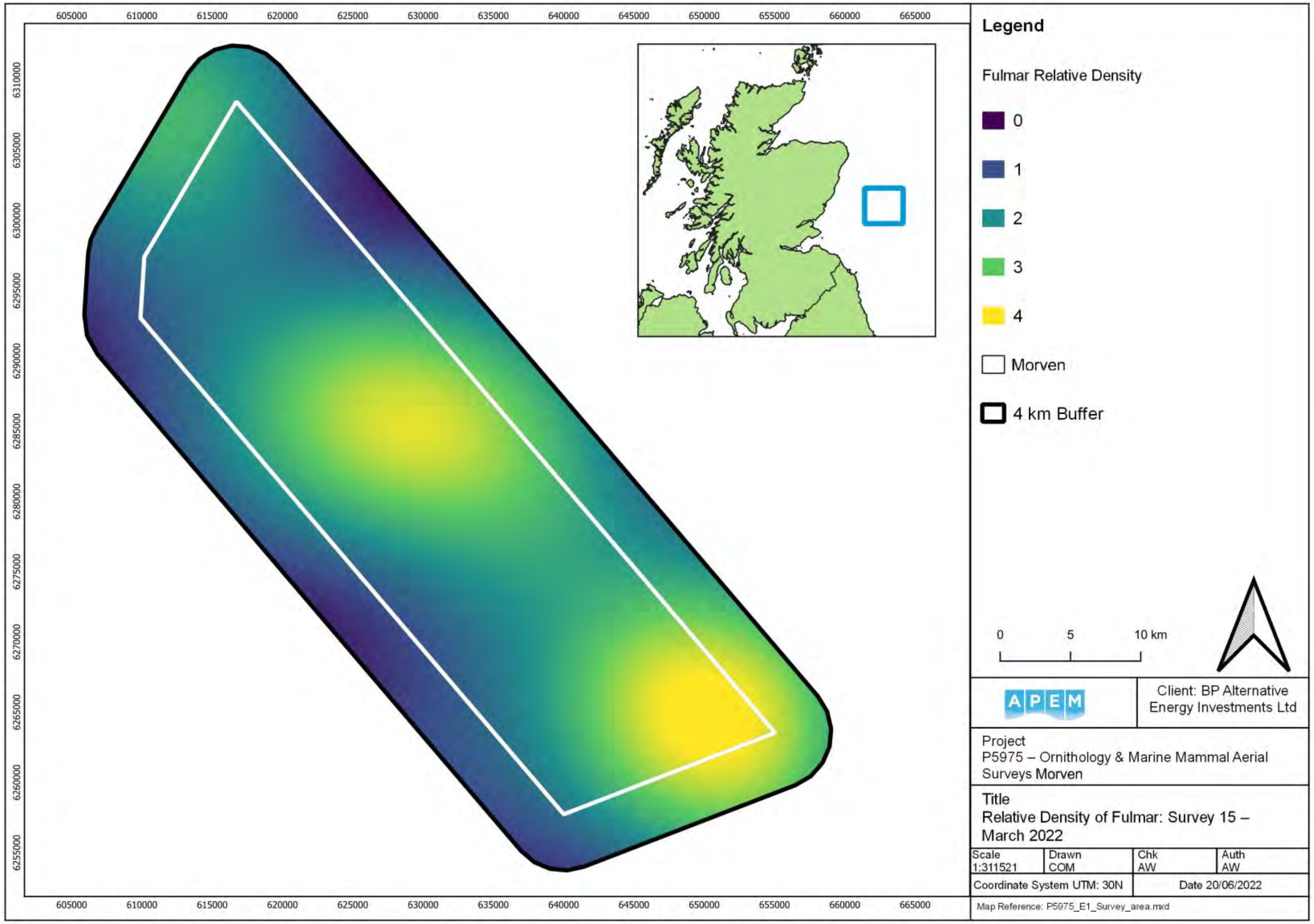
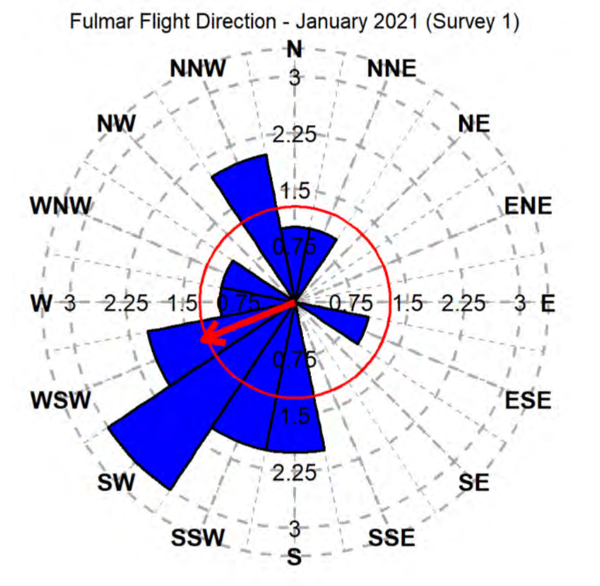
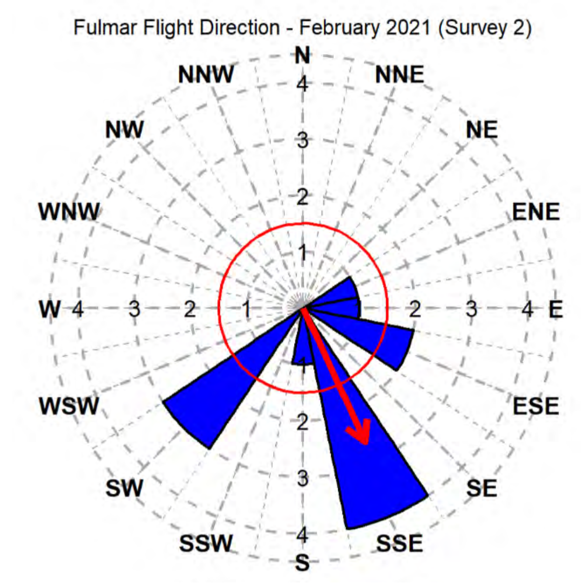


Figure 171 Relative density of fulmar in March 2022 (Survey 15).



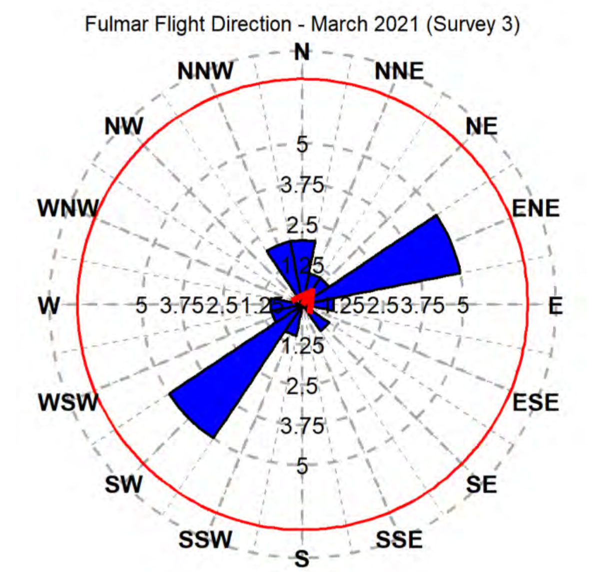
Number of Observations	16
Mean Vector (µ)	248.863
Length of Mean Vector (r)	0.441
Rayleigh Test (Z)	3.108
Rayleigh Test (p)	0.042

Figure 172a January 2021 (Survey 01)



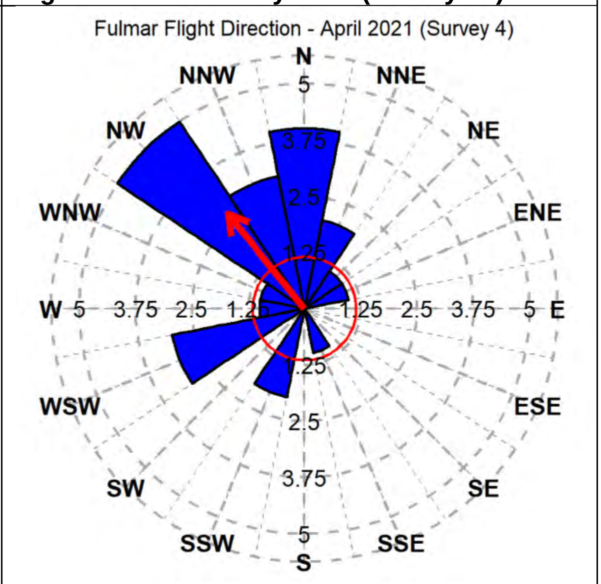
Number of Observations	12
Mean Vector (µ)	155.193
Length of Mean Vector (r)	0.653
Rayleigh Test (Z)	5.111
Rayleigh Test (p)	0.004

Figure 172b February 2021 (Survey 02)



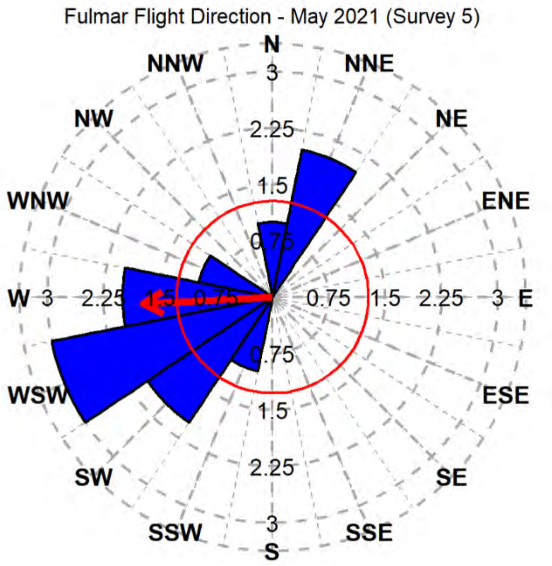
Number of Observations	21
Mean Vector (µ)	36.212
Length of Mean Vector (r)	0.101
Rayleigh Test (Z)	0.216
Rayleigh Test (p)	0.810

Figure 172c March 2021 (Survey 03)



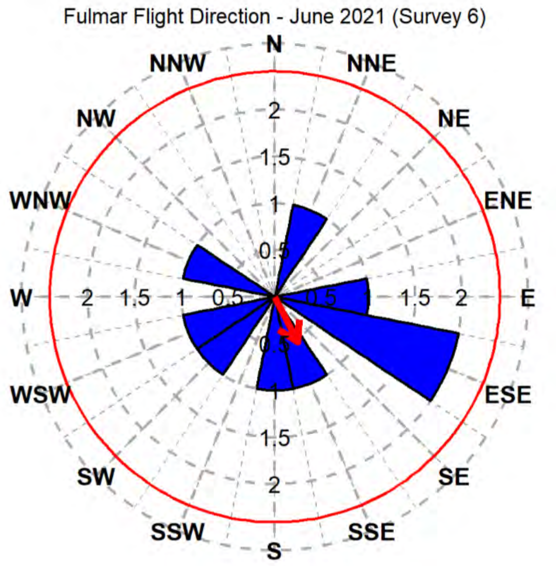
Number of Observations	24
Mean Vector (µ)	321.475
Length of Mean Vector (r)	0.540
Rayleigh Test (Z)	7.010
Rayleigh Test (p)	<0.001

Figure 172d April 2021 (Survey 04)



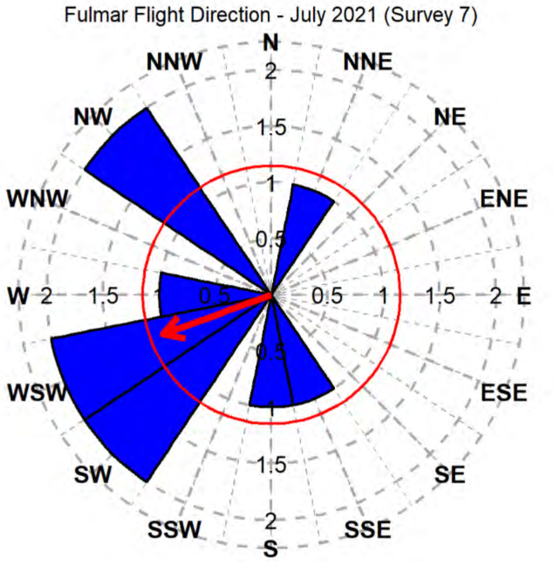
Number of Observations	12
Mean Vector (µ)	267.715
Length of Mean Vector (r)	0.575
Rayleigh Test (Z)	3.972
Rayleigh Test (p)	0.016

Figure 172e May 2021 (Survey 05)



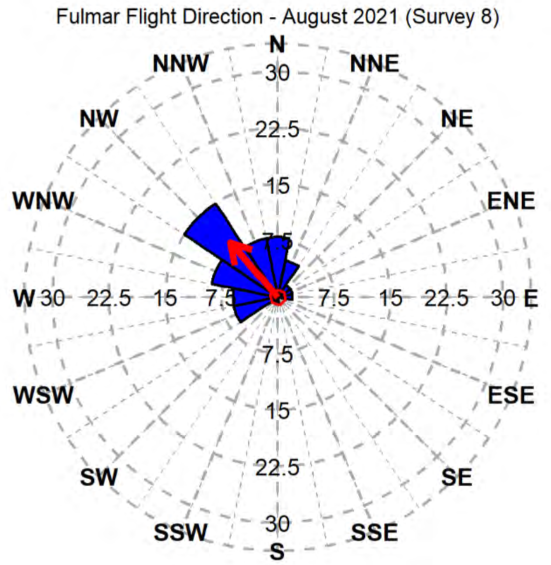
Number of Observations	9
Mean Vector (µ)	153.434
Length of Mean Vector (r)	0.271
Rayleigh Test (Z)	0.663
Rayleigh Test (p)	0.528

Figure 172f June 2021 (Survey 06)



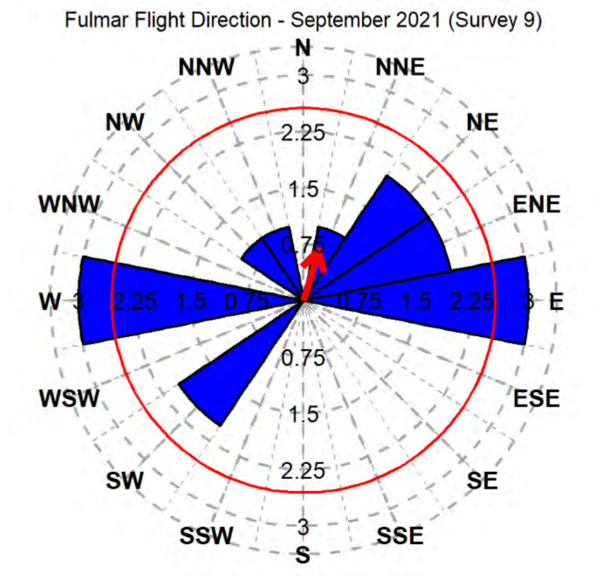
Number of Observations	10
Mean Vector (µ)	250.204
Length of Mean Vector (r)	0.513
Rayleigh Test (Z)	2.632
Rayleigh Test (p)	0.069

Figure 172g July 2021 (Survey 07)



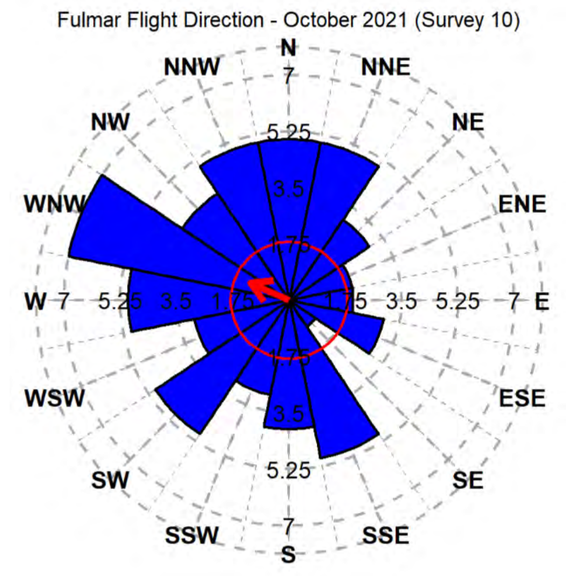
Number of Observations	66
Mean Vector (µ)	319.288
Length of Mean Vector (r)	0.640
Rayleigh Test (Z)	26.993
Rayleigh Test (p)	<0.001

Figure 172h August 2021 (Survey 08)



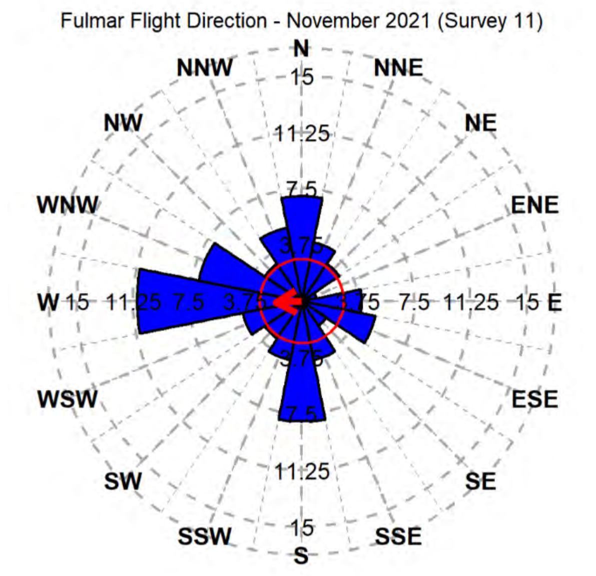
Number of Observations	15
Mean Vector (μ)	17.183
Length of Mean Vector (r)	0.230
Rayleigh Test (Z)	0.792
Rayleigh Test (p)	0.460

Figure 172i September 2021 (Survey 09)



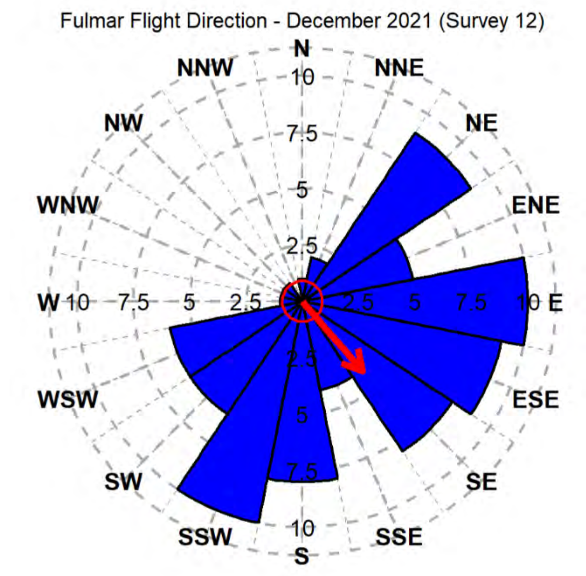
Number of Observations	62
Mean Vector (μ)	294.951
Length of Mean Vector (r)	0.186
Rayleigh Test (Z)	2.148
Rayleigh Test (p)	0.117

Figure 172j October 2021 (Survey 10)



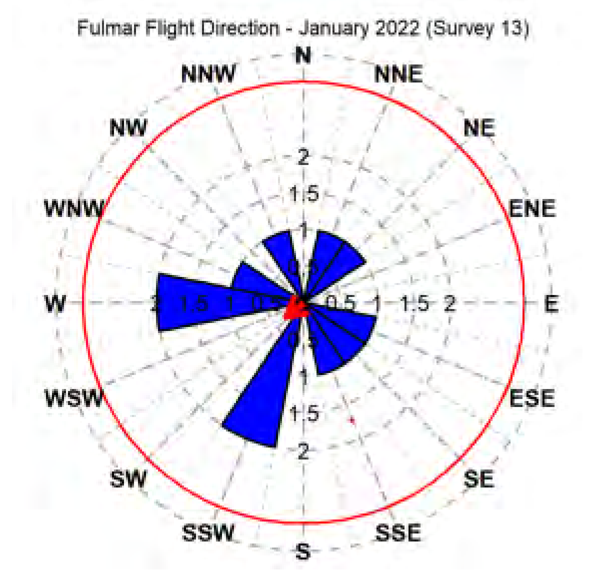
Number of Observations	75
Mean Vector (μ)	267.125
Length of Mean Vector (r)	0.156
Rayleigh Test (Z)	1.835
Rayleigh Test (p)	0.160

Figure 172k November 2021 (Survey 11)



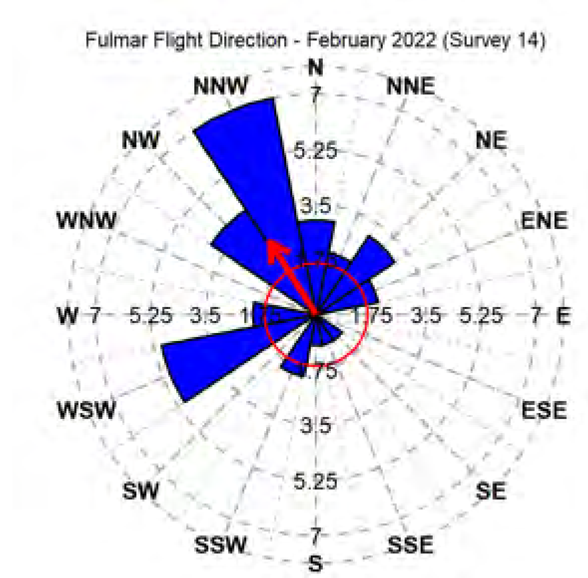
Number of Observations	81
Mean Vector (μ)	139.411
Length of Mean Vector (r)	0.407
Rayleigh Test (Z)	13.429
Rayleigh Test (p)	<0.001

Figure 172l December 2021 (Survey 12)



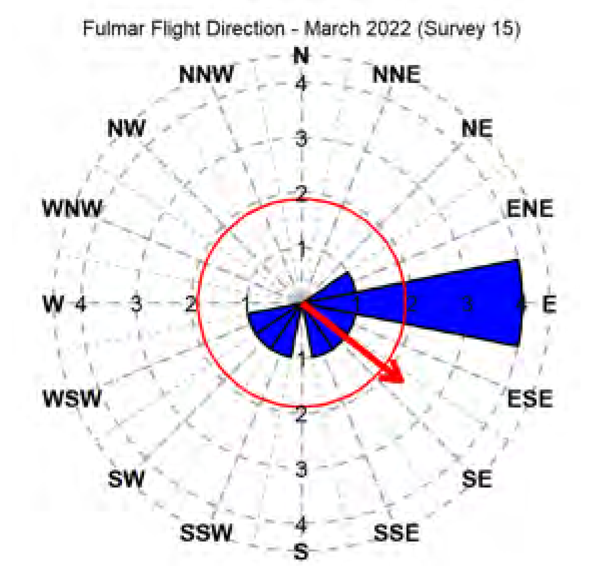
Number of Observations	11
Mean Vector (µ)	230.568
Length of Mean Vector (r)	0.149
Rayleigh Test (Z)	0.244
Rayleigh Test (p)	0.791

Figure 172m January 2022 (Survey 13)



Number of Observations	3
Mean Vector (µ)	277.444
Length of Mean Vector (r)	0.502
Rayleigh Test (Z)	0.758
Rayleigh Test (p)	0.511

Figure 172n February 2022 (Survey 14)



Number of Observations	21
Mean Vector (µ)	296.026
Length of Mean Vector (r)	0.746
Rayleigh Test (Z)	11.691
Rayleigh Test (p)	<0.001

Figure 172o March 2022 (Survey 15)

Figure 172 Summary of flight directions of fulmars recorded in the Array Project.

4.28 Sooty Shearwater – *Ardenna grisea*

Sooty shearwaters were recorded in September 2021 only - two individuals centrally to the west of the Array Project (Figure 147). This resulted in an abundance estimate of 16 within the Array Project (Table 32).

The two sooty shearwaters recorded were not flying in a significant direction (p>0.05).

Table 32 Raw counts, abundance and density estimates of sooty shearwater in the Array Project.

Survey	Raw Count	Sitting	Flying	Abundance	Lower CL	Upper CL	Precision	Density
Sep-21	2	-	2	16	2	49	0.71	0.01

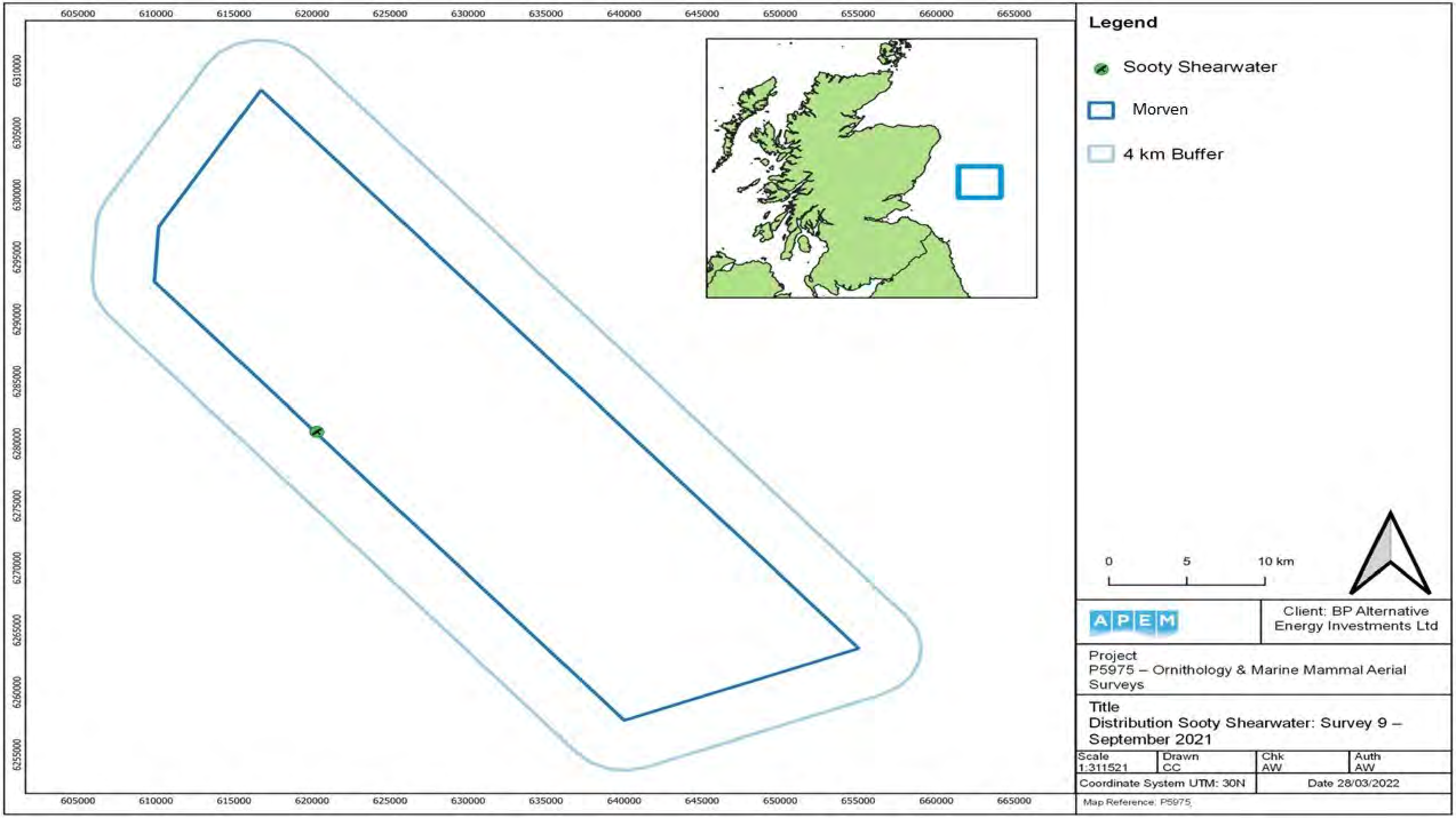


Figure 173 Location of sooty shearwaters in September 2021 (Survey 09).

4.29 Manx Shearwater – *Puffinus puffinus*

Manx shearwaters were recorded in May, June, and July 2021, with peak numbers in July of 49 individuals, resulting in an abundance estimate of 402 within the Array Project (Table 33).

These were in the northwest in May (Figure 174); north in June (Figure 175); and mainly to the north with some to the south in July (Figure 176).

Manx shearwaters were recorded flying in a significant west-south-westerly direction (μ=255.905; $p<0.05$) (Figure 177).

Table 33 Raw counts, abundance and density estimates of Manx shearwater in the Array Project.

Survey	Raw Count	Sitting	Flying	Abundance	Lower CL	Upper CL	Precision	Density
May-21	1	1	-	8	1	33	1.00	0.01
Jun-21	2	2	-	17	2	49	0.71	0.01
Jul-21	49	27	22	402	238	631	0.14	0.28

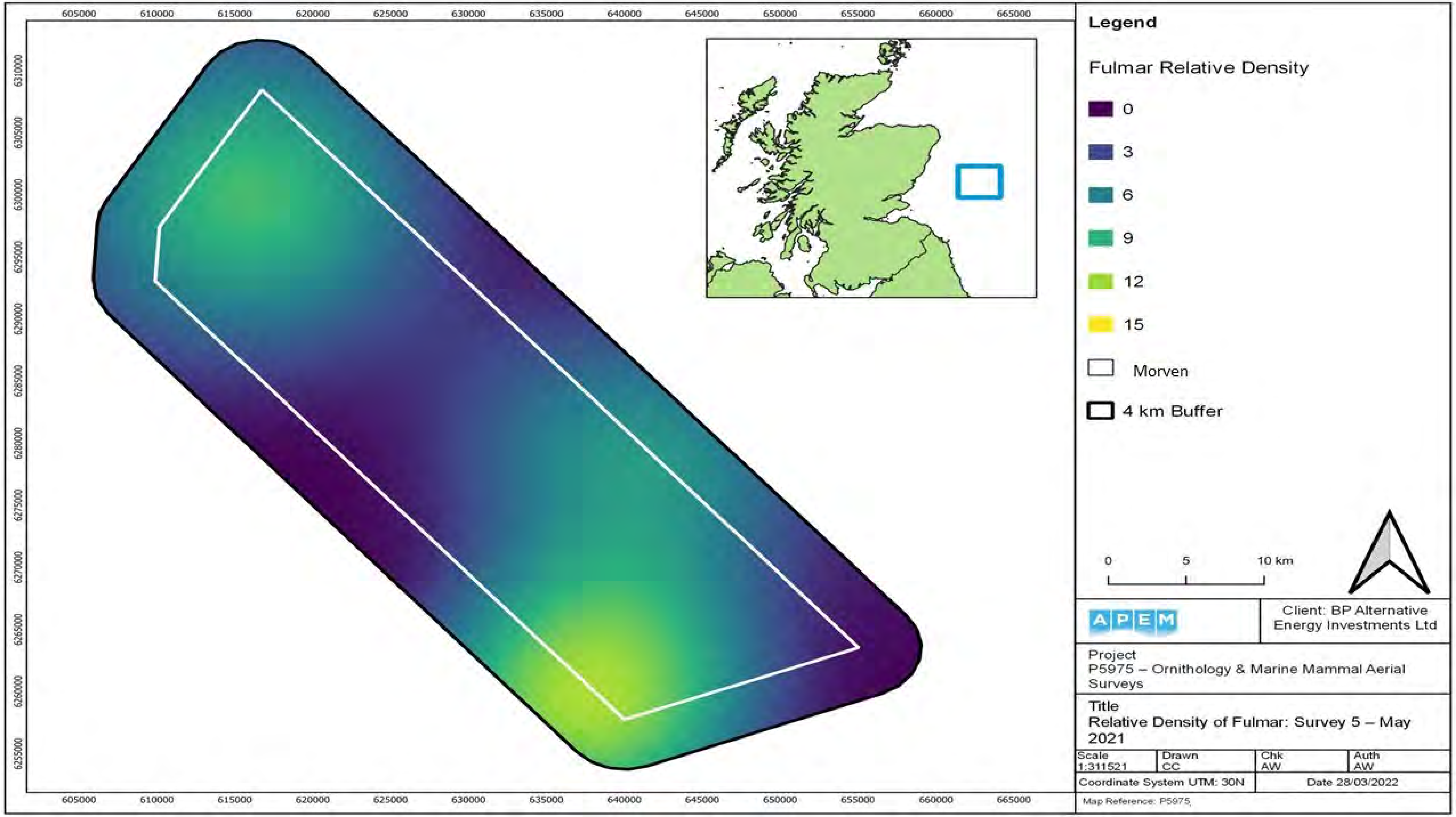


Figure 174 Location of a Manx shearwater in May 2021 (Survey 05).

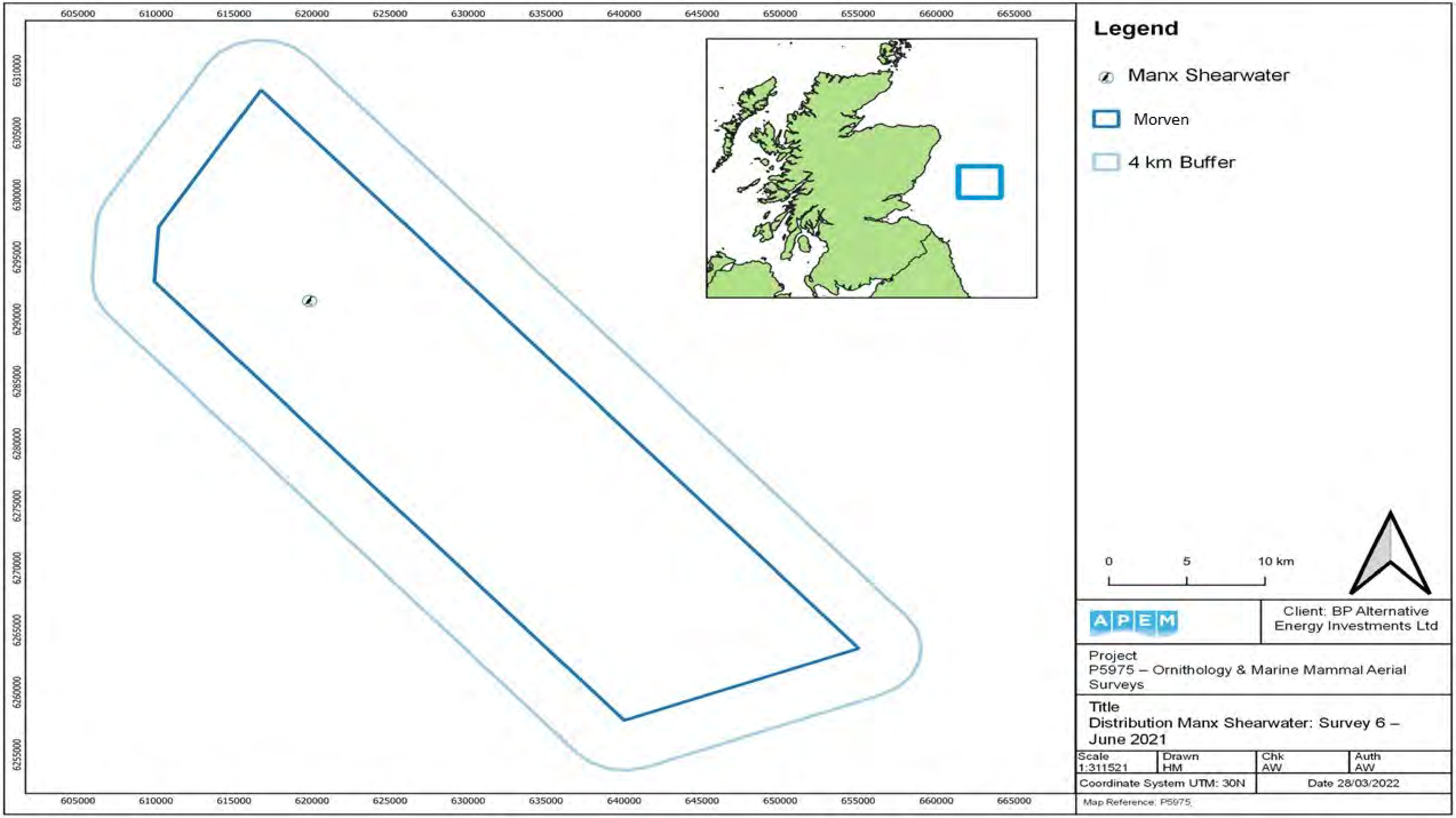


Figure 175 Location of Manx shearwaters in June 2021 (Survey 06).

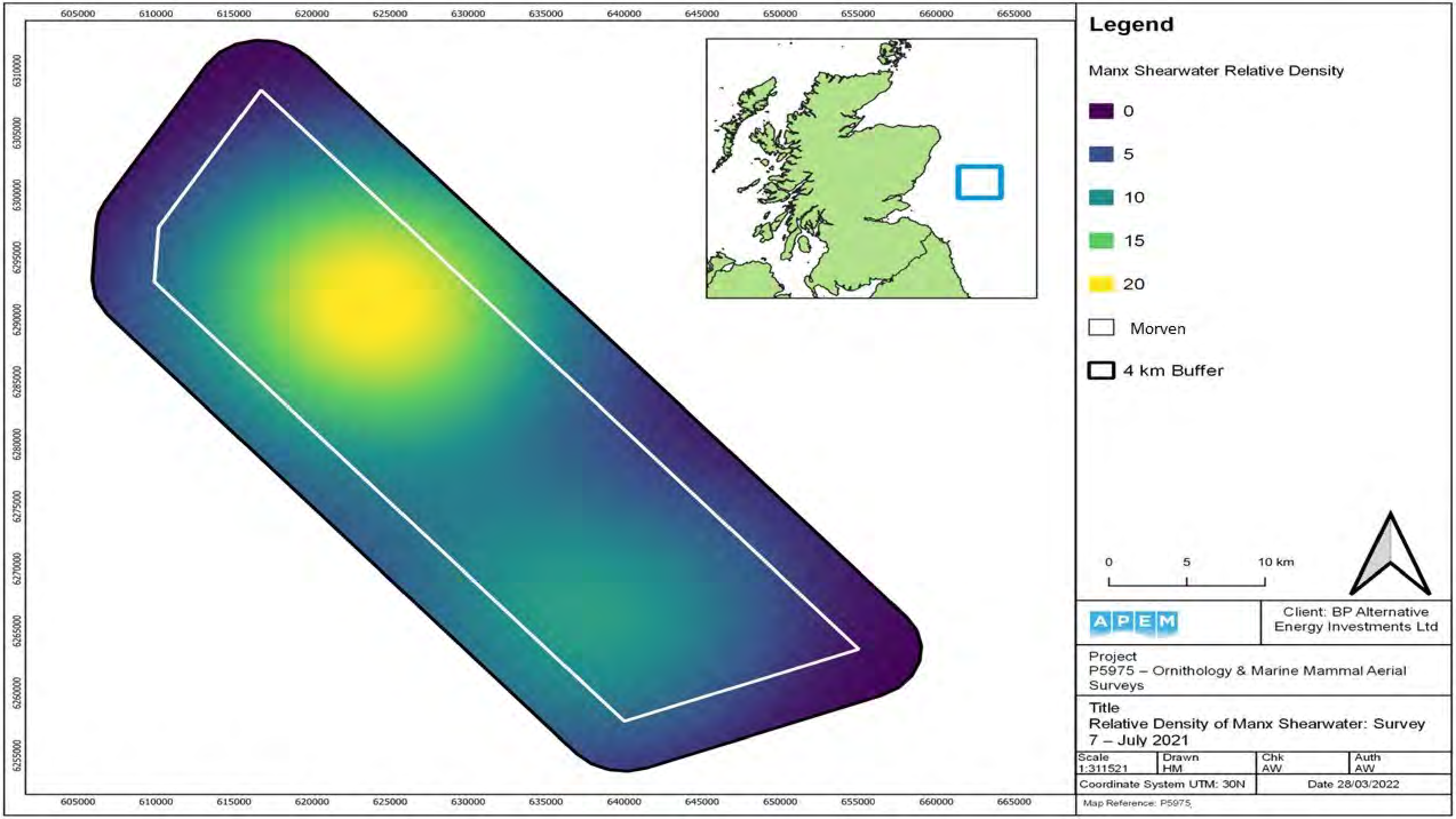
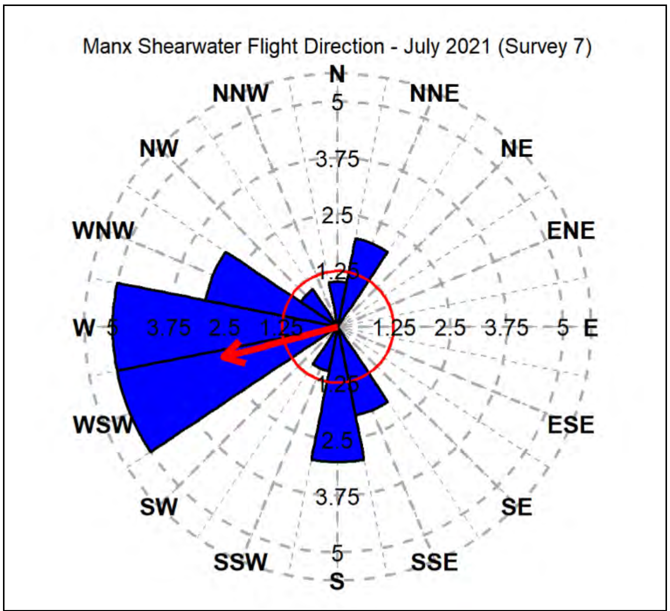


Figure 176 Relative density of Manx shearwater in July 2021 (Survey 07).



Number of Observations	23
Mean Vector (µ)	255.905
Length of Mean Vector (r)	0.524
Rayleigh Test (Z)	6.321
Rayleigh Test (p)	0.001

Figure 177 Summary of flight directions of Manx shearwaters recorded in the Array Project.

5.30 Auk / Shearwater species - *Unidentified*

Auks / shearwaters were recorded in June and July 2021, with peak numbers in July - 100 individuals, resulting in an abundance estimate of 820 within the Array Project (Table 34).

These were identified centrally and to the south in June (Figure 178), and northwest in July (Figure 179).

Auk / shearwater species were not recorded flying in a uniform direction (p>0.05) (Figure 180).

Table 34 Raw counts, abundance and density estimates of auk / shearwater in the Array Project.

Survey	Raw Count	Sitting	Flying	Abundance	Lower CL	Upper CL	Precision	Density
Jun-21	3	3	-	25	3	58	0.58	0.02
Jul-21	99	97	2	812	607	1,041	0.10	0.57

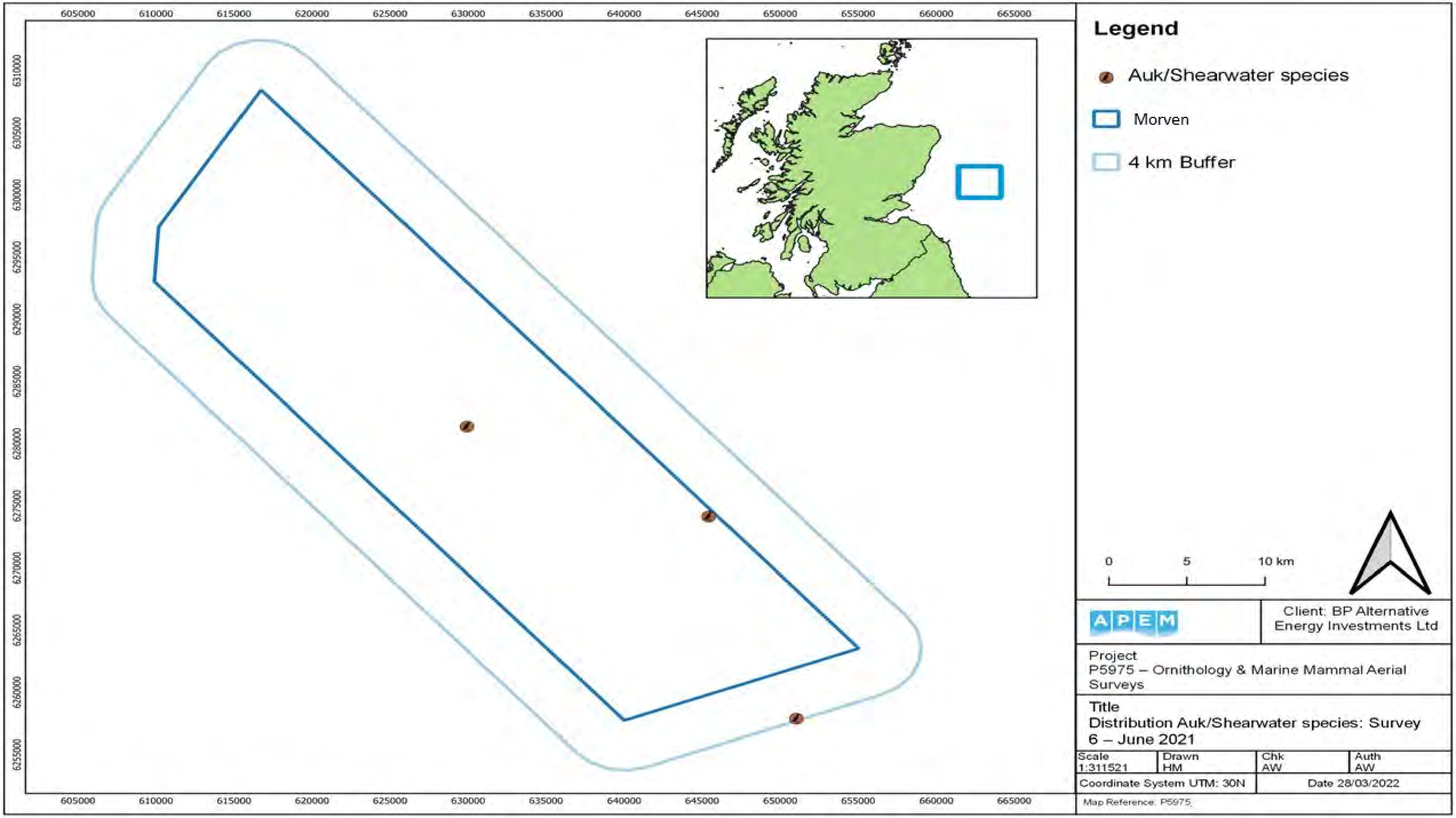


Figure 178 Distribution of auks / shearwaters in June 2021 (Survey 06).

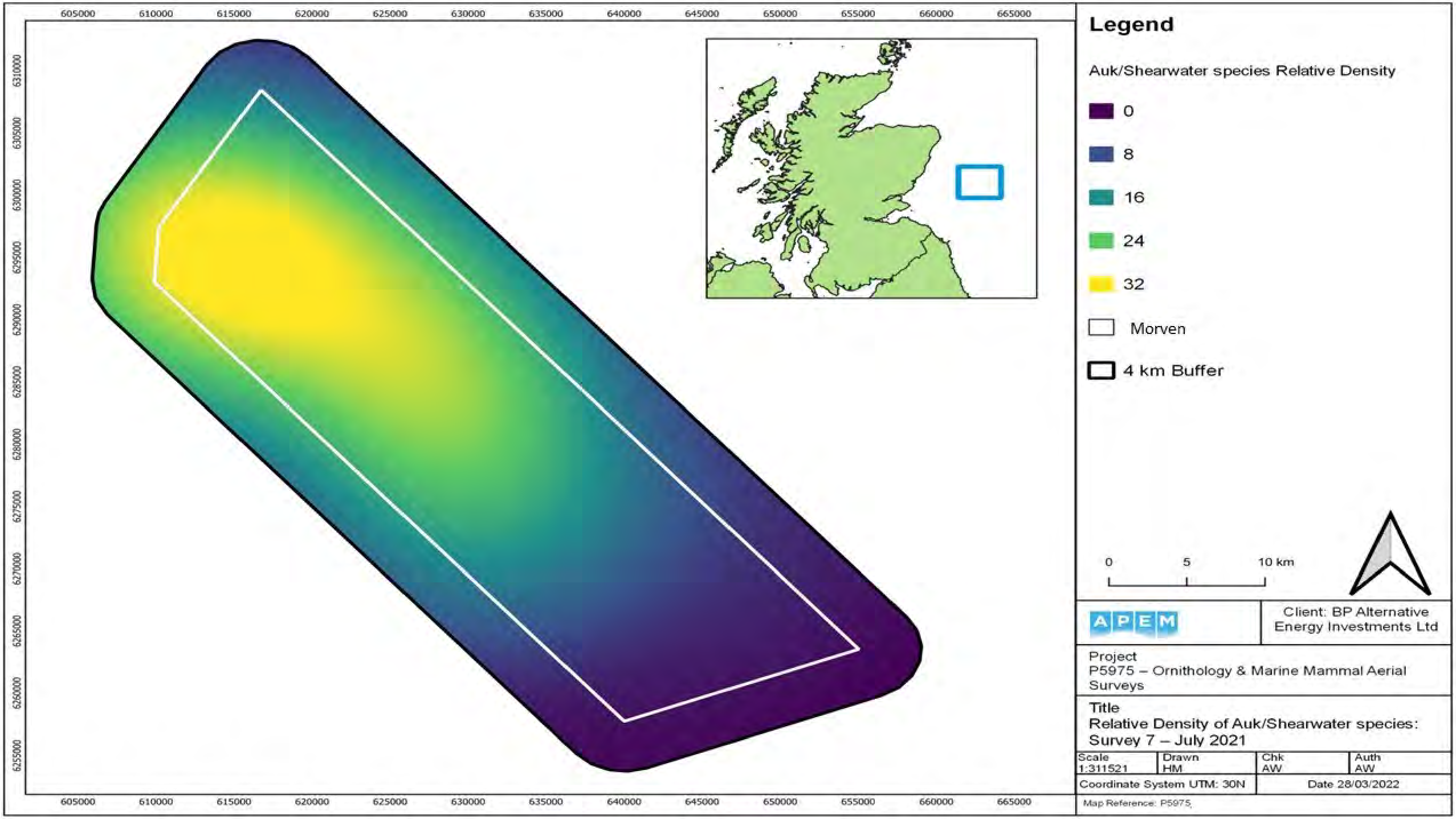
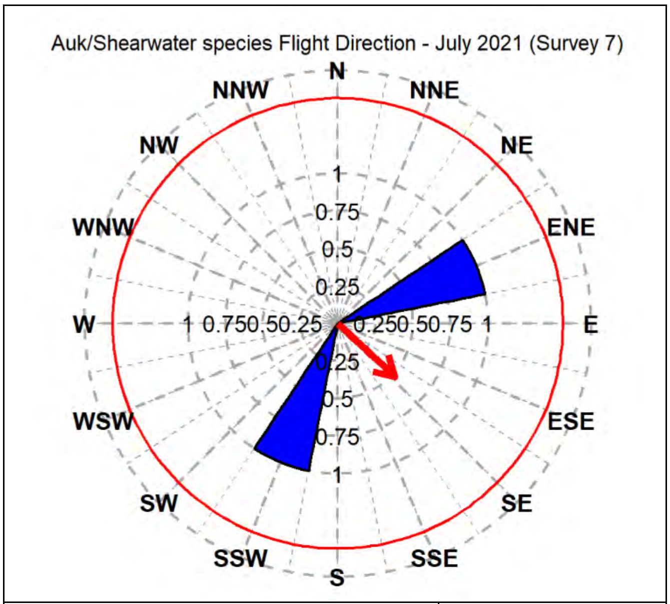


Figure 179 Relative density of auk / shearwater in July 2021 (Survey 07).



Number of Observations	2
Mean Vector (µ)	133.468
Length of Mean Vector (r)	0.520
Rayleigh Test (Z)	0.542
Rayleigh Test (p)	0.646

Figure 180 Summary of flight directions of auks / shearwaters recorded in the Array Project.

4.30 Gannet – *Morus bassanus*

Gannets were recorded in in all months except January 2021. Peak numbers were in July - 262 individuals, resulting in an abundance estimate of 2,148 within the Array Project (Table 35).

They were recorded throughout the Array Project – to the south in February (Figure 181); the center in January 2022 and February 2022 (Figure 192; Figure 193) to south and north in March (Figure 182); to south and northwest in June (Figure 185); centrally with some to north and south in April and March 2022 (Figure 183; Figure 194) and July (Figure 186); centrally in September (Figure 188); centrally and northwest in December (Figure 191); and to north in May (Figure 184), August (Figure 187), October (Figure 189) and November (Figure 190).

Age class of gannet were recorded in the surveys. 90% of gannet were recorded as adult, 8% as unknown, and 1% as third summer. <1% were recorded as first summer. Second summer, fourth summer and fourth winter (Table 36).

Gannet were recorded flying in a significant north-easterly direction in March 2021, a westerly direction in July and April, a northerly direction in August and October, and an easterly direction in September ($p<0.05$). All other months in which gannet were recorded flying showed no statistically significant flight direction ($p>0.05$) (Figure 195).

Table 35 Raw counts, abundance and density estimates of gannet in the Array Project.

Survey	Raw Count	Sitting	Flying	Perched	Deceased	Abundance	Lower CL	Upper CL	Precision	Density
Feb-21	1	-	1	-	-	8	1	24	1.00	0.01
Mar-21	14	4	10	-	-	116	58	182	0.27	0.08
Apr-21	38	2	36	-	-	307	146	510	0.16	0.22
May-21	96	9	87	-	-	784	596	1,013	0.10	0.55
Jun-21	142	58	83	1	-	1,169	947	1,400	0.08	0.82
Jul-21	262	118	144	-	-	2,148	1,804	2,509	0.06	1.51
Aug-21	83	39	44	-	-	681	533	837	0.11	0.48
Sep-21	166	73	92	-	1	1,356	1,060	1,693	0.08	0.96
Oct-21	101	28	73	-	-	812	651	988	0.10	0.57
Nov-21	10	7	3	-	-	83	33	141	0.32	0.06
Dec-21	3	-	3	-	-	25	3	57	0.58	0.02
Jan-22	1	-	1	-	-	8	1	24	1.00	0.01
Feb-22	4	-	4	-	-	32	8	65	0.50	0.02
Mar-22	3	-	3	-	-	24	3	56	0.58	0.02

Table 36 Raw counts of age classes of gannet

Survey	Raw Count	First Summer	Second Summer	Third Summer	Fourth Summer	Fourth Winter	Adult	Unknown
Feb-21	1	-	-	-	-	-	1	-
Mar-21	14	-	-	-	-	-	14	-
Apr-21	38	-	-	-	-	-	37	1
May-21	96	-	-	-	-	-	96	-
Jun-21	142	1	1	1	1	-	132	6
Jul-21	262	-	1	5	3	-	232	21
Aug-21	83	1	-	-	-	-	81	1
Sep-21	166	1	-	1	-	-	119	45
Oct-21	101	-	-	-	-	1	100	-
Nov-21	10	-	-	-	-	-	10	-
Dec-21	3	-	-	-	-	-	3	-
Jan-22	1	-	-	-	-	-	1	-
Feb-22	4	-	-	-	-	-	4	-
Mar-22	3	-	-	-	-	-	2	1
Total	**924**	**3**	**2**	**7**	**4**	**1**	**832**	**75**

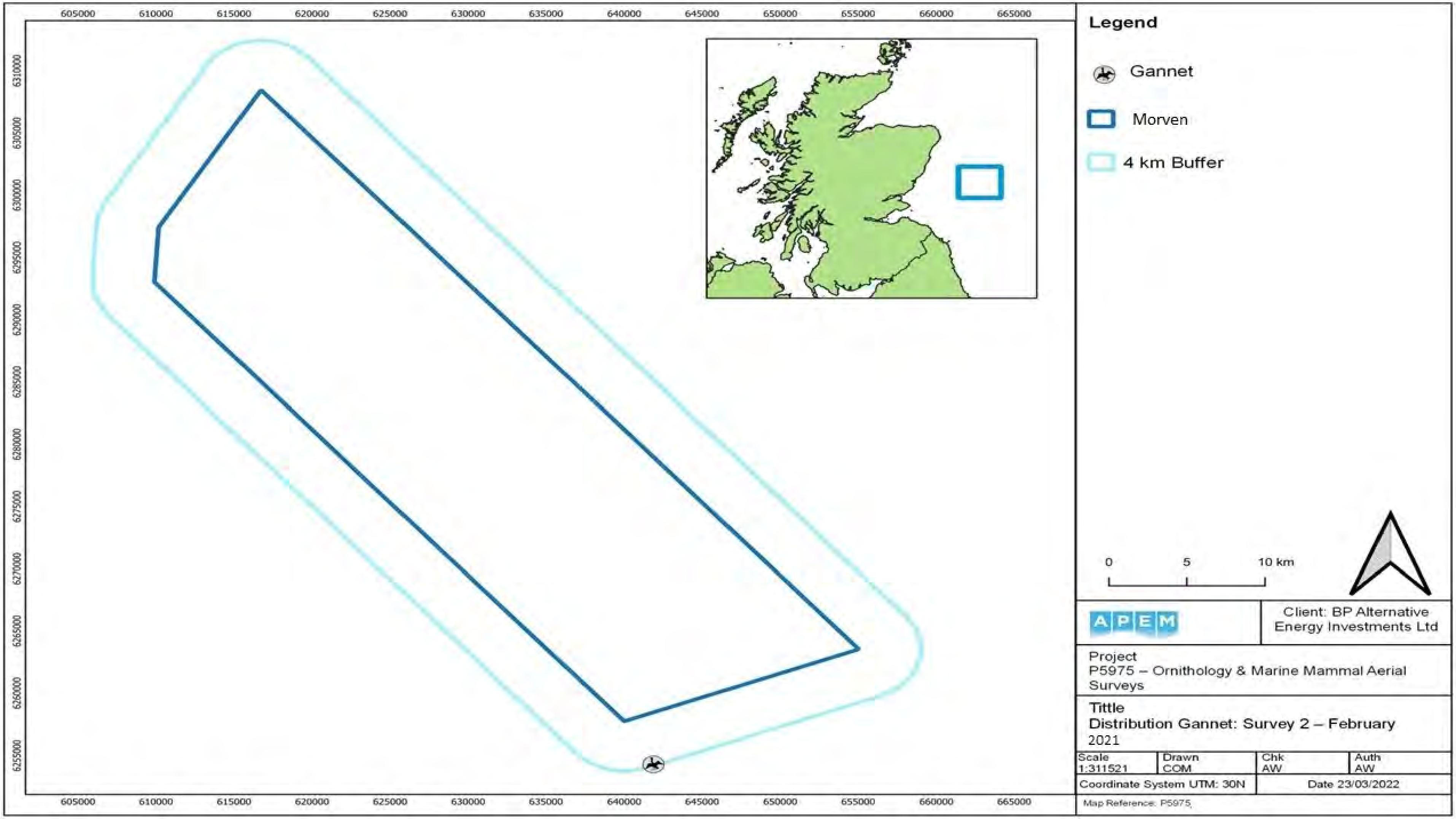


Figure 181 Location of a gannet in February 2021 (Survey 02).

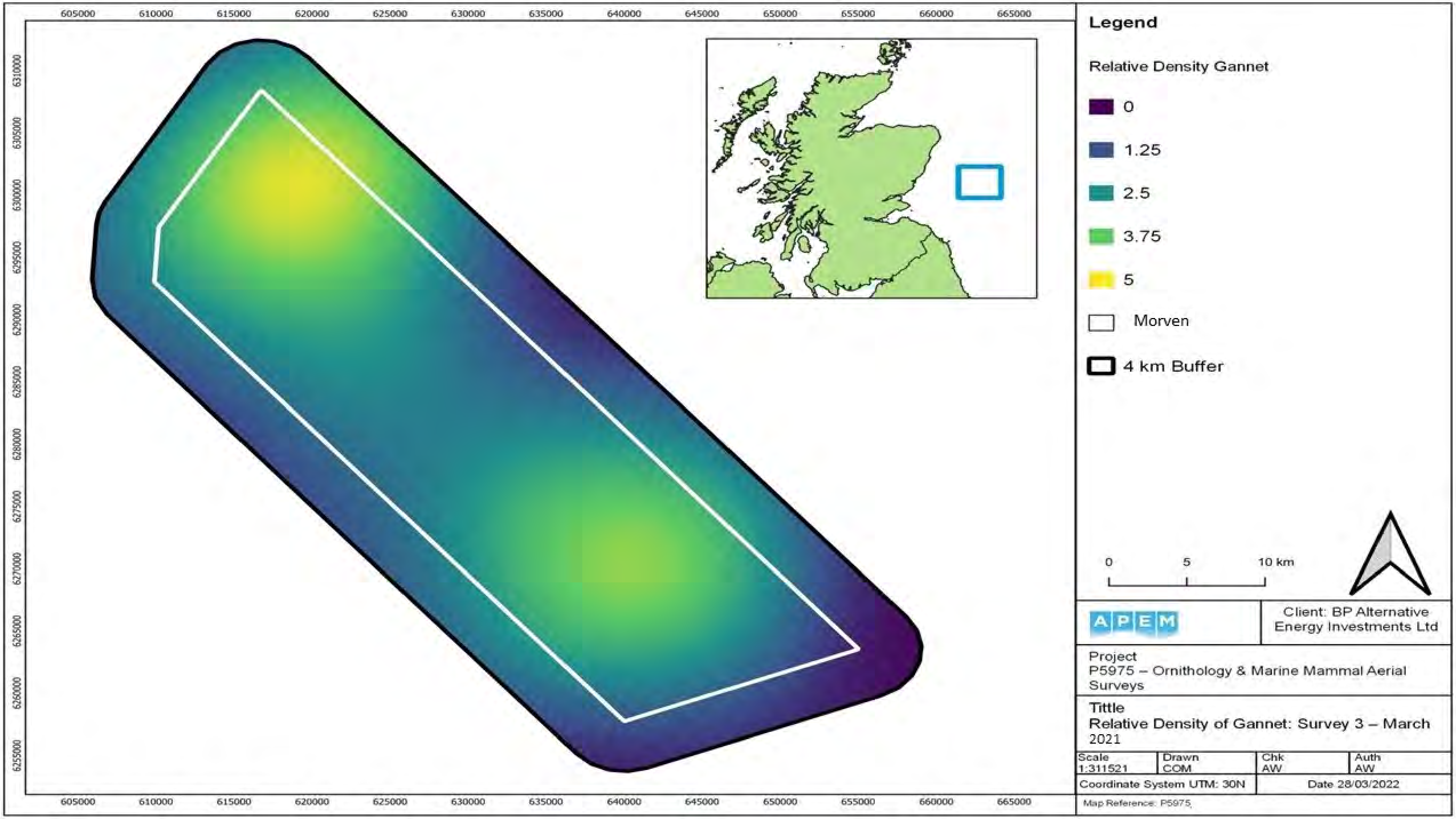


Figure 182 Relative density of gannet in March 2021 (Survey 03).

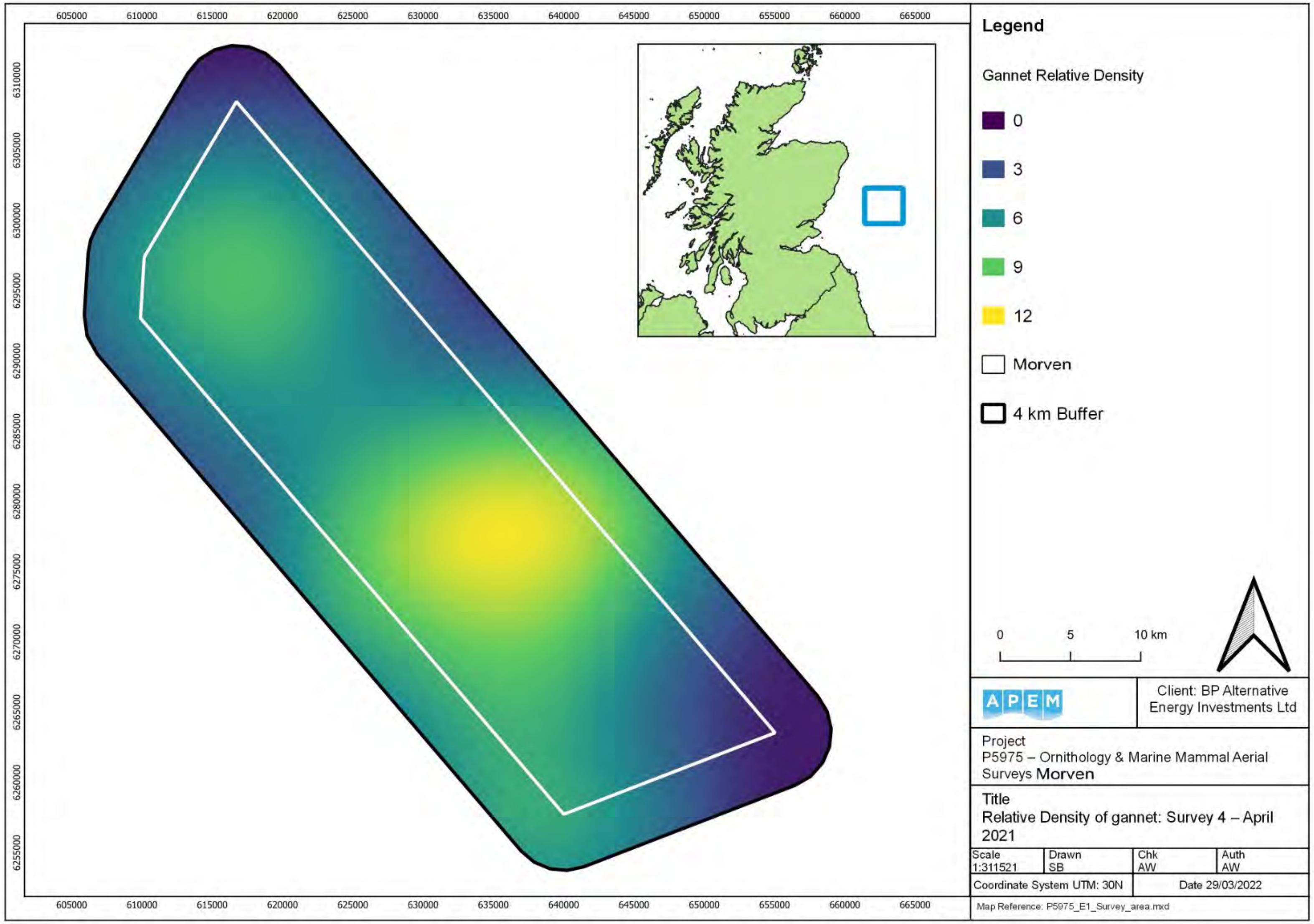


Figure 183 Relative density of gannet in April 2021 (Survey 04).

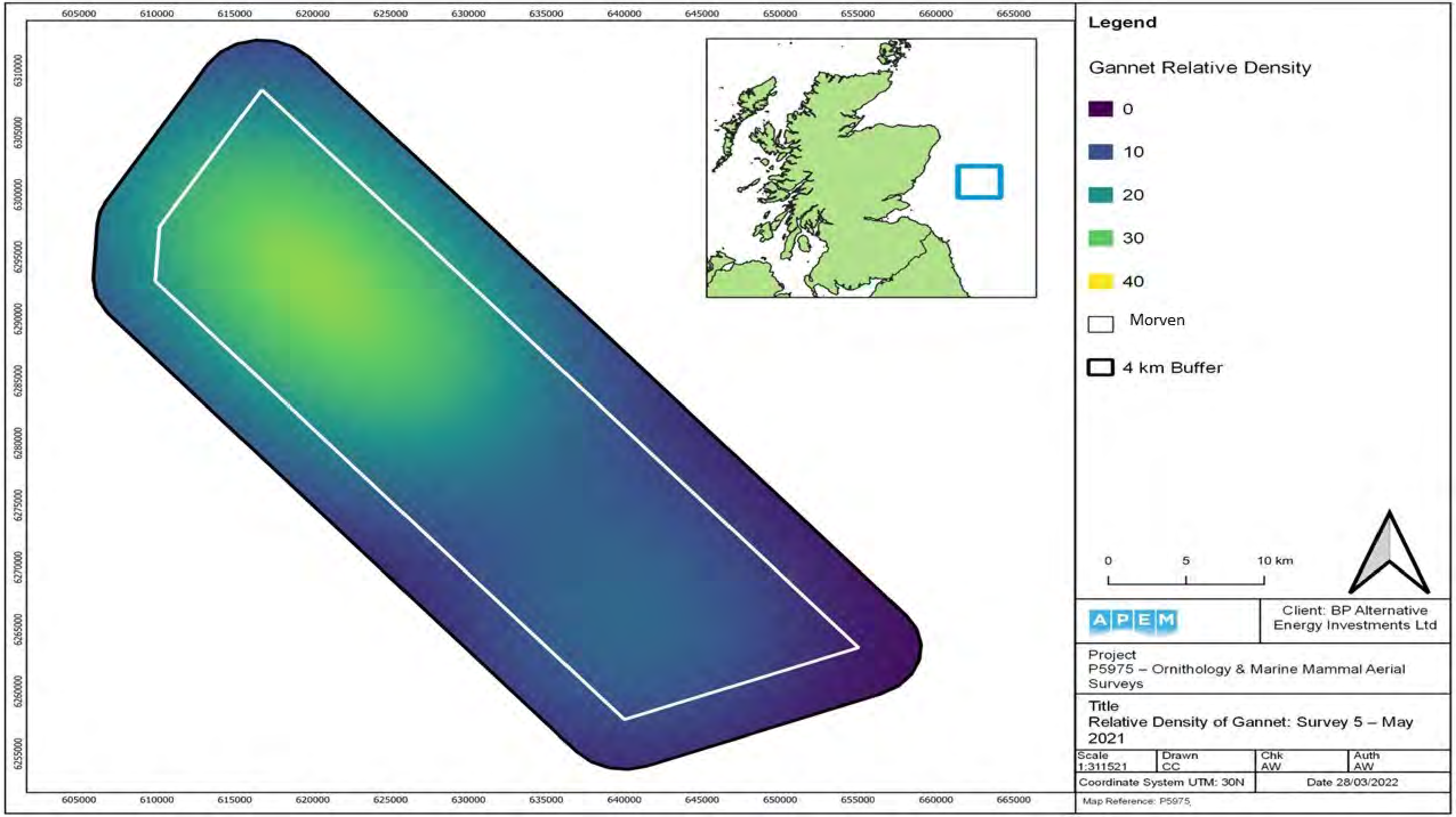


Figure 184 Relative density of gannet in May 2021 (Survey 05).

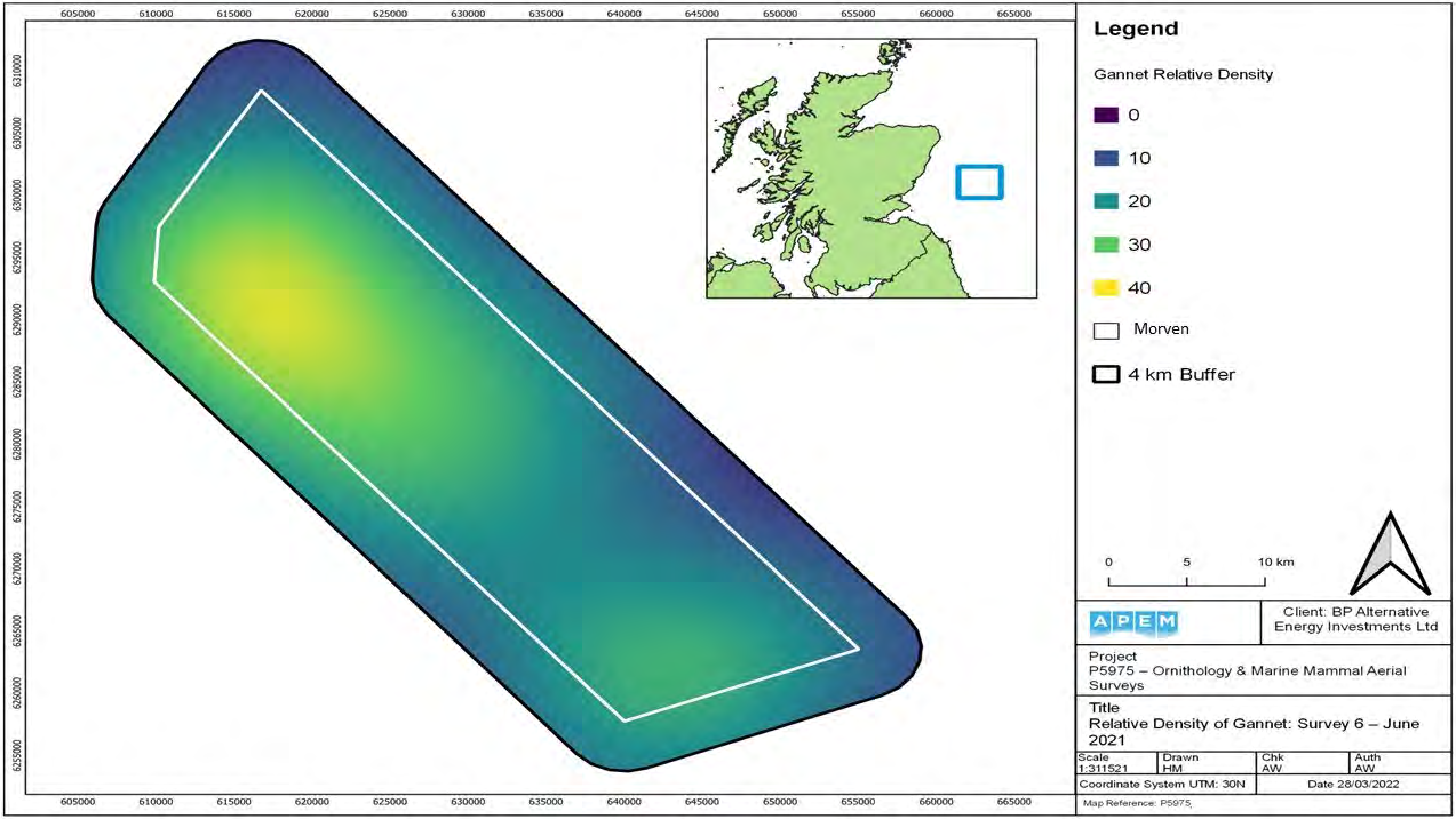


Figure 185 Relative density of gannet in June 2021 (Survey 06).

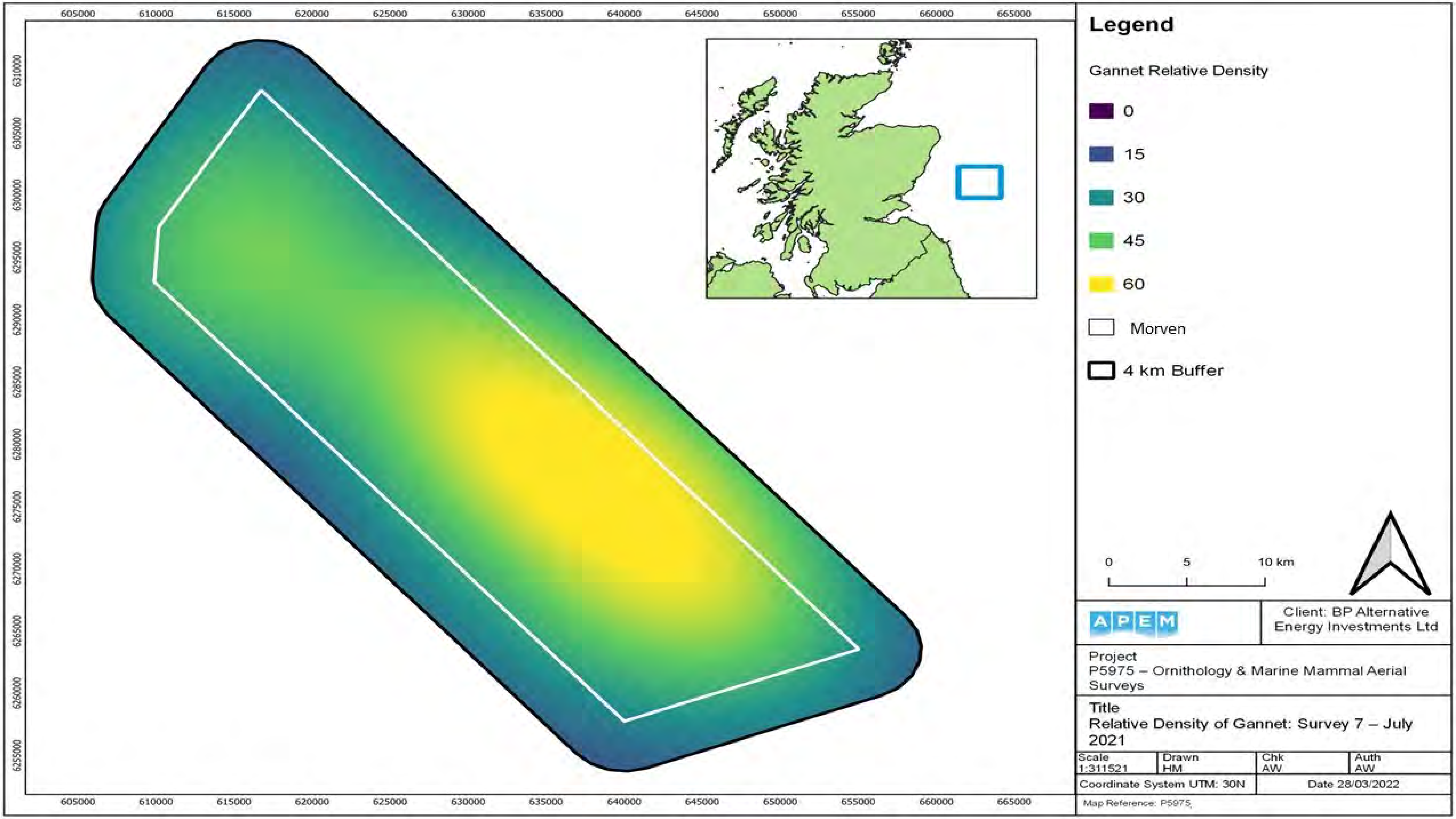


Figure 186 Relative density of gannet in July 2021 (Survey 07).

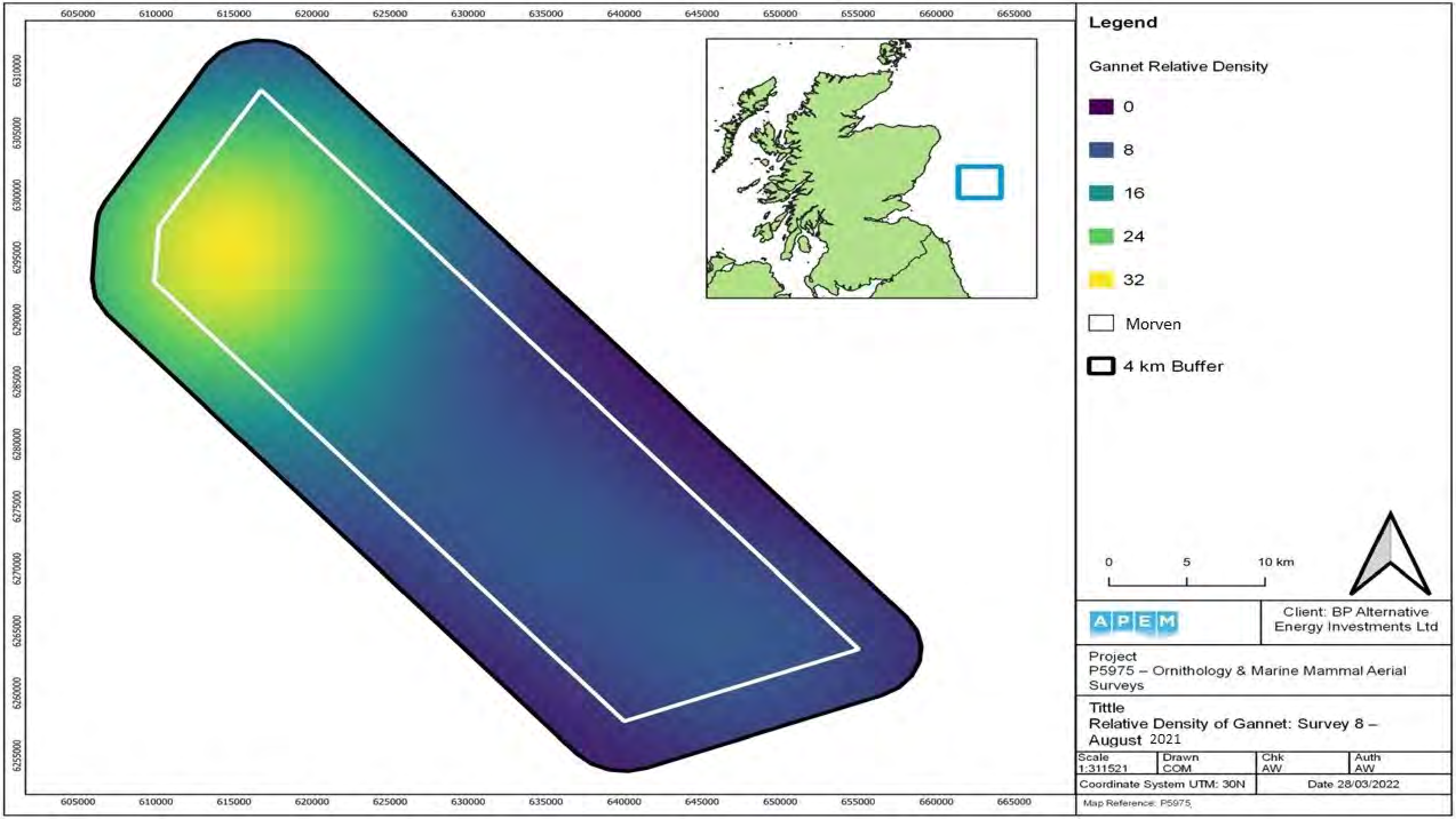


Figure 187 Relative density of gannet in August 2021 (Survey 08).

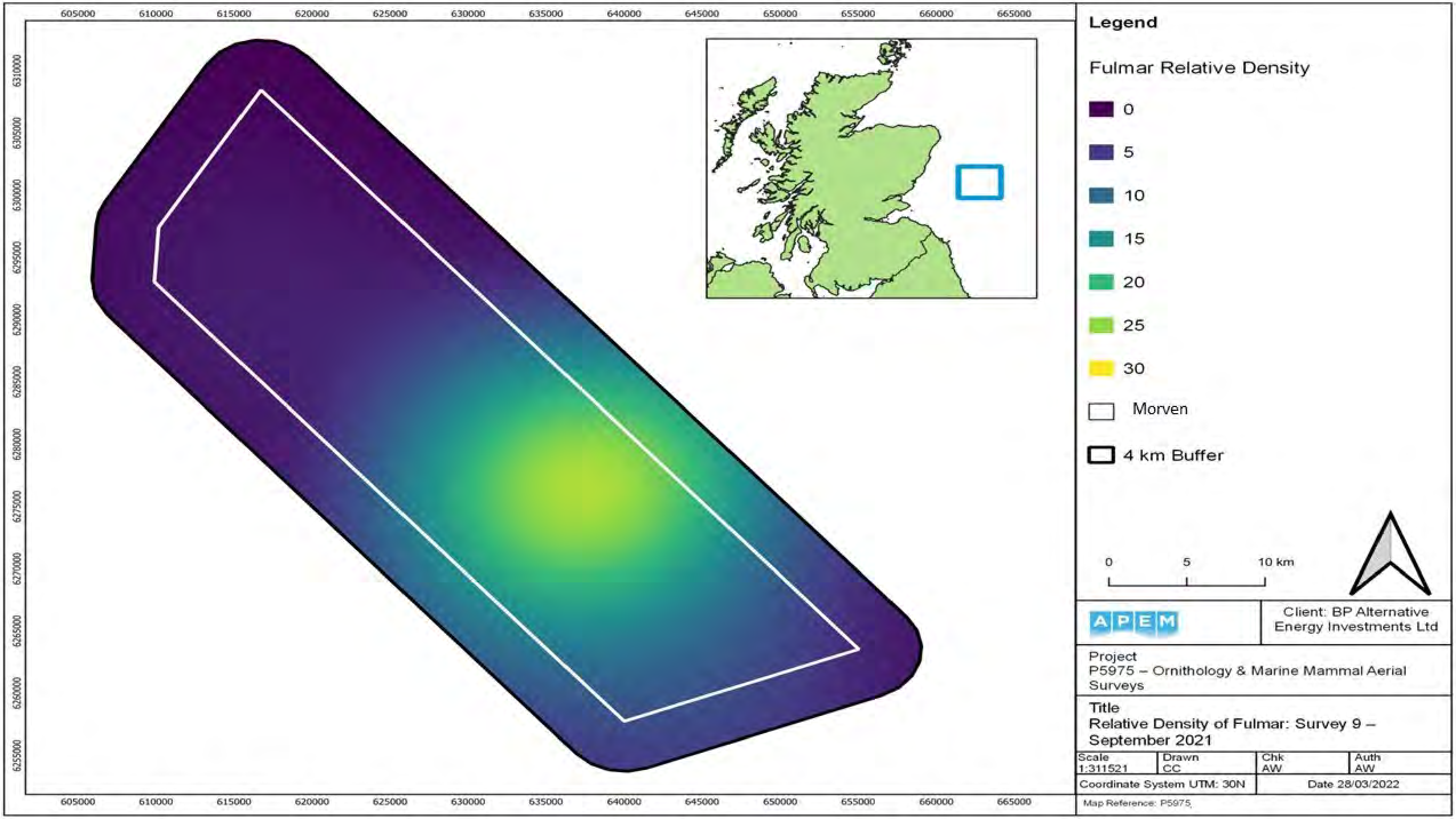


Figure 188 Relative density of gannet in September 2021 (Survey 09).

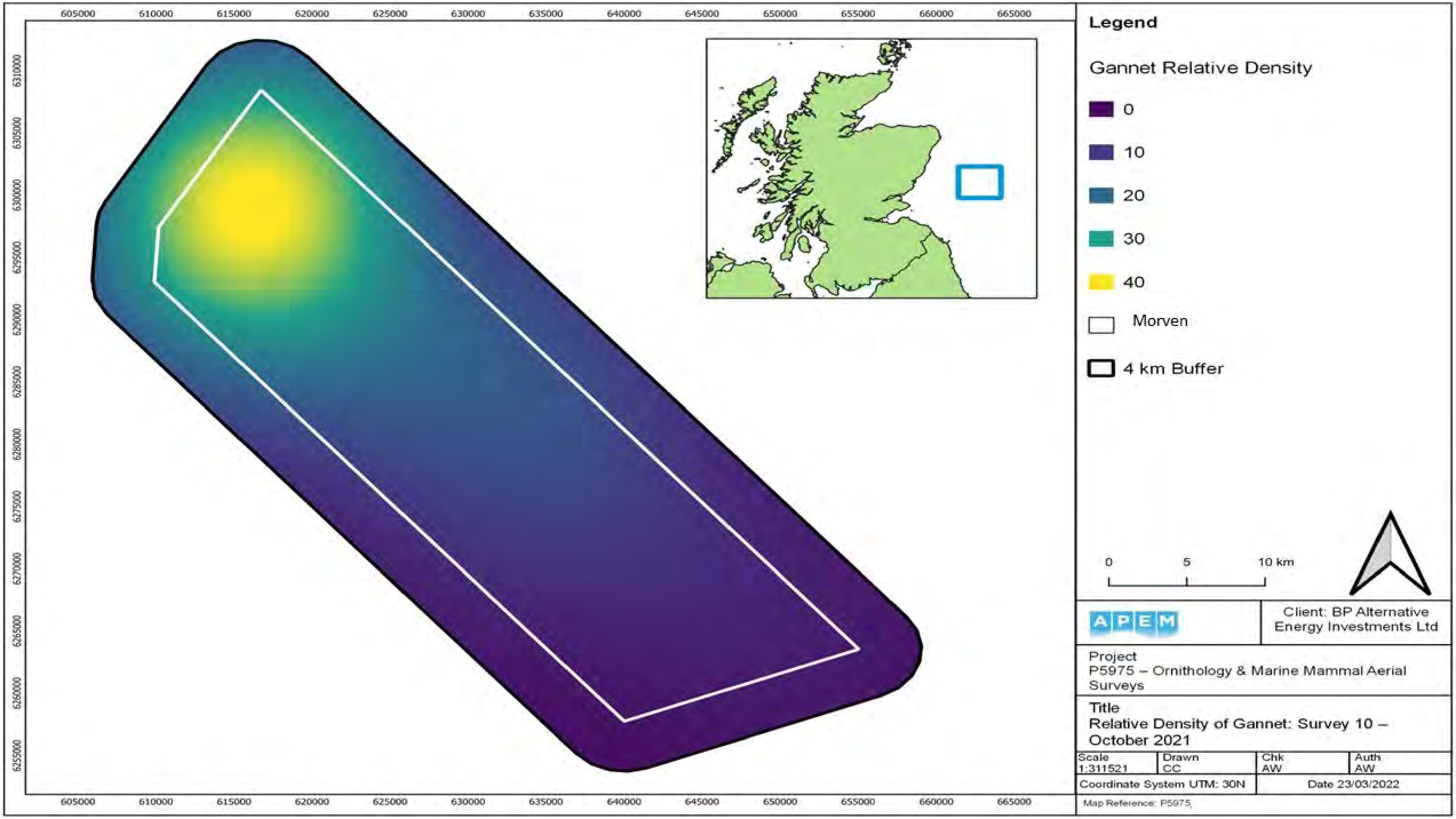


Figure 189 Relative density of gannet in October 2021 (Survey 10).

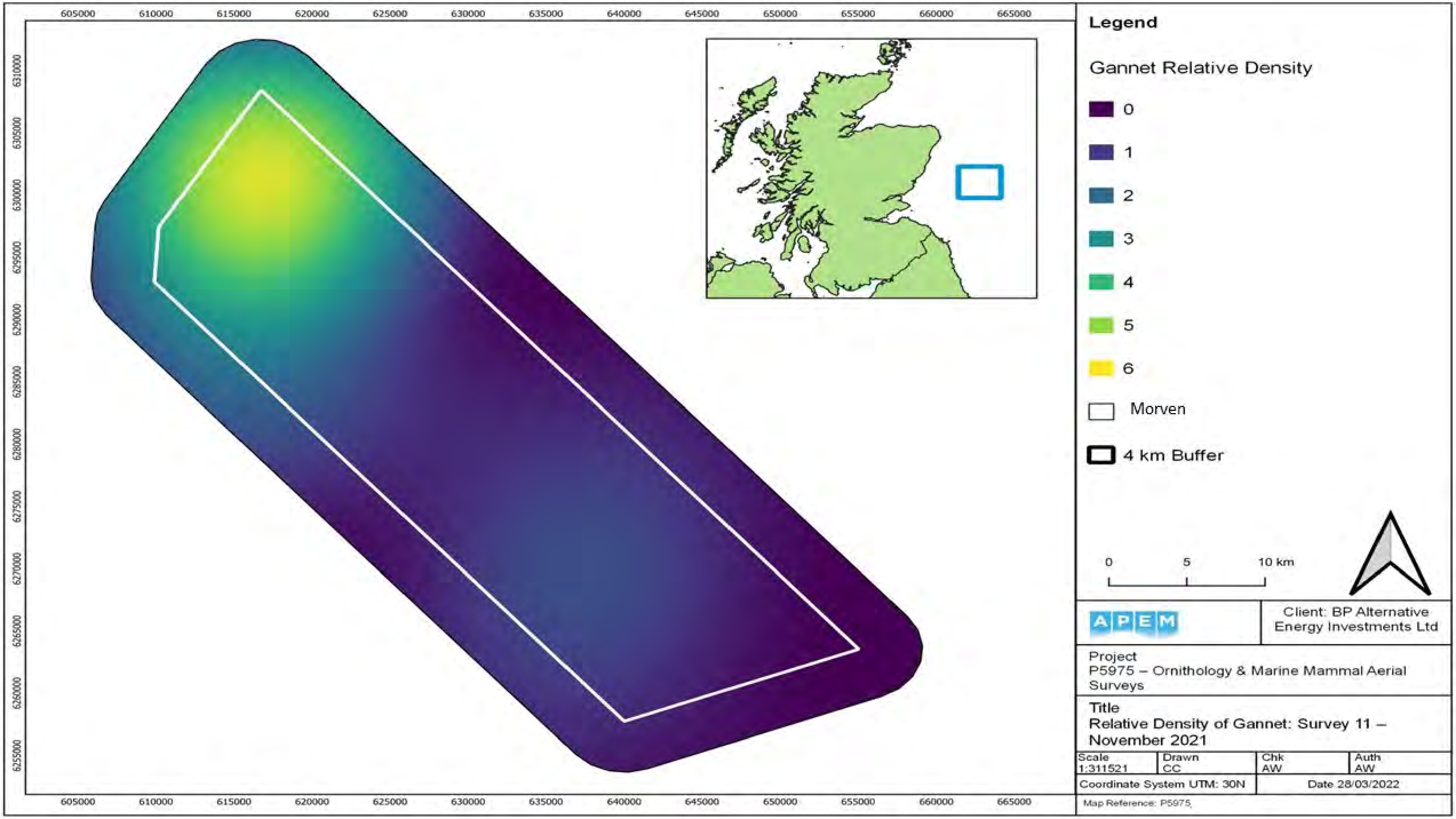


Figure 190 Relative density of gannet in November 2021 (Survey 11).

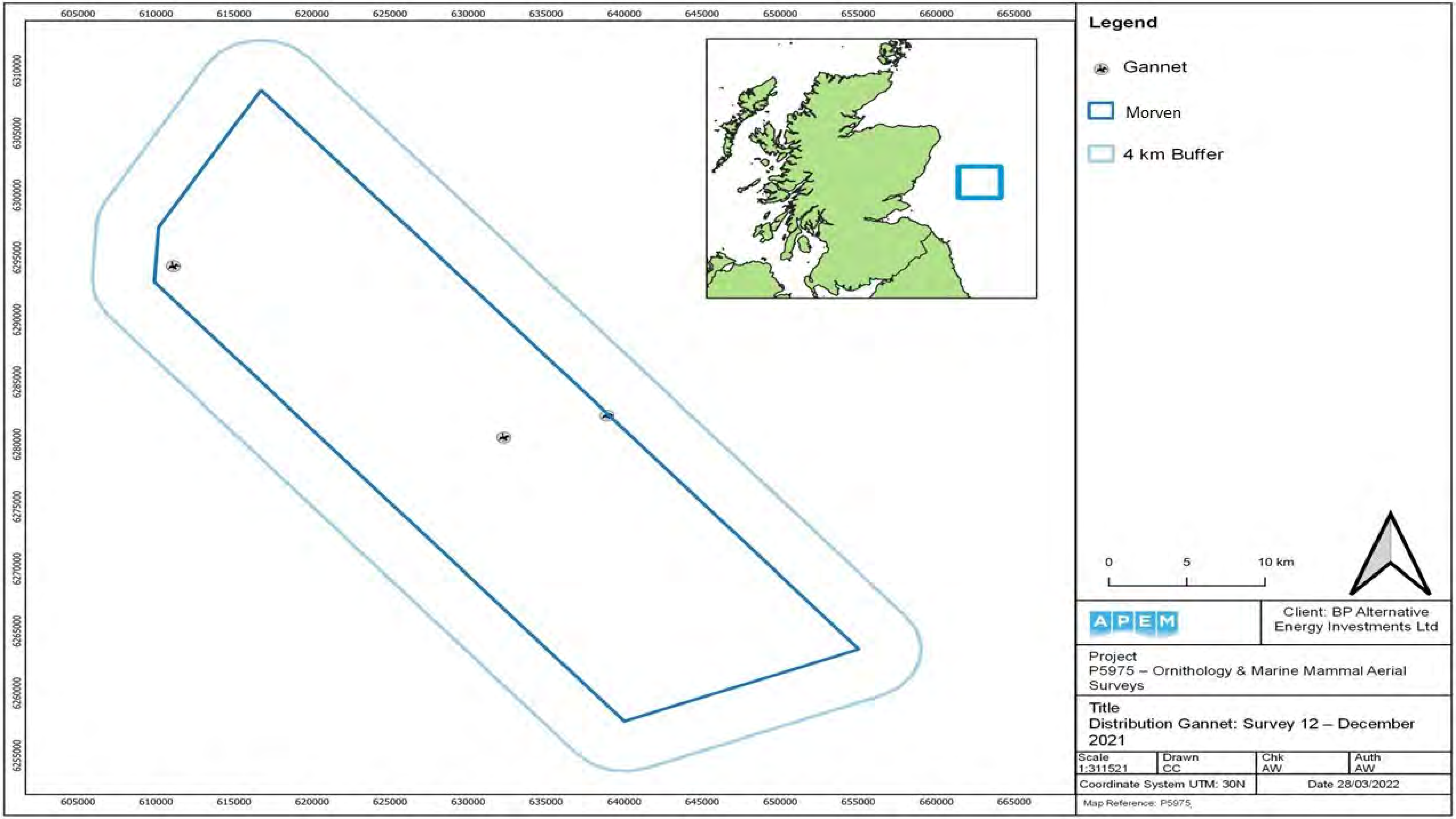


Figure 191 Distribution of gannets in December 2021 (Survey 12).

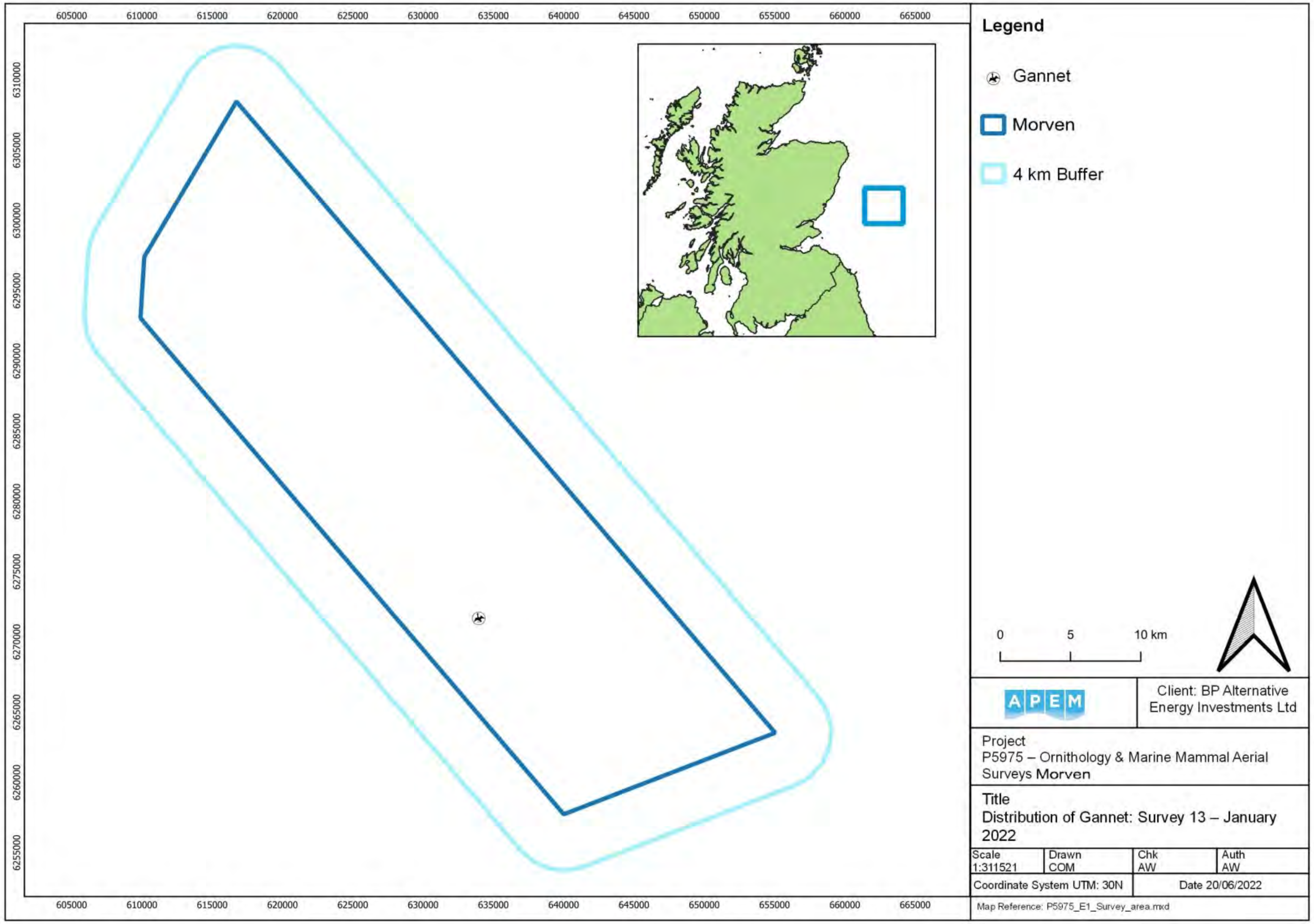


Figure 192 Location of a gannet in January 2022 (Survey 13).

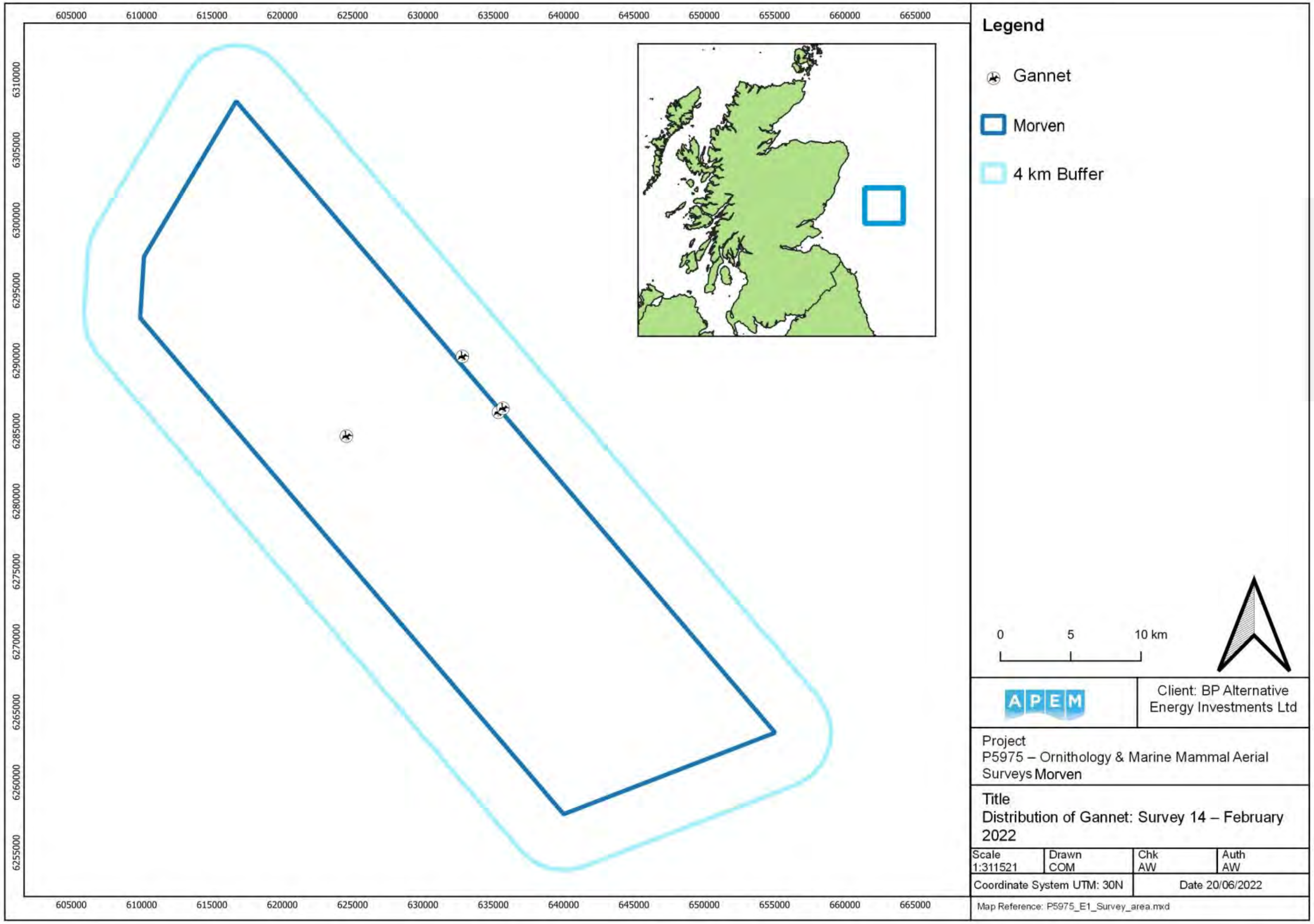


Figure 193 Distribution of gannets in February 2022 (Survey 14).

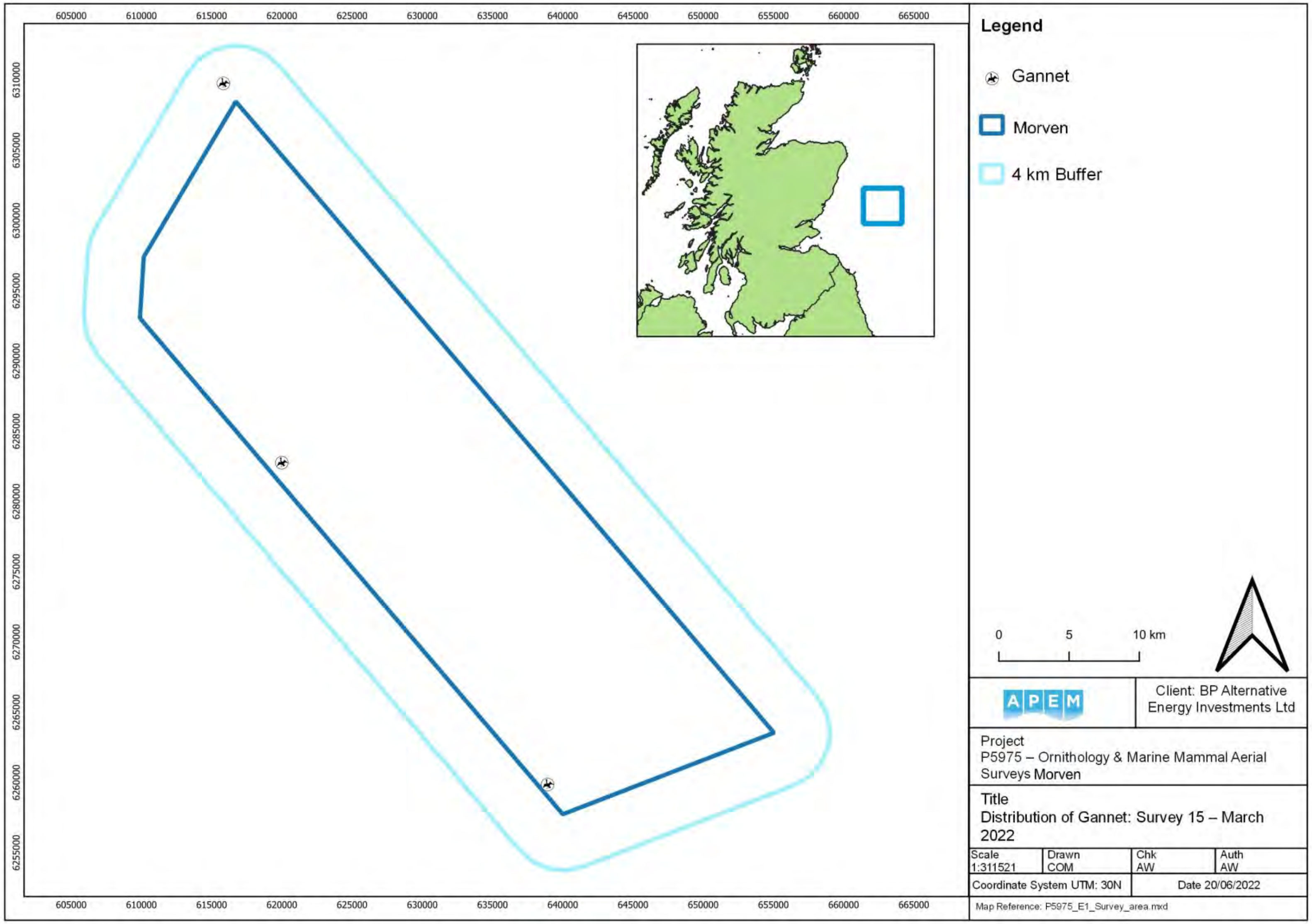
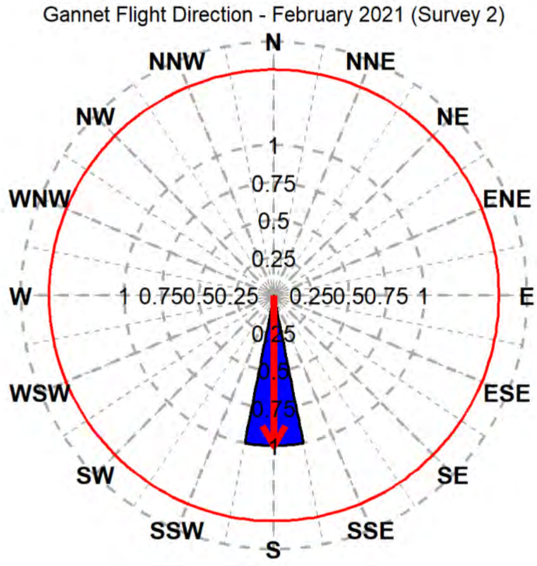
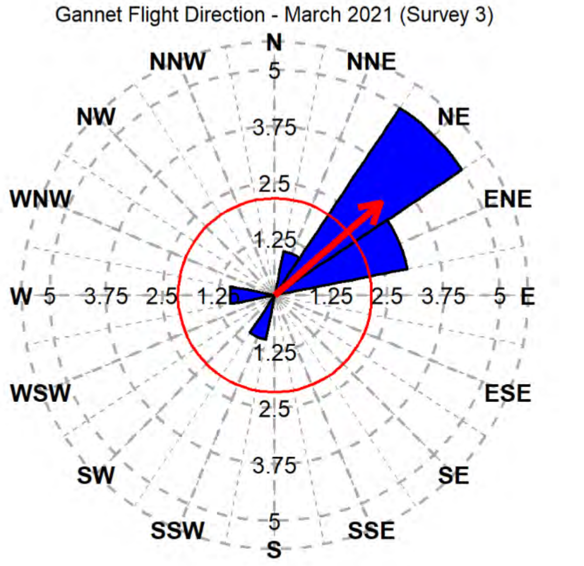


Figure 194 Distribution of gannets in March 2022 (Survey 15).



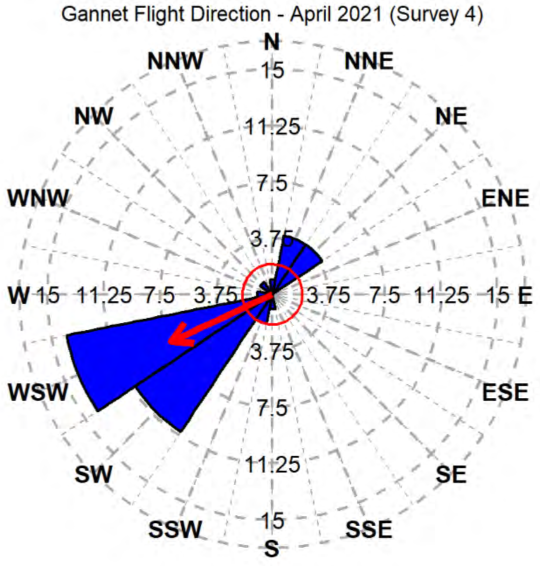
Number of Observations	1
Mean Vector (μ)	180.843
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

Figure 195a February 2021 (Survey 02)



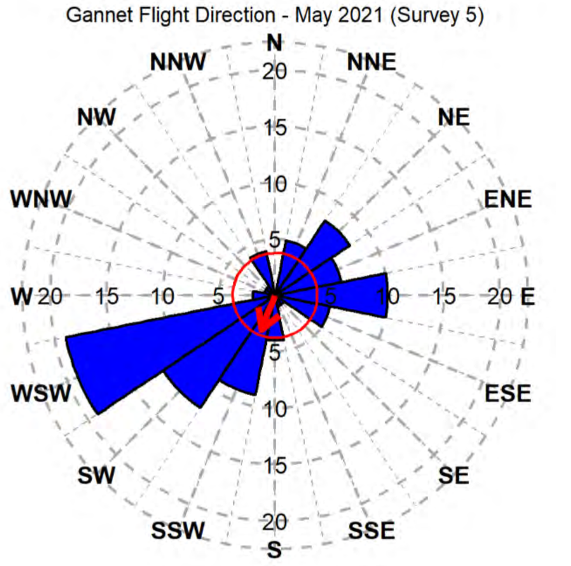
Number of Observations	11
Mean Vector (μ)	49.633
Length of Mean Vector (r)	0.621
Rayleigh Test (Z)	4.247
Rayleigh Test (p)	0.011

Figure 195b March 2021 (Survey 03)



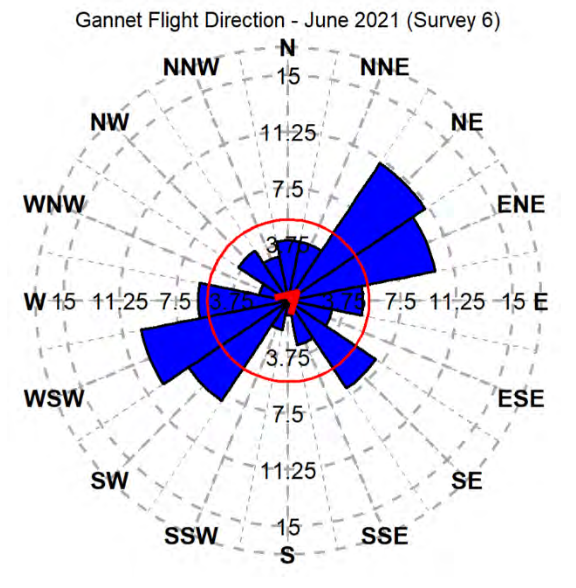
Number of Observations	39
Mean Vector (μ)	245.707
Length of Mean Vector (r)	0.531
Rayleigh Test (Z)	10.998
Rayleigh Test (p)	<0.001

Figure 195c April 2021 (Survey 04)



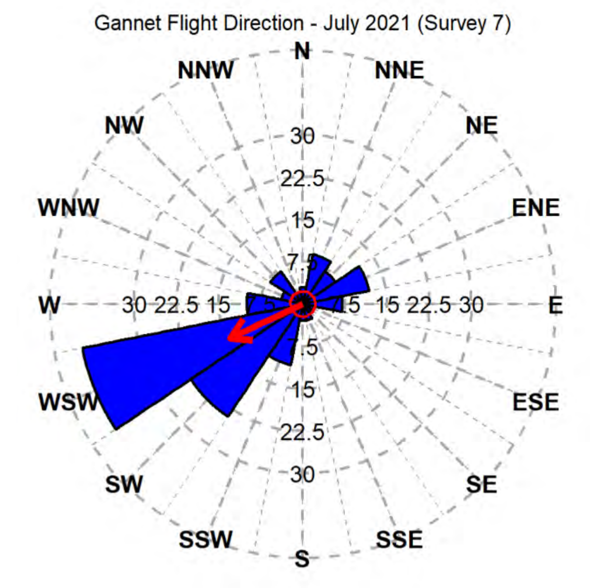
Number of Observations	88
Mean Vector (μ)	202.724
Length of Mean Vector (r)	0.171
Rayleigh Test (Z)	2.581
Rayleigh Test (p)	0.076

Figure 195d May 2021 (Survey 05)



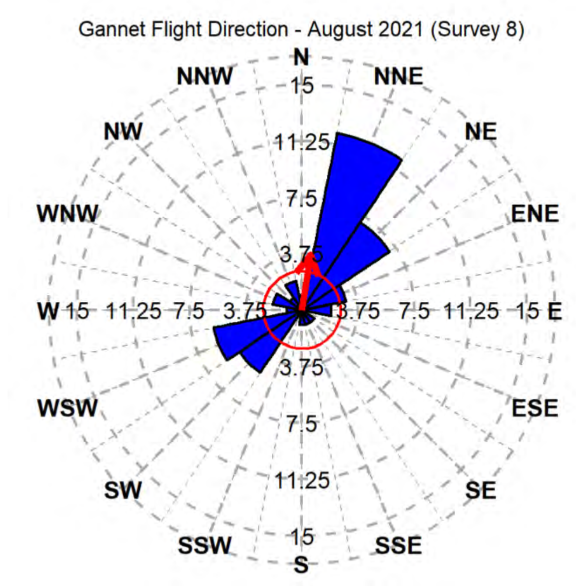
Number of Observations	83
Mean Vector (µ)	46.467
Length of Mean Vector (r)	0.073
Rayleigh Test (Z)	0.447
Rayleigh Test (p)	0.640

Figure 195e June 2021 (Survey 06)



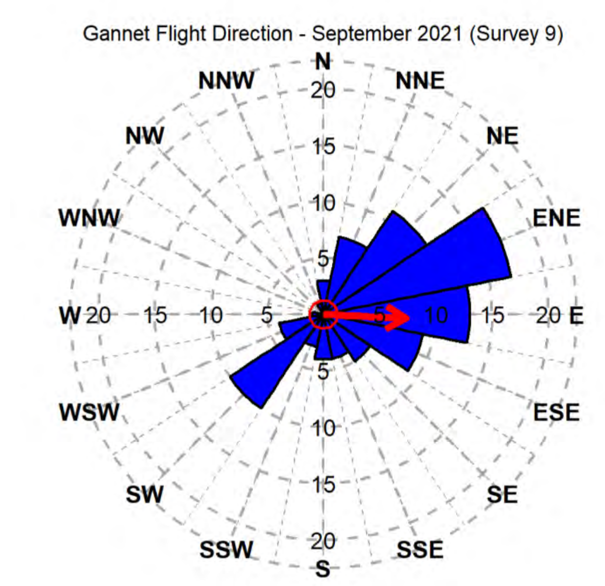
Number of Observations	146
Mean Vector (µ)	245.037
Length of Mean Vector (r)	0.355
Rayleigh Test (Z)	18.446
Rayleigh Test (p)	<0.001

Figure 195f July 2021 (Survey 07)



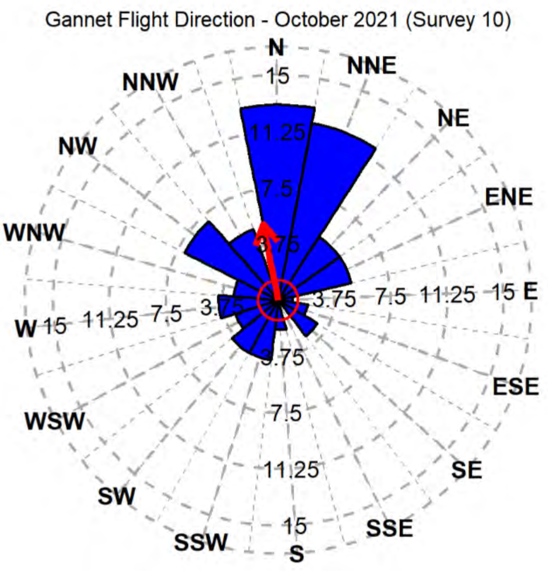
Number of Observations	45
Mean Vector (µ)	9.290
Length of Mean Vector (r)	0.308
Rayleigh Test (Z)	4.265
Rayleigh Test (p)	0.013

Figure 195g August 2021 (Survey 08)



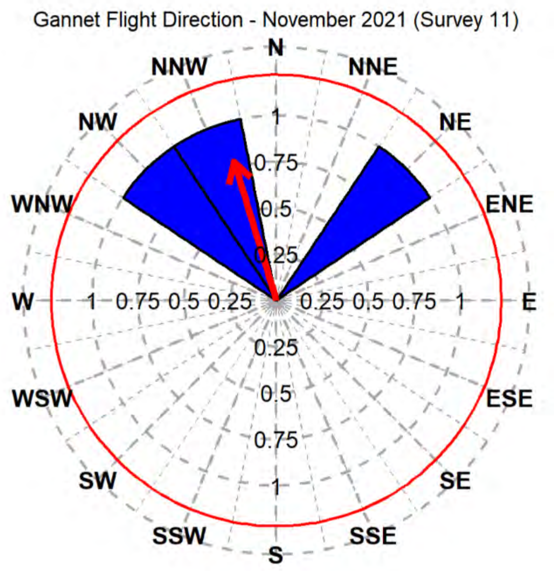
Number of Observations	92
Mean Vector (µ)	93.455
Length of Mean Vector (r)	0.431
Rayleigh Test (Z)	17.103
Rayleigh Test (p)	<0.001

Figure 195h September 2021 (Survey 09)



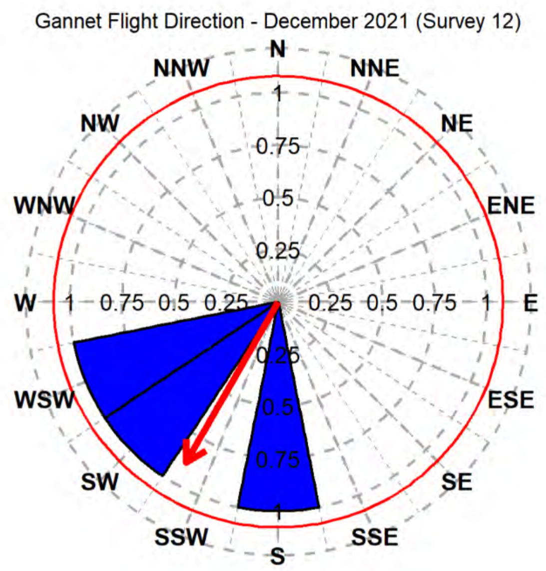
Number of Observations	73
Mean Vector (µ)	357.299
Length of Mean Vector (r)	0.395
Rayleigh Test (Z)	11.395
Rayleigh Test (p)	<0.001

Figure 195i August 2021 (Survey 08)



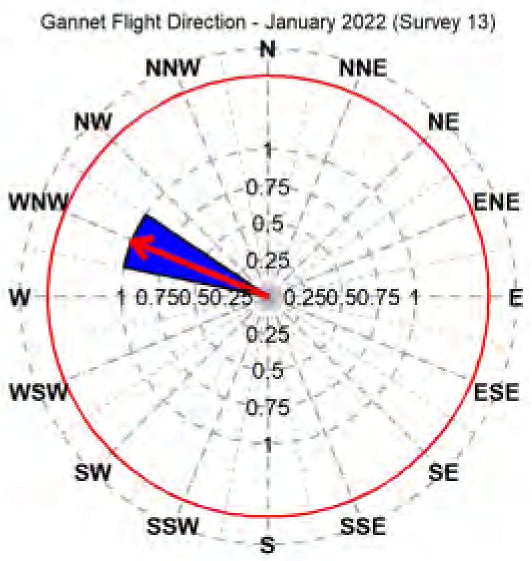
Number of Observations	3
Mean Vector (µ)	343.687
Length of Mean Vector (r)	0.782
Rayleigh Test (Z)	1.835
Rayleigh Test (p)	0.166

Figure 195j August 2021 (Survey 08)



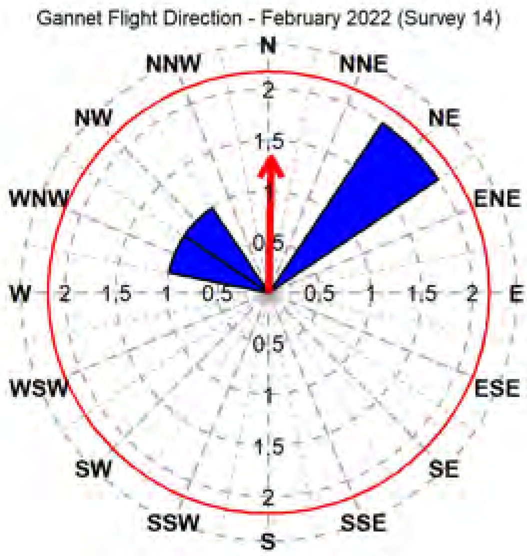
Number of Observations	3
Mean Vector (µ)	210.3490
Length of Mean Vector (r)	0.885
Rayleigh Test (Z)	2.349
Rayleigh Test (p)	0.087

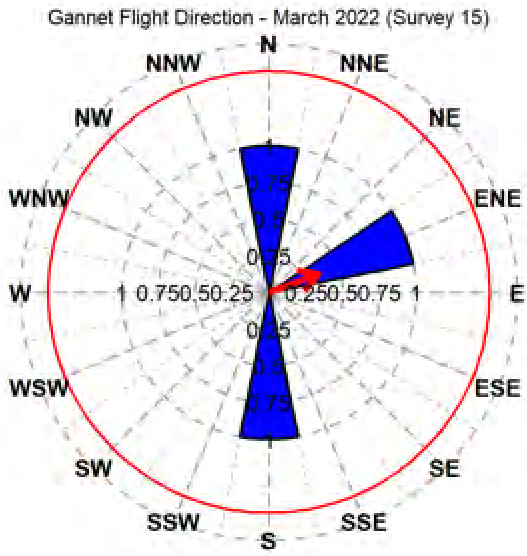
Figure 195k December 2021 (Survey 12)



Number of Observations	1
Mean Vector (µ)	292.309
Length of Mean Vector (r)	1.000
Rayleigh Test (Z)	1.000
Rayleigh Test (p)	0.512

Figure 195l January 2022 (Survey 13)





Number of Observations	4	Number of Observations	3
Mean Vector (µ)	1.530	Mean Vector (µ)	69.733
Length of Mean Vector (r)	0.661	Length of Mean Vector (r)	0.358
Rayleigh Test (Z)	1.745	Rayleigh Test (Z)	0.385
Rayleigh Test (p)	0.181	Rayleigh Test (p)	0.717
Figure 195m February 2022 (Survey 14)		**Figure 195n March 2022 (Survey 15)**	

Figure 195 Summary of flight direction of gannets recorded in the Array Project.

4.31 Osprey – *Pandion haliaetus*

An osprey was recorded in June 2021, resulting in an abundance estimate of eight within the Array Project (Table 37).

This single osprey was seen in the southwest of the Array Project (Figure 196).

The osprey was not recorded flying in a significant direction.

Table 37 Raw counts, abundance and density estimates of osprey in the Array Project.

Survey	Raw Count	Sitting	Flying	Abundance	Lower CL	Upper CL	Precision	Density
Jun-21	1	-	1	8	1	25	1.00	0.01

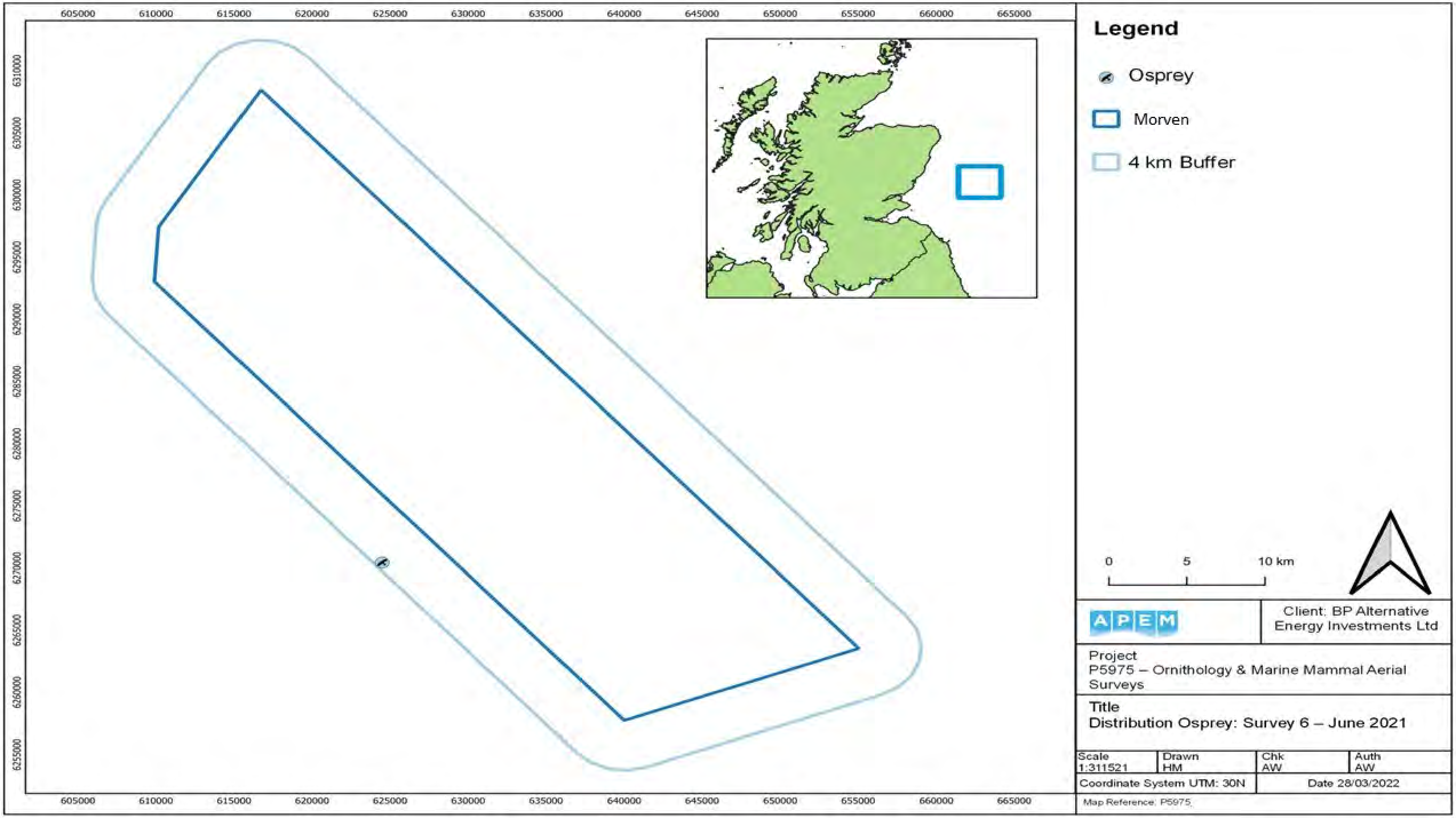


Figure 196 Location of an ospreys in June 2021 (Survey 06).

4.32 Thrushes - *Unidentified*

Unidentified thrushes were recorded in November 2021, with six individuals, resulting in an abundance estimate of 50 within the Array Project (Table 38).

These were located in the central Array Project (Figure 197).

These were flying in a significant south-westerly direction (μ=234.460; $p<0.05$) (Figure 198).

Table 38 Raw counts, abundance and density estimates of unidentified thrush in the Array Project.

Survey	Raw Count	Sitting	Flying	Abundance	Lower CL	Upper CL	Precision	Density
Nov-21	6	-	6	50	6	150	0.41	0.04

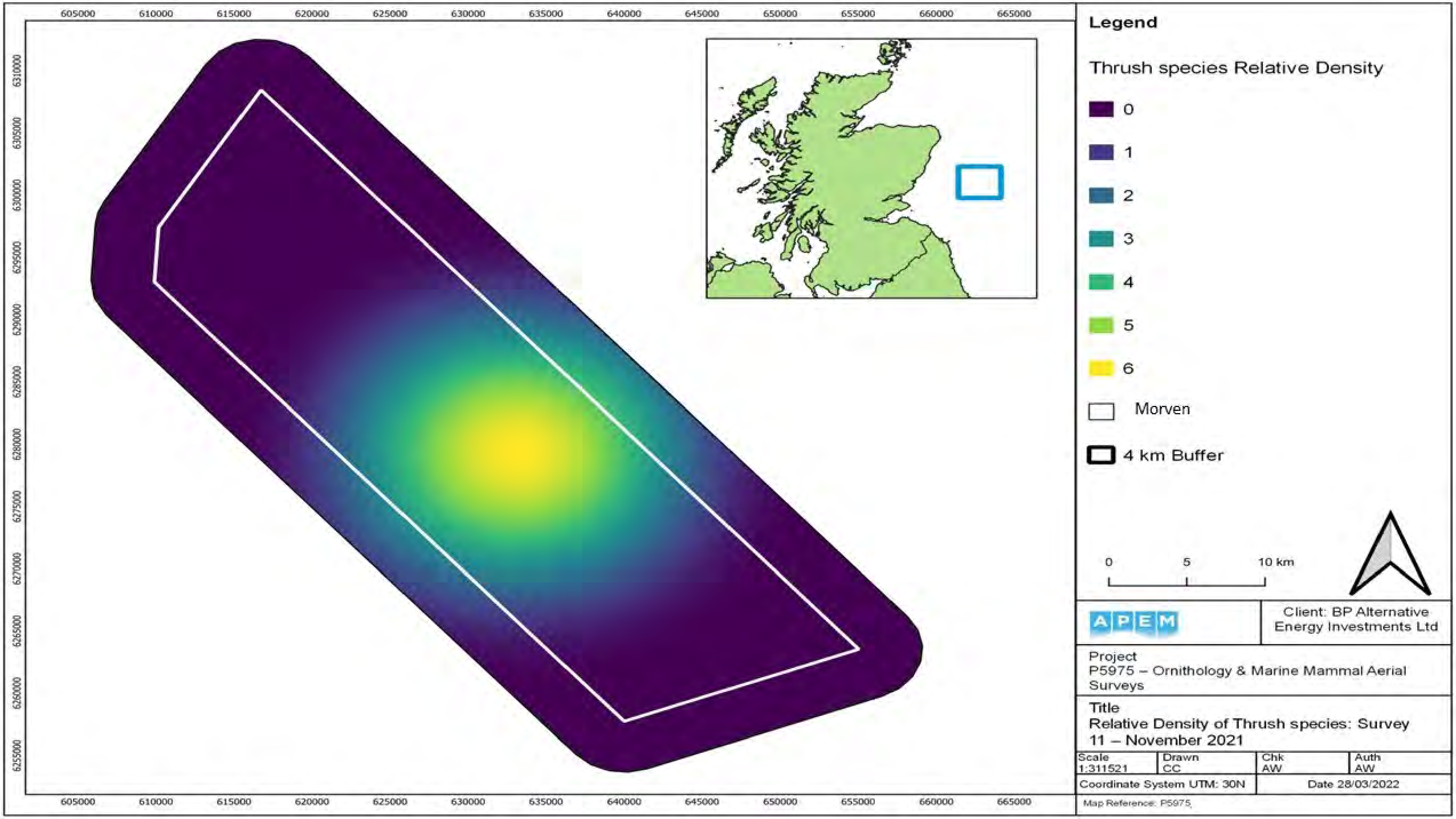
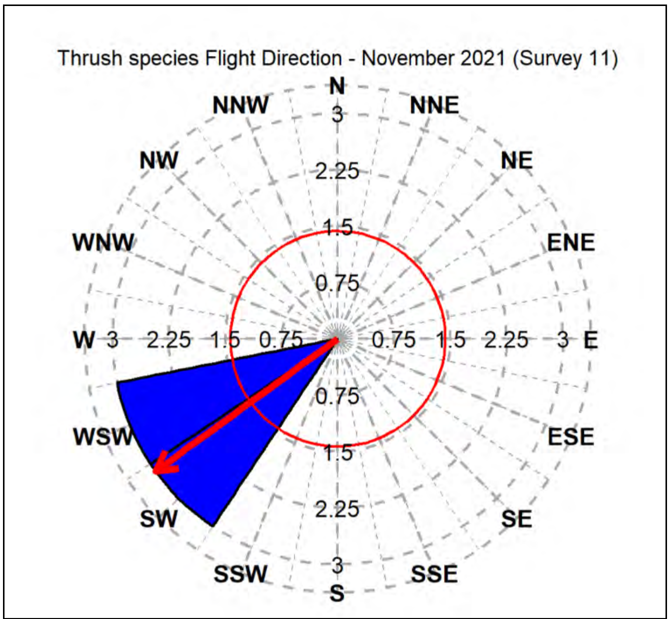


Figure 197 Relative density of unidentified thrush in November 2021 (Survey 11).



Number of Observations	6
Mean Vector (µ)	234.460
Length of Mean Vector (r)	0.998
Rayleigh Test (Z)	5.977
Rayleigh Test (p)	<0.001

Figure 198 Summary of flight directions of unidentified thrushes recorded in the Array Project.

4.33 Birds - *Unidentified*

Unidentified birds were recorded in July, September, and October 2021 and, January and February 2022 (Table 39).

Table 39 Raw counts of unidentified birds in the Array Project.

Survey	Raw Count	Sitting	Flying
Jul-21	2	1	1
Sep-21	2	2	-
Oct-21	1	1	-
Jan-22	2	1	1
Feb-22	3	3	-

4.34 Grey Seal – *Halichoerus grypus*

Grey seals were recorded in June and December 2021 and, February 2022 with one individual each survey, resulting in an abundance estimate of eight within the Array Project (Table 40).

These were in the south during June (Figure 199), north during December (Figure 200), and central in February (Figure 201).

Table 40 Raw counts, abundance and density estimates of grey seal in the Array Project.

Survey	Raw Count	Submerged	Surfacing	Abundance	Lower CL	Upper CL	Precision	Density
Jun-21	1	1	-	8	1	33	1.00	0.01
Dec-21	1	1	-	8	1	25	1.00	0.01
Feb-22	1	-	1	8	1	24	1.00	0.01

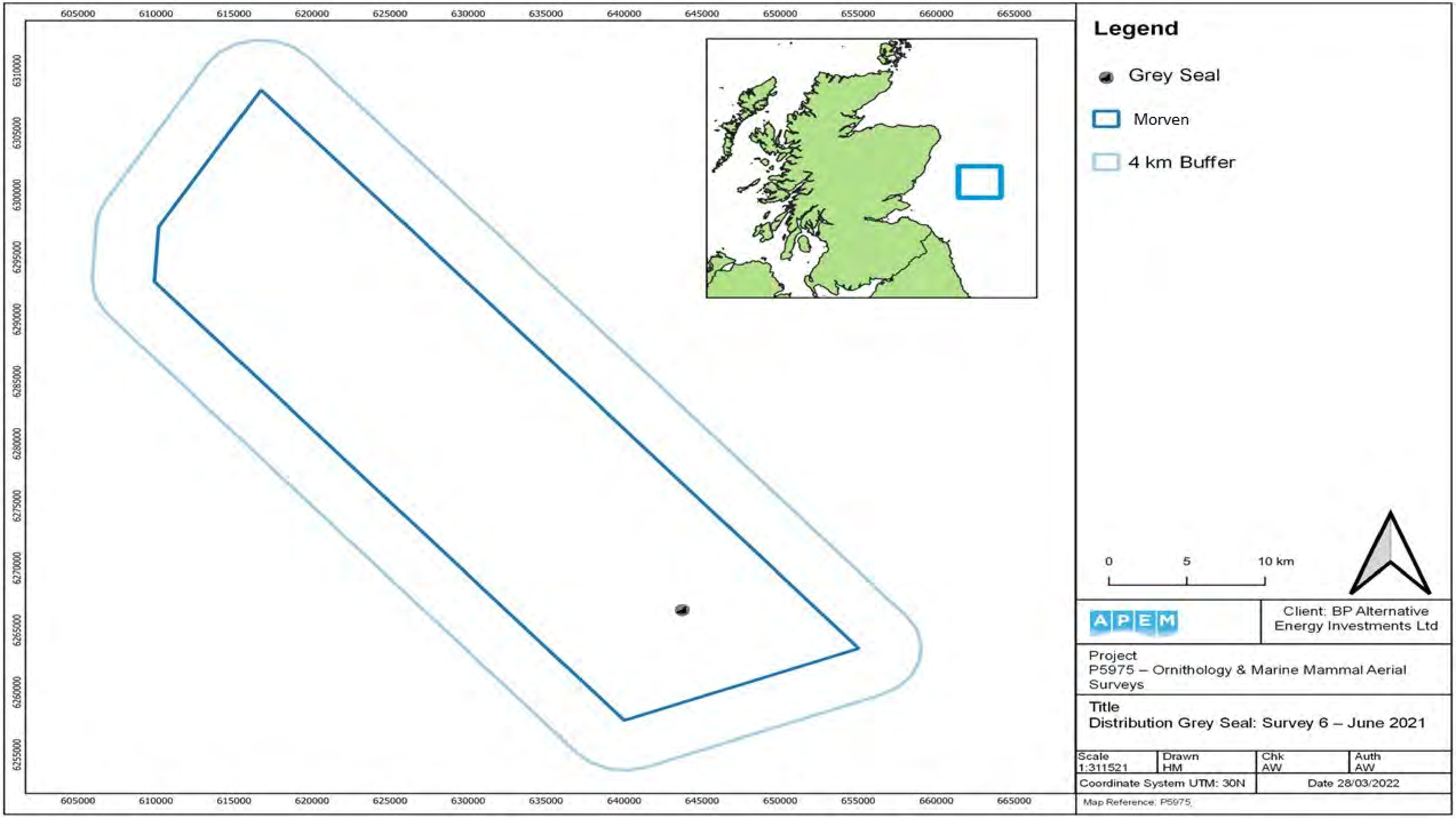


Figure 199 Location of a grey seal in June 2021 (Survey 06).

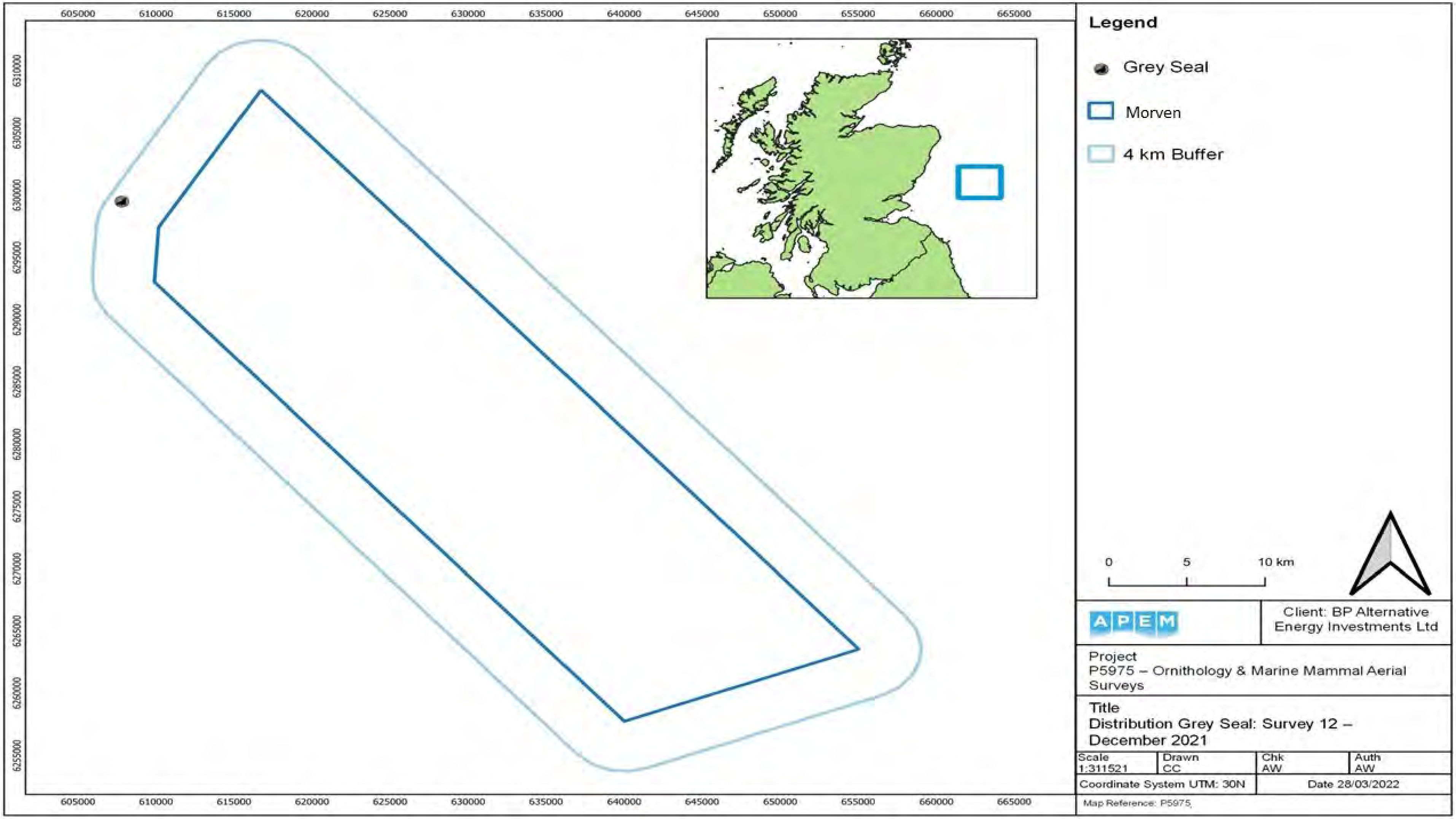


Figure 200 Location of a grey seal in December 2021 (Survey 12).

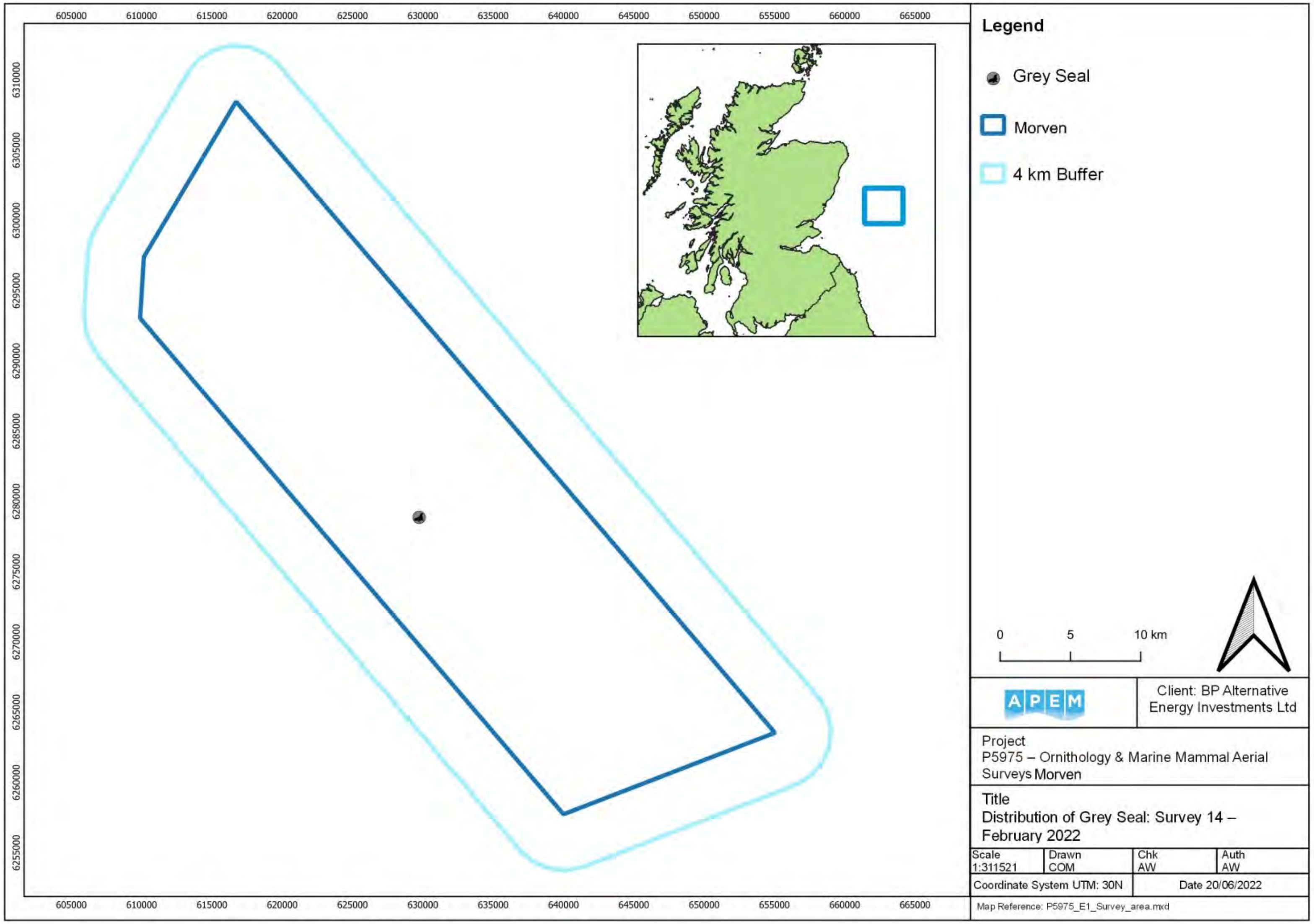


Figure 201 Location of a grey seal in February (Survey 14).

4.35 Seal species – Unidentified

Unidentified seal species were recorded in February, March, April, May, July, and November 2021 and, February and March 2022, with peak numbers in April - seven individuals, resulting in an abundance estimate of 57 within the Array Project (Table 41).

These were recorded throughout the Array Project – north in January (Figure 202), March (Figure 204) and November (Figure 208); central in February (Figure 203); south in April (Figure 205) July (Figure 207), and March 2022 (Figure 210); north and south in May (Figure 206), and loosely scattered throughout the Array Project in February 2022 (Figure 209).

Table 41 Raw counts, abundance and density estimates of unidentified seal species in the Array Project.

Survey	Raw Count	Submerged	Surfacing	Deceased	Abundance	Lower CL	Upper CL	Precision	Density
Jan-21	1	1	-	-	8	1	24	1.00	0.01
Feb-21	2	2	-	-	16	2	41	0.71	0.01
Mar-21	1	1	-	-	8	1	25	1.00	0.01
Apr-21	7	6	1	-	57	16	105	0.38	0.04
May-21	2	2	-	-	16	2	41	0.71	0.01
Jul-21	1	-	-	1	-	-	-	-	-
Nov-21	1	1	-	-	8	1	25	1.00	0.01
Feb-22	3	-	3	-	24	3	57	0.58	0.02
Mar-22	4	2	2	-	32	8	64	0.50	0.03

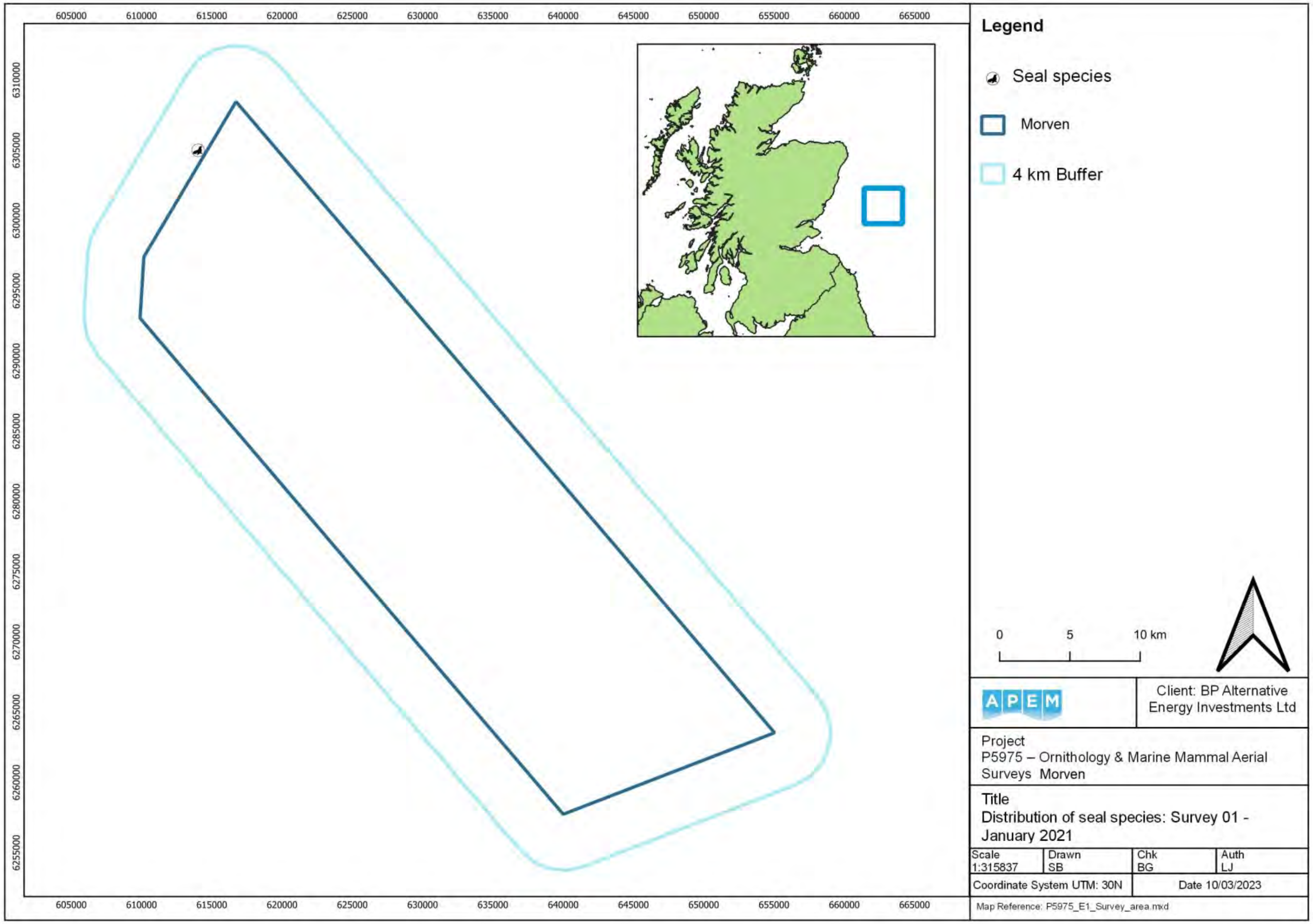


Figure 202 Distribution of seals in January 2021 (Survey 01).

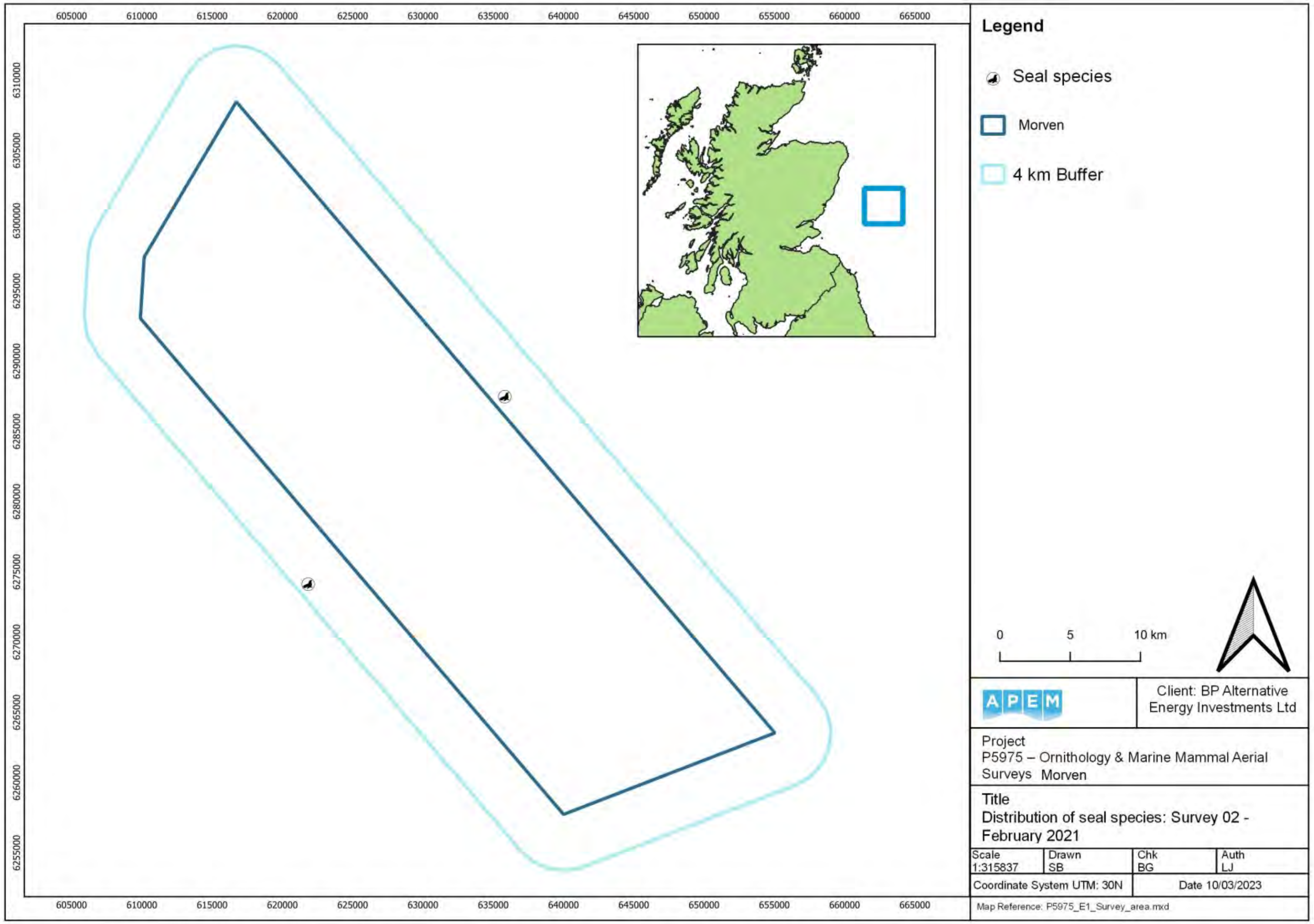


Figure 203 Distribution of seals in February 2021 (Survey 02).

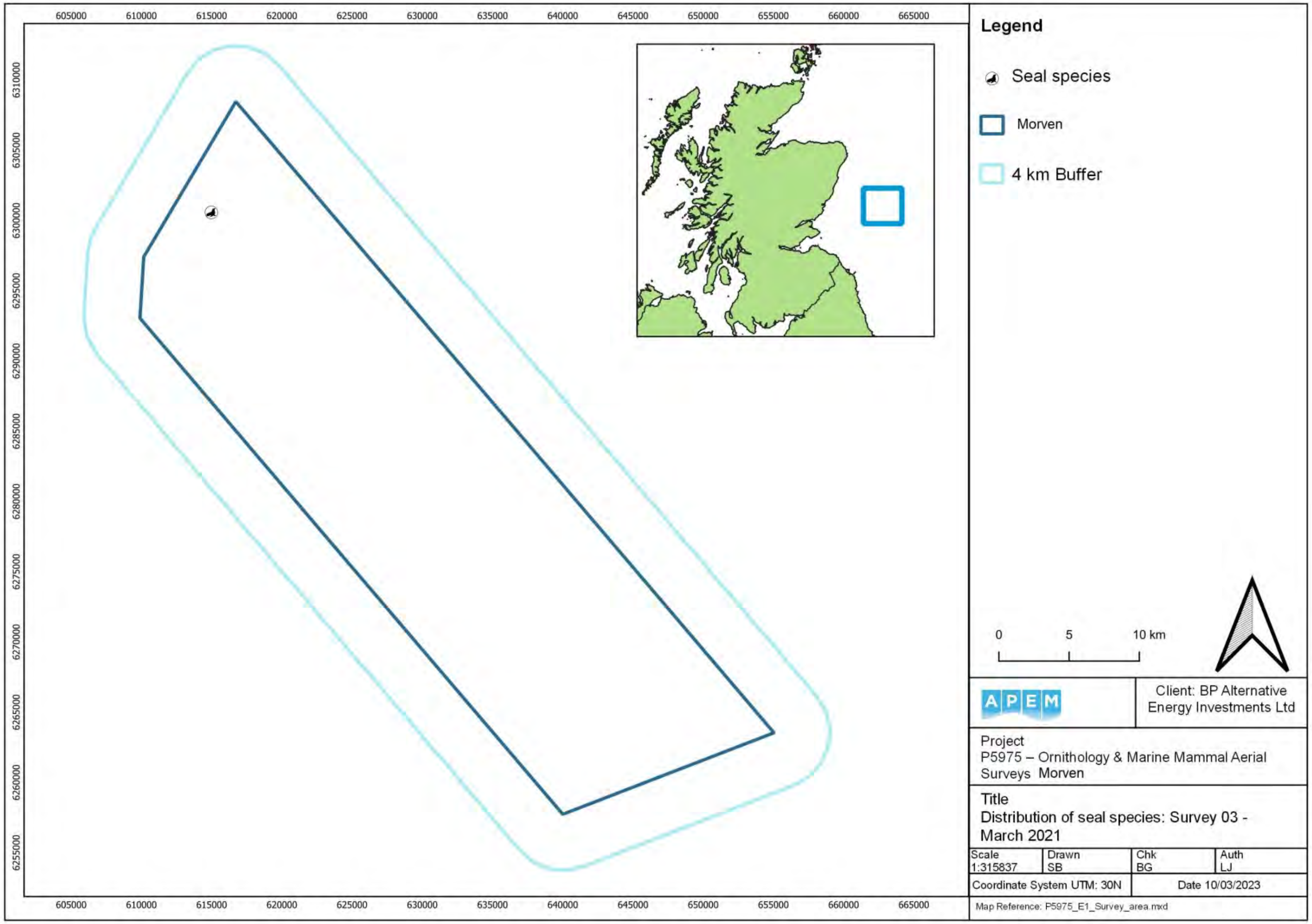


Figure 204 Distribution of seals in March 2021 (Survey 03).

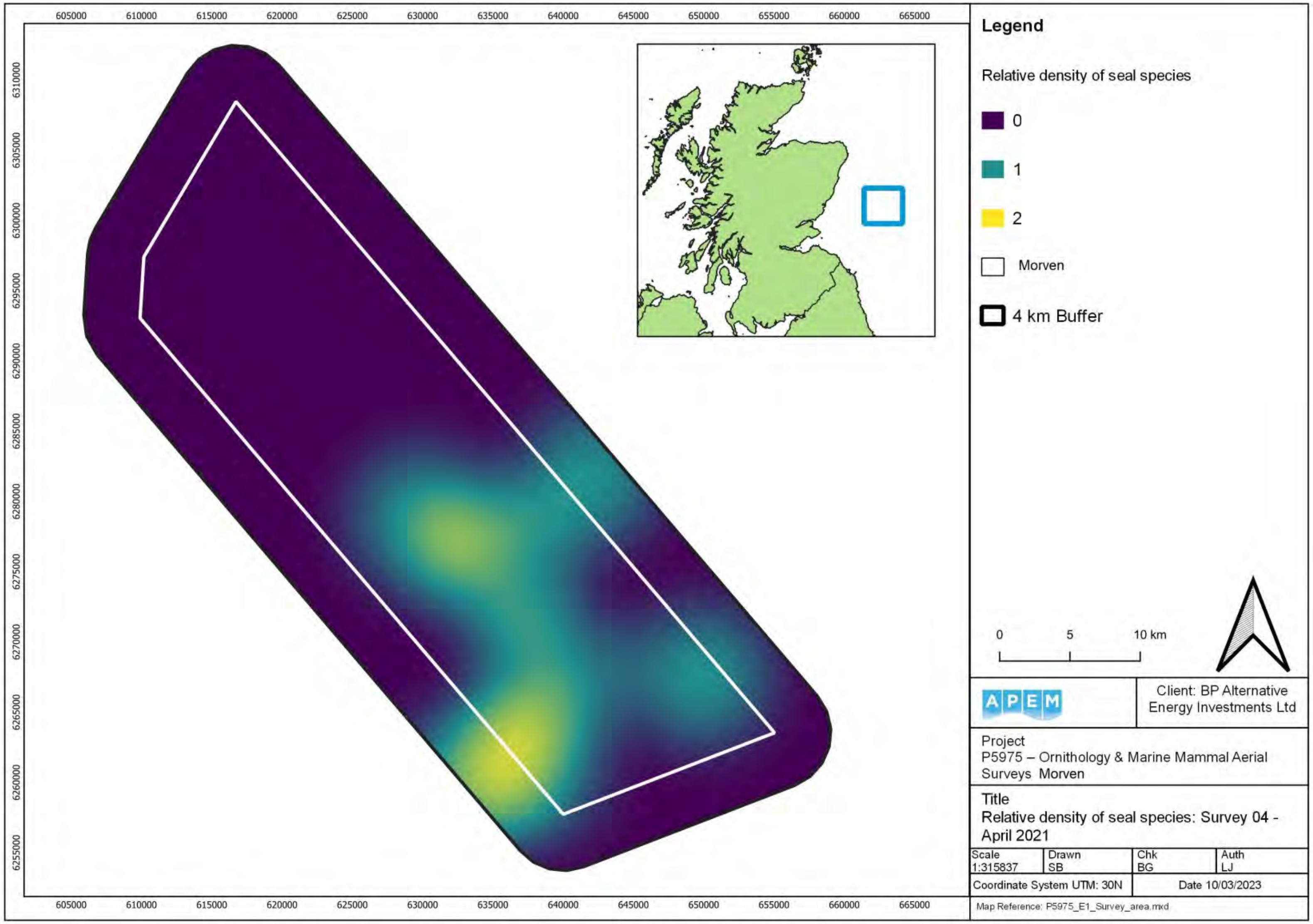


Figure 205 Relative density of seal in April 2021 (Survey 04).

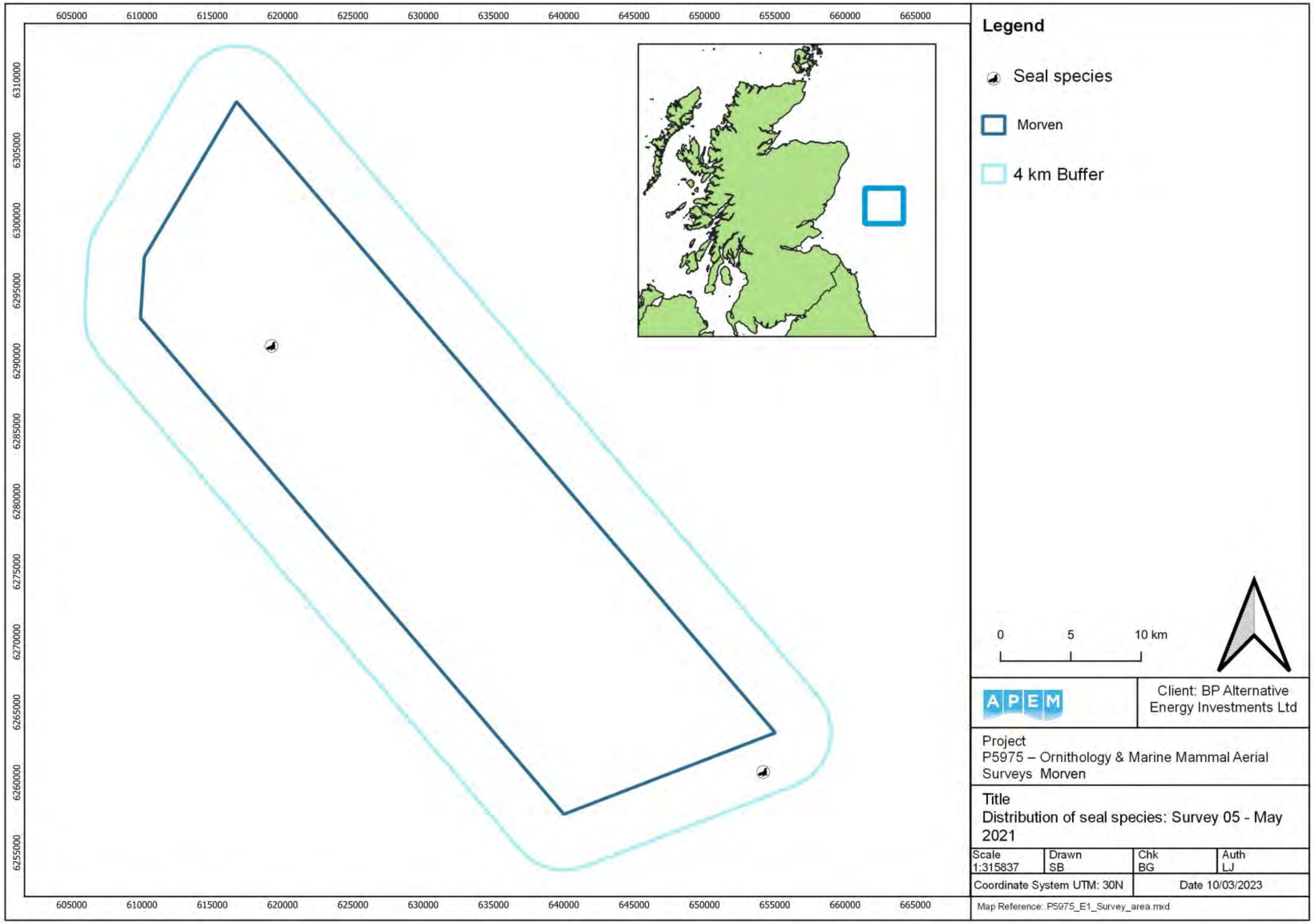


Figure 206 Distribution of seals in May 2021 (Survey 05).

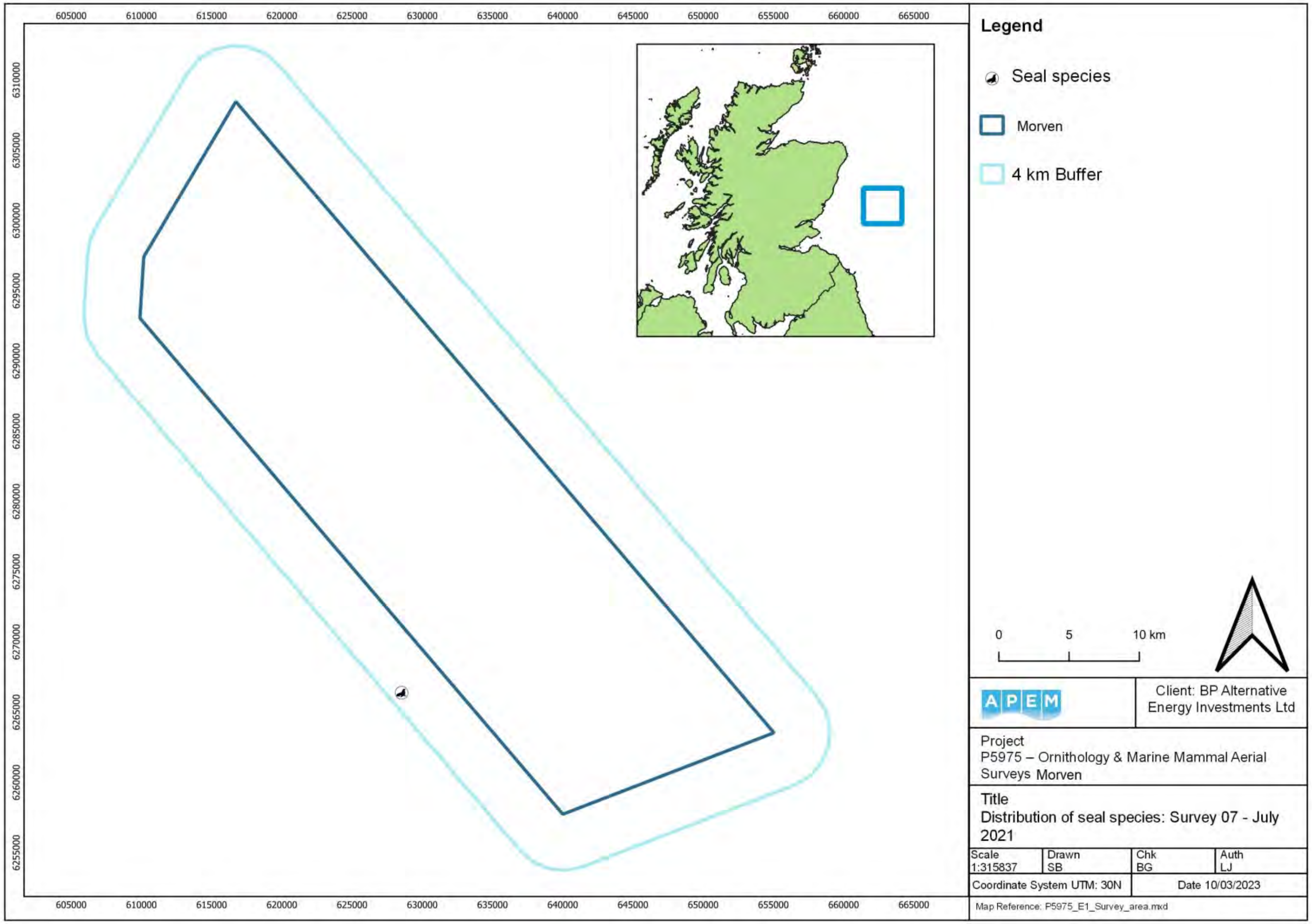


Figure 207 Location of seals in July 2021 (Survey 07).

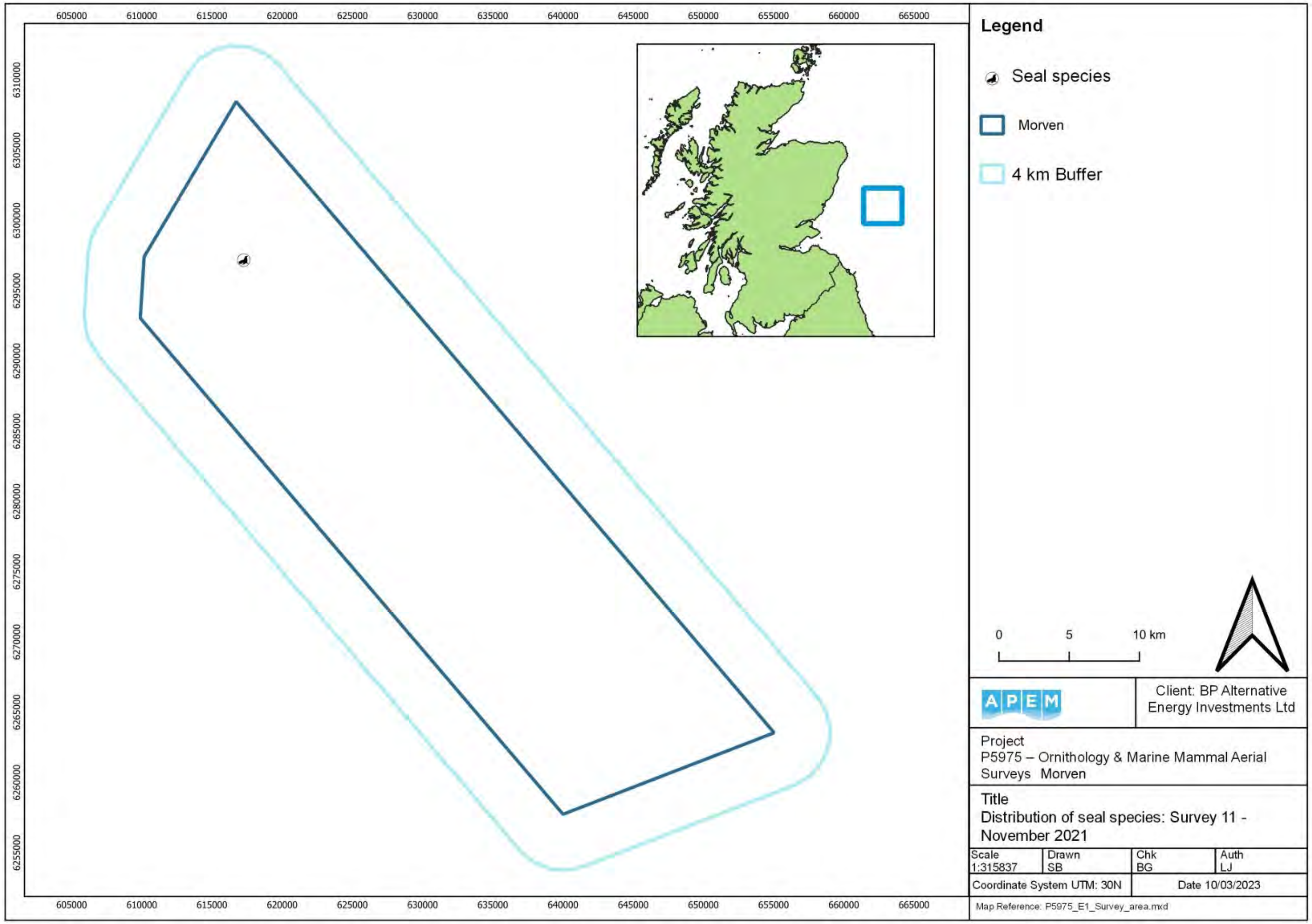


Figure 208 Location of seal species in November 2021 (S11)

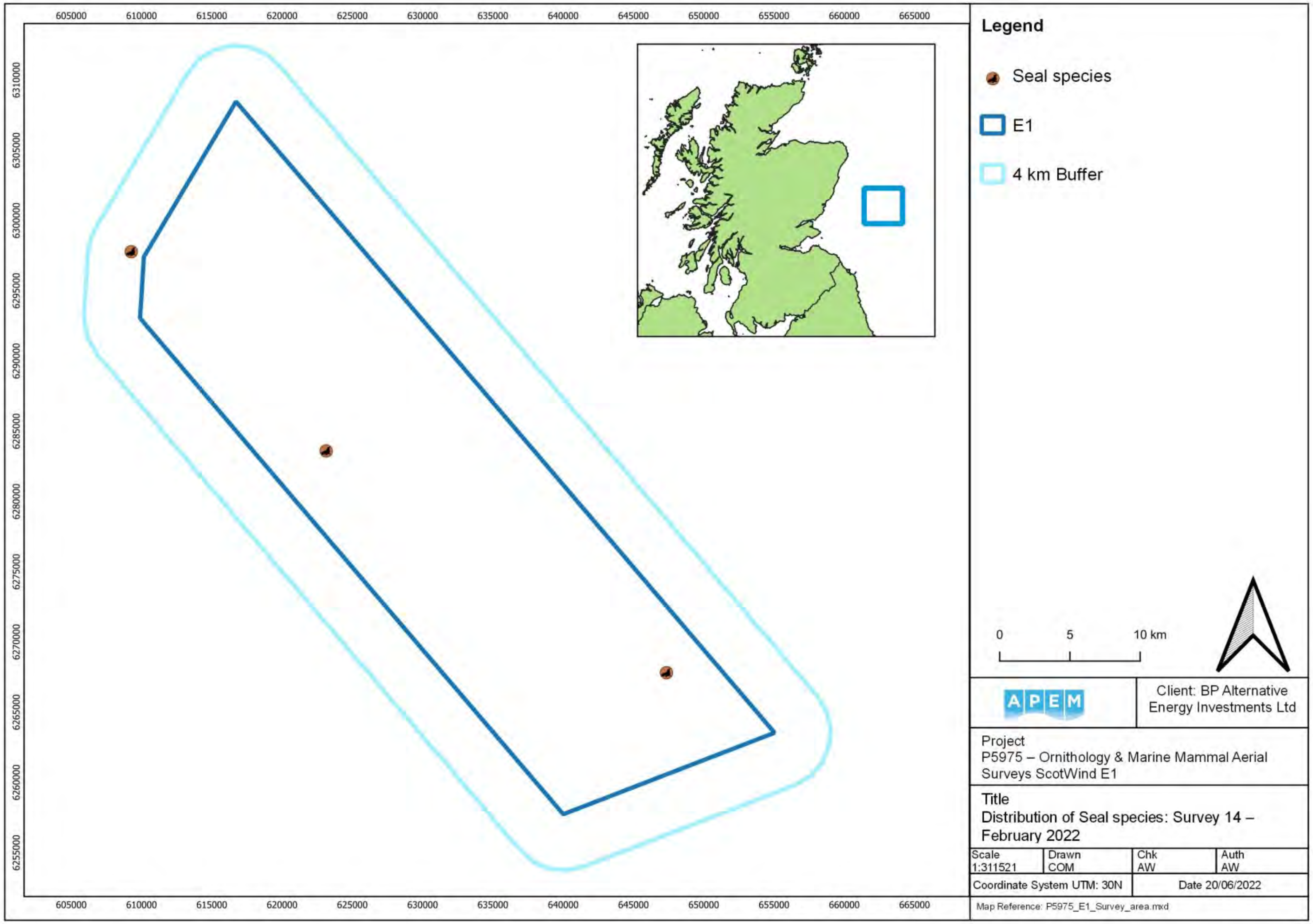


Figure 209 Distribution of seal species in February 2022 (S14)

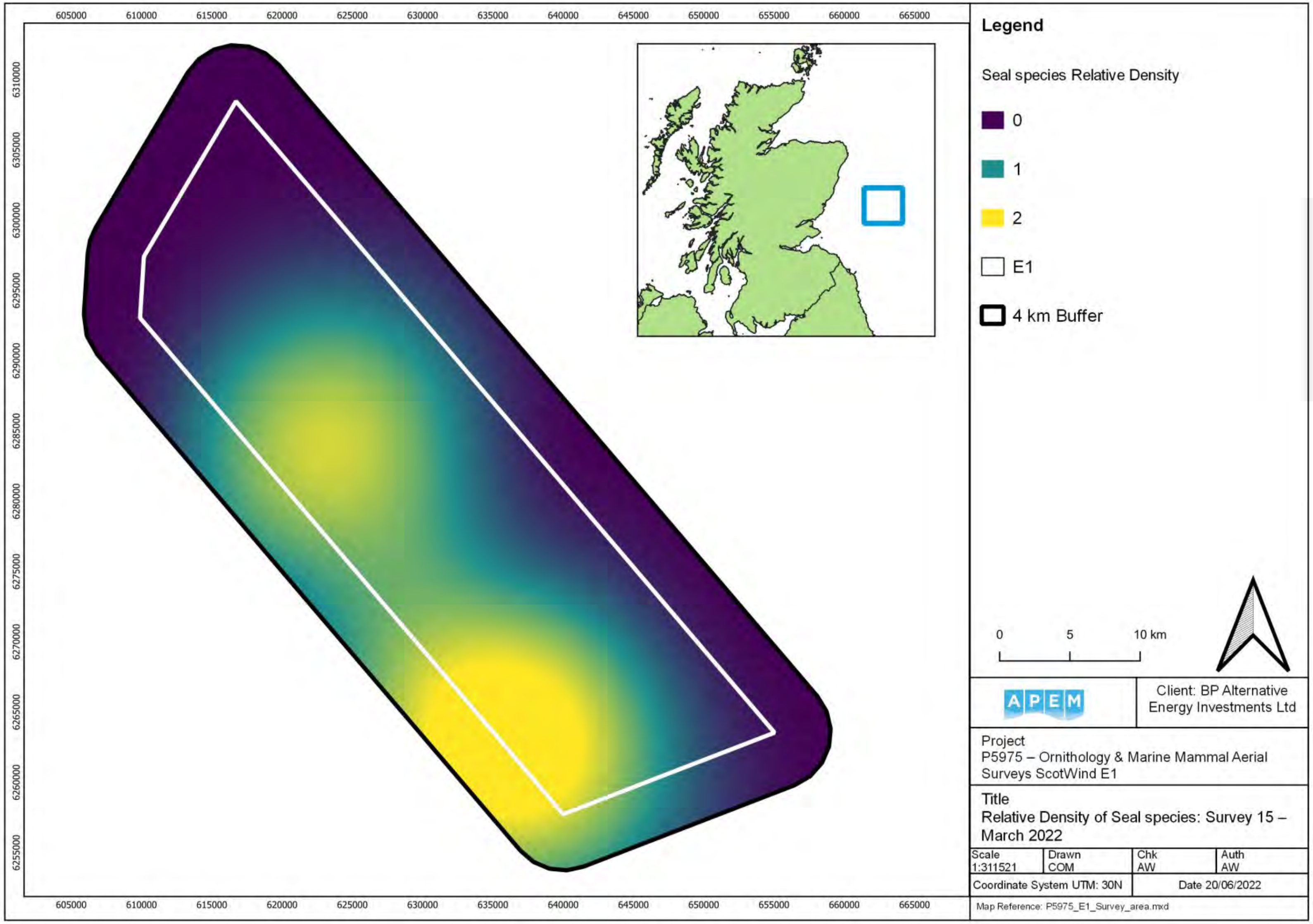


Figure 210 Relative density of seal species in March 2022 (S15)

4.36 White-beaked Dolphin – *Lagenorhynchus albirostris*

White-beaked dolphin were recorded in June, July, August, and September 2021 and, February 2022 with peak numbers in June - 10 individuals, resulting in an abundance estimate of 82 within the Array Project (Table 42).

These were in the central south-south-west of the Array Project in June (Figure 211), July (Figure 212), August (Figure 213), and September (Figure 214).

Table 42 Raw counts, abundance and density estimates of white-beaked dolphin in the Array Project.

Survey	Raw Count	Submerged	Surfacing	Abundance	Lower CL	Upper CL	Precision	Density
Jun-21	10	10	-	82	10	231	0.32	0.06
Jul-21	4	4	-	33	4	98	0.50	0.02
Aug-21	2	2	-	16	2	49	0.71	0.01
Sep-21	8	6	2	66	8	197	0.35	0.05
Feb-22	8	8	-	65	8	195	0.35	0.05

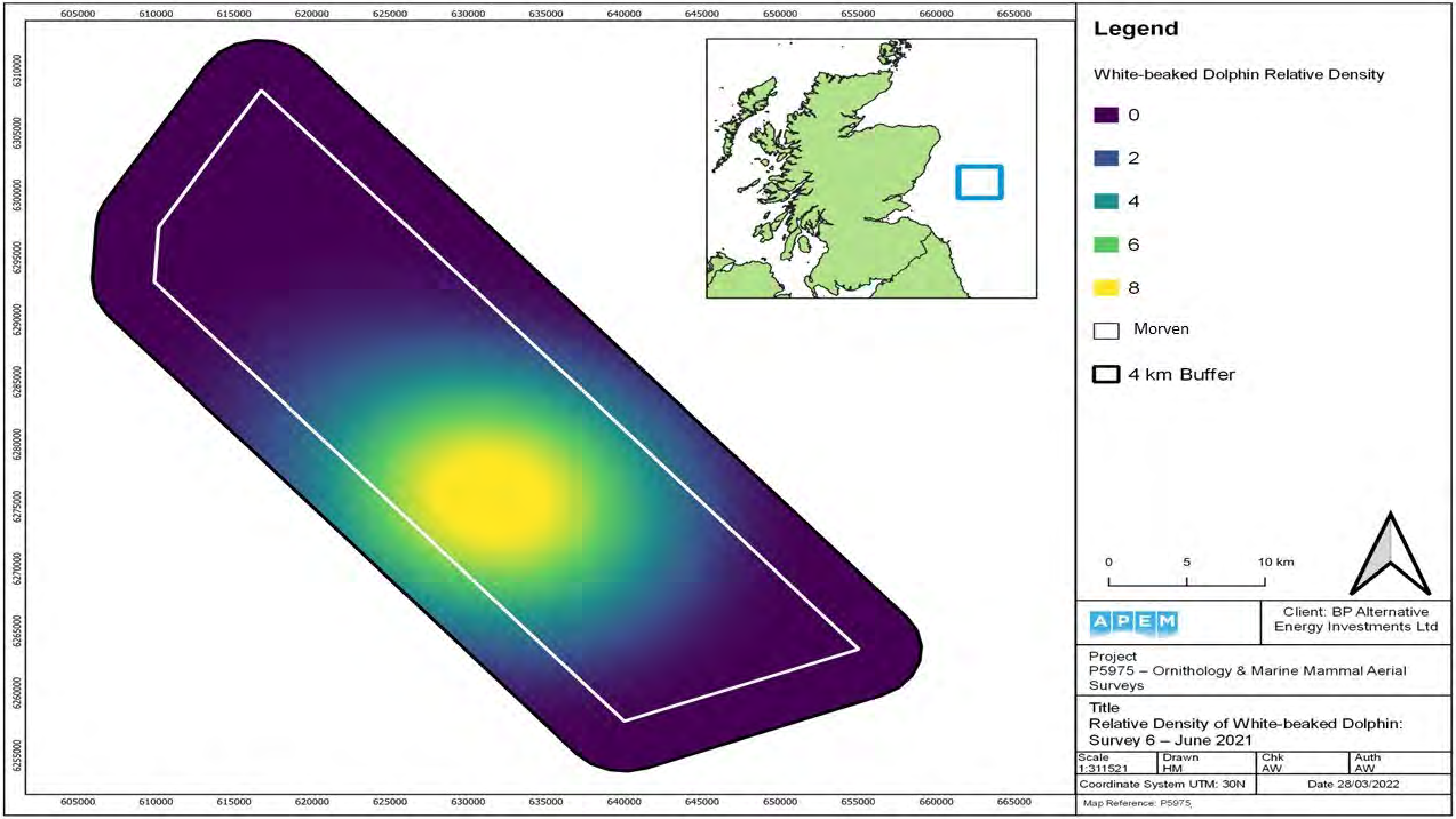


Figure 211 Relative density of white-beaked dolphin in June 2021 (Survey 06).

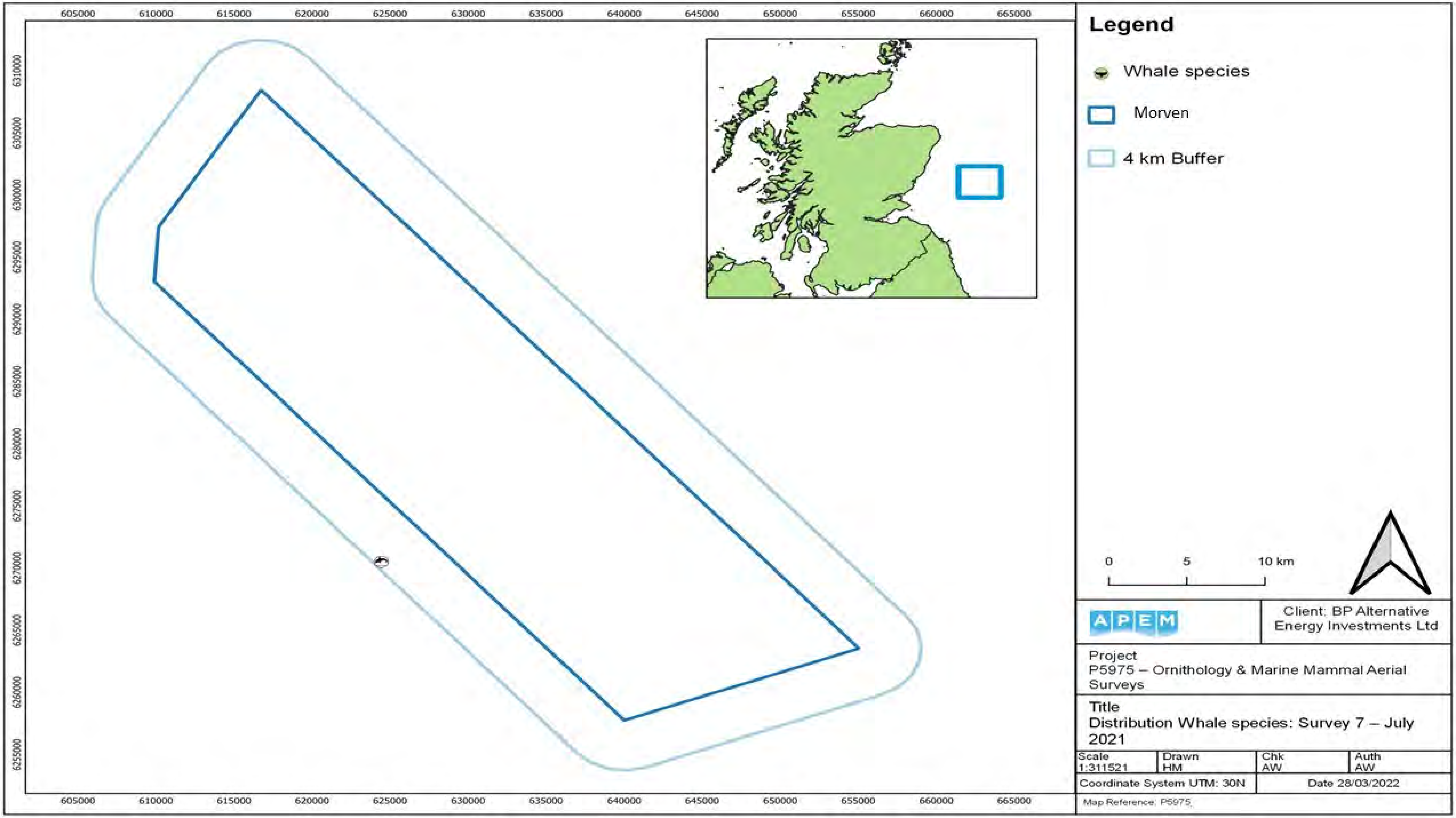


Figure 212 Location of white-beaked dolphins in July 2021 (Survey 07).

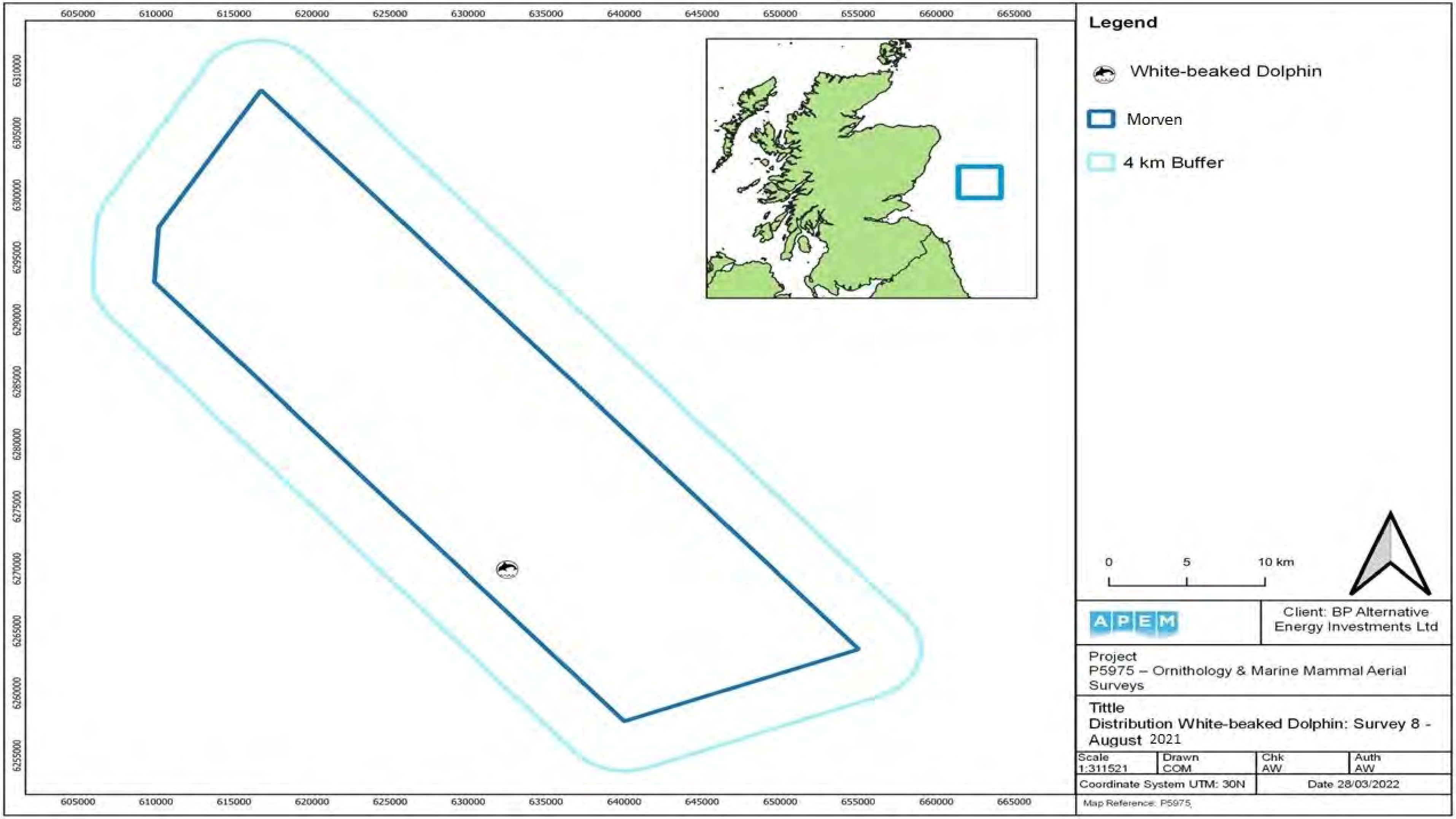


Figure 213 Location of white-beaked dolphins in August 2021 (Survey 08).

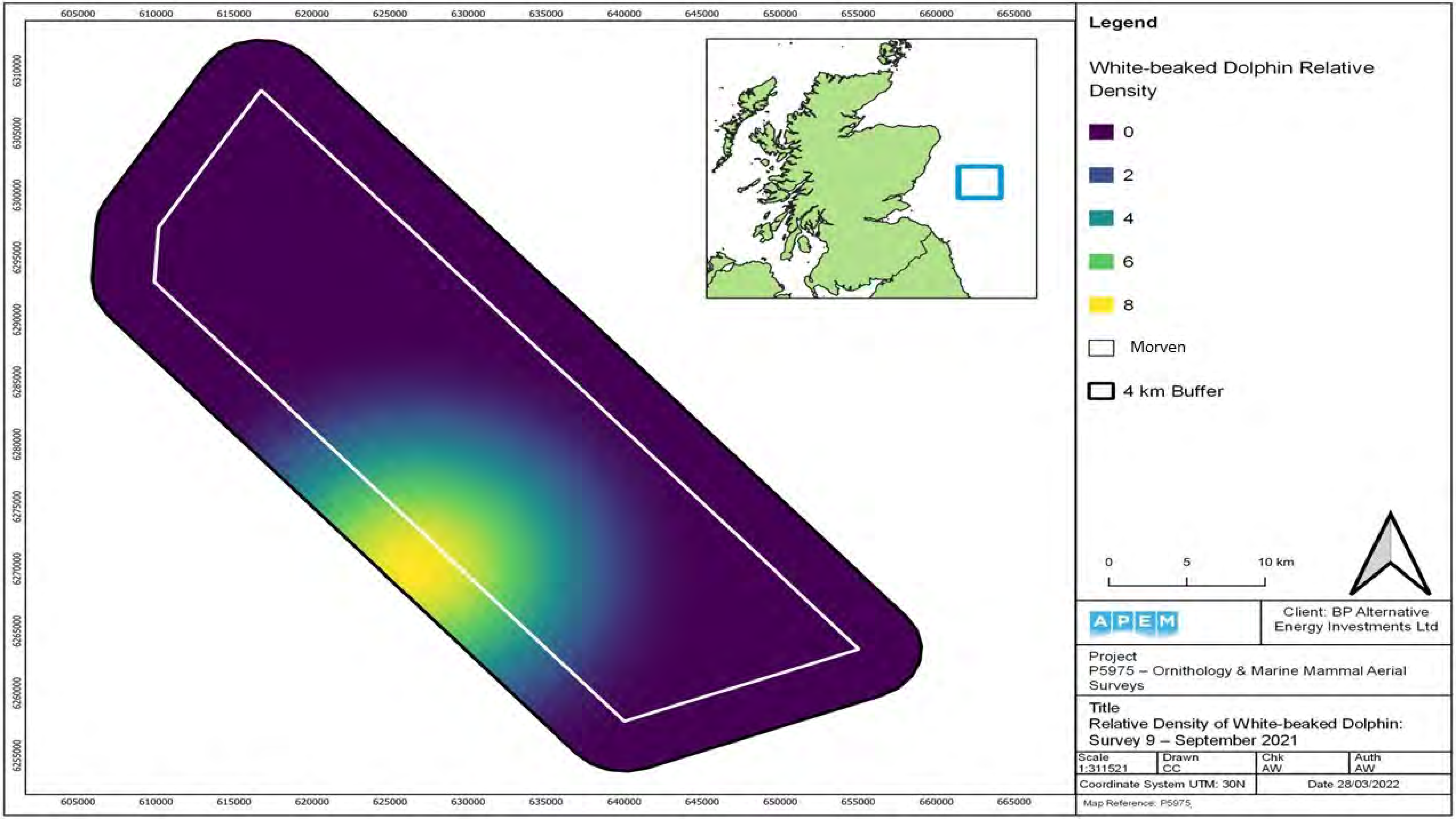


Figure 214 Relative density of white-beaked dolphin in September 2021 (Survey 09).

4.37 Dolphins – Unidentified

Unidentified dolphins were recorded in May and June 2021, with peak numbers in May - nine individuals, resulting in an abundance estimate of 73 within the Array Project (Table 43).

These were in the north of the Array Project in May (Figure 215), and northwest in June (Figure 216).

Table 43 Raw counts, abundance and density estimates of unidentified dolphin in the Array Project.

Survey	Raw Count	Submerged	Surfacing	Abundance	Lower CL	Upper CL	Precision	Density
May-21	9	9	-	73	25	131	0.33	0.05
Jun-21	1	1	-	8	1	33	1.00	0.01

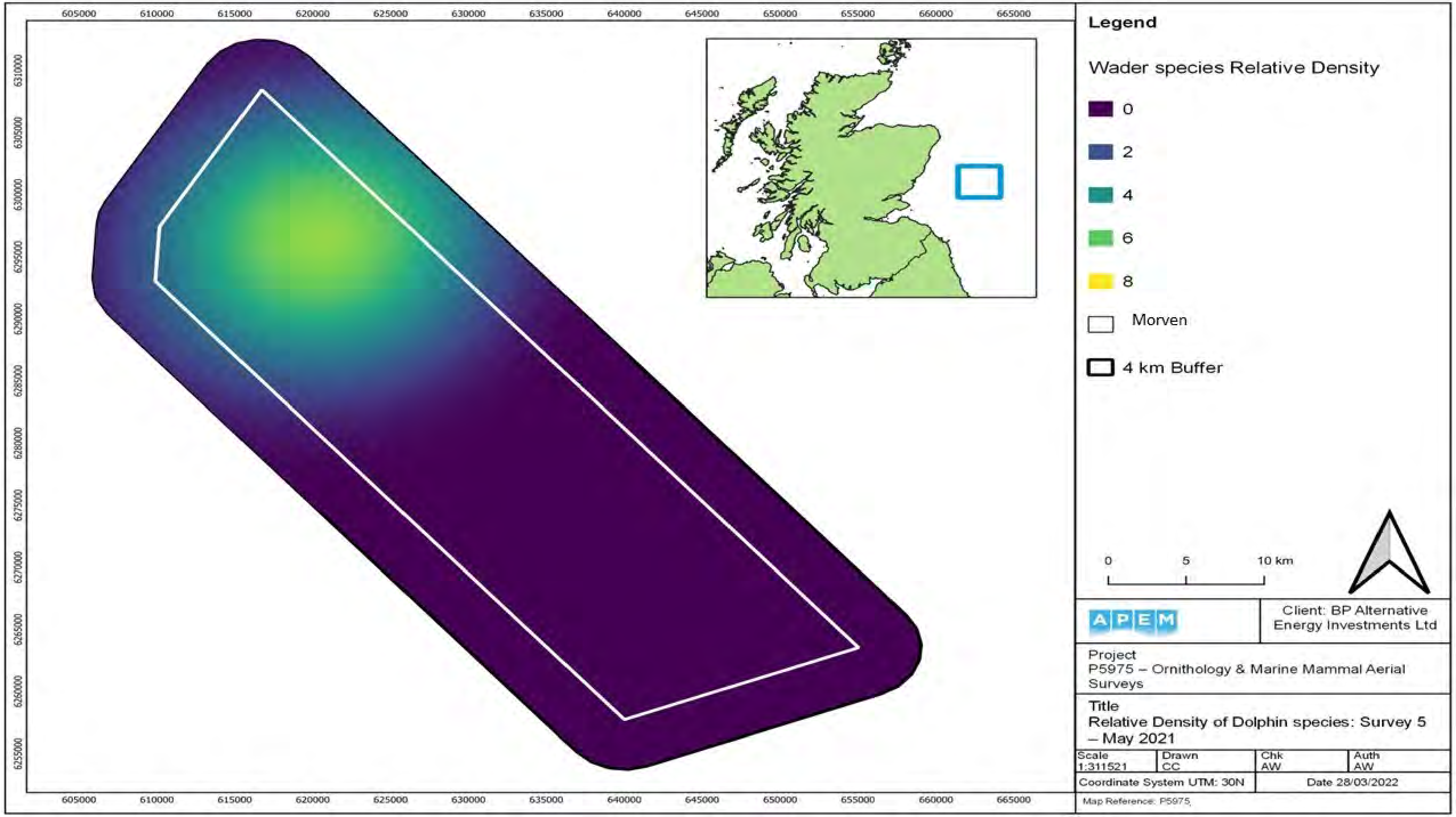


Figure 215 Relative density of unidentified dolphin in May 2021 (Survey 05).

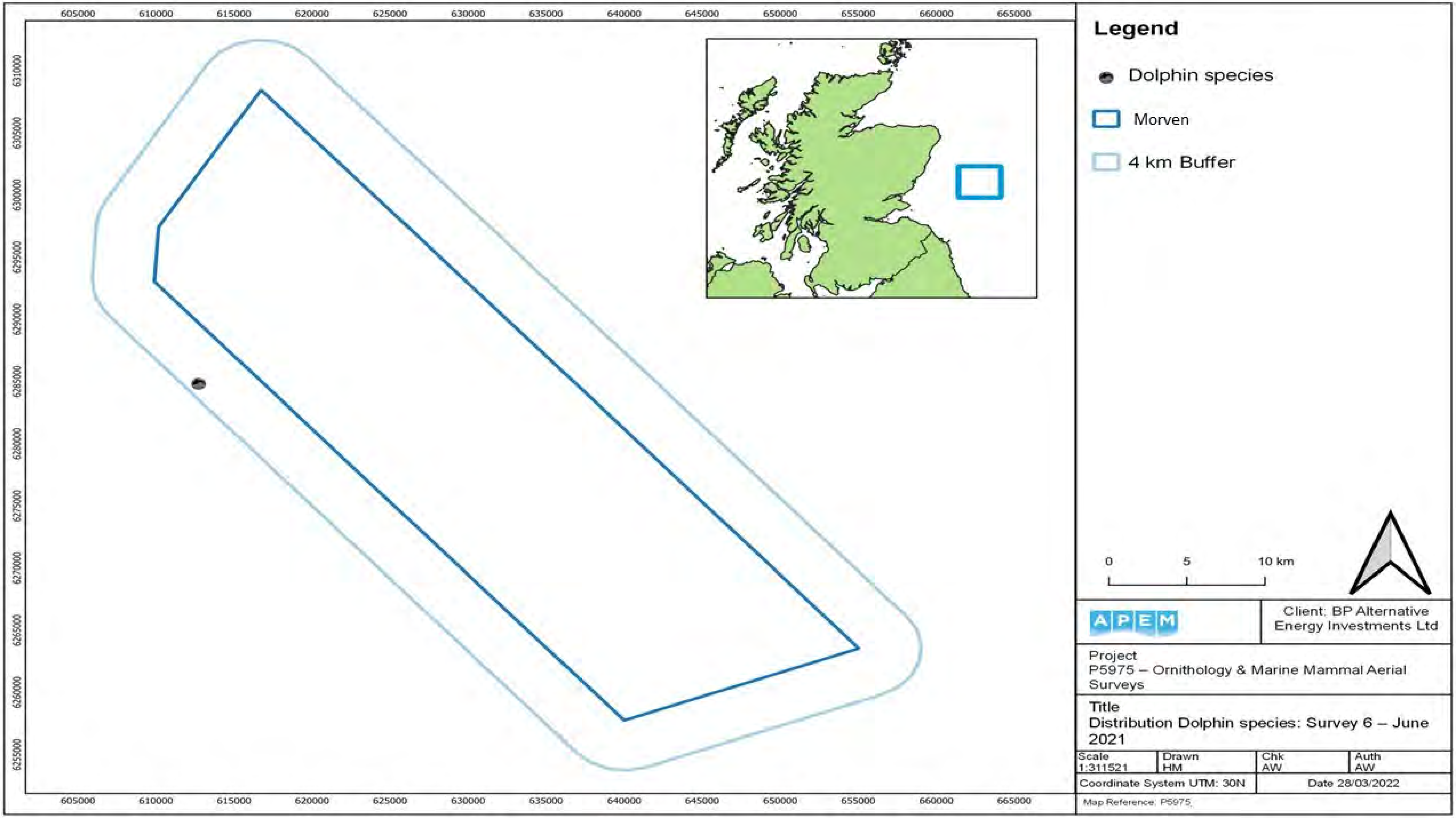


Figure 216 Location of an unidentified dolphin in June 2021 (Survey 06).

4.38 Harbour Porpoise – *Phocoena phocoena*

Harbour porpoises were recorded in April, May, June, July, August, September, October, November, and December 2021 and, February and March 2022. Peak numbers were recorded in May - 116 individuals, resulting in an abundance estimate of 948 within the Array Project (Table 44).

They were throughout the Array Project – south in March 2022 (Figure 227), south and central in April (Figure 217); north in May (Figure 218), June (Figure 219), September (Figure 222) November (Figure 224), and February 2022 (Figure 226); northwest in December (Figure 225); and central in July (Figure 220), August (Figure 221) and October (Figure 223).

Table 44 Raw counts, abundance and density estimates of harbour porpoise in the Array Project.

Survey	Raw Count	Submerged	Surfacing	Abundance	Lower CL	Upper CL	Precision	Density
Apr-21	3	3	-	24	3	57	0.58	0.02
May-21	116	91	25	948	662	1,266	0.09	0.67
Jun-21	3	2	1	25	3	66	0.58	0.02
Jul-21	47	44	3	385	271	525	0.15	0.27
Aug-21	7	7	-	57	16	107	0.38	0.04
Sep-21	9	8	1	74	9	222	0.33	0.05
Oct-21	5	2	3	40	8	80	0.45	0.03
Nov-21	2	-	2	17	2	42	0.71	0.01
Dec-21	7	7	-	57	16	107	0.38	0.04
Feb-22	7	3	4	57	24	106	0.38	0.04
Mar-22	4	2	2	32	8	64	0.50	0.03

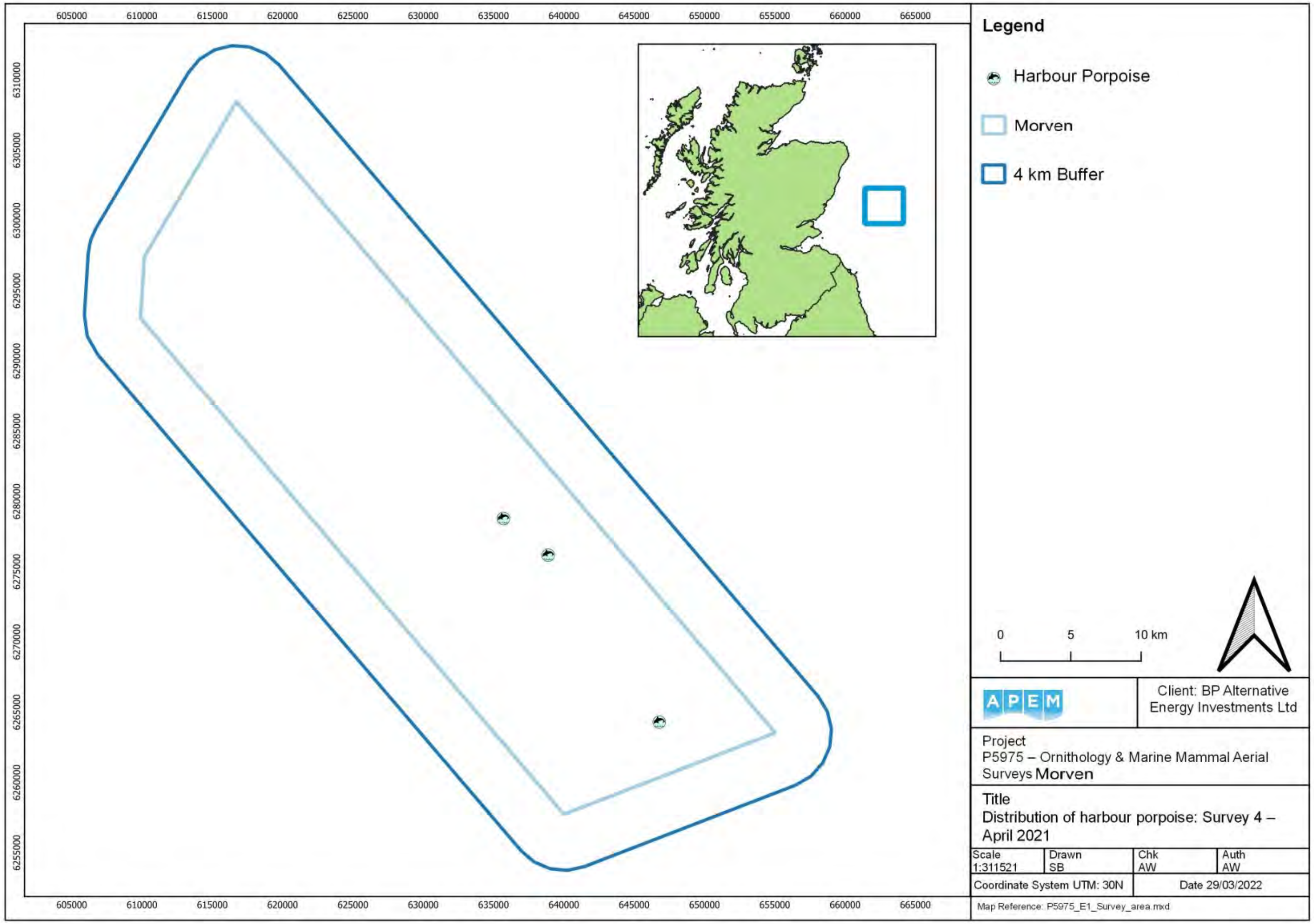


Figure 217 Distribution of harbour porpoises in April 2021 (Survey 04).

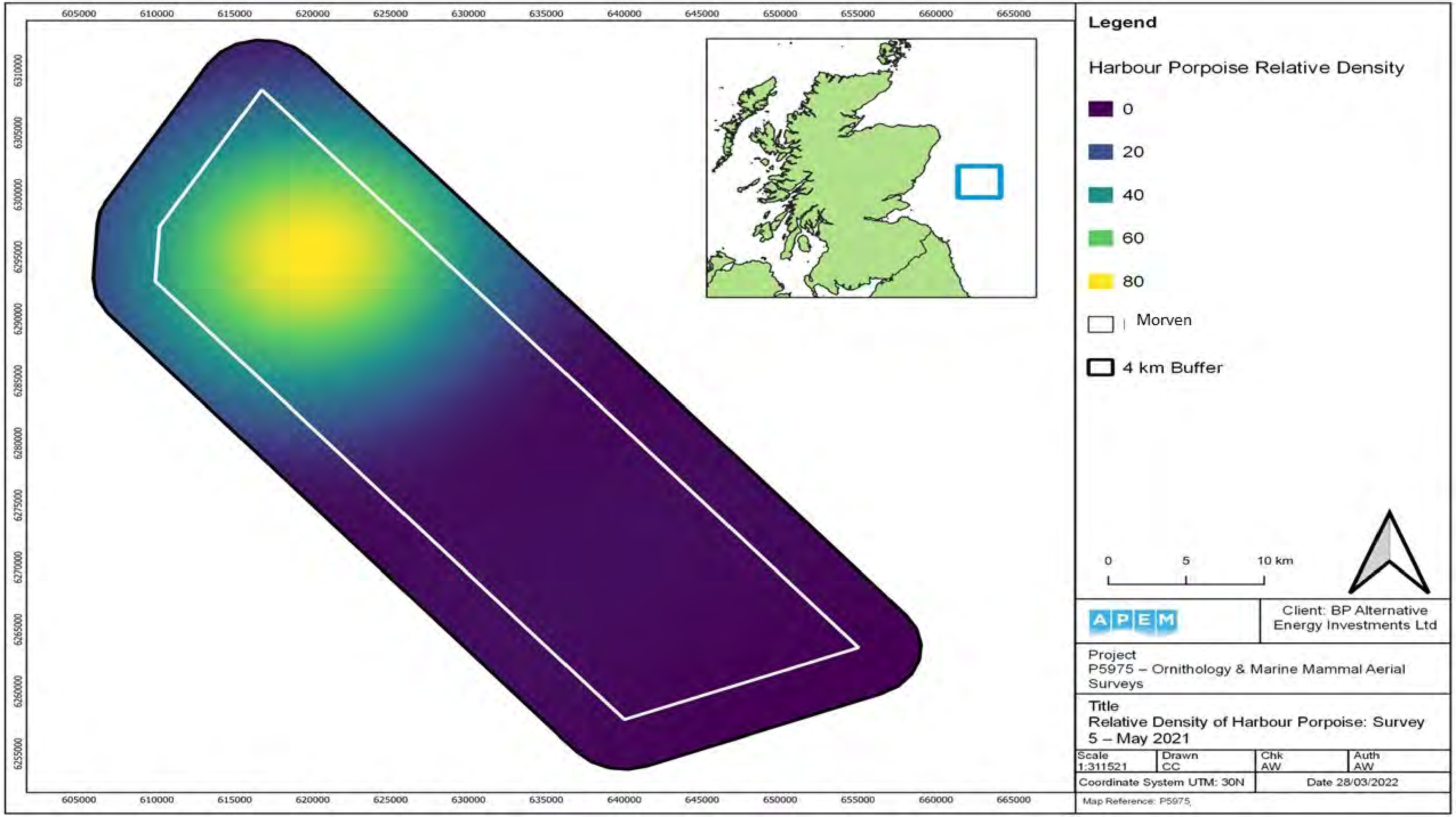


Figure 218 Relative density of harbour porpoise in May 2021 (Survey 05).

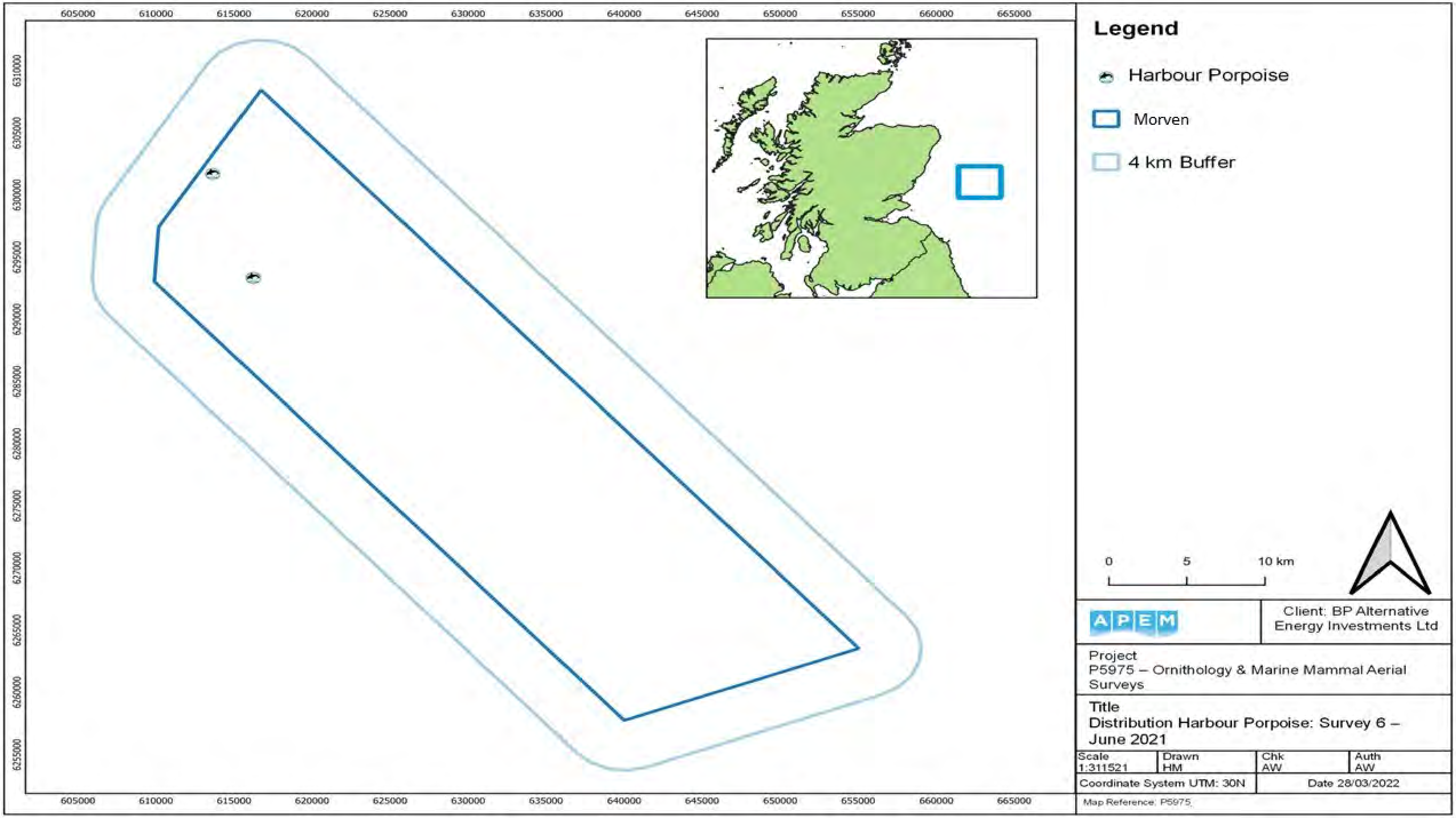


Figure 219 Distribution of harbour porpoises in June 2021 (Survey 06).

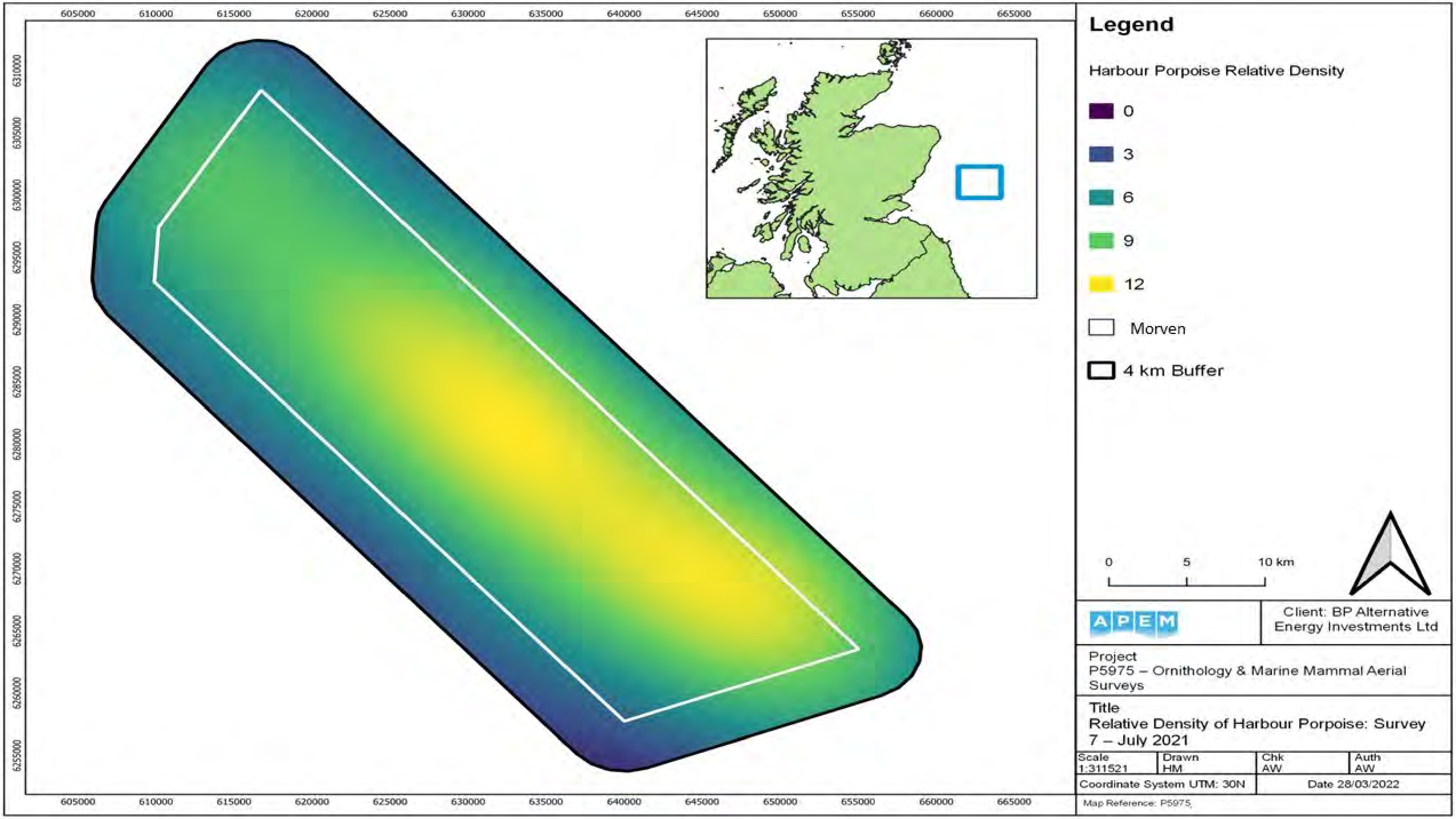


Figure 220 Relative density of harbour porpoise in July 2021 (Survey 07).

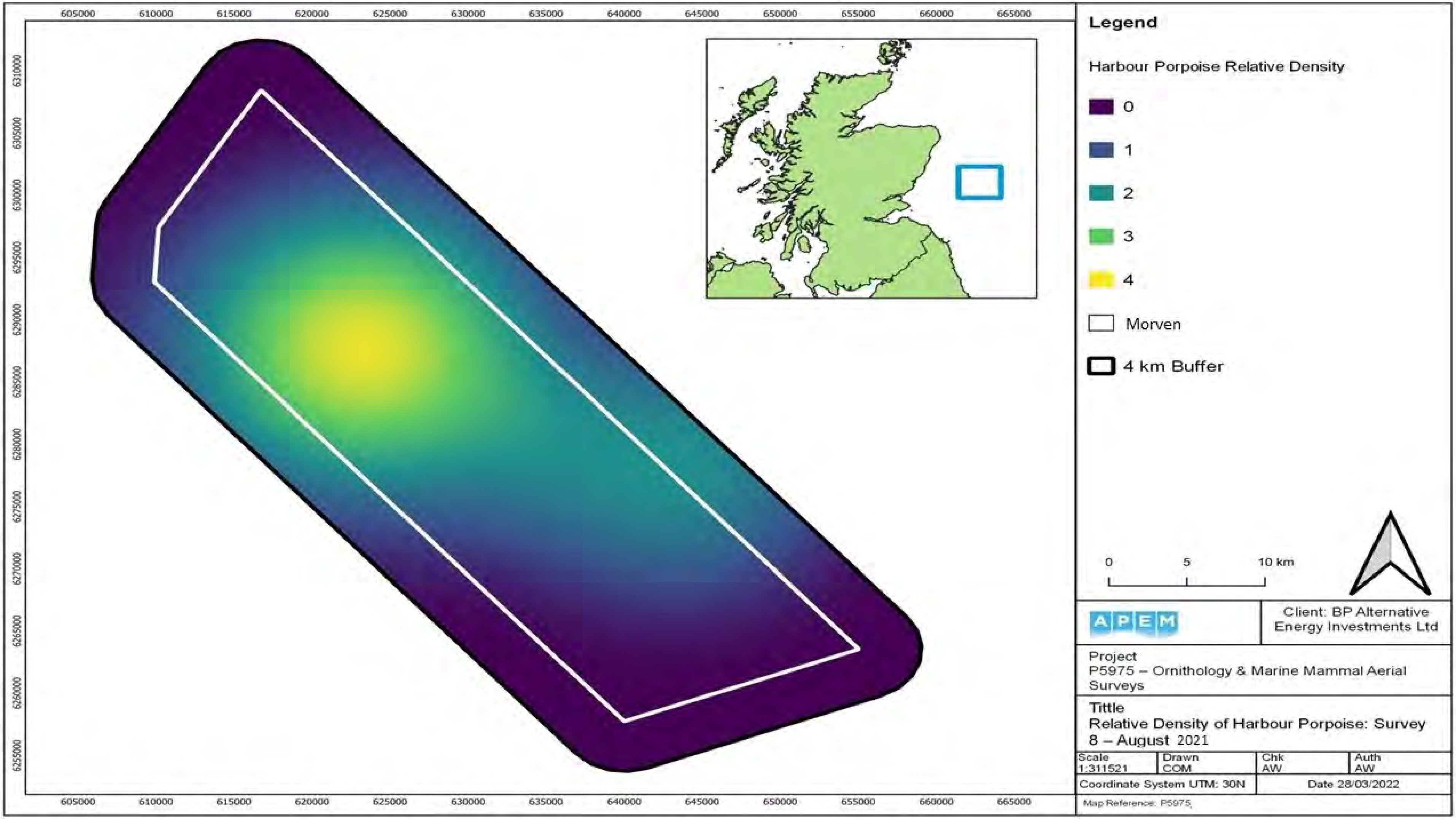


Figure 221 Relative density of harbour porpoise in August 2021 (Survey 08).

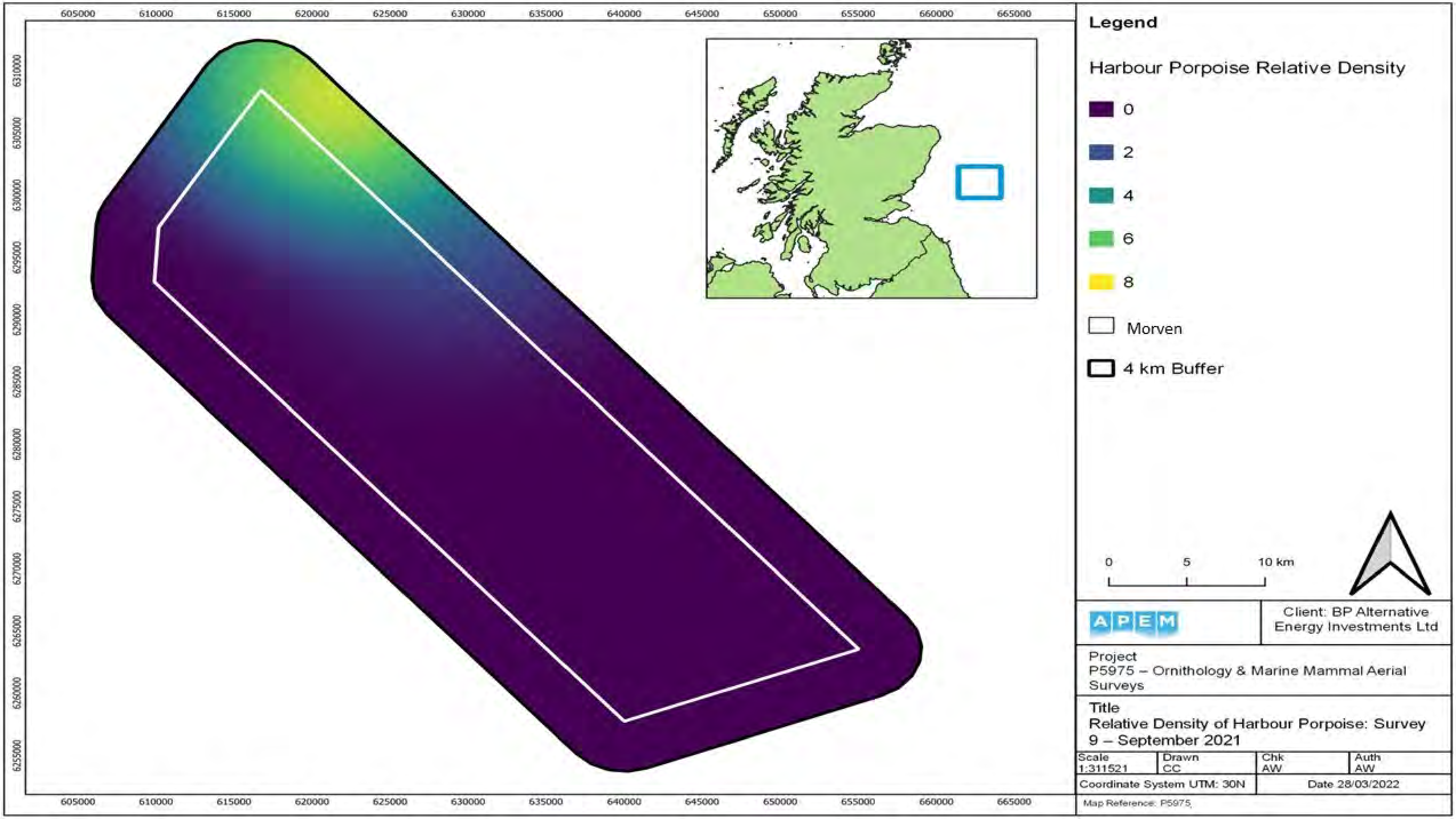


Figure 222 Relative density of harbour porpoise in September 2021 (Survey 09).

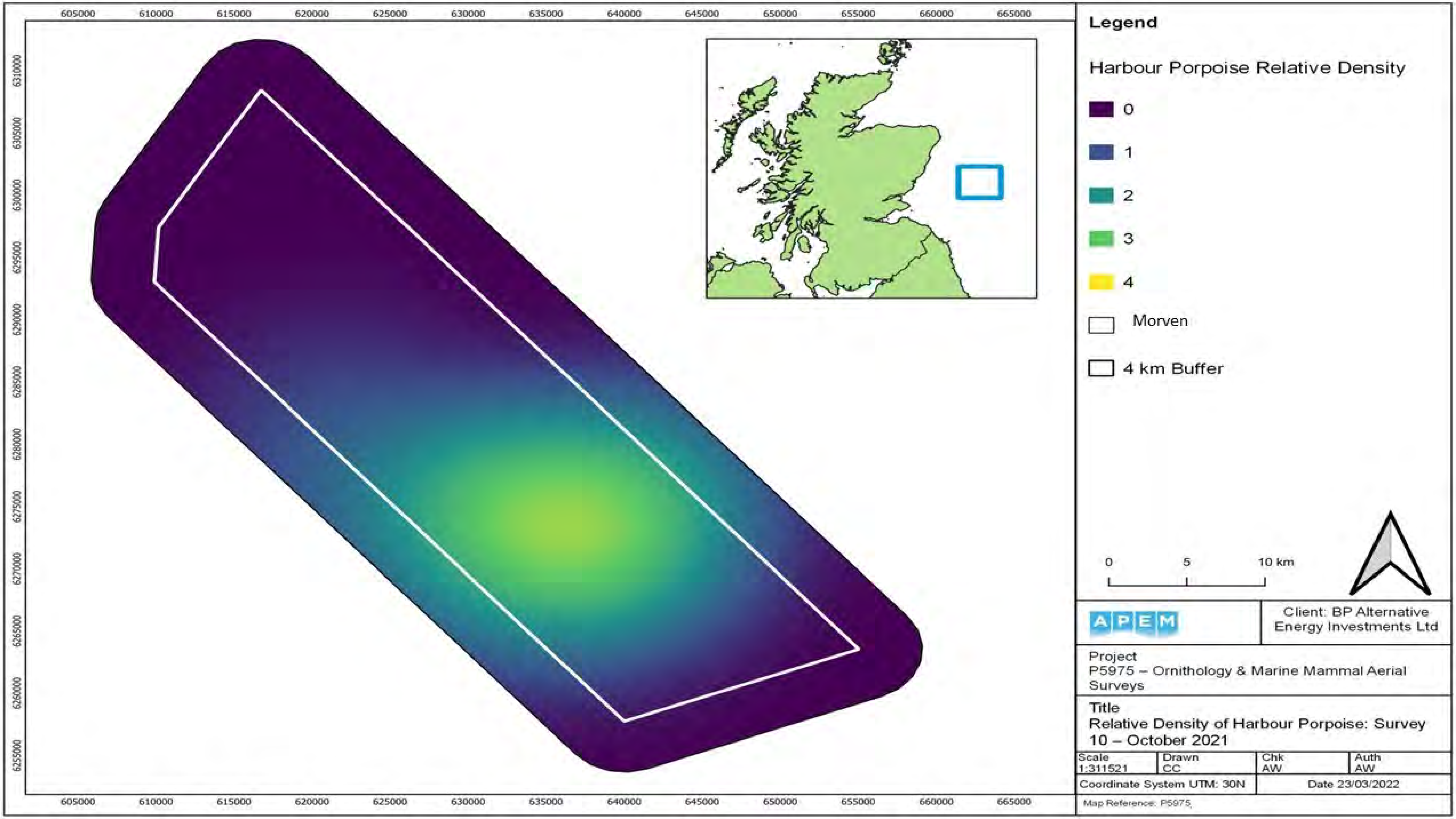


Figure 223 Relative density of harbour porpoise in October 2021 (Survey 10).

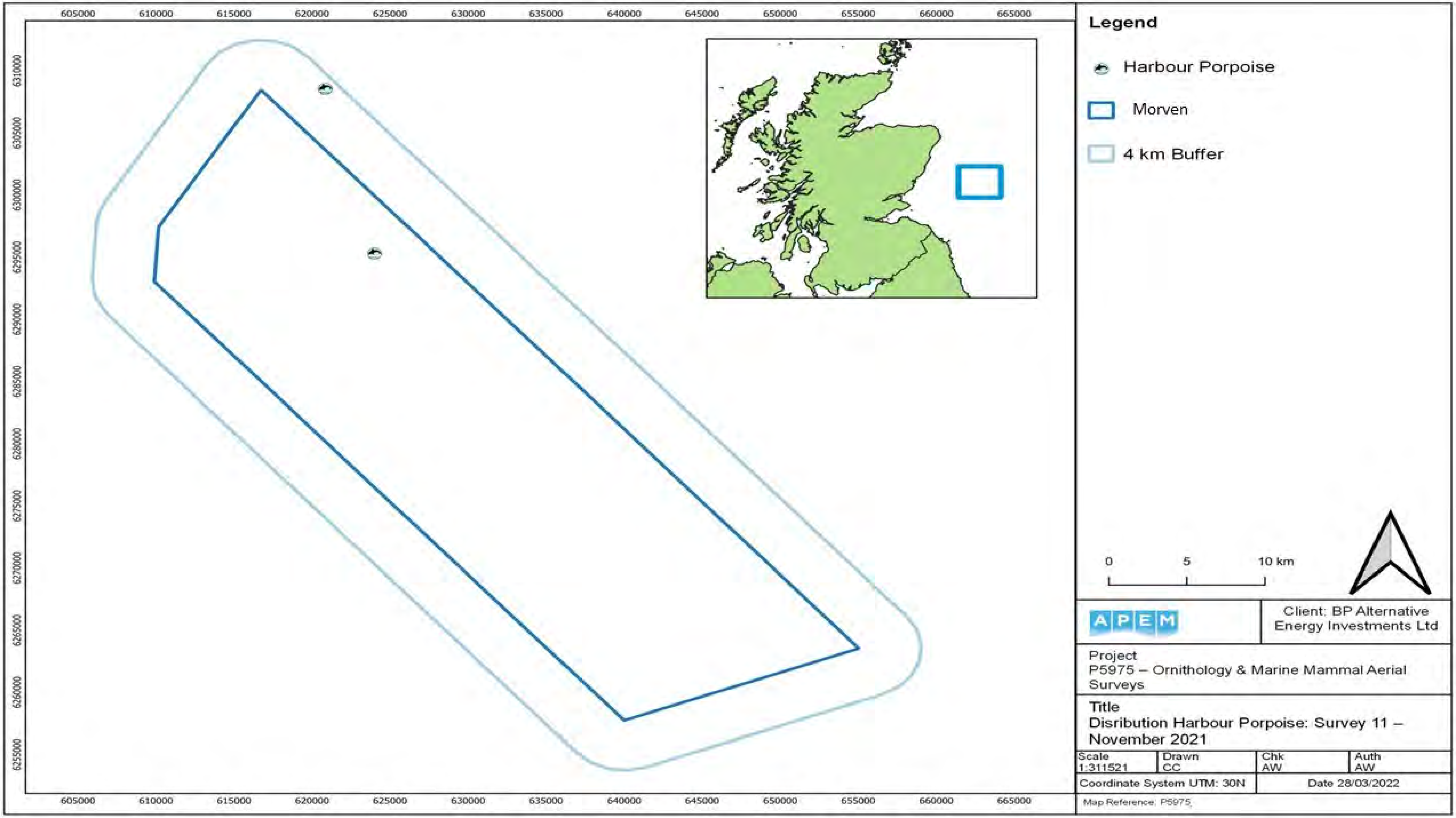


Figure 224 Location of harbour porpoises in November 2021 (Survey 11).

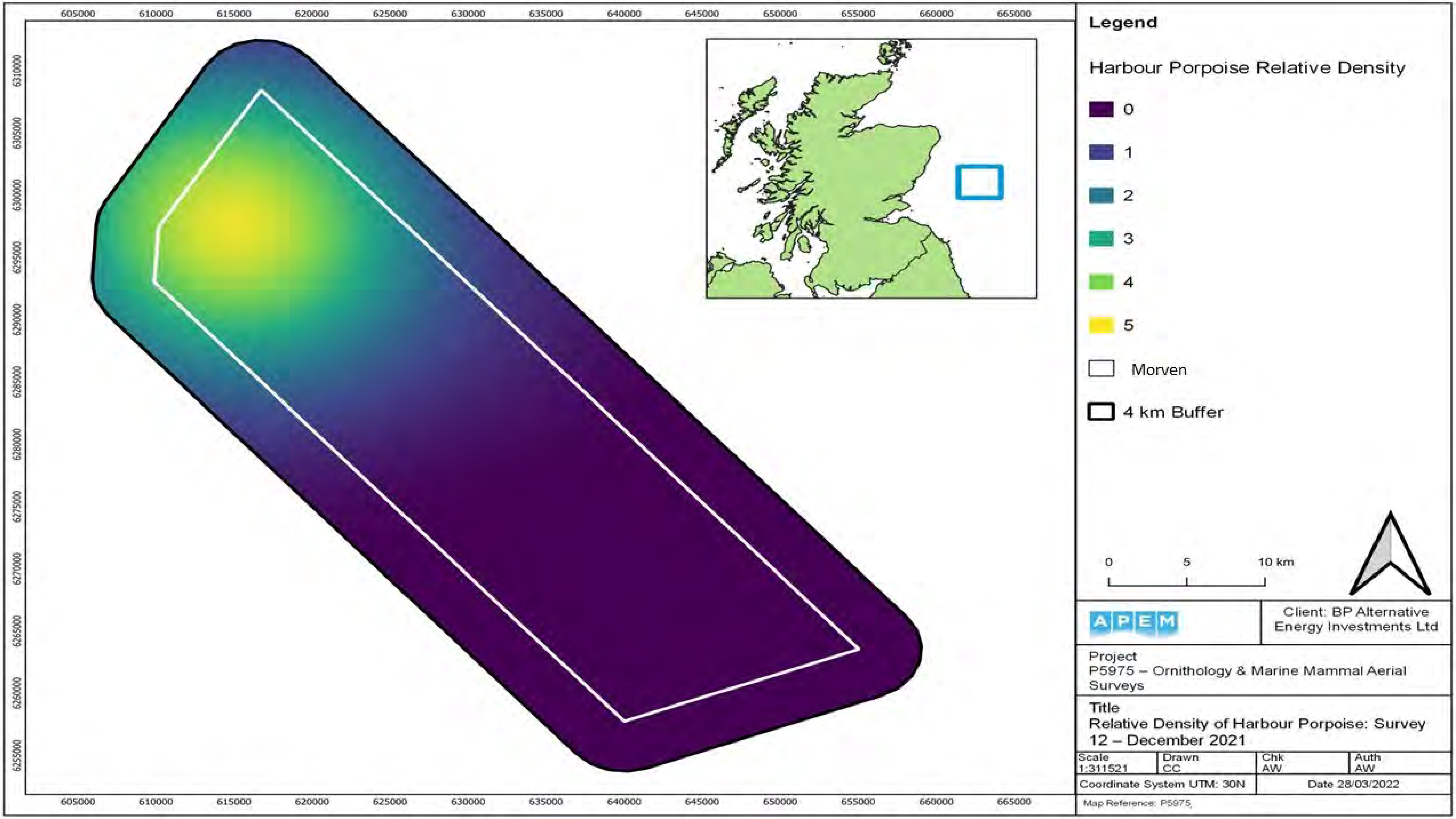


Figure 225 Relative density of harbour porpoise in December 2021 (Survey 12).

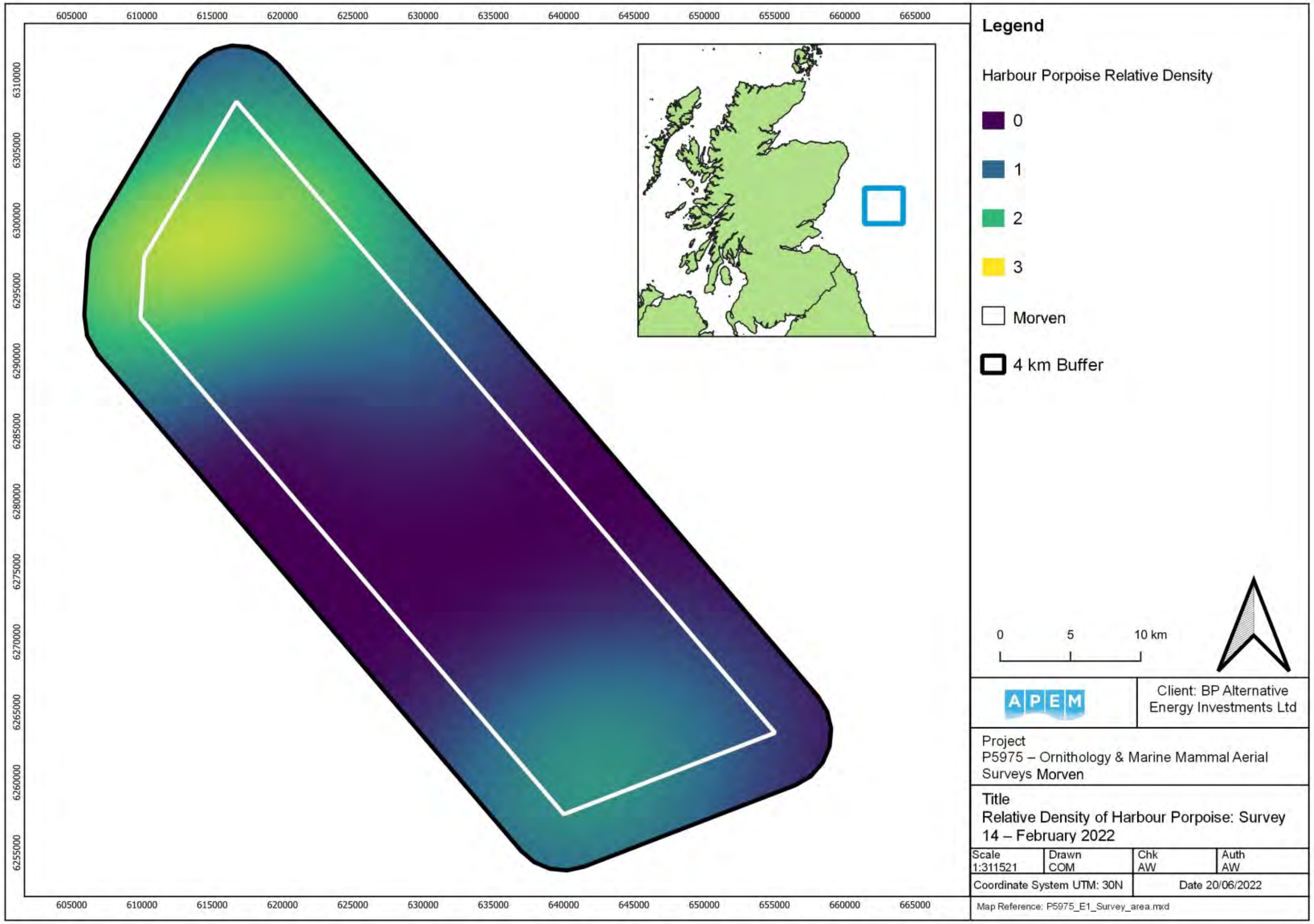


Figure 226 Relative density of harbour porpoise in February 2022 (Survey 14).

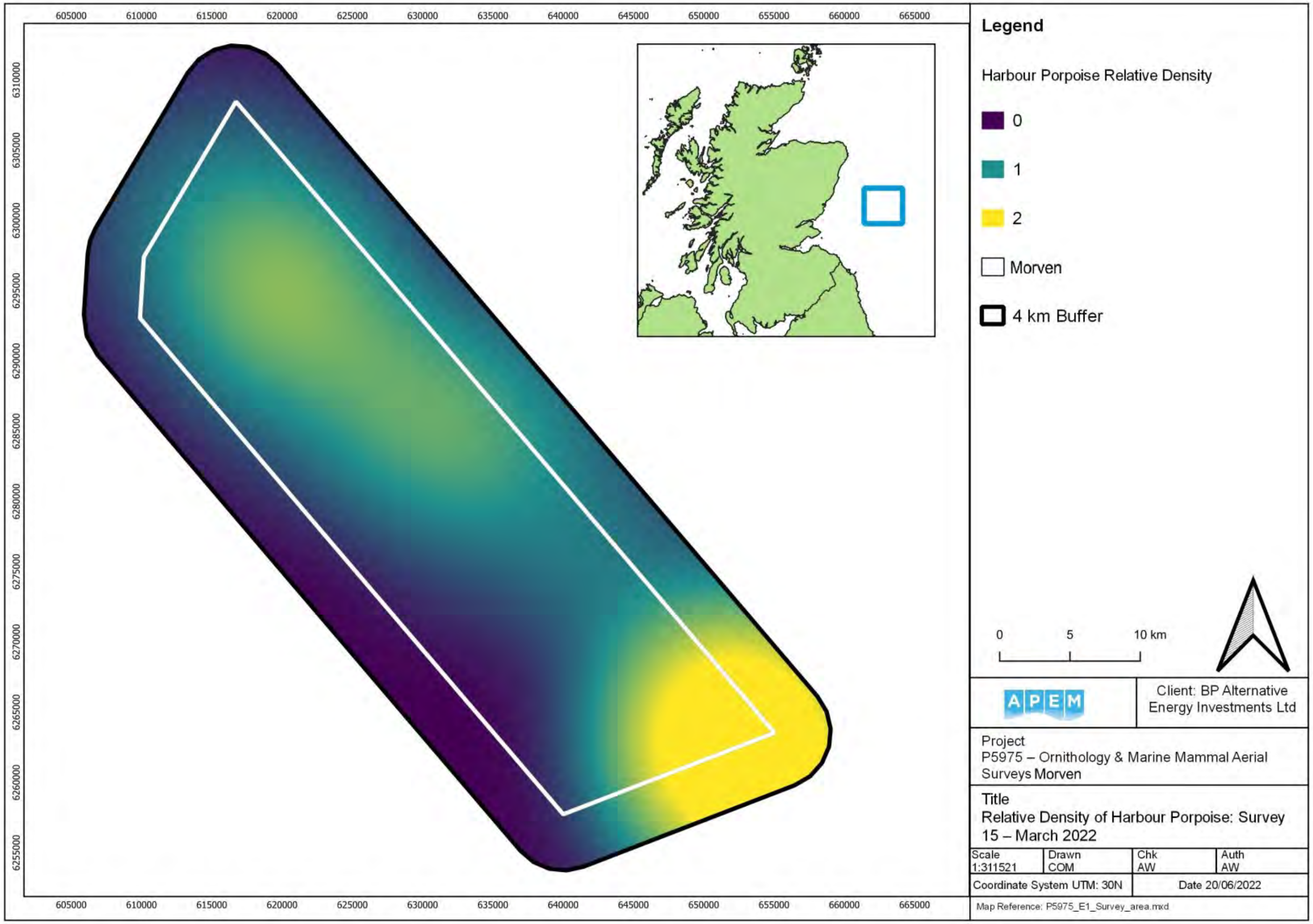


Figure 227 Relative density of harbour porpoise in March 2022 (Survey 15).

4.39 Dolphin / Porpoise – Unidentified

Dolphins / porpoises were recorded in February, March, April, May, June, July, and October 2021 and February 2022. The peak numbers were in May with 32 individuals, resulting in an abundance estimate of 261 within the Array Project (Table 45).

They were mainly in the north of the Array Project in May (Figure 231), October (Figure 234), and February 2022 (Figure 235); central in February 2021 (Figure 228), April (Figure 230), June (Figure 232) and July (Figure 233); and between the northwest and central areas in March (Figure 229).

Table 45 Raw counts, abundance and density estimates of dolphin / porpoise in the Array Project.

Survey	Raw Count	Submerged	Surfacing	Abundance	Lower CL	Upper CL	Precision	Density
Feb-21	2	2	-	16	2	41	0.71	0.01
Mar-21	2	2	-	17	2	50	0.71	0.01
Apr-21	2	2	-	16	2	40	0.71	0.01
May-21	32	30	2	261	172	376	0.18	0.18
Jun-21	2	2	-	17	2	41	0.71	0.01
Jul-21	2	2	-	16	2	41	0.71	0.01
Oct-21	4	4	-	32	4	96	0.50	0.02
Feb-22	6	6	-	49	6	122	0.41	0.03

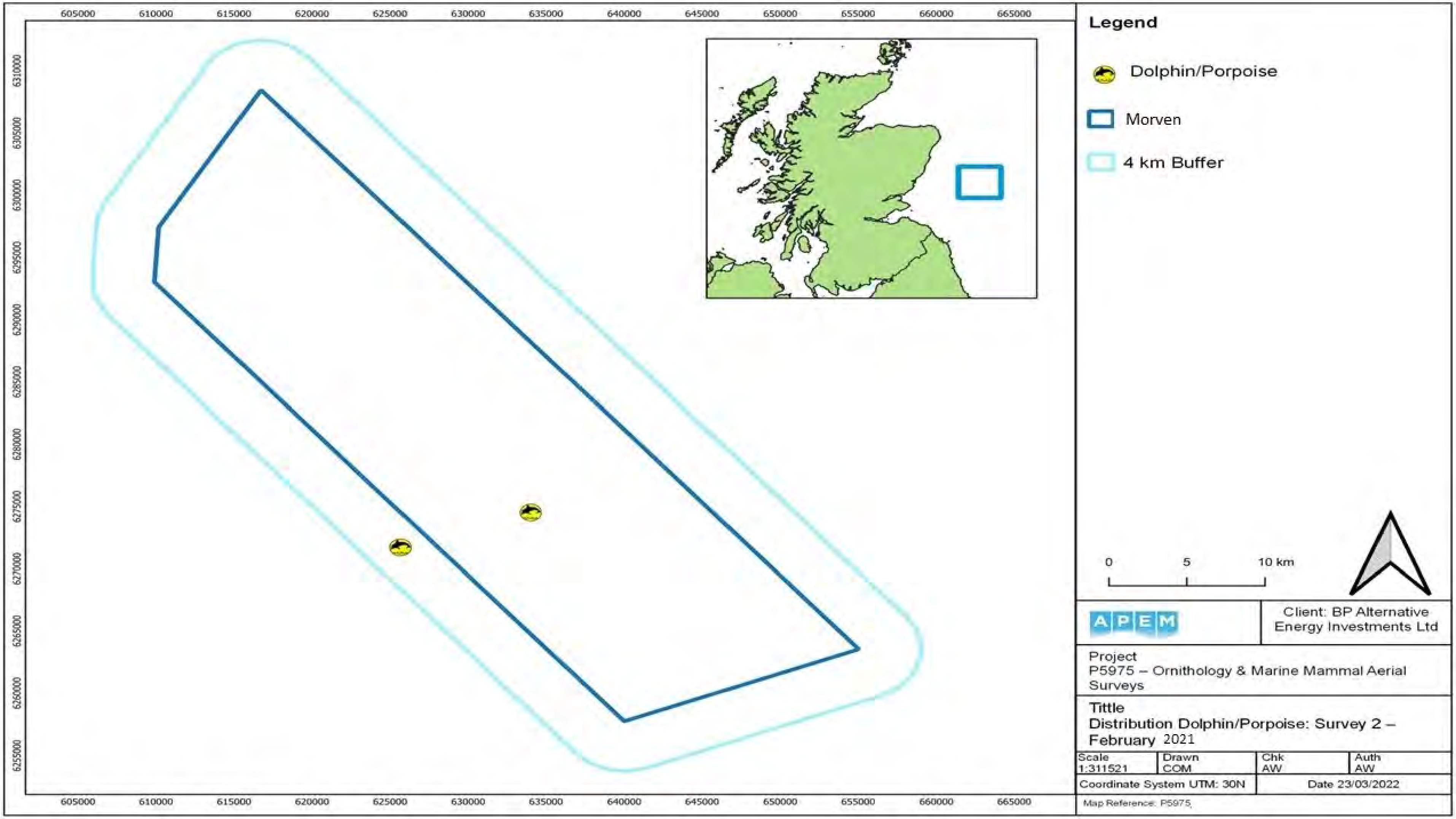


Figure 228 Distribution of dolphins / porpoises in February 2021 (Survey 02).

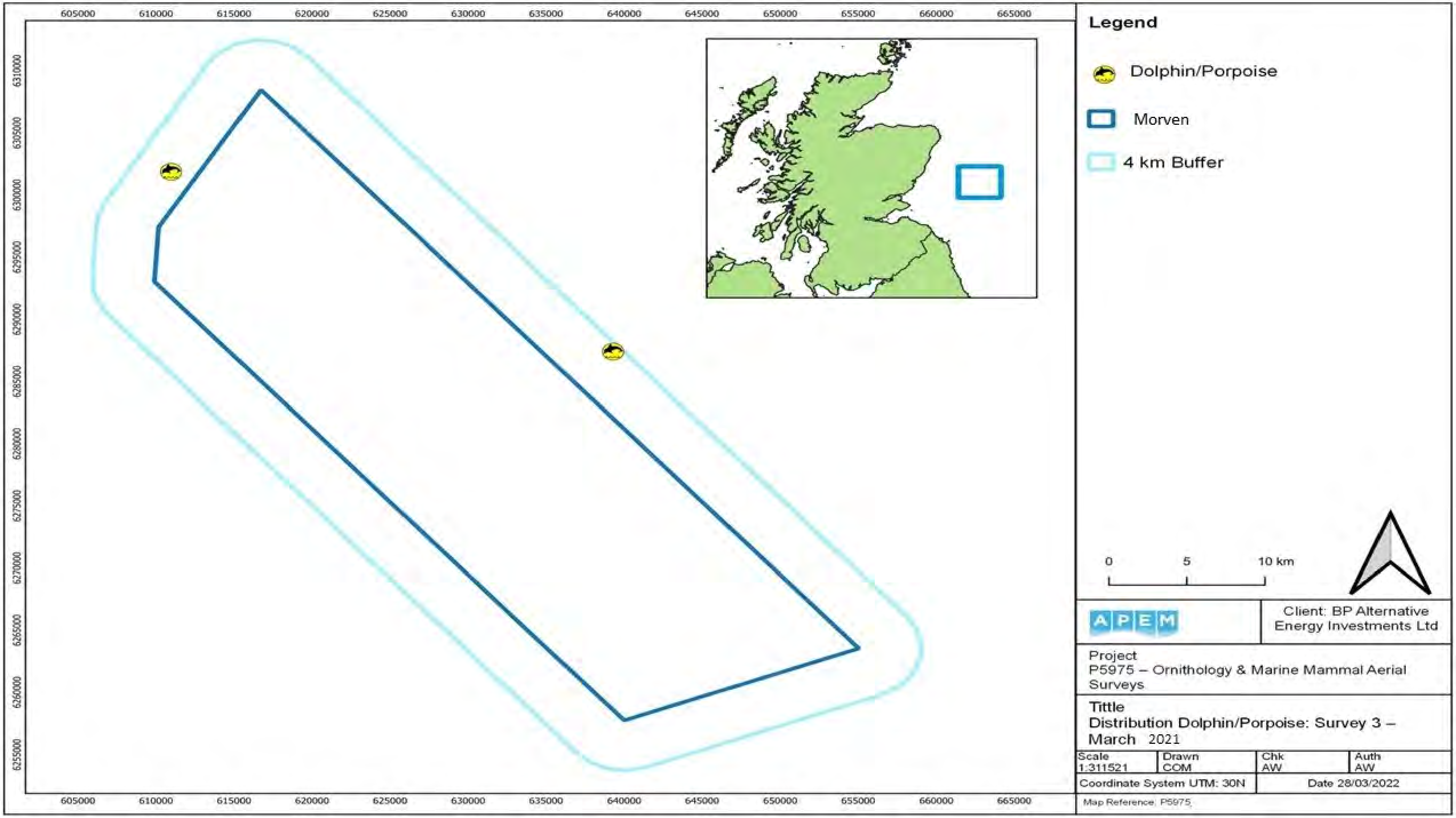


Figure 229 Distribution of dolphins / porpoises in March 2021 (Survey 03).

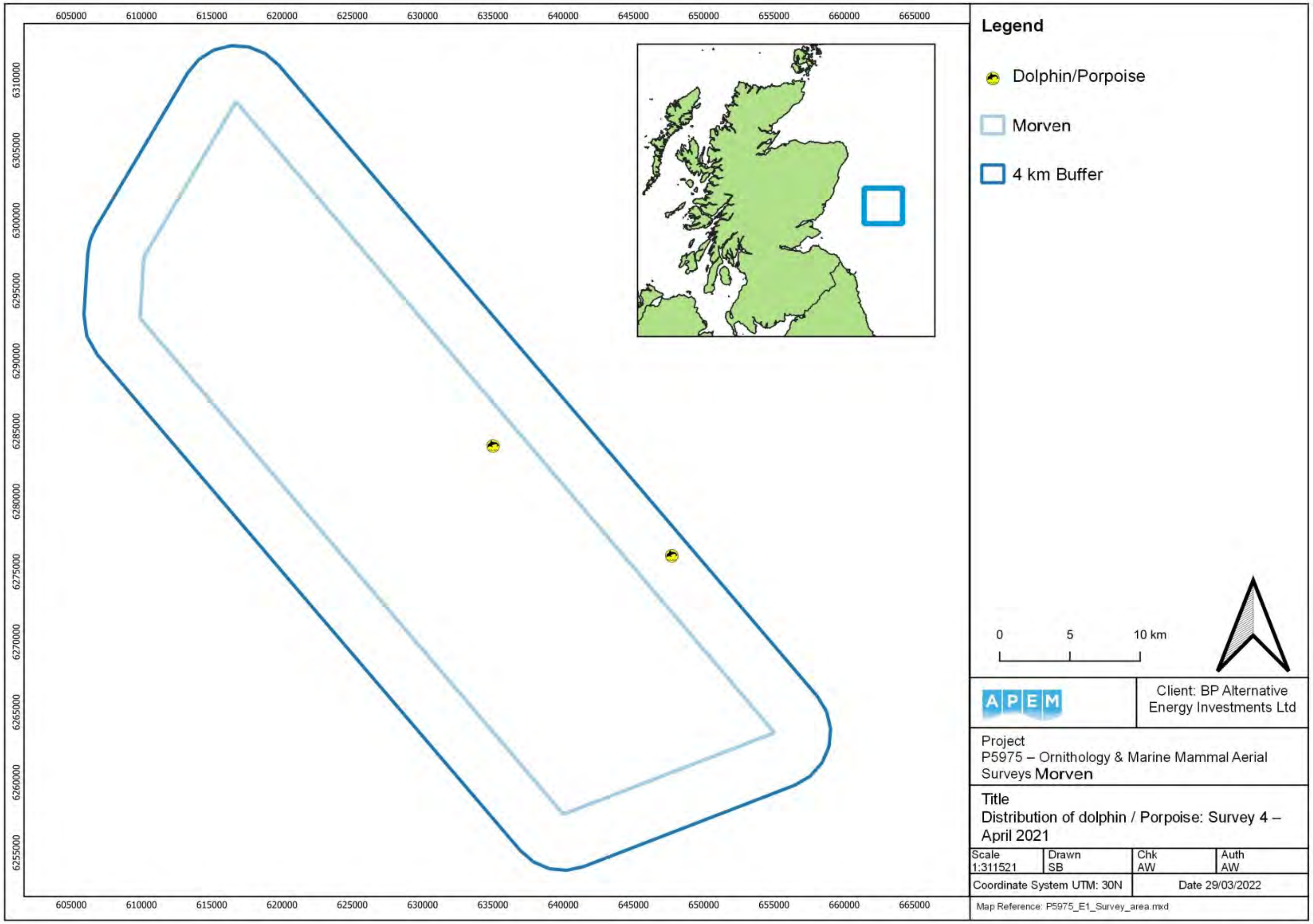


Figure 230 Distribution of dolphins / porpoises in April 2021 (Survey 04).

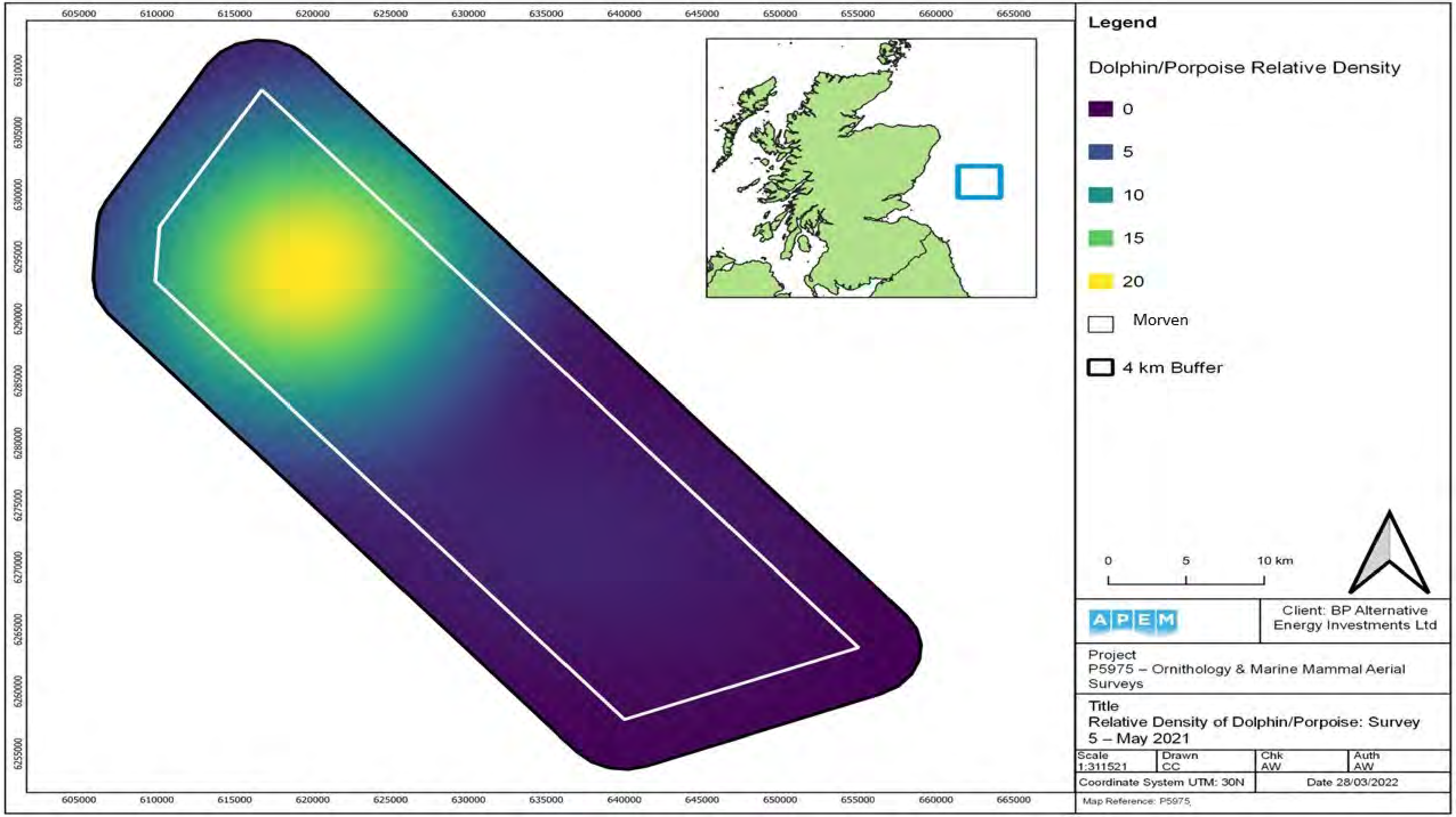


Figure 231 Relative density of dolphin / porpoise in May 2021 (Survey 05).

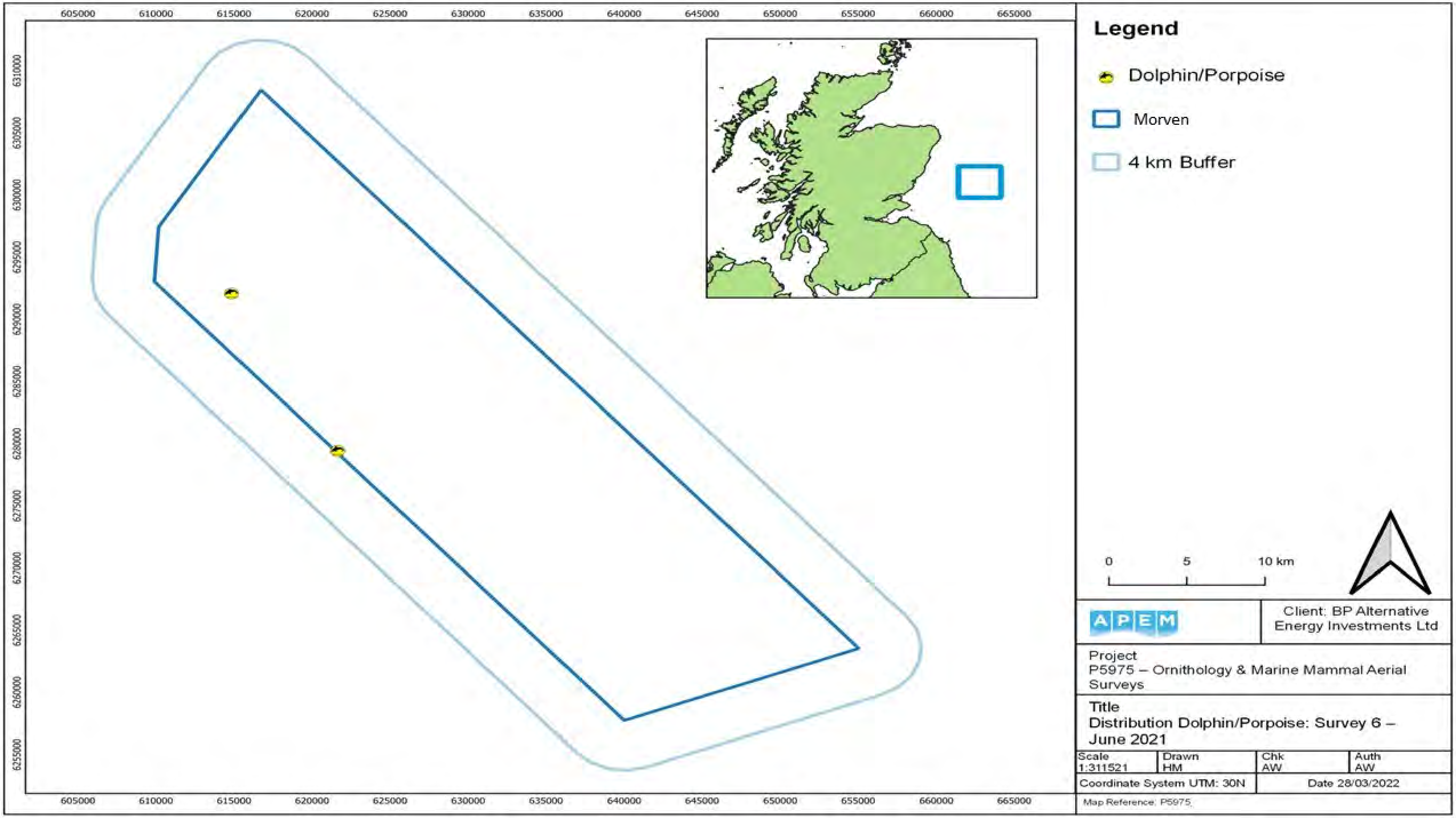


Figure 232 Distribution of dolphins / porpoises in June 2021 (Survey 06).

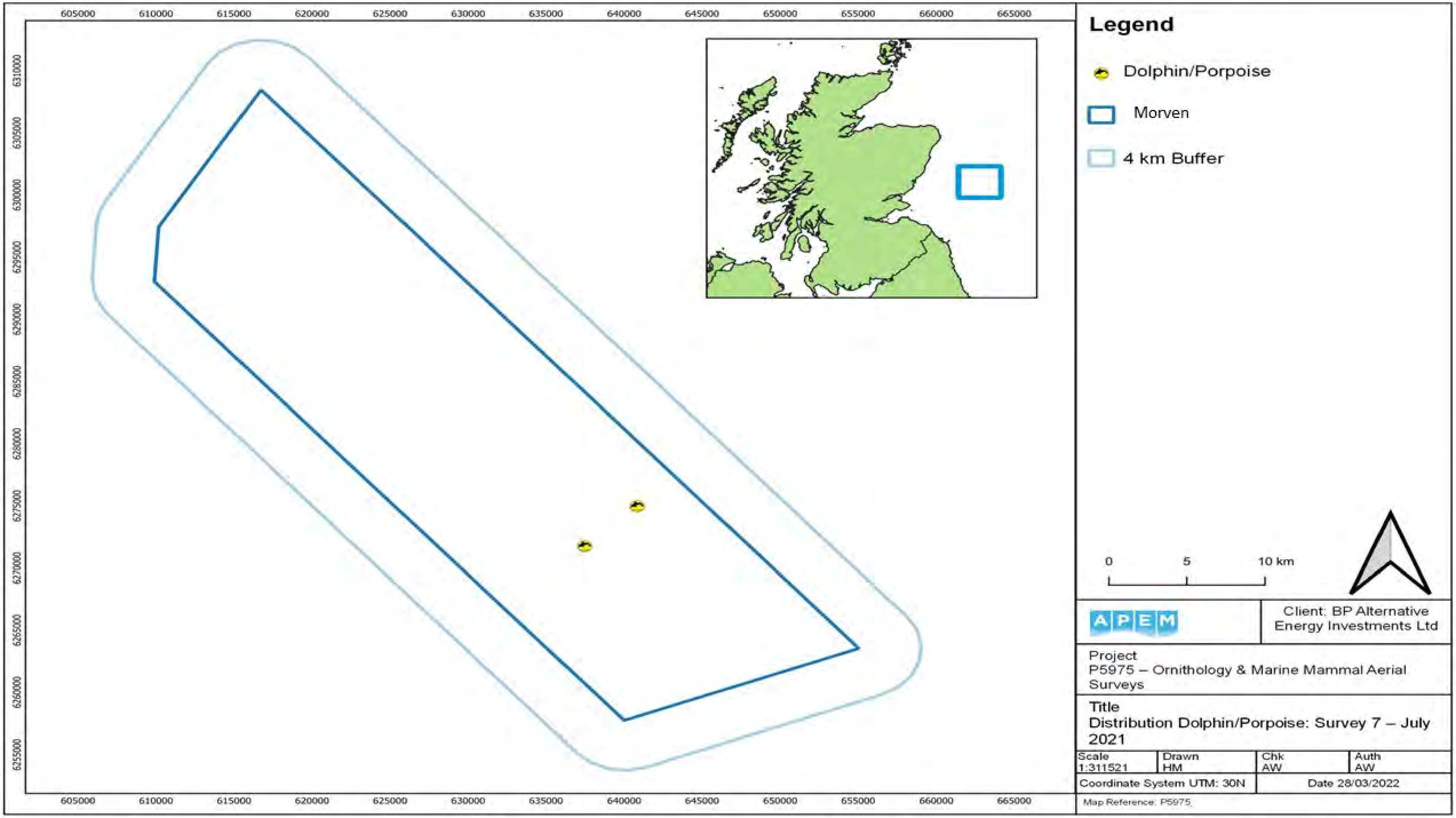


Figure 233 Distribution of dolphins / porpoises in July 2021 (Survey 07).

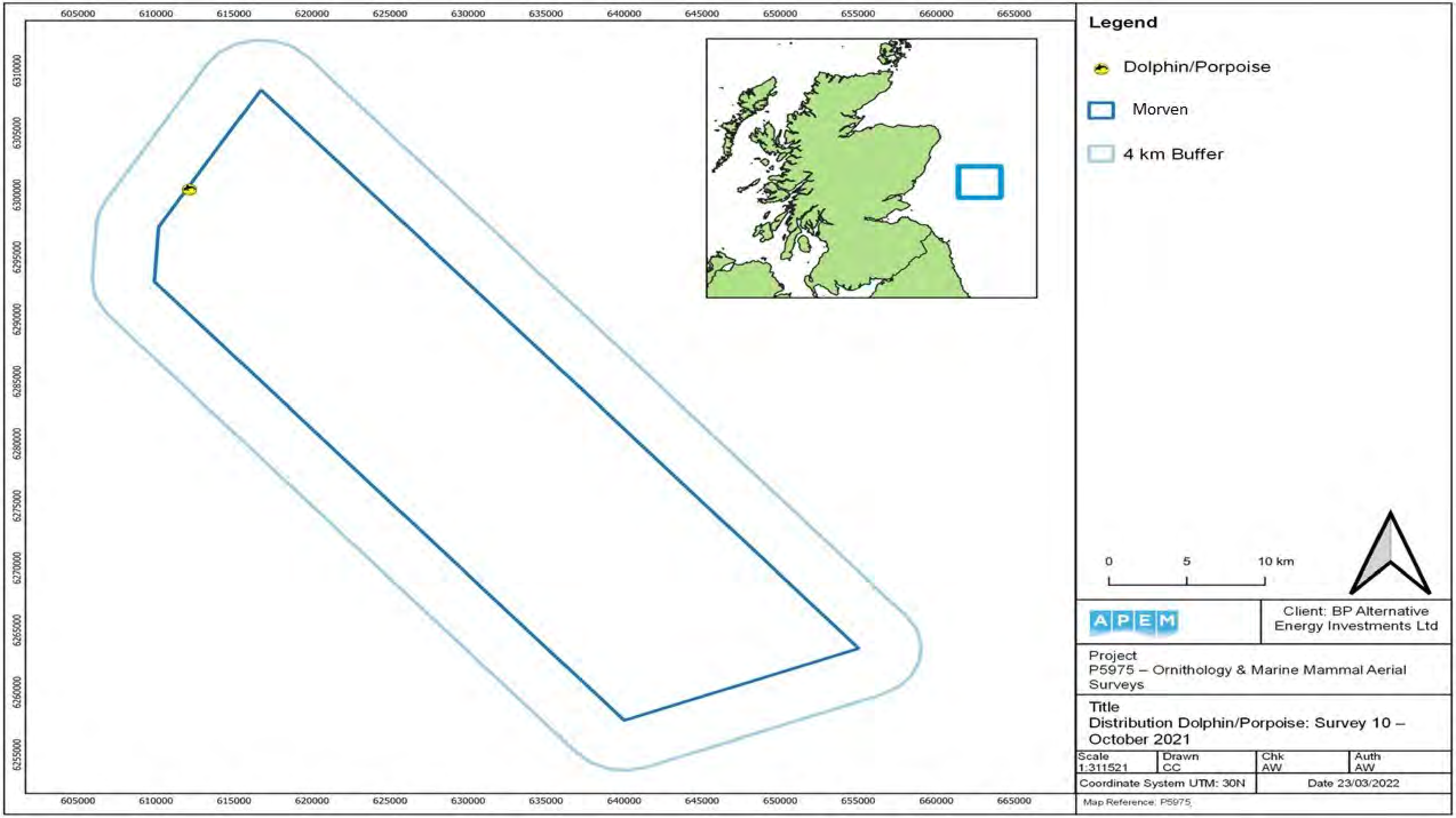


Figure 234 Location of dolphins / porpoises in October 2021 (Survey 10).

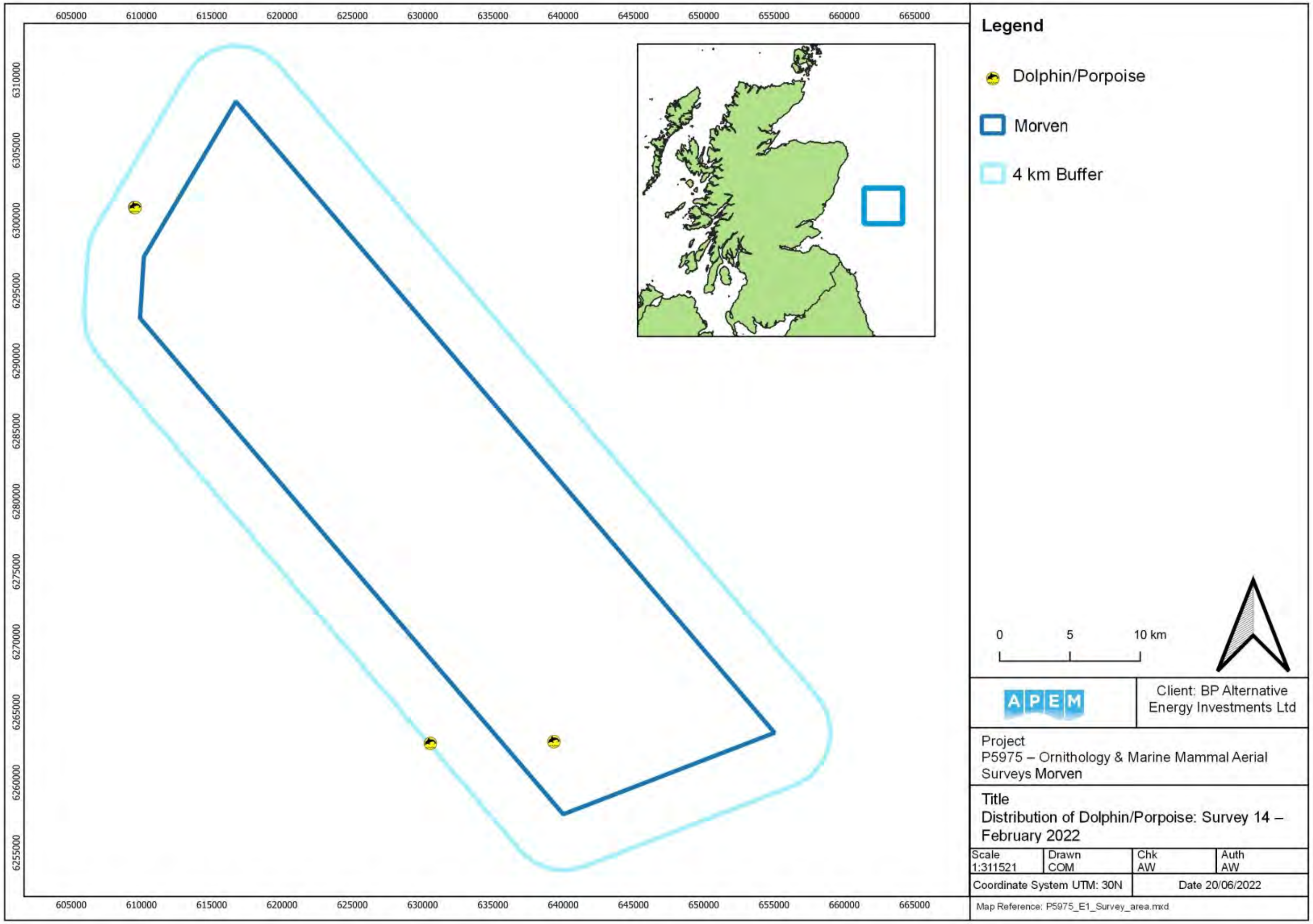


Figure 235 Relative density of dolphins / porpoises in February 2022 (Survey 14).

4.40 Common Minke Whale – *Balaenoptera acutorostrata*

Common minke whales were recorded in May, June, and July 2021, with peak numbers in July - two individuals, resulting in an abundance estimate of 16 within the Array Project (Table 46).

They were in the north of the Array Project in May (Figure 236), and northwest of the Array Project in June (Figure 237) and July (Figure 238).

Table 46 Raw counts, abundance and density estimates of common minke whale in the Array Project.

Survey	Raw Count	Submerged	Surfacing	Abundance	Lower CL	Upper CL	Precision	Density
May-21	1	1	-	8	1	25	1.00	0.01
Jun-21	1	-	1	8	1	25	1.00	0.01
Jul-21	2	2	-	16	2	41	0.71	0.01

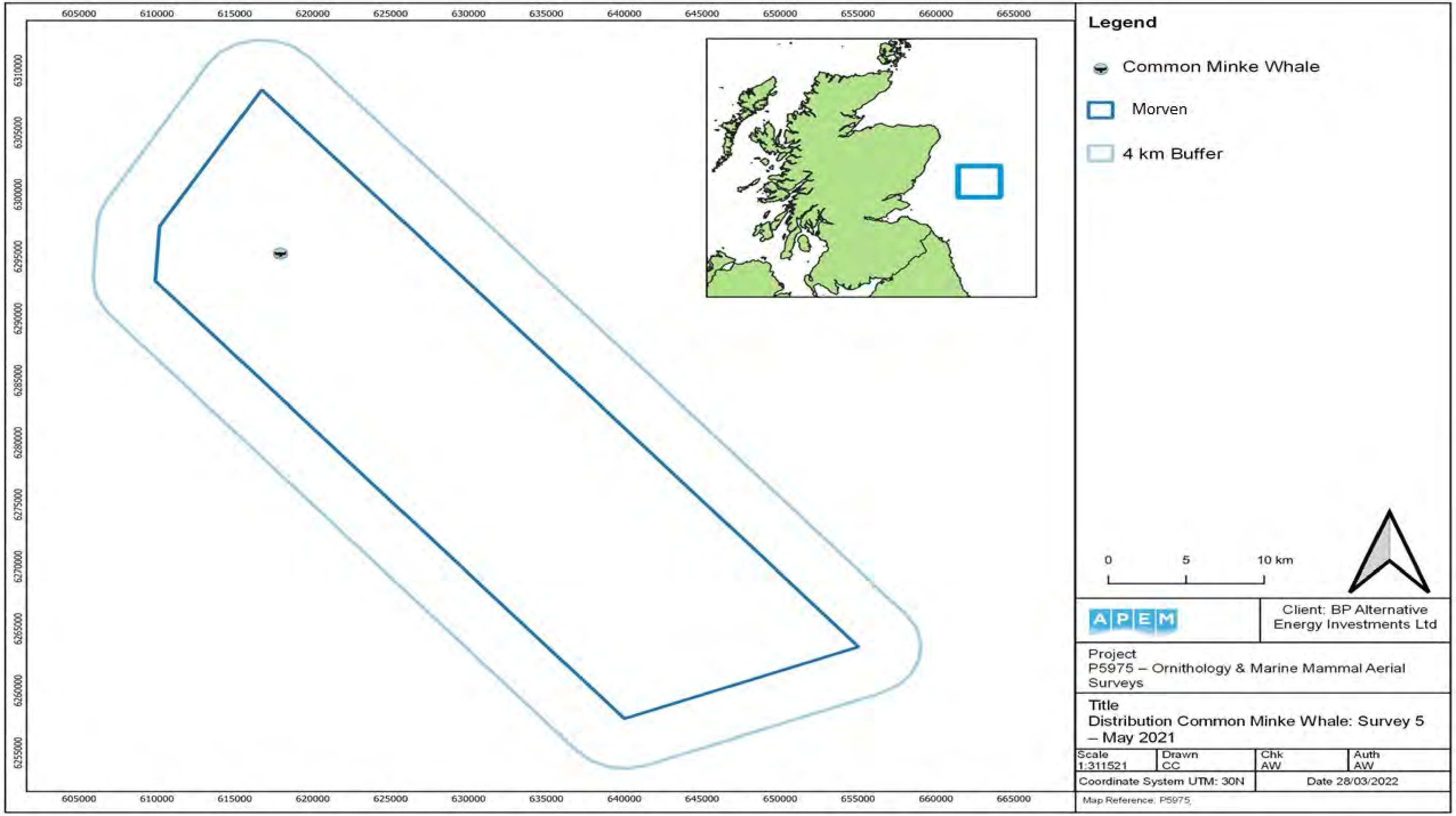


Figure 236 Location of a common minke whale in May 2021 (Survey 05).

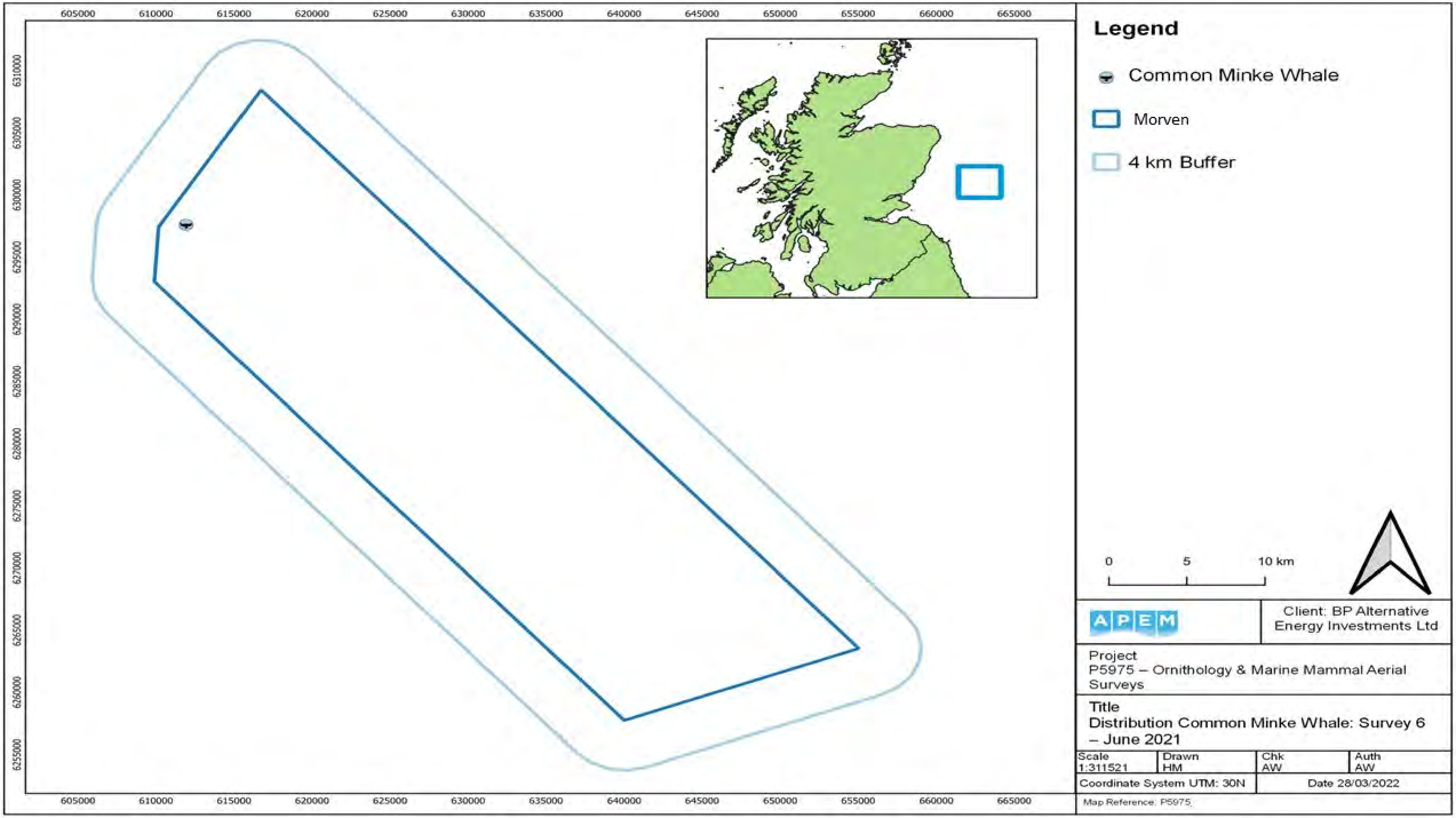


Figure 237 Location of common minke whale in June 2021 (Survey 06).

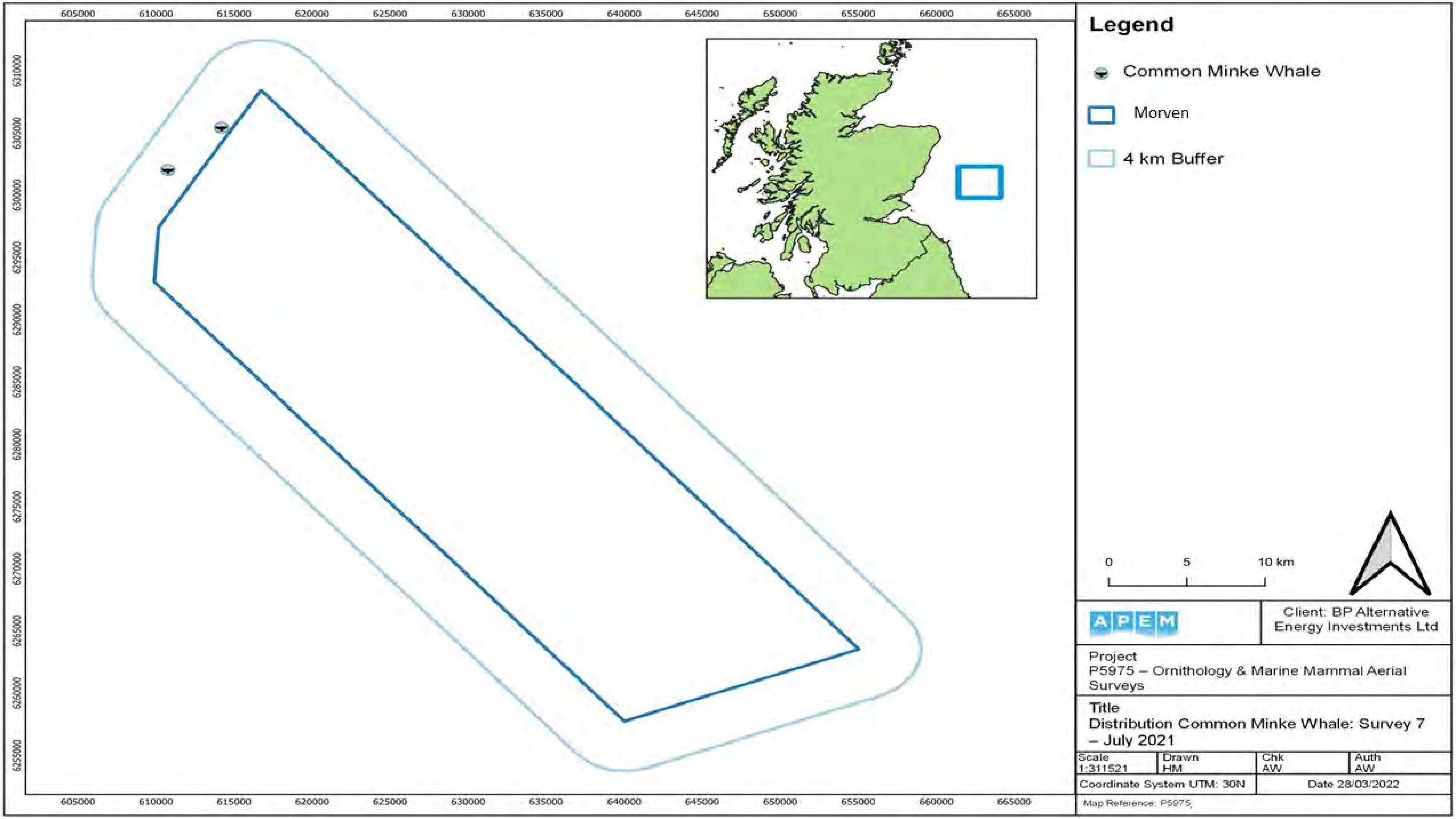


Figure 238 Distribution of common minke whales in July 2021 (Survey 07).

4.41 Whale species - *Unidentified*

Unidentified whales were recorded in July 2021 only, with one (deceased) individual in the southwest of the Array Project in July (Table 47; Figure 239).

Table 47 Raw counts, abundance and density estimates of unidentified whale in the Array Project.

Survey	Raw Count	Submerged	Surfacing	Deceased	Abundance	Lower CL	Upper CL	Precision	Density
Jul-21	1	-	-	1	-	-	-	-	-

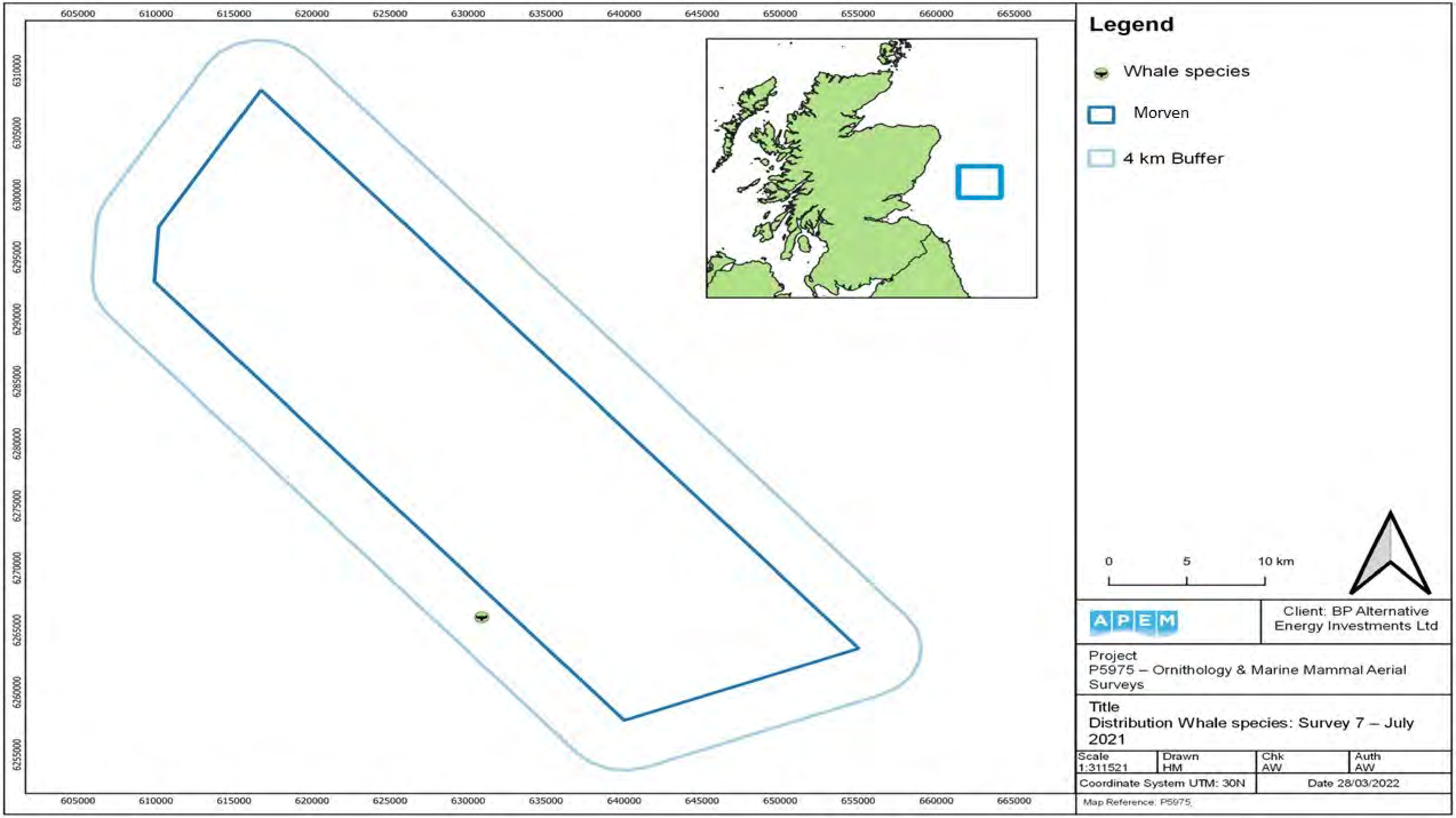


Figure 239 Location of an unidentified whale in July 2021 (Survey 07).

4.42 Marine Mammal species - *Unidentified*

Unidentified marine mammals were recorded in June, July, August, September, and December 2021, and February and March 2022. Peak numbers were in July - three individuals, resulting in an abundance estimate of 25 within the Array Project (Table 48).

These were loosely in the central Array Project in June (Figure 240), July (Figure 241), August (Figure 242) September (Figure 243), and March (Figure 246), and mainly the north in December (Figure 244) and February (Figure 245).

Table 48 Raw counts, abundance and density estimates of unidentified marine mammals in the Array Project.

Survey	Raw Count	Submerged	Surfacing	Deceased	Abundance	Lower CL	Upper CL	Precision	Density
Jun-21	1	1	-	-	8	1	25	1.00	0.01
Jul-21	3	3	-	-	25	3	49	0.58	0.02
Aug-21	1	1	-	-	8	1	25	1.00	0.01
Sep-21	2	-	-	2	-	-	-	-	-
Dec-21	2	2	-	-	16	2	41	0.71	0.01
Feb-22	1	1	-	-	8	1	24	1.00	0.01
Mar-22	2	2	-	-	16	2	40	0.71	0.01

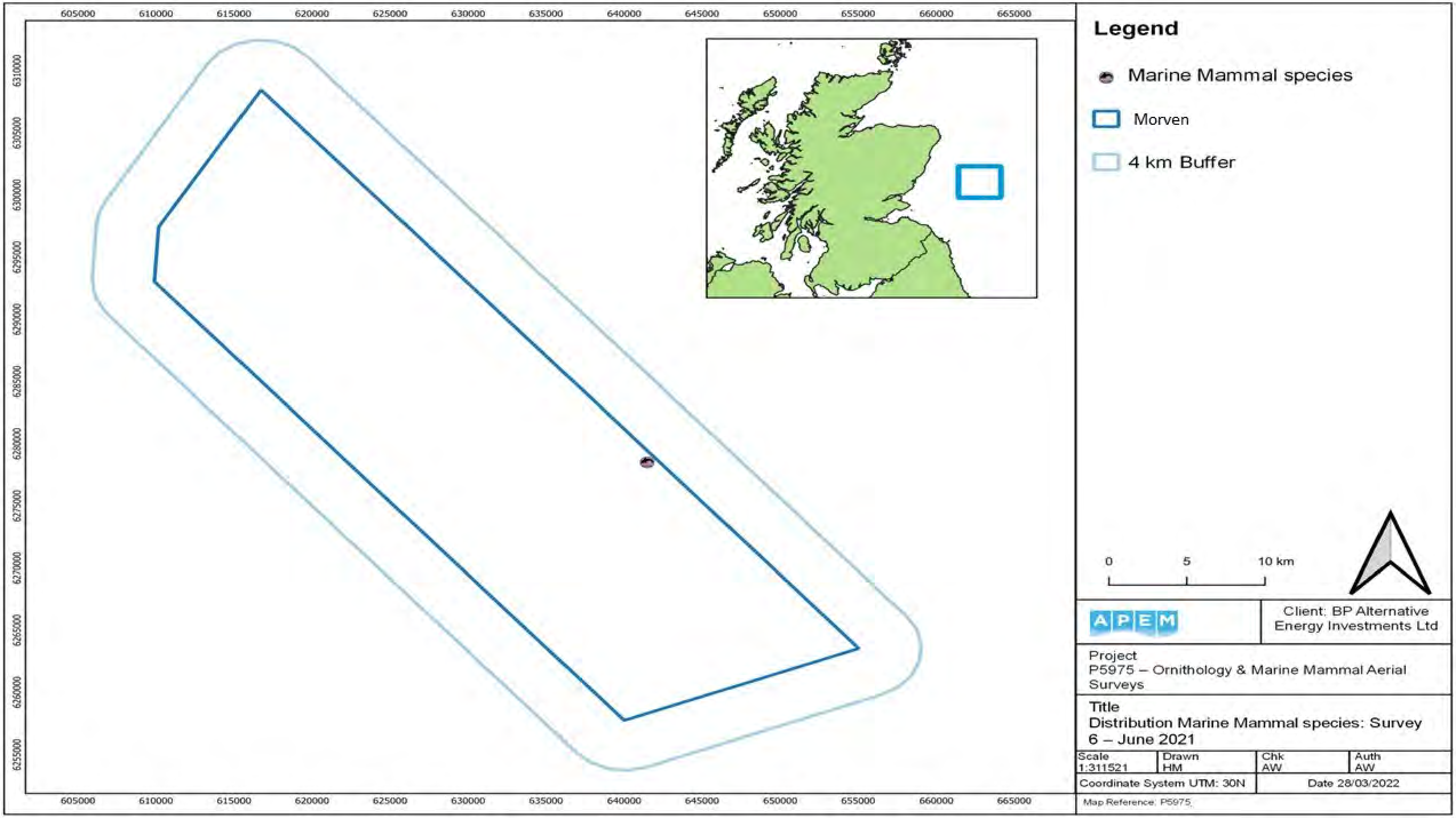


Figure 240 Location of an unidentified marine mammal in June 2021 (Survey 06).

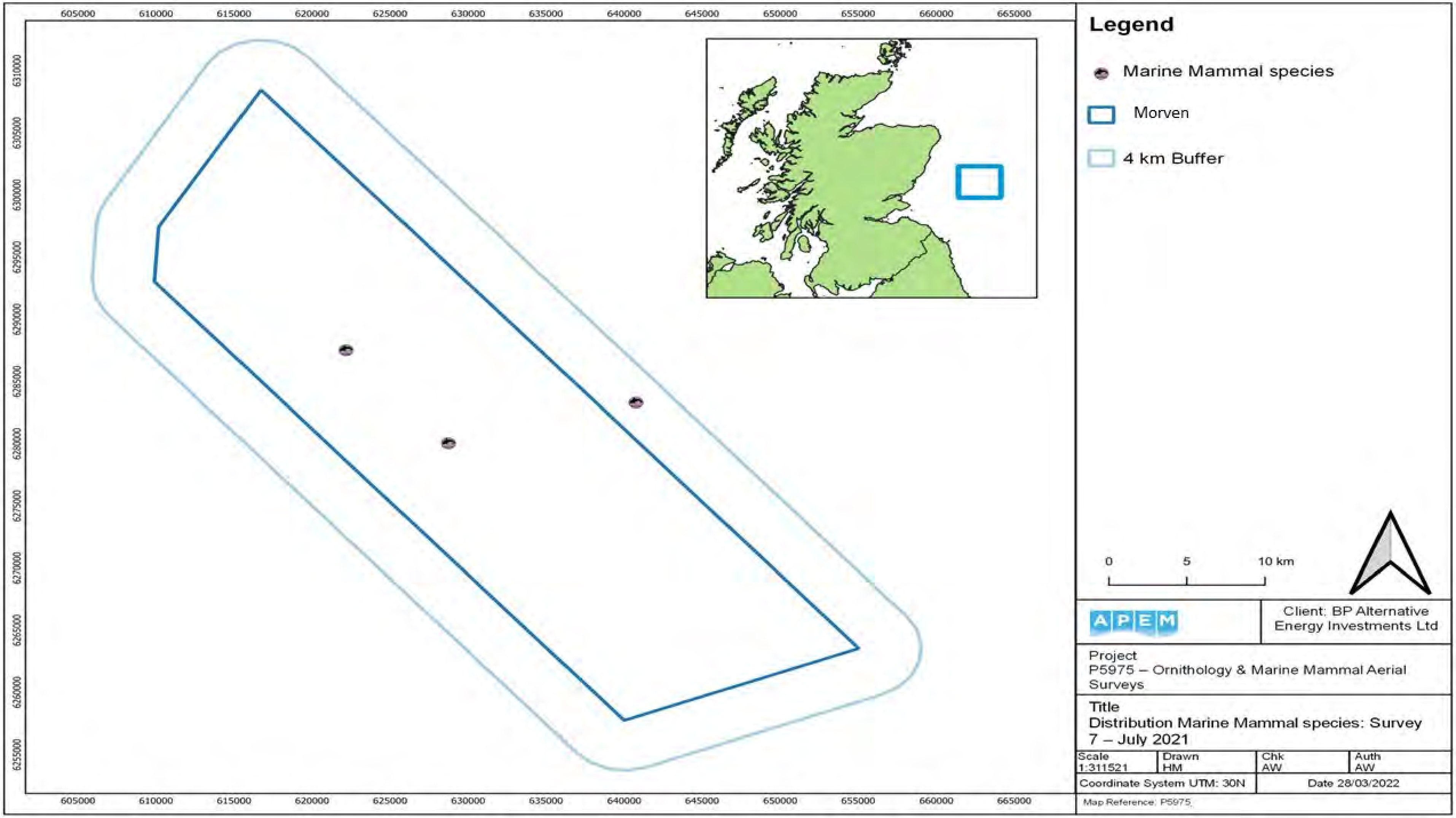


Figure 241 Distribution of unidentified marine mammals in July 2021 (Survey 07).

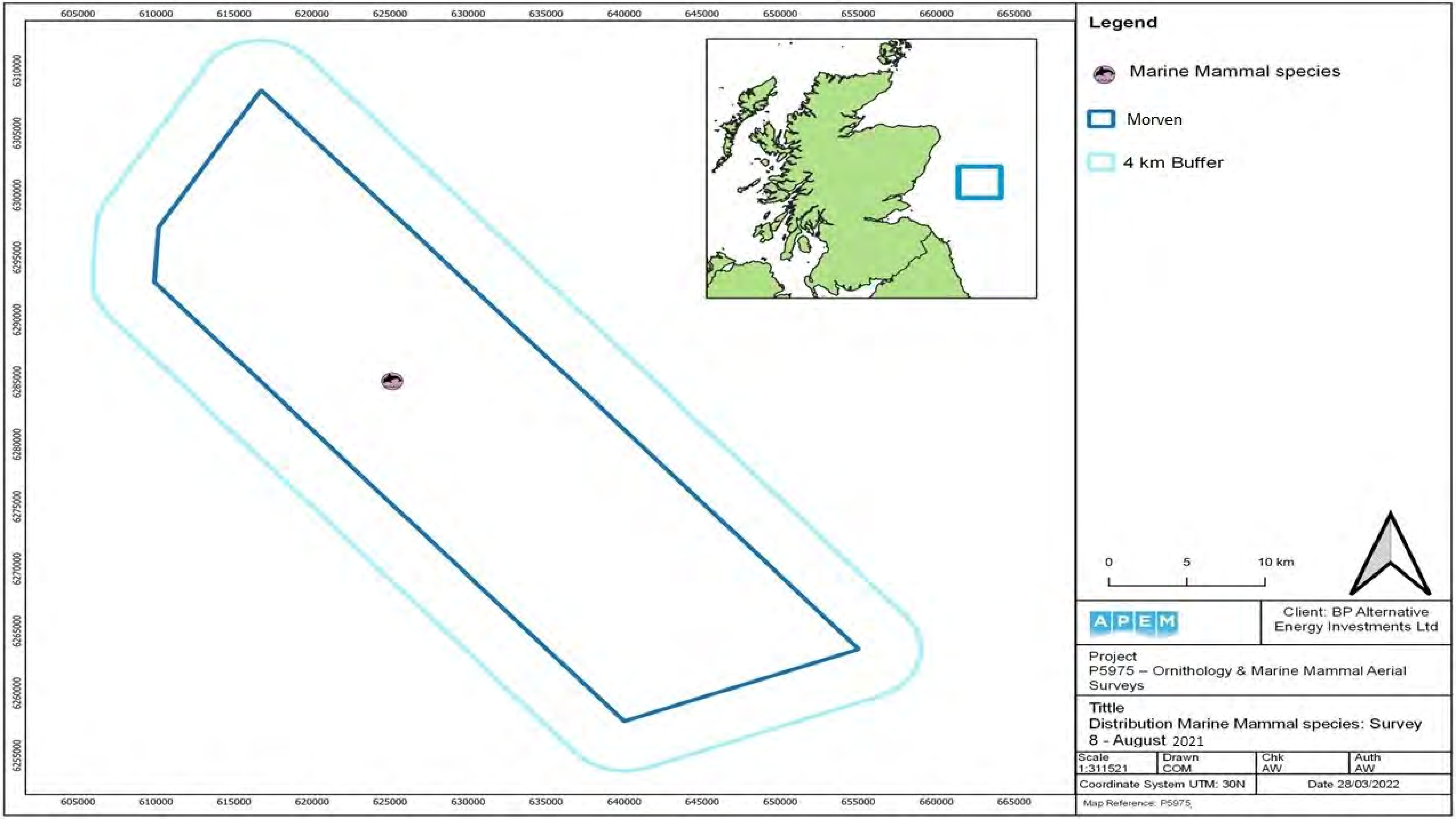


Figure 242 Loctaion of an unidentified marine mammal in August 2021 (Survey 08).

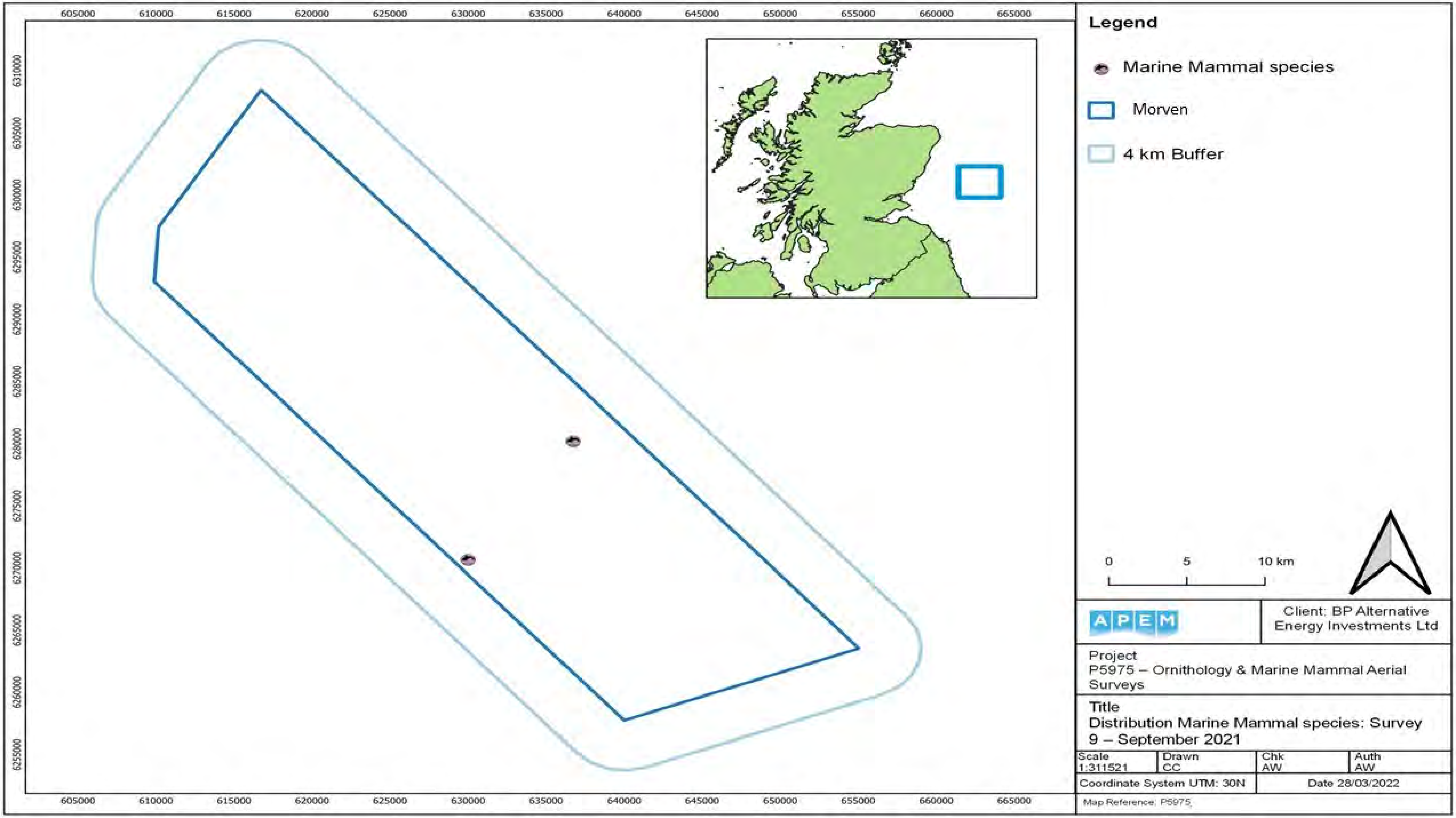


Figure 243 Distribution of unidentified marine mammals in September 2021 (Survey 09).

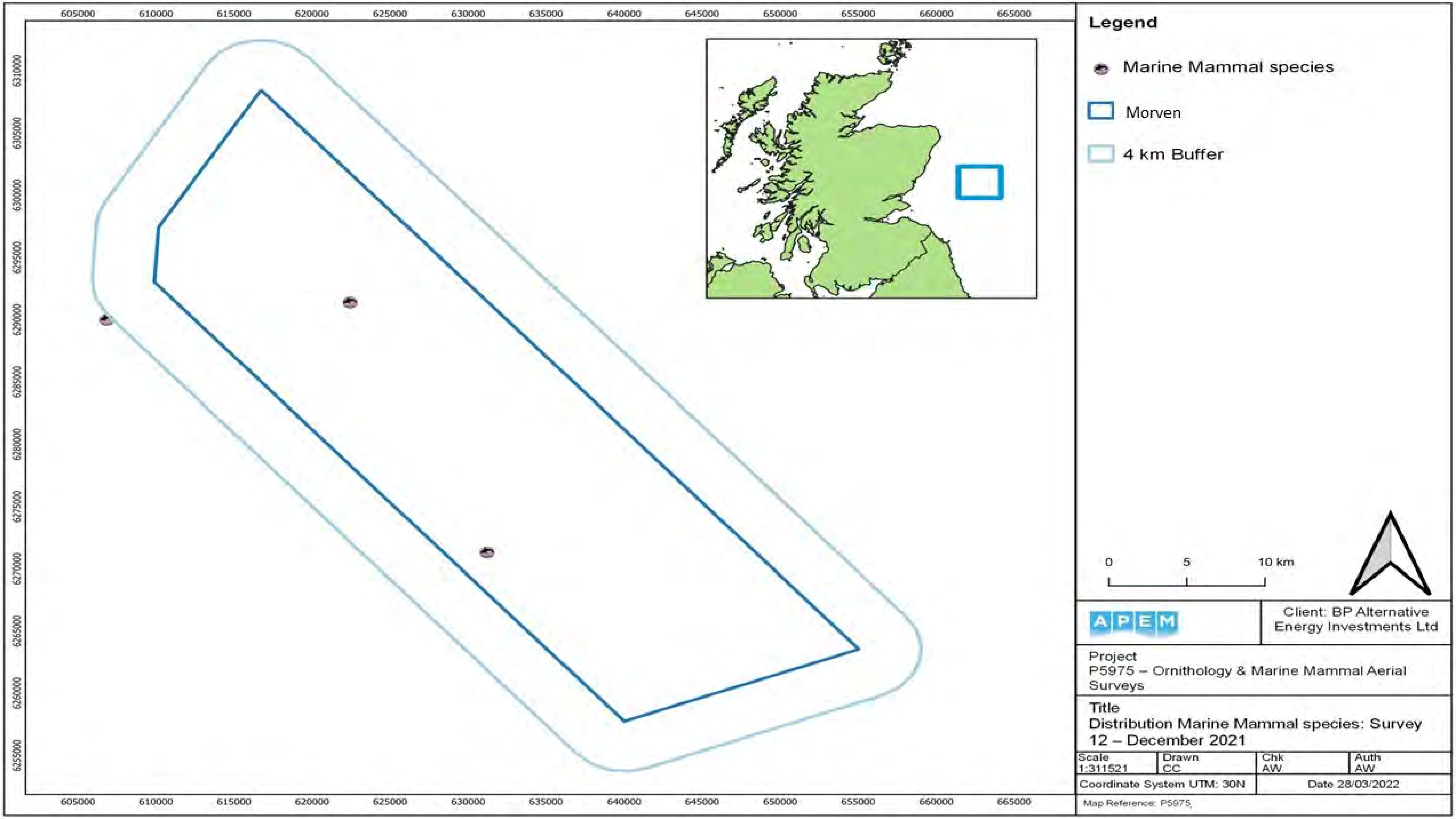


Figure 244 Distribution of unidentified marine mammals in December 2021 (Survey 12).

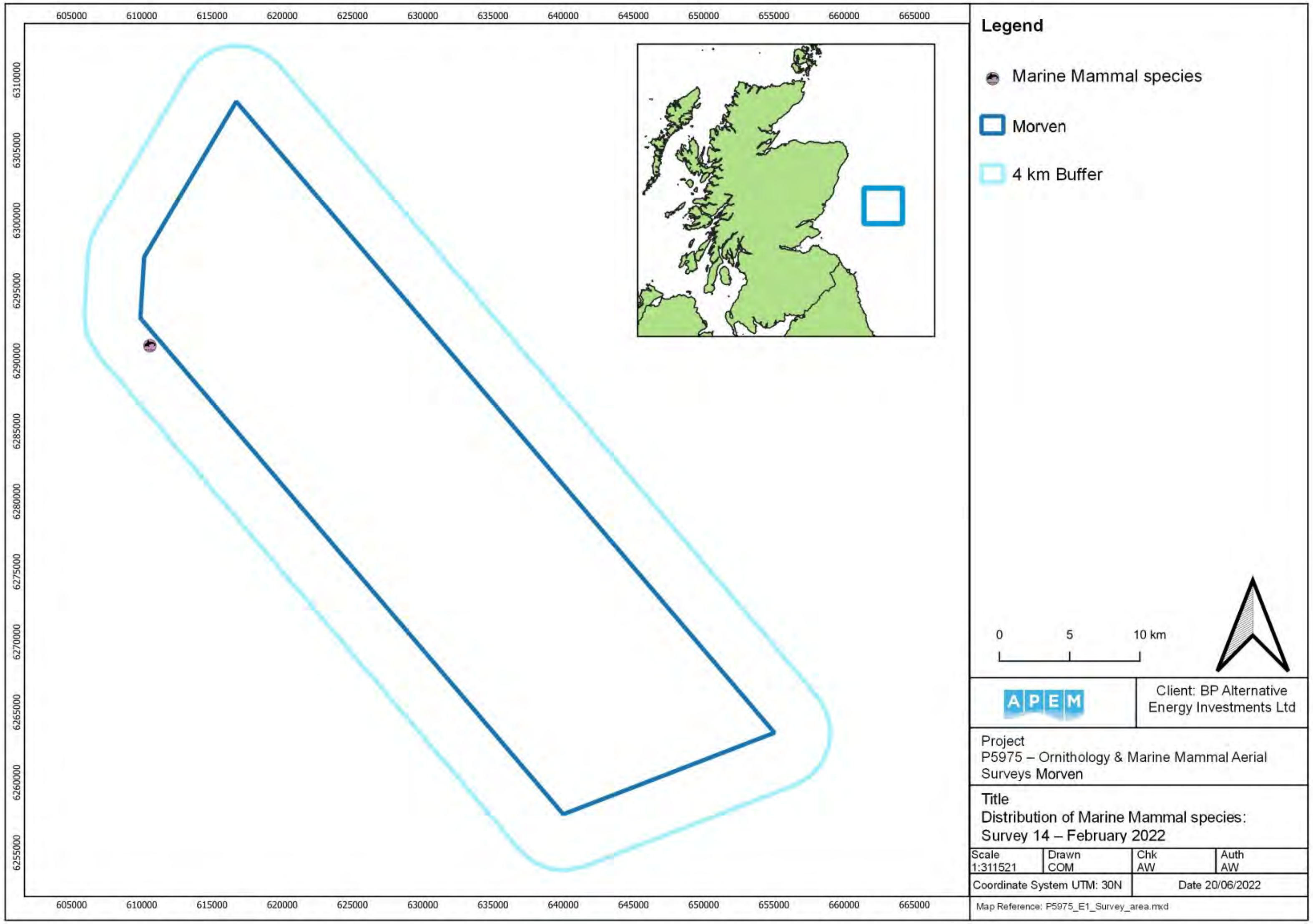


Figure 245 Location of an unidentified marine mammal in February 2022 (Survey 14).

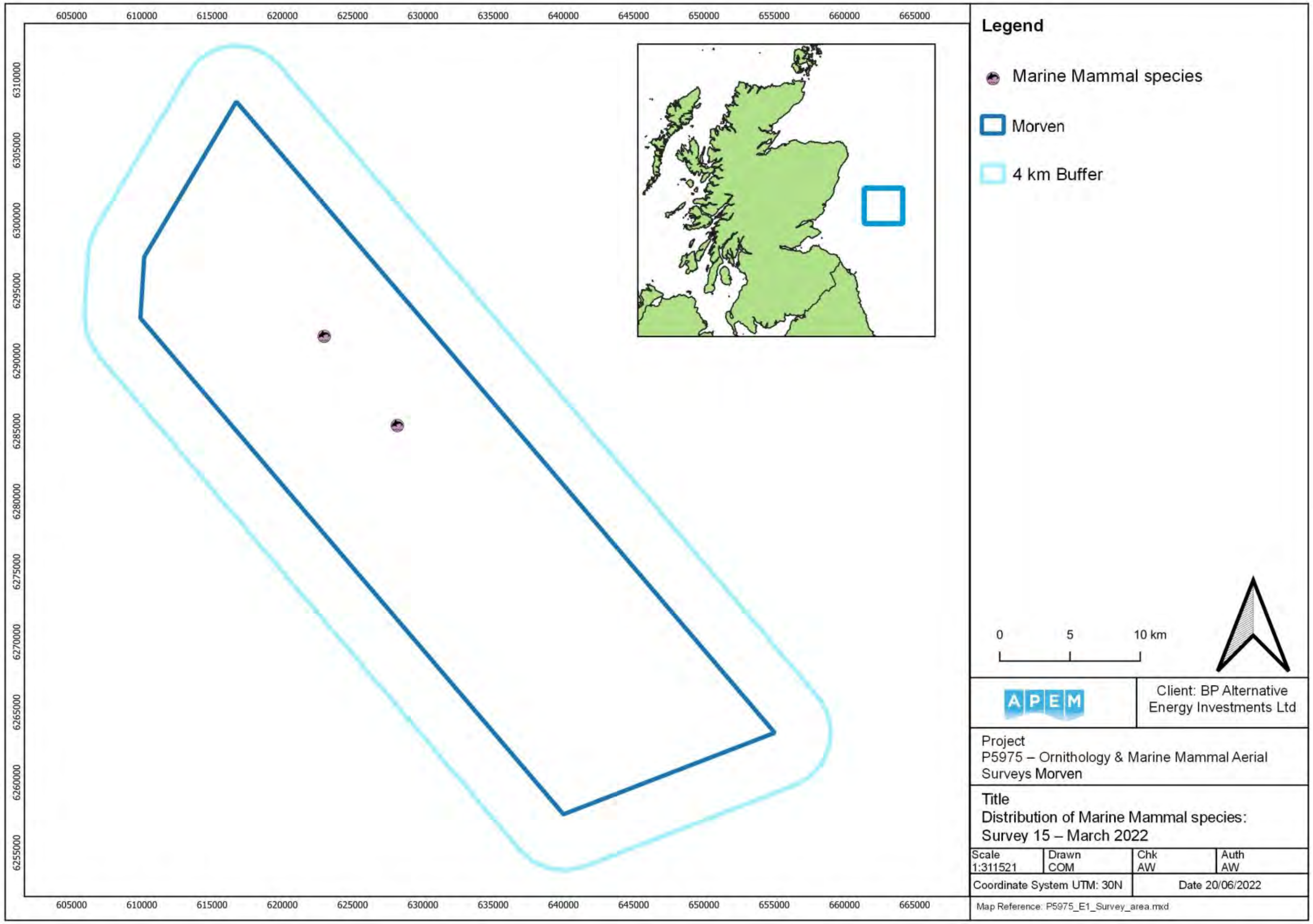


Figure 246 Distribution of unidentified marine mammals in March 2022 (Survey 15).

4.43 Sharks - *Unidentified*

Unidentified sharks were recorded in May 2021 only, with one individual, resulting in an abundance estimate of eight within the Array Project (Table 49).

This was in the north of the Array Project (Figure 247).

Table 49 Raw counts, abundance and density estimates of unidentified shark in the Array Project

Survey	Raw Count	Submerged	Surfacing	Abundance	Lower CL	Upper CL	Precision	Density
May-21	1	1	-	8	1	25	1.00	0.01

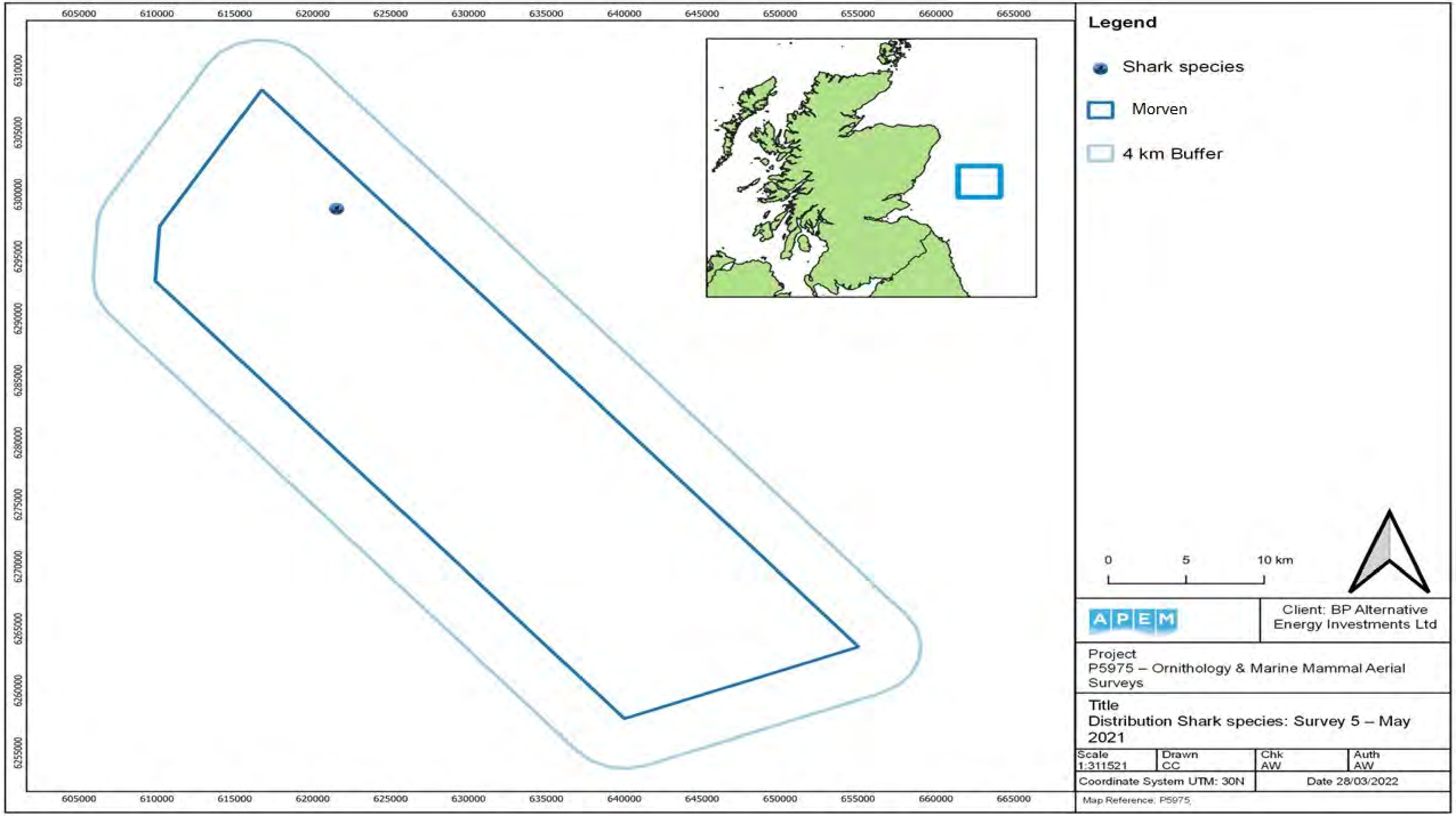


Figure 247 Location of an unidentified shark in May 2021 (Survey 05).

5. Anecdotal Information

The following anecdotal observations were made during Y01 with respect to anthropogenic activities within the Array Project.

Five vessels were recorded in July 2021 - tanker (n=2), container (n=1), small boat (n=1) and transport vessel (n=1).

One vessel was recorded in August 2021 - rig boat (n=1).

Two vessels were recorded in October 2021 - tanker (n=1) and cargo (n=1).

6. References

Anderson, H.B., Evans, P.G.H., Potts, J.M., Harris, M.P. and Wanless, S.,2013. The diet of Common Guillemot (*Uria aalge*) chicks at colonies in the UK, 2006-2011: evidence for changing prey communities in the North Sea. *Ibis*, 156(1). 23-34.

Balmer, D.E., Gillings, S., Caffrey, B.J., Swann, R.L., Downie, I.S. and Fuller, R.J.,2013. Bird Atlas 2007-11: the breeding and wintering birds of Britain and Ireland. *Thetford: BTO*

Bolton, M., Sheehan, D., Bolton, S., Bolton, J. A. and Bolton J. R.,2017. Resurvey reveals arrested population growth of the largest UK colony of European storm-petrels *Hydrobates pelagicus,* Mousa, Shetland. *Seabird Group.*

Borrmann, R.M., Phillips, R.A., Clay, T.A. and Garthe, S.,2019. High foraging site fidelity and spatial segregation among individual great black-backed gulls. *Journal of Avian Biology*, 50. https://doi.org/10.1111/jav.02156

Brown, A. and Grice, P.,2005. Birds in England. *Poyser, London*.

Chivers, L., Lundy, M., Colhoun, K., Newton, S. and Reid N.,2012. Diet of black-legged kittiwakes (*Rissa tridactyla*) feeding chicks at two Irish colonies highlight the importance of clupeids. *Bird Study,* 59(3). 363-367.

Clay, T., Small, C., Tuck, G., Pardo, D., Carneiro, A., Wood, A., Croxall, J., Crossin, G. and Phillips, R.,2019. A comprehensive large-scale assessment of fisheries bycatch risk to threatened seabird populations. *Journal of Applied Ecology*, 56(8). 1882-1893.

Fayet, A., Clucas, G., Anker-Nilssen, T., Syposz, M. and Hansen, E.,2021. Local prey shortages drive foraging costs and breeding success in a declining seabird, the Atlantic puffin. *Journal of Animal Ecology*, 90(5). 1152-1164.

Harris, M.P., Anker-Nilssen, T., McCleery, R.H., Erikstad, K.E., Shaw, D.N., and Grosbois, V.,2005. Effect of wintering area and climate on the survival of adult Atlantic puffins *Fratercula arctica* in the eastern Atlantic. *Marine Ecology Progress Series*, 297. 283-296.

Hume, R., Still, R., Swash, A., Harrop, H. and Tipling, D.,2016. Britain's Birds: An identification guide to the birds of Britain and Ireland. *Woodstock: Princeton University Press.*

JNCC,2021. Fulmar. (Accessed: 04/04/2022 via https://jncc.gov.uk/our-work/northern-fulmar-fulmarus-glacialis/)

JNCC,2021[1]. Grey Seal. (Accessed: 24/03/2022 via https://sac.jncc.gov.uk/species/S1364/)

JNCC,2021[2]. Harbour Seal. (Accessed: 25/03/2022 via https://sac.jncc.gov.uk/species/S1365/)

JNCC, 2018. Red-throated Diver Energetics Project 2018 Field Season Report. (Accessed: 04/04/2022 via https://helda.helsinki.fi/bitstream/handle/10138/321363/JNCC_Report_627_v2.1_Revised_WEB.pdf?sequence=1)

JNCC, 2021[3]. Seabird Population Trends and Causes of Change: 1986–2019 Report. *Joint Nature Conservation Committee, Peterborough.* (Accessed: 31/03/2022 via https://jncc.gov.uk/our-work/smp-report-1986-2019)

Magnusdottir, E., Leat, E.H.K., Bourgeon, S., Strøm, H., Petersen, A., Phillips, R.A., Hanssen, S.A., Bustnes, J.O., Hersteinsson, P. and Furness, R.W.,201). Wintering areas of Great Skuas *Stercorarius skua* breeding in Scotland, Iceland, and Norway. *Bird Study*, 59(1). 1-9. DOI: 10.1080/00063657.2011.636798

Marine Traffic, 2022. Accessed: 24/03/2022 via https://www.marinetraffic.com/en/data/?asset_type=ports)

NatureScot, 2020[1]. Outer Firth of Forth and St Andrews Bay Complex SPA. (Accessed: 24/03/2022 via https://sitelink.nature.scot/site/10478)

NatureScot, 2020[2]. Forth Islands SPA. (Accessed: 24/03/2022 via https://sitelink.nature.scot/site/8500)

NatureScot, 2020[3]. Firth of Forth SPA. (Accessed: 24/03/2022 via https://sitelink.nature.scot/site/8499)

NatureScot, 2020[4]. Isle of May SAC. (Accessed: 24/03/2022 via https://sitelink.nature.scot/site/8278)

NatureScot, 2020[5]. Fowlsheugh SPA. (Accessed: 24/03/2022 via https://sitelink.nature.scot/site/8505)

NatureScot, 2020[6]. Buchan Ness to Collieston Coast SPA. (Accessed: 24/03/2022 via https://sitelink.nature.scot/site/8473)

NatureScot, 2020[7]. Ythan Estuary, Sands of Forvie and Meikle Loch SPA. (Accessed: 24/03/2022 via https://sitelink.nature.scot/site/8592)

NatureScot, 2020[8-11]. St Abb's Head to Fast Castle SPA. (Accessed: 25/03/2022 via https://sitelink.nature.scot/site/8579)

Rae, S., Jones, M.G.W., Stewart, F. and Tingay, R., 2009. Counts of spring passage Golden Plover *Pluvialis apricaria* in north Lewis. *Ringing & Migration*, 24(4). 253-258. DOI: 10.1080/03078698.2009.9674399.

Russell, D.J., Morris, C.D., Duck, C.D., Thompson, D. and Hiby, L., 2019. Monitoring long-term changes in UK grey seal pup production. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 29. 24-39.

Russel, A., 2017. Conflicts Facing Seal Populations in the UK. *Wildlife Articles.*

Sea Watch Foundation, 2021. (Accessed: 24/03/2022 via https://www.seawatchfoundation.org.uk/3a-north-east-scotland/.)

Sparling, C.E., 2012. Seagreen Firth of Forth Round 3 Zone Marine Mammal Surveys. Report number SMRUL-ROY-2012-006 to Royal Haskoning and Seagreen Wind Energy Ltd.

Thaxter, C.B., Lascelles, B., Sugar, K., Cook, A.S.C.P., Roos, S., Bolton, M., Langston, R.H.W. and Burton, N.H.K., 2012. Seabird foraging ranges as a preliminary tool for identifying candidate Marine Protected Areas. *Biological Conservation*, 156. 53-61.

Wernham, C., Toms, M., Marchant, J., Clark, J., Siriwardena, G. and Baillie, S., 2002. *The migration atlas: movements of the birds of Britain and Ireland*. T & AD Poyser.

Appendix I Scientific Names of Birds and Marine Mammals

Common Name	Scientific Name	Family	Class
Golden Plover	*Pluvialis apricaria*	Charadriiformes	Aves
Kittiwake	*Rissa tridactyla*	Laridae	Aves
Common Gull	*Larus canus*	Laridae	Aves
Great Black-backed Gull	*Larus marinus*	Laridae	Aves
Herring Gull	*Larus argentatus*	Laridae	Aves
Lesser Black-backed Gull	*Larus fuscus*	Laridae	Aves
Common Tern	*Sterna hirundo*	Laridae	Aves
Arctic Tern	*Sterna paradisaea*	Laridae	Aves
Great Skua	*Stercorarius skua*	Stercorariidae	Aves
Arctic Skua	*Stercorarius parasiticus*	Stercorariidae	Aves
Long-tailed Skua	*Stercorarius longicaudus*	Stercorariidae	Aves
Guillemot	*Uria aalge*	Alcidae	Aves
Razorbill	*Alca torda*	Alcidae	Aves
Black Guillemot	*Cepphus grylle*	Alcidae	Aves
Puffin	*Fratercula arctica*	Alcidae	Aves
Red-throated Diver	*Gavia stellata*	Gaviidae	Aves
Fulmar	*Fulmarus glacialis*	Procellaridae	Aves
Sooty Shearwater	*Ardenna grisea*	Procellaridae	Aves
Manx Shearwater	*Puffinus*	Procellariidae	Aves
Gannet	*Morus bassanus*	Sulidae	Aves
Osprey	*Pandion haliaetus*	Pandionidae	Aves
Grey Seal	*Halichoerus grypus*	Sealae	Mammalia
White-beaked Dolphin	*Lagenorhynchus albirostris*	Delphinidae	Mammalia
Harbour Porpoise	*Phocoena*	Phocoenidae	Mammalia
Common Minke Whale	*Balaenoptera acutorostrata*	Balaenopteridae	Mammalia

Appendix II Percentage of the Array Project Captured and Analysed

Survey	Percentage Captured %	Percentage Analysed %
Jan-21	31.88	10.63
Feb-21	31.81	10.60
Mar-21	31.77	10.59
Apr-21	31.90	10.63
May-21	31.92	10.64
Jun-21	31.73	10.58
Jul-21	31.71	10.64
Aug-21	31.84	10.57
Sep-21	31.88	10.58
Oct-21	31.90	10.63
Nov-21	31.89	10.63
Dec-21	31.83	10.63

9 Appendix 9 - Offshore Ornithology Methodology Statement

9.1 Introduction

9.1.1.1 A draft of this Offshore Ornithology Method Statement was provided to support the Scoping Workshop held for the Array Project on 18 April 2023. The offshore ornithology Environmental Impact Assessment (EIA) will follow the methodology set out herein and in chapter 4: EIA Methodology of the Scoping Report. The draft Offshore Ornithology Method Statement was updated subsequently to account for written advice provided to the Applicant by NatureScot, dated 15 May 2023.

9.1.1.2 This revised Method Statement provides a detailed methodology to enable further consultation and stakeholder review.

9.2 Guidance

9.2.1.1 The following guidance documents, specific to the offshore ornithology EIA, will also be considered:

- Guidelines for Ecological Impact Assessment in Britain and Ireland. Terrestrial, Freshwater, Coastal and Marine (CIEEM, 2018);
- Guidance on Environmental Considerations for Offshore Wind Farm Development (OSPAR, 2008).

9.2.1.2 The key international conventions promoting the conservation of birds of relevance to the offshore ornithology EIA are the Convention on Wetlands of International Importance, the Waterfowl Habitat (the 'Ramsar Convention'), the Convention on the Conservation of Migratory Species of Wild Animals (the 'Bonn Convention') and the Convention on the Conservation of European Wildlife and Natural Habitats (the 'Bern Convention').

9.2.2 Valued Ornithological Receptors (VORs)

9.2.2.1 In accordance with the Chartered Institute of Ecology and Environmental Management guidelines on Ecological Impact Assessments (EcIA) (CIEEM, 2018), the assessment of the likely ecological effects of the Array Project has focused on 'Valued Ornithological Receptors' (VORs). VORs are species populations and assemblages of high ecological value, present within the ZoI of the Array Project in numbers that could mean that any effects could be considered significant.

9.2.2.2 The value of species populations and of assemblages will be evaluated with reference to their importance in terms of 'biodiversity conservation' value (which relates to the need to conserve representative areas of different habitats and the genetic diversity of species populations), the species' abundance at the relevant study area and the species' legal status.

9.2.2.3 For the purposes of this assessment, species populations and assemblages will be valued using the following scale:

- International;
- National;
- Regional;
- Local;
- Negligible.

9.2.2.4 The Chartered Institute of Ecology and Environmental Management guidelines on EcIA (CIEEM, 2018) recommend an approach to valuation that involves defining the different values that could be attached to the ornithological receptors under consideration. A VOR will be identified where the abundance of a species present at the project surpasses the 1% threshold of the regional population in any season. It is considered that any impacts on species occurring in numbers of less than 1% of the relevant regional population will not be significant. Expert judgement will also be applied to identify further species where such thresholds are not applicable. The criteria for conservation status and value presented in Appendix Table 9.1 are then used to identify the conservation value for each VOR. This process will be presented in a Baseline Characterisation report, which will be an appendix to the EIA.

Table 9.1: Definition of terms relating to the conservation value of ornithological receptors

Value of VOR	Criteria to define value
International	Conservation status Bird species that form part of a cited interest of a Special Protection Area (SPA) or Ramsar Site that may, potentially, interact with the Array Project at some stage of their life cycle; and/or At least 20% of the European breeding or non-breeding population is found in the UK.
	Importance A species that is present in the Offshore Ornithology Study Area in numbers of greater than 1% of the international biogeographic population.
National	Conservation status Species listed on Schedule 1 of the Wildlife and Countryside Act 1981 not already covered by International criteria; Species listed on Annex I of the EU Birds Directive; Bird species that form part of an SSSI, which may potentially interact with the project at some stage of their life cycle; and/or At least 50% of the UK breeding or non-breeding population found in ten or fewer sites; An impact on an ecologically-sensitive species (<300 breeding pairs or <900 wintering individuals in the UK).
	Importance A species which is present in the Offshore Ornithology Study Area in numbers of greater than 1% of the national population.
Regional	Conservation status Species listed on the Birds of Conservation Concern Red list (Stanbury *et al.*, 2021); and/or Species that are the subject of a specific action plan within the UK or species considered to be of principal importance for biodiversity and conservation in Scotland as listed on the Scottish Biodiversity List (Nature Conservation (Scotland) Act 2004).
	Importance A species which is present in the Offshore Ornithology Study Area in numbers of greater than 1% of the regional population.
Local	Conservation status Any other species of conservation value (e.g. Amber-listed species listed on the Birds of Conservation Concern (Stanbury *et al.*, 2021)) not covered in the categories below.
	Importance A species that is present in the Offshore Ornithology Study Area in numbers lower than 1% of the regional population.
Negligible	Conservation status All species of lowest conservation status (e.g. Green-listed species listed on the Birds of Conservation Concern).
	Importance None.

9.2.3 Abundance Data

9.2.3.1 Abundance data, either densities or population estimates (with associated confidence intervals and levels of precision), for use in collision risk modelling and displacement analysis have been collected through digital aerial survey. These data will be analysed using design-based methods and MRSea if this package can be shown to function effectively with the dataset. Abundance metrics will also incorporate the attribution of birds recorded to species groups to species level and availability bias to account for diving birds.

9.2.4 Seasonality, Connectivity and Seabird Populations

9.2.4.1 The seasons to be used for each species will follow those recommended by NatureScot (NatureScot, 2020). Consideration will also be given to the seasons presented in Furness (2015). Where appropriate, the non-breeding seasons presented in NatureScot (2020) may be split to include post-breeding, winter and pre-breeding seasons. Consideration will also be given to any trends in the abundance of birds recorded during baseline surveys and how this may correspond to the seasons presented in other sources.

9.2.4.2 To identify important populations of birds that may interact with the Array Project (i.e. connectivity), information on the foraging range of each species from Woodward *et al.* (2019) will be used alongside any site-specific foraging range data, where available. The use of foraging ranges from Woodward *et al.* (2019) will follow guidance in NatureScot (2023d), where appropriate.

9.2.4.3 Regional seabird populations, representing the population of birds that may interact with the Array Project during specific seasons will be sourced from relevant sources including, for the breeding season, the Seabird Monitoring Programme database (BTO, 2021) and for non-breeding seasons, from Furness (2015). Guidance provided by NatureScot (2023a) will be followed when identifying and estimating regional populations for consideration in assessments. National and international populations will also be sourced from appropriate sources including Woodward *et al*. (2020), Mitchell *et al*. (2004) and Furness (2015).

9.2.5 Collision Risk Modelling

9.2.5.1 Collision risk modelling (CRM) will be undertaken for all VORs that are vulnerable to collision risk impacts based on the vulnerability scores presented in Wade *et al.* (2016) (Moderate and above). The methodology and results will be presented in an Appendix to the EIA. Without prejudice to the species for which CRM will be required in the EIA and Habitats Regulations Appraisal (HRA), this section outlines the approach to be taken for species and identifies the parameters to be used for those species most commonly included in collision risk modelling.

9.2.5.2 CRM will be undertaken using the Band (2012) collision risk model and will incorporate the guidance provided by NatureScot (2023b). Modelling will be undertaken using both the deterministic and stochastic versions of the model (MacGregor *et al*., 2018). Collision risk estimates obtained through both deterministic and stochastic modelling will be presented following recent guidance from NatureScot (NatureScot, 2023b).

9.2.5.3 Site specific flight height data have not been collected and, therefore, modelling will be undertaken using Options 2 and 3 of the Band (2012) collision risk model. Generic flight height distributions from Johnston *et al*. (2014) will be used to parameterise the model.

9.2.5.4 Wind farm and turbine parameters will be provided by the Applicant. An initial CRM exercise will be undertaken modelling a range of wind turbine scenarios that will be informed by the Project Design Envelope (PDE). Outputs from this exercise will inform the identification of the Maximum Design Scenario (MDS) CRM for each key species.

9.2.5.5 The monthly mean densities of flying birds for each relevant species will be used for CRM and will be derived from baseline digital aerial survey data. This follows the guidance from the Marine Directorate to previous OWF projects (e.g. Marine Scotland, 2017) and recent guidance from NatureScot (2023b).

9.2.5.6 Biometric and behavioural bird parameters will be sourced from relevant sources (e.g. Robinson, 2005; Alerstam *et al.,* 2007; Pennycuick, 1987; Skov *et al.* 2018; Garthe and Hüppop, 2004) and will include those recommended by statutory advisers (e.g. NatureScot, 2023b). It may also be necessary to calculate collision risk estimates utilising alternative parameter values including recently published information and, where this is conducted, assessments will be presented incorporating all potential collision risk estimates across all parameter sets. A summary of biometric and behavioural parameters that will be used for modelling are presented in Appendix Table 9.2.

Table 9.2: Biometric and behavioural parameters for use in collision risk modelling (where required)

Parameter	Reference (unless otherwise stated)	Kittiwake	Great black-backed gull	Herring gull	Lesser black-backed gull	Gannet
Bird length (m)	BTO (2022) / NatureScot (2023b)	0.39	0.71	0.6	0.58	0.94
Wingspan (m)	BTO (2022) / NatureScot (2023b)	1.08	1.58	1.44	1.42	1.72
Flight speed (m/s)	Alerstam *et al.* (2007) / NatureScot (2023b)	13.1	13.7	12.8	13.1	-
	Pennycuick (1987) / NatureScot (2023b)	-	-	-	-	14.9
	Skov *et al.* (2015)	8.71	9.8	9.8	9.8	13.33
Nocturnal activity factor	NatureScot (2023b)	2-3	2-3	2-3	2-3	1.32[a]
Flight type	User-defined	Flapping	Flapping	Flapping	Flapping	Gliding
Proportion of flights upwind (%)	User-defined	50	50	50	50	50

[a] Furness *et al.* (2018)

9.2.5.7 Collision risk estimates will be estimated using a range of avoidance rates including those currently endorsed by Statutory Nature Conservation Bodies (JNCC *et al.,* 2014; NatureScot, 2023b) and those that have been published more recently (Bowgen and Cook, 2018; Ozsanlav-Harris *et al.,* 2023) for all applicable model Options.

Table 9.3: Avoidance rates

Band model	Reference	Kittiwake	Great black-backed gull	Herring gull	Lesser black-backed gull	Gannet
Deterministic						
Basic (Option 2)	NatureScot (2023b)	99.2	99.4	99.4	99.4	99.2
	JNCC *et al.* (2014)	98.9	99.5	99.5	99.5	98.9
	Bowgen and Cook (2018)	99.0	99.5	99.5	99.5	99.5
	Ozsanlav-Harris (2023)	99.7	99.91	99.52	99.54	(99.2)[a]
Extended (Option 3)	JNCC *et al.* (2014)	N/A	98.9	99.0	98.9	N/A
	Bowgen and Cook (2018)	98.0	99.3	99.3	99.3	N/A
	Ozsanlav-Harris (2023)	99.24	99.66	98.25	97.99	97.2
Stochastic						
Basic (Option 2)	NatureScot (2023b)	99.3	99.4	99.4	99.4	99.3
	Ozsanlav-Harris (2023)	99.79	99.91	99.52	99.54	99.28
	Bowgen and Cook (2018)	99.4	99.7	99.7	99.7	N/A
Extended (Option 3)	Ozsanlav-Harris (2023)	99.47	99.7	95.04	98.1	95.33
	Bowgen and Cook (2018)	97.0	99.0	99.0	99.0	N/A

[a] All gull rate - used in the absence of a species-specific rate for gannet following practice elsewhere (e.g. NatureScot, 2023b)

9.2.5.8 Assessment of collision impacts on migratory seabird species (defined as species of tern, skua, petrel and little gull) will utilise the information presented in Wildfowl and Wetlands Trust (WWT) Consulting and MacArthur Green (2014). Assessments will either utilise the information presented in WWT Consulting and MacArthur Green (2014) or will apply the modelling approaches presented in that report using the Band (2012) deterministic Excel workbook. For migratory waterbirds a similar approach will be taken. However, if quantification of impacts is required then the Wright *et al.* (2012) approach will be applied. Alternatively, if the migratory collision risk model currently under development by the Marine Directorate is available in time for incorporation into the relevant assessments, this will be applied for migratory waterbirds and seabirds.

9.2.6 Displacement Analysis

9.2.6.1 Displacement analyses will be undertaken for all VORs that are vulnerable to displacement impacts based on the vulnerability scores presented in Wade *et al.* (2016). The methodology and results will be presented in an appendix to the EIA Report.

9.2.6.2 Displacement effects will be assessed using the displacement matrix approach following the guidance presented in JNCC *et al.* (2022) and, where applicable, using SeabORD (Searle *et al.,* 2018). Guidance provided by NatureScot (2023c) will be followed.

9.2.6.3 The displacement matrix approach requires seasonal mean-peak populations for the Array Project plus a buffer, which is defined based on the vulnerability of a species to displacement impacts. Seasonal mean-peak populations will be calculated using abundance data derived from baseline digital aerial survey data. Where applicable, SeabORD will be used to assess displacement impacts in the breeding season.

9.2.6.4 Displacement matrices will be presented using a range of displacement and mortality rates with assessments conducted utilising specific displacement and mortality rates informed by published evidence and those recommended by statutory advisors (NatureScot, 2023c; Appendix Table 9.4; JNCC *et al.,* 2022).

Table 9.4: Displacement and mortality rates as advised by NatureScot (2023c)

Species/species group	Displacement rate (%)	Mortality rate (%)	
		Breeding season	Non-breeding season
Auks (guillemot, razorbill, puffin)	60	3 and 5	1 and 3
Gannet	70	1 and 3	1 and 3
Kittiwake	30	1 and 3	1 and 3

9.2.7 Apportioning

9.2.7.1 A population of birds in a sea area may consist of breeding adult birds, immature birds and non-breeding birds. For the assessment of impacts upon SPA breeding seabird features, both in the breeding season and non-breeding seasons, it is necessary to identify the proportion of an impact that is applicable to the breeding component of an SPA population. This is achieved through apportioning, the approach to which differs depending on the season under consideration.

9.2.7.2 In the breeding season, guidance provided in NatureScot (2020) will be followed incorporating the apportionment of impacts to breeding birds, immature birds and sabbatical birds. In addition, the apportioning approach developed by Butler *et al.* (2020) will be considered based on the utilisation distributions produced by Wakefield *et al.* (2017) and utilised by Cleasby *et al.* (2020), where it is applicable to one of the four species considered (black-legged kittiwake, common guillemot, razorbill and European shag). In the non-breeding season, population data presented in Furness (2015) will be used to calculate apportioning values, which will then be applied to relevant seasonal impacts for each relevant population.

9.2.7.3 Consideration will also be given to the apportioning approach required for species such as guillemot and razorbill where the approach incorporating data in Furness (2015) may not accurately reflect the movements of these species during post-breeding dispersal movements and the species' distribution in the non-breeding season.

9.2.7.4 The methodology and apportioning values calculated will be presented in an appendix to the Report to Inform Appropriate Assessment for the HRA.

9.2.8 Population Viability Analysis

9.2.8.1 Population Viability Analysis (PVA), required to understand the impacts of collision and displacement on key seabird populations, will be undertaken using the Natural England PVA tool (Searle *et al.,* 2019). Special Pro412action Area (SPA) populations for which PVA is required will be identified based on the proportional increase in baseline mortality represented by the impact from the Array Project alone and/or in-combination. The application of PVA will be based on recent NatureScot guidance (NatureScot, 2023e) whilst ensuring that the latest evidence is also considered. PVA will be conducted over a 25 and 50 years, and the consent period (to be outlined in the EIA Report) and guidance from NatureScot (NatureScot, 2023e).

9.2.8.2 The derivation of input parameters for PVA, which include productivity and survival rates, will follow the recommendations in Searle *et al.* (2020). Values will be sourced from Horswill and Robinson (2015), the Seabird Monitoring Programme database or from colony-specific studies, where available and appropriate.

9.2.8.3 PVA outputs including the counterfactuals of final population size and population growth rate will be incorporated into all relevant assessments.

9.2.8.4 The methodology and PVA outputs will be presented in an appendix to the HRA for SPA populations and in the EIA for regional populations, where required.

10 Appendix 10 – Commercial Fisheries Methodology Statement

10.1 Introduction

10.1.1.1 The commercial fisheries Environmental Impact Assessment (EIA) will follow the standard methodology set out in the Array Project Scoping Report (hereafter, the 'Scoping Report'). This Commercial Fisheries Method Statement addresses the aspects of that methodology that are specific to or have been modified in minor aspects for commercial fisheries EIA. This approach seeks to capture the specific factors that influence receptor sensitivity and effect magnitude for commercial fisheries receptors in particular. It has been developed and accepted as an approach for the sector over time. This Commercial Fisheries Method Statement was provided to support the Array Project Scoping Workshop (hereafter, 'Scoping Workshop', which was held on 18 April 2023).

10.2 Guidance

10.2.1.1 The following guidance specific to the commercial fisheries EIA will be considered:

- Fishing Liaison with Offshore Wind and Wet Renewables Group (FLOWW) Best Practice Guidance for Offshore Renewables Developments: Recommendations for Fisheries Liaison. (FLOWW, 2014);
- FLOWW Best Practice Guidance for Offshore Renewables Developments: Recommendations for Fisheries Disruption Settlements and Community Funds. (FLOWW, 2015);
- Best Practice Guidance for Fishing Industry Financial and Economic Impact Assessments (UKFEN, 2012);
- Options and Opportunities for Marine Fisheries Mitigation Associated with Windfarms (Blyth-Skyrme, 2010);
- Fishing and Submarine Cables - Working Together (ICPC, 2009);
- Spatial Squeeze in Fisheries - Final Report (ABPmer no. R3900, June 2022);
- Good Practice Guidance for Assessing Fisheries Displacement (Marine Scotland, 2022);
- Offshore Impacts to Fisheries: Practitioner Guidance for Social Baselines (IPIECA, 2023).

10.2.1.2 The commercial fisheries EIA will also consider any new guidance and updates to existing guidance, as and where applicable.

10.3 Receptor Sensitivity

10.3.1.1 The definitions of receptor sensitivity and the magnitude of an effect are outlined in Appendix Table 10.1.

Table 10.1: Definition of terms relating to receptor sensitivity

Term	Definition
Very High	Very localised and limited operational range, with total dependence on a single local fishing ground and ability to deploy only one gear type. Fishing opportunities are highly weather dependent. Very limited target species opportunities.
High	Limited operational range and ability to deploy only one gear type. High dependence upon a single fishing ground.
Medium	Moderate extent of operational range and / or ability to deploy an alternative gear type. Dependence upon a limited number of fishing grounds.

Term	Definition
Low	Extensive operational range and / or ability to deploy a number of gear types or modify gears. Ability to fish a number of fishing grounds.
Negligible	Extensive operational range and/or very high method versatility in terms of gear types. Vessels are able to exploit a large number of fishing grounds.

10.4 Magnitude of an Effect

10.4.1.1 The definitions to discern the magnitude of an effect are outlined in Appendix Table 10.2

Table 10.2: Definition of terms relating to magnitude of an effect.

Term	Definition
Very High	The Array Project sustains a very high level of activity by the fleet and covers the majority or all of the extent of its grounds; and/or the effect is permanent.
High	The Array Project sustains high levels of activity by the fleet and covers a large or moderate extent of its grounds; and/or the effect is permanent.
Medium	The Array Project sustains moderate/high levels of activity by the fleet and covers a small/moderate extent of its grounds; and/or the effect is long term.
Low	The Array Project sustains low/moderate levels of activity by the fleet and covers a small extent of its grounds; and/or the effect is short to medium term.
Negligible	The Array Project sustains low/ negligible activity by the fleet and covers a small/negligible extent of its grounds; and/or the effect is short term.

10.4.1.2 The significance of the potential effect on commercial fisheries is determined by correlating the magnitude of the impact and the sensitivity of the receptor. The method employed for this assessment is presented in Appendix Table 10.3.

Table 10.3: Significance of an impact resulting from each combination of receptor sensitivity and the magnitude of the effect

Sensitivity of receptor	Magnitude of impact				
	Negligible	Low	Medium	High	Very High
Negligible	No change	Negligible	Negligible or Minor	Negligible or Minor	Minor
Low	No change	Negligible or Minor	Negligible or Minor	Minor	Minor or Moderate
Medium	No change	Negligible or Minor	Minor	Moderate	Moderate or Major
High	No change	Minor	Minor or Moderate	Moderate or Major	Major
Very High	No change	Minor	Moderate or Major	Major	Major

11 Appendix 11 - Seascape, Landscape and Visual, and Onshore Historic Environment Methodology Statement

11.1 Introduction

11.1.1.1 This appendix has been provided to the support the approach to the Environmental Impact Assessment (EIA) for the Morven Offshore Wind Array Project (hereafter, 'Array Project'). This is with respect to seascape, landscape and visual, and onshore historic environment receptors in the event this topic is not scoped out of the EIA, as proposed by the Applicant in chapter 9.7: Seascape, Landscape and Visual, and Onshore Historic Environment of the Array Project Scoping Report (hereafter, Scoping Report').

11.2 Data Sources

11.2.1.1 A range of desk- and site-based data sources covering seascape, landscape, visual and onshore heritage receptors and other relevant cumulative development are included below. The desk-based data has been drawn from the Ordnance Survey and a range of document sources in addition to the relevant planning policy documents outlined in chapter 2: Policy and Legislation of the Scoping Report. The key desk-based data sources used to inform the seascape, landscape and visual impact assessment (SLVIA) and onshore historic environment scoping chapter are set out in Appendix Table 11.1.

Table 11.1: Key sources of seascape, landscape, visual and onshore heritage data

Source	Date	Summary	Coverage of the study area
Scottish Natural Heritage (SNH)	2005	An assessment of the sensitivity and capacity of the Scottish seascape in relation to windfarms (available online: https://www.nature.scot/doc/naturescot-commissioned-report-103-assessment-sensitivity-and-capacity-scottish-seascape-relation).	Full coverage of SLVIA Study Area
SNH	2018	Map and guidance on Coastal Character Assessment (CCA) (available online: https://www.nature.scot/professional-advice/landscape/coastal-character-assessment).	Full coverage of SLVIA Study Area
NorthLink Ferries	Accessed 2022	Ferry routes (available online: https://www.northlinkferries.co.uk/).	Full coverage of SLVIA Study Area
Note: The following data sources will only be applicable if the SLV Study Area for the Array Project, located outwith the Scoping Boundary, overlaps with land-based receptors.			
SNH	2019	Landscape Character Assessment (LCA) for maps and descriptions of Landscape Character Types (LCTs) (available online: https://www.nature.scot/professional-advice/landscape/landscape-character-assessment/scottish-landscape-character-types-map-and-descriptions).	Full coverage of SLVIA Study Area
NatureScot	2022	Ancient Woodland Inventory (AWI) (available online: https://www.nature.scot/doc/guide-understanding-scottish-ancient-woodland-inventory-awi).	Full coverage of SLVIA Study Area
Historic Environment Scotland	2019	Gardens and Designed Landscapes of Aberdeenshire (available online: https://www.historicenvironment.scot/archives-and-	Full coverage of SLVIA Study Area

Source	Date	Summary	Coverage of the study area
		research/publications/publication/?publicationId=7c365ace-e62d-46d2-8a10-a5f700a788f3).	
Aberdeenshire Council	2023	Aberdeenshire Local Development Plan Appendix 13: Special Landscape Areas (available online: https://online.aberdeenshire.gov.uk/ldpmedia/LDP2021/Appendix13AberdeenshireSpecialLandscapeAreas.pdf).	Full coverage of SLVIA Study Area
Aberdeenshire Council	2022	Core Paths in Aberdeenshire (available online: https://wml.io/1u7).	Full coverage of SLVIA Study Area
Aberdeen City Council	2017	Aberdeen Local Development Plan (available online: https://www.aberdeencity.gov.uk/sites/default/files/LDP_WS_20170328.pdf).	Full coverage of SLVIA Study Area
Aberdeen City Council	2021	Aberdeen Landscape Study. Coastal Character Assessment (available online: https://www.aberdeencity.gov.uk/sites/default/files/2023-03/CoastalCharacterAssessmentFinal2021.pdf)	Full coverage of SLVIA Study Area
Aberdeen City Council	2021	Aberdeen Landscape Study. Landscape Character Assessment (available online: https://www.aberdeencity.gov.uk/sites/default/files/2023-03/Landscape%20Character%20Assessment%20Final%202021.pdf)	Full coverage of SLVIA Study Area
Aberdeen City Council	2023	Development Framework Phase 1: Aberdeen Beachfront (available online: https://committees.aberdeencity.gov.uk/mgAi.aspx?ID=97611#mgDocuments).	Full coverage of SLVIA Study Area
Angus Council	2016	Angus Local Development Plan (available online: https://www.angus.gov.uk/sites/default/files/Angus%20local%20development%20plan%20adopted%20September%202016.pdf).	Full coverage of SLVIA Study Area
National Planning Framework 4	2023	National Planning Framework 4 (www.gov.scot).	Full coverage of SLVIA Study Area
Angus Council	2014	Strategic Landscape Capacity Assessment for Wind Energy in Angus (available online: https://www.angus.gov.uk/sites/default/files/202003/Strategic%20Landscape%20Capacity%20Assessment%20of%20Wind%20Energy_0.pdf).	Full coverage of SLVIA Study Area
VisitScotland	2022	Visitor attractions and tourist destinations (available online: https://www.visitscotland.com/destinations-maps/aberdeen-city-shire/).	Full coverage of SLVIA Study Area
Scotland's Great Trails	2018	Scotland's Great Trails map (available online: https://www.scotlandsgreattrails.com).	Full coverage of SLVIA Study Area
Sustrans	2022	Sustrans Cycle Network (available online: https://www.sustrans.org.uk/national-cycle-network/).	Full coverage of SLVIA Study Area
Scottish Rights of Way and Access Society	2022	Heritage Paths (available online: https://scotways.com/heritage-path/#zoom=6&lat=56.7000&lon=-4.9000).	Full coverage of SLVIA Study Area

Source	Date	Summary	Coverage of the study area
Scottish Rights of Way and Access Society	2012	Scottish Hill Tracks, 5th Edition (not available online).	Full coverage of SLVIA Study Area
Google Earth Pro	2022	Aerial Photography.	Full coverage of SLVIA Study Area
Ordnance Survey	2022	1:50,000 and 1:25,000 scale mapping.	Full coverage of SLVIA Study Area
National Trust for Scotland	2022	Any specific visitor attractions/tourist destinations (available online: https://www.nts.org.uk/).	Full coverage of SLVIA Study Area
Historic Environment Scotland	2022	Designations portal.	Full coverage of SLVIA Study Area
Pastmap	2022	Repository for non-designated heritage assets.	Full coverage of SLVIA Study Area
Canmore	2022	Repository for non-designated heritage assets.	Full coverage of SLVIA Study Area

11.3 Baseline Environment

11.3.1.1 Information on the existing seascape, landscape, visual and onshore heritage receptors has been collected from Local Development Plans, Ordnance Survey (OS) maps and relevant literature. The baseline information in this Appendix includes an inventory of the existing seascape, landscape, visual and onshore heritage receptors within the SLVIA Study Area.

11.3.2 Seascape, Landscape and Visual Baseline Environment

11.3.2.1 The following seascape, landscape, visual and onshore heritage receptors within the SLVIA Study Area include:

Seascape receptors: National Seascape Character

11.3.2.2 Scottish Natural Heritage's Commissioned Report No. 103: An Assessment of the Sensitivity and Capacity of the Scottish Seascape in Relation to Windfarms (SNH, 2005) identified one national seascape within the SLV Study Area and set out the key characteristics of the Scottish Seascape Area 4: North East Coast as follows:

- "long, east-facing generally 'straight' coastline with many small indentations and few significant headlands and with open views out to North Sea;
- mix of long broad sandy beaches backed by dunes and low cliffs/rocky coastline;
- farmland predominantly backs coast; flat and low lying against deposition coast; gently rolling against rocky headlands/cliffs – some remnant heathland in places e.g. Findon Moor;
- frequent fishing villages and harbours and several sizeable urban settlements;
- industry is infrequent but large scale where it occurs e.g. St Fergus and Peterhead power stations are highly visible features within the lower lying northeast."

11.3.2.3 The Commissioned Report found that the Seascape Area 4: North East Coast has a very high capacity rating and low visibility/sensitivity ratings for offshore wind farm (OWF) development.

Seascape receptors: Coastal Character Types (CCT)

11.3.2.4 These seascape assessments were defined as part of SNH's Commissioned Report No. 103: An Assessment of the Sensitivity and Capacity of the Scottish Seascape in Relation to Windfarms (SNH, 2005):

- CCT 2: Mainland Rocky Coastline with Open Sea Views (located across Aberdeenshire and Aberdeen City coastlines within the SLVIA Study Area):
  - "Long straight stretches of coastline with cliffs rising to some 30 metres height and often with a raised beach edge. There are few significant headlands although geological differences create variety where softer sandstone forms an indented coast with bays and inlets, arches and caves; harder volcanic rocks produce a more resistant coastline of promontories, low cliffs and rocky shoreline. Notable groups on the northeast coast. Productive arable farming occurs up to the cliff edge and tree cover is minimal. Compact fishing villages are located at the base of cliffs in small bays, while castles and cliff-top forts perch on dramatic headland locations, for example Dunnottar, near Stonehaven. These are highlighted against the simple sea backdrop. These settlements and built features all appear to be spaced at even intervals and thus provide a visual rhythm of foci along the coast. Views over the North Sea are generally expansive and open, although parts of the Caithness coast have views of Hoy over the Pentland Firth. Shipping is a common feature in gazing out to sea."
- CCT 3: Deposition Coastline, Open Views (located across Angus and part of Aberdeenshire coastline north of Aberdeen City within the SLVIA Study Area):
  - "Low-lying coastal sections comprising long, sweeping curved sandy beaches. These are often backed by dunes and form a soft linear edge to the sea. This type is distinguished by a simple horizontal visual composition of sky, sea and land. Grassland and gorse occurs behind dunes and in turn, this is backed by flat, mixed or arable farmland. Some areas of dunes (e.g. Barry Links) are reserved for military live firing. Golf courses occur within this type and settlements are located within farmland. Larger settlements such as Carnoustie, are popular holiday and golf resorts. St Fergus Gas terminal is a distinct, visually prominent feature in Aberdeenshire. Uninterrupted views are long and expansive along beaches with low level, and sea level views over the North Sea. Shipping traffic is a common feature."

Landscape receptors: Landscape Character

11.3.2.5 There are nine Landscape Character Types (LCTs) within the SLVIA Study Area as classified by NatureScot's Landscape Character Assessment (NatureScot, 2019), as follows:

- LCT 17 - Coastal Agricultural Plain – Aberdeenshire;
- LCT 11 - Fragmented Rocky Coast;
- LCT 13 - Raised Beach Coast – Aberdeenshire;
- LCT 31 - Broad Wooded and Farmed Valley;
- LCT 27 - Farmed Moorland Edge – Aberdeenshire;
- LCT 24 - Coastal Farmed Ridges and Hills – Aberdeenshire;
- LCT 12 - Beaches, Dunes and Links – Aberdeen;
- LCT 389 - Cliffs and Rocky Coast – Aberdeen;
- LCT 2 - Cliffs and Rocky Coast – Tayside.

Landscape receptors: Designated Landscapes

11.3.2.6 One local landscape designation, a Special Landscape Area (SLA), is included in the Aberdeenshire Local Development Plan 2023 Appendix 13: *Aberdeenshire Special Landscape Areas* (Aberdeenshire

Council, 2023). The South East Aberdeenshire Coast SLA is described in the supplementary guidance as follows:

- "Rugged and intricate scenery of weathered coastal cliffs and raised beach landforms, including sites of geological interest.
- The broad sweep of sand at St Cyrus, backed by dunes that form a National Nature Reserve.
- Iconic Dunnottar Castle, on a rocky headland south of Stonehaven, is the most striking of many coastal archaeological sites.
- The coast provides the immediate and wider setting for a number of larger settlements, including Portlethen, Newtonhill, and Stonehaven, framed by rising cliffs on either side.
- Intact traditional fishing villages with diminutive harbours including Gourdon and Catterline.
- Coastal routes include the A92, A90, east coast railway, footpaths and National Cycle Network (Route 1), all offering expansive views out to sea.
- Panoramic views out to sea from headlands and beaches and important views along the coast, including the view over the sands at St Cyrus, and views from Dunnottar."

11.3.2.7 A small part of the North East Aberdeenshire Coast SLA is also within the SLVIA Study Area, at approximately 70km distance.

Visual receptors

11.3.2.8 Information on visual receptors has been collected from local development plans, OS maps, relevant tourist literature and through consultation with stakeholders. The baseline information presented here provides an inventory of the visual receptors focusing on those most likely to be affected.

11.3.2.9 The baseline inventory includes the following visual receptors overlapped by the ZTV:

- views from settlements and residential properties;
- views experienced whilst travelling through the landscape (road/rail users, walkers, horse riders and cyclists, for example);
- views from tourist and recreational destinations.

11.3.2.10 Within the SLVIA Study Area, the following principal visual receptors include:

- Larger coastal settlements include Aberdeen, Bridge of Don, Portlethen, Stonehaven, Inverbervie, St Cyrus and Montrose. Small coastal settlements include Balmedie, Newtonhill and Johnshaven.
- Coastal transport routes include the A90 and A92 between Aberdeen and Montrose, A956 and A957, and a series of minor roads.
- Recreational routes include part of The Formartine and Buchan Way (one of Scotland's Great Trails), the North East 250, Part of the Sustrans Cycle Network: Route 1; and the Core Path and Heritage Path Network.
- Tourist and visitor attractions along the coast include Dunnottar Castle, Tod Head, Girdle Ness and Scurdie Ness Lighthouses, St Cyrus National Nature Reserve, and a number of coastal beaches, golf course and camp sites.
- The route of the Aberdeen to Lerwick ferry is illustrated in Figures 9.1 and 9.2 of the Scoping Report. The timetable (Northlink Ferries) indicates that this service operates through the evening and overnight.

Onshore heritage assets baseline environment

11.3.2.11 Onshore heritage assets within the SLVIA Study Area encompass a long chronology of human activity along the coast of Aberdeenshire, Aberdeen City and Angus Councils. Records from the initial data searches within the SLIVA Study Area are plotted in Figure 12.1 to Figure 12.3 in Appendix 12: Seascape, Landscape and Visual and Onshore Historic Environment Wirelines and Zones of Theoretical Visibility.

11.3.2.12 The SLVIA Study Area incorporates nine distinct landscape types, defined as 'areas of consistent and recognisable landscape character' through the Landscape Character Assessment in Scotland initiative (NatureScot, 2019). Four of these character types have been used to inform the baseline environment below.

11.3.2.13 Onshore heritage assets in the Beach, Dunes and Links landscapes north of the SLVIA Study Area (LCT 12), between Peterhead and Aberdeen, range from prehistoric flint mining to modern anti-invasion defences. This landscape is generally relatively low-lying, and the topography means that views of the sea are frequently glimpsed, contributing to a more general coastal context. In contrast, long and uninterrupted views to seaward are generally available only from the beaches or localised higher viewpoints within the dunes.

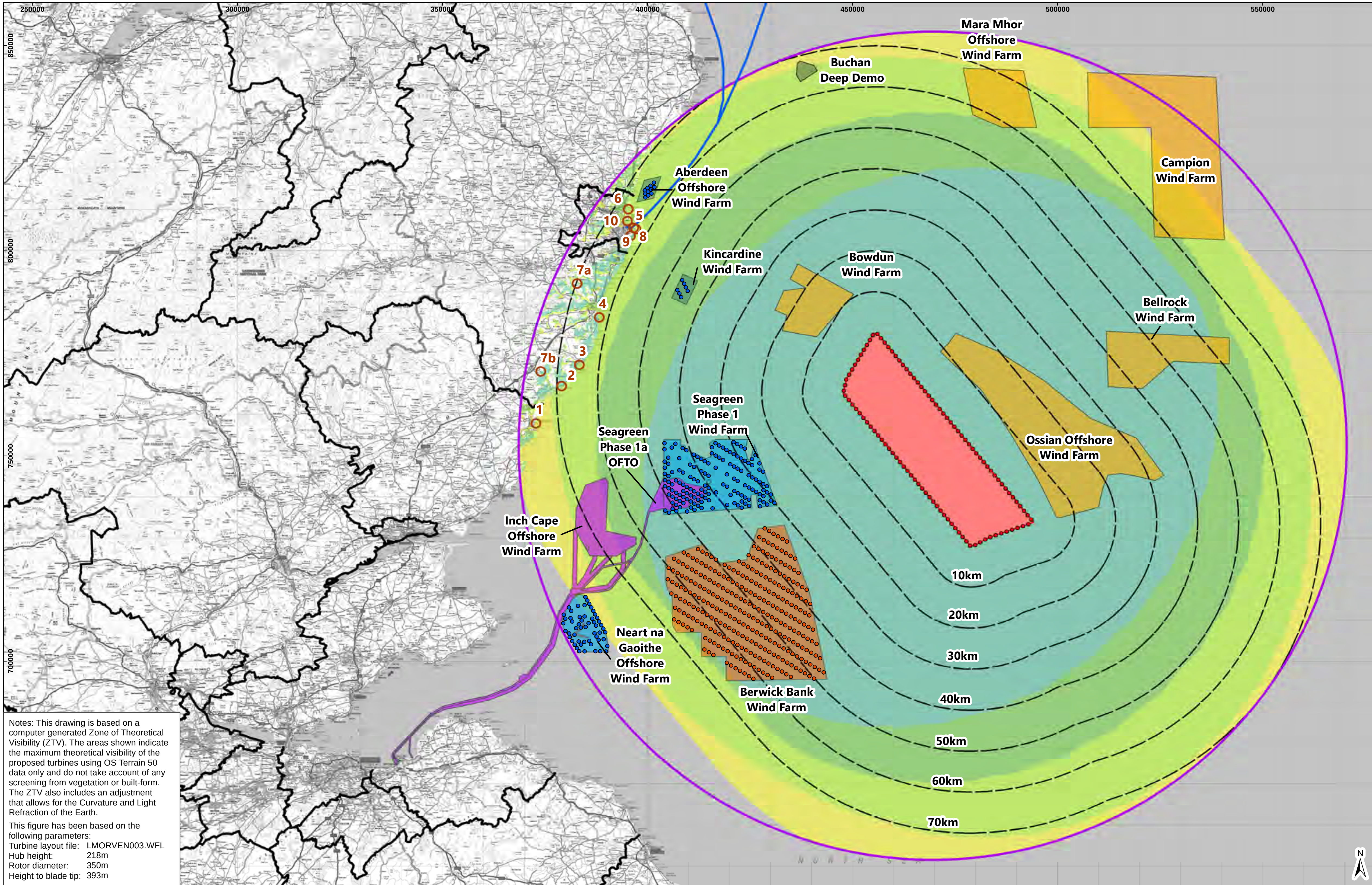
11.3.2.14 Onshore heritage assets within the Cliffs and Rocky Coast (LCT 2) and Fragmented Rocky Coast (LCT 11), roughly between Aberdeen and Inverbervie, range from late prehistoric promontory forts to 19th and 20th century military sites. Sites such as those built upon promontories, such as Dunnottar Castle (SM986), can often have visually dramatic settings that reflect the rocky landscape in which they are situated and which can present views that are framed or otherwise constrained by the cliffs and hills. Onshore heritage assets within the Raised Beach Coast (LCT 13) landscape, roughly between Inverbervie and Arbroath, range from prehistoric cairns and barrow cemeteries to medieval castles. The raised beach coast is generally low-lying, but intermittent promontories give rise to longer views up and down the coast and further out to sea.

11.3.3 Future Baseline

11.3.3.1 Seascape and landscape change is an ongoing process and will continue across the SLVIA Study Area irrespective of whether the Array Project proceeds. Change can arise through natural processes and systems (for example, coastal erosion) or because of human activity, including land use and land management.

11.3.3.2 The Aberdeenshire Local Development Plan 2023 (Aberdeenshire Council, 2023) indicates strategic and economic growth within their districts, likely to affect various settlements along the coastline. Other land management, and consequently landscape character, depends on economic and environmental factors, including the future effects of climate change and human adaptation, which are difficult to predict at a local level and are not a matter for this assessment. However, it is likely that mitigation and adaptation in response to changing climate and biodiversity pressures will continue to influence this area in the form of increased renewable energy and other environmental changes, such as changes to the current levels of forestry and woodland. Other OWF developments in construction, planning and proposed are illustrated in Figure 12.1 to Figure 12.3 in Appendix 12: Seascape, Landscape and Visual and Onshore Historic Environment Wirelines and Zones of Theoretical Visibility.

12 Appendix 12 - Seascape, Landscape and Visual and Onshore Historic Environment Wireline and Zones of Theoretical Visibility



Notes: This drawing is based on a computer generated Zone of Theoretical Visibility (ZTV). The areas shown indicate the maximum theoretical visibility of the proposed turbines using OS Terrain 50 data only and do not take account of any screening from vegetation or built-form. The ZTV also includes an adjustment that allows for the Curvature and Light Refraction of the Earth.

This figure has been based on the following parameters:

Turbine layout file: LMORVEN003.WFL
Hub height: 218m
Rotor diameter: 350m
Height to blade tip: 393m

LEGEND

- Morven Lease Area
- Turbine Location
- Landscape and Visual Study Area

Note: The study area is based on a 100,938m radius circle that allows a minimum of 70km distance from the Lease Area

- Lines indicating the distance from the proposed turbines
- Local authority boundaries
- Ferry Routes
- 1 to 25 turbines may be theoretically visible
- 26 to 50 turbines may be theoretically visible
- 51 to 75 turbines may be theoretically visible
- 76 to 101 turbines may be theoretically visible

Other offshore wind farms

- Operational
- Under Construction
- Consented
- In Planning
- Pre Planning

- Viewpoint Locations

VP1) Montrose Seafront
VP2) Johnshaven
VP3) Inverbervie Beach Picnic Site
VP4) Dunottar Castle Stonehaven
VP5) Girdle Ness Lighthouse
VP6) Royal Aberdeen Golf Course
VP7a) Meikle Carewe
VP7b) Garvock Viewpoint
VP8) SM4126 Baron's Cairn, cairn
VP9) SM9215 Torry Battery, battery 130m ESE of Old South Breakwater
VP10) Broad Hill, Aberdeen

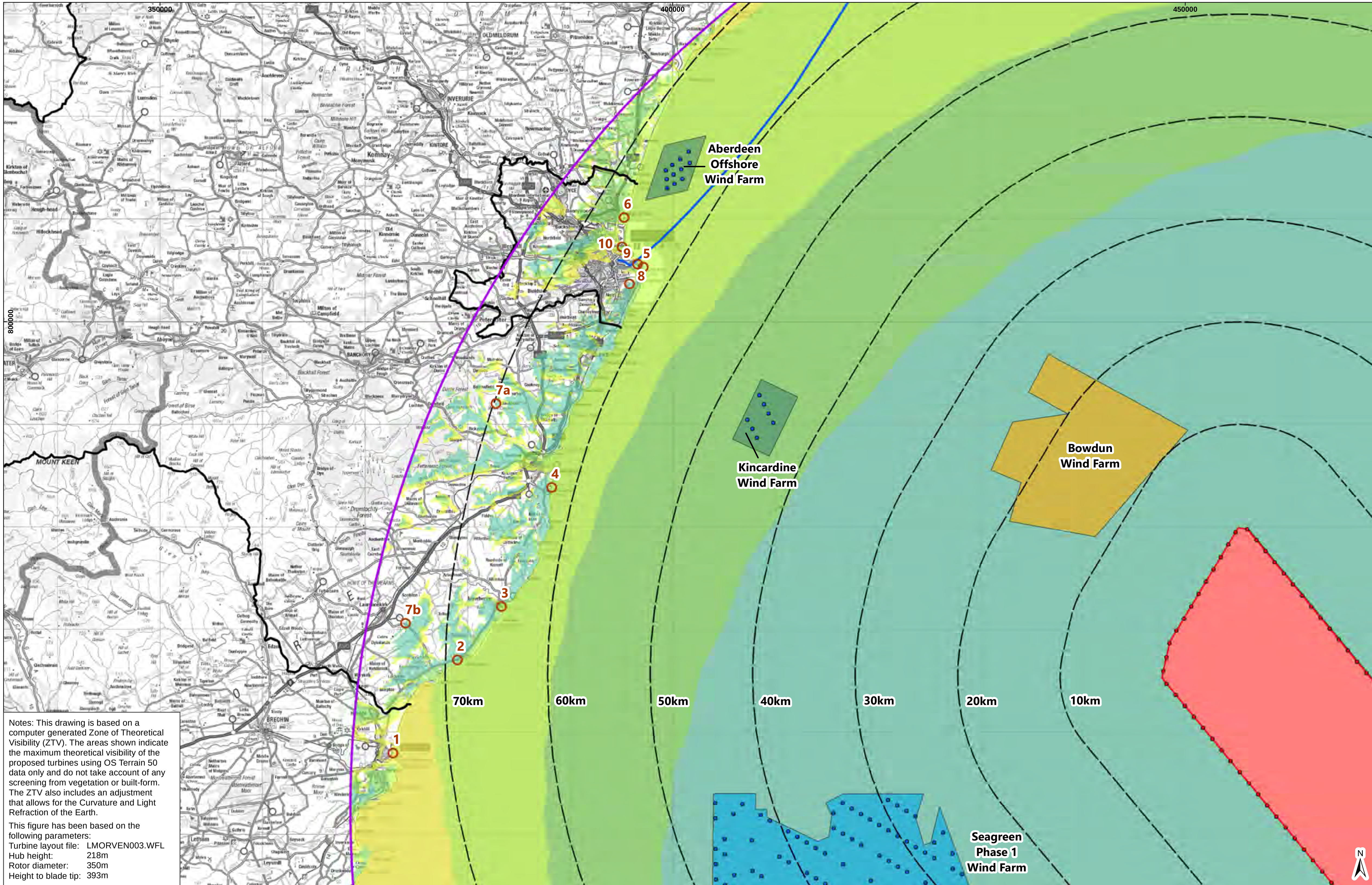
EnBW bp rps

Drawing Number:

RPSE-TEM-001-00

Project Name:	Drawing Title:	Scale	Geodetic Information:	Data Sources:	Service Layer Credits:
MORVEN OFFSHORE WIND PROJECT SCOPING REPORT	FIGURE 12.1: ZONE OF THEORETICAL VISIBILITY (ZTV) TO BLADE TIP	0 1 2 4 6 8 10 12 14 16 nm; 0 2.5 5 10 15 20 25 30 km	Datum: OSGB 1936 Projection: British National Grid Scale@379mmx231mm: 1:1,000,000	Client, **References for all data shown in the map to be added here**	Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

VER	DATE	DETAILS	BY	CHECK
09	02/06/23	Initial Issue	brycc	sinhr



LEGEND

- Morven Lease Area
- Turbine Location
- Landscape and Visual Study Area

Note: The study area is based on a 100,938m radius circle that allows a minimum of 70km distance from the Lease Area

- Lines indicating the distance from the proposed turbines
- Local authority boundaries
- Ferry Routes
- 1 to 25 turbines may be theoretically visible
- 26 to 50 turbines may be theoretically visible
- 51 to 75 turbines may be theoretically visible
- 76 to 101 turbines may be theoretically visible

Other offshore wind farms

- Operational
- Under Construction
- Consented
- Pre Planning
- Viewpoint Locations

VP1) Montrose Seafront
VP2) Johnshaven
VP3) Inverbervie Beach Picnic Site
VP4) Dunottar Castle Stonehaven
VP5) Girdle Ness Lighthouse
VP6) Royal Aberdeen Golf Course
VP7a) Meikle Carewe
VP7b) Garvock Viewpoint
VP8) SM4126 Baron's Cairn, cairn
VP9) SM9215 Torry Battery, battery 130m ESE of Old South Breakwater
VP10) Broad Hill, Aberdeen

Notes: This drawing is based on a computer generated Zone of Theoretical Visibility (ZTV). The areas shown indicate the maximum theoretical visibility of the proposed turbines using OS Terrain 50 data only and do not take account of any screening from vegetation or built-form. The ZTV also includes an adjustment that allows for the Curvature and Light Refraction of the Earth.

This figure has been based on the following parameters:

Turbine layout file:	LMORVEN003.WFL
Hub height:	218m
Rotor diameter:	350m
Height to blade tip:	393m

EnBW bp rps

Partners in UK offshore wind

Drawing Number:

RPSE-TEM-001-00

Project Name:
MORVEN OFFSHORE WIND PROJECT SCOPING REPORT

Drawing Title:
FIGURE 12.2: DETAILED ZONE OF THEORETICAL VISIBILITY (ZTV) TO BLADE TIP

0 1 2 4 6 nm
0 2.5 5 10 km

Geodetic Information:
Datum: OSGB 1936
Projection: British National Grid
Scale@379mmx231mm: 1:400,000

Data Sources: Client, **References for all data shown in the map to be added here**

Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

VER	DATE	DETAILS	BY	CHECK
09	02/06/23	Initial Issue	brycc	sinhr

Wireline drawing

View flat at a comfortable arm's length

Wind Farm Key: Morven Wind Farm (Outer Boundary) | Existing / Under Construction | In Planning | Consented | Pre Planning

OS reference:	E372 688, N757 961	Horizontal field of view:	90º (cylindrical projection)
Eye level:	7.5m AOD	Principal distance:	522mm
Direction of view:	85°	Paper size:	841mm x 297mm (half A1)
Nearest turbine:	75,580m	Correct printed image size:	820 x 260mm

Client

Partners in UK offshore wind

Morven Offshore Wind Project
Scoping Report

Figure 12.3a
Viewpoint Wirelines
Viewpoint 1: Montrose Seafront

June 2023

H:\data\Projects\TEMP LG\Morven - TEMP FOLDER\InDesign\Figure 9.3a-k Wirelines 852336-FG-SA-00005_R7.indd Originator: wilsc03

Wireline drawing

View flat at a comfortable arm's length

Wind Farm Key: Morven Wind Farm (Outer Boundary) | Existing / Under Construction | In Planning | Consented | Pre Planning

OS reference:	E378 980, N767 044	Horizontal field of view:	90º (cylindrical projection)
Eye level:	67.5m AOD	Principal distance:	522mm
Direction of view:	99°	Paper size:	841mm x 297mm (half A1)
Nearest turbine:	68,877m	Correct printed image size:	820 x 260mm

Client

Partners in UK offshore wind

Morven Offshore Wind Project
Scoping Report

Figure 12.3b
Viewpoint Wirelines
Viewpoint 2: Johnshaven

June 2023

Wireline drawing

View flat at a comfortable arm's length

Wind Farm Key: Morven Wind Farm (Outer Boundary) | Existing / Under Construction | In Planning | Consented | Pre Planning

OS reference:	E383 275, N772 240	Horizontal field of view:	90º (cylindrical projection)
Eye level:	5.5m AOD	Principal distance:	522mm
Direction of view:	97°	Paper size:	841mm x 297mm (half A1)
Nearest turbine:	64,881m	Correct printed image size:	820 x 260mm

Client

Partners in UK offshore wind

Morven Offshore Wind Project
Scoping Report

Figure 12.3c
Viewpoint Wirelines
Viewpoint 3: Inverbervie Beach Picnic Site

June 2023

Wireline drawing

View flat at a comfortable arm's length

Wind Farm Key: Morven Wind Farm (Outer Boundary) | Existing / Under Construction | In Planning | Consented | Pre Planning

OS reference:	E388 167, N783 839	Horizontal field of view:	90° (cylindrical projection)
Eye level:	30.5m AOD	Principal distance:	522mm
Direction of view:	107°	Paper size:	841mm x 297mm (half A1)
Nearest turbine:	62,158m	Correct printed image size:	820 x 260mm

Client

Partners in UK offshore wind

Morven Offshore Wind Project
Scoping Report

Figure 12.3d
Viewpoint Wirelines
Viewpoint 4: Dunottar Castle Stonehaven

June 2023

Wireline drawing

View flat at a comfortable arm's length

Wind Farm Key: Morven Wind Farm (Outer Boundary) | Existing / Under Construction | In Planning | Consented | Pre Planning

OS reference:	E397 103, N805 334	Horizontal field of view:	90º (cylindrical projection)
Eye level:	18.5m AOD	Principal distance:	522mm
Direction of view:	123°	Paper size:	841mm x 297mm (half A1)
Nearest turbine:	62,874m	Correct printed image size:	820 x 260mm

Client

Partners in UK offshore wind

Morven Offshore Wind Project
Scoping Report

Figure 12.3e
Viewpoint Wirelines
Viewpoint 5: Girdle Ness Lighthouse

June 2023

Wireline drawing

View flat at a comfortable arm's length

Wind Farm Key: Morven Wind Farm (Outer Boundary) | Existing / Under Construction | In Planning | Consented | Pre Planning

OS reference:	E395 237, N810 156	Horizontal field of view:	90º (cylindrical projection)
Eye level:	19.5m AOD	Principal distance:	522mm
Direction of view:	124°	Paper size:	841mm x 297mm (half A1)
Nearest turbine:	66,953m	Correct printed image size:	820 x 260mm

Client

Partners in UK offshore wind

Morven Offshore Wind Project
Scoping Report

Figure 12.3f
Viewpoint Wirelines
Viewpoint 6: Royal Aberdeen Golf Course

June 2023

H:\data\Projects\TEMP LG\Morven - TEMP FOLDER\InDesign\Figure 9.3a-k Wirelines 852336-FG-SA-00005_R7.indd
Originator: wilsc03

Wireline drawing

View flat at a comfortable arm's length

Wind Farm Key: Morven Wind Farm (Outer Boundary) | Existing / Under Construction | In Planning | Consented | Pre Planning

OS reference:	E382 745, N792 024	Horizontal field of view:	90° (cylindrical projection)
Eye level:	265.5m AOD	Principal distance:	522mm
Direction of view:	114°	Paper size:	841mm x 297mm (half A1)
Nearest turbine:	69,729m	Correct printed image size:	820 x 260mm

Client

Partners in UK offshore wind

Morven Offshore Wind Project
Scoping Report

Figure 12.3g
Viewpoint Wirelines
Viewpoint 7a: Meikle Carewe

June 2023

H:\data\Projects\TEMP LG\Morven - TEMP FOLDER\InDesign\Figure 9.3a-k Wirelines 852336-FG-SA-00005_R7.indd Originator: wilsc03

Wireline drawing

View flat at a comfortable arm's length

Wind Farm Key: Morven Wind Farm (Outer Boundary) | Existing / Under Construction | In Planning | Consented | Pre Planning

OS reference:	E373 904, N770 615	Horizontal field of view:	90º (cylindrical projection)
Eye level:	239.5m AOD	Principal distance:	522mm
Direction of view:	101°	Paper size:	841mm x 297mm (half A1)
Nearest turbine:	74,092m	Correct printed image size:	820 x 260mm

Client

Partners in UK offshore wind

Morven Offshore Wind Project
Scoping Report

Figure 12.3h
Viewpoint Wirelines
Viewpoint 7b: Garvock Viewpoint

June 2023

H:\data\Projects\TEMP LG\Morven - TEMP FOLDER\InDesign\Figure 9.3a-k Wirelines 852336-FG-SA-00005_R7.indd Originator: wilsc03

Wireline drawing

View flat at a comfortable arm's length

Wind Farm Key: Morven Wind Farm (Outer Boundary) | Existing / Under Construction | In Planning | Consented | Pre Planning

OS reference:	E395 770, N803 692	Horizontal field of view:	90º (cylindrical projection)
Eye level:	84.5m AOD	Principal distance:	522mm
Direction of view:	125°	Paper size:	841mm x 297mm (half A1)
Nearest turbine:	63,169m	Correct printed image size:	820 x 260mm

Client

Partners in UK offshore wind

Morven Offshore Wind Project
Scoping Report

Figure 12.3i
Viewpoint Wirelines
Viewpoint 8: SM4126 Baron's Cairn, cairn

June 2023

H:\data\Projects\TEMP LG\Morven - TEMP FOLDER\InDesign\Figure 9.3a-k Wirelines 852336-FG-SA-00005_R7.indd   Originator: wilsc03

Wireline drawing

View flat at a comfortable arm's length

Wind Farm Key: Morven Wind Farm (Outer Boundary) | Existing / Under Construction | In Planning | Consented | Pre Planning

OS reference:	E396 543, N805 631	Horizontal field of view:	90º (cylindrical projection)
Eye level:	27.5m AOD	Principal distance:	522mm
Direction of view:	126°	Paper size:	841mm x 297mm (half A1)
Nearest turbine:	63,507m	Correct printed image size:	820 x 260mm

Client

Partners in UK offshore wind

Morven Offshore Wind Project
Scoping Report

Figure 12.3j
Viewpoint Wirelines
Viewpoint 9: SM9215 Torry Battery, battery 130m ESE of Old South Breakwater

June 2023

H:\data\Projects\TEMP LG\Morven - TEMP FOLDER\InDesign\Figure 9.3a-k Wirelines 852336-FG-SA-00005_R7.indd Originator: wilsc03

Wireline drawing

View flat at a comfortable arm's length

Wind Farm Key: Morven Wind Farm (Outer Boundary) | Existing / Under Construction | In Planning | Consented | Pre Planning

OS reference:	E395 040, N807 300	Horizontal field of view:	90º (cylindrical projection)
Eye level:	29.5m AOD	Principal distance:	522mm
Direction of view:	126°	Paper size:	841mm x 297mm (half A1)
Nearest turbine:	65,652m	Correct printed image size:	820 x 260mm

Client

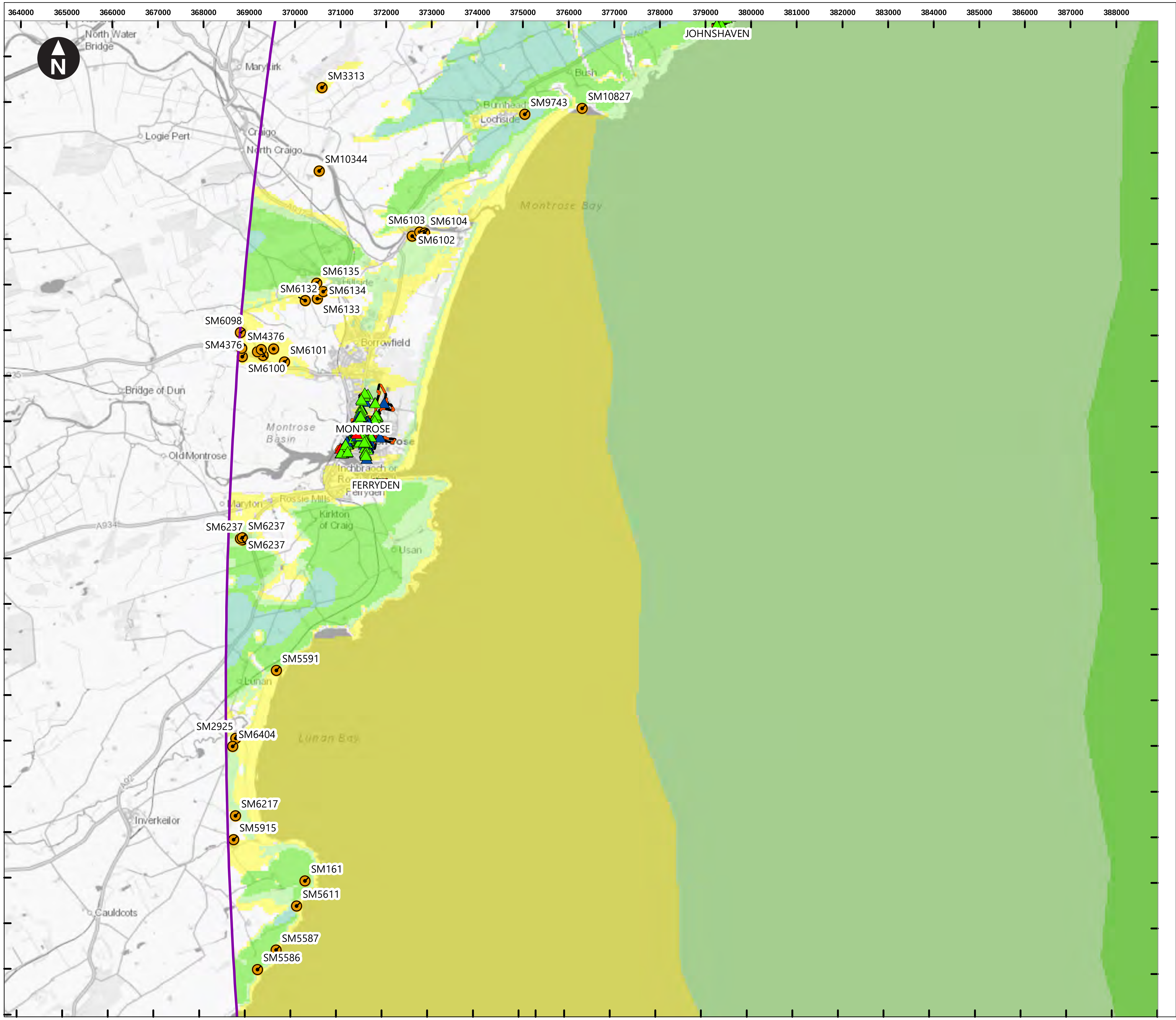
Partners in UK offshore wind

Morven Offshore Wind Project
Scoping Report

Figure 12.3k
Viewpoint Wirelines
Viewpoint 10: Broad Hill, Aberdeen

June 2023

H:\data\Projects\TEMP LG\Morven - TEMP FOLDER\InDesign\Figure 9.3a-k Wirelines 852336-FG-SA-00005_R7.indd Originator: wilsc03



C:\Users\david.astbury.GLOBAL\Documents\GIS\Morven\Morven.mxd Originator: david.astbury

Key

- Landscape and Visual Study Area
- Scheduled Monument
- Category A Listed Building
- Category B Listed Building
- Category C Listed Building
- Conservation Area
- 1 to 25 turbines may be theoretically visible
- 26 to 50 turbines may be theoretically visible
- 51 to 75 turbines may be theoretically visible
- 76 to 101 turbines may be theoretically visible

0 1 2 3 4 Kilometers

Scale at A3: 1:80,263

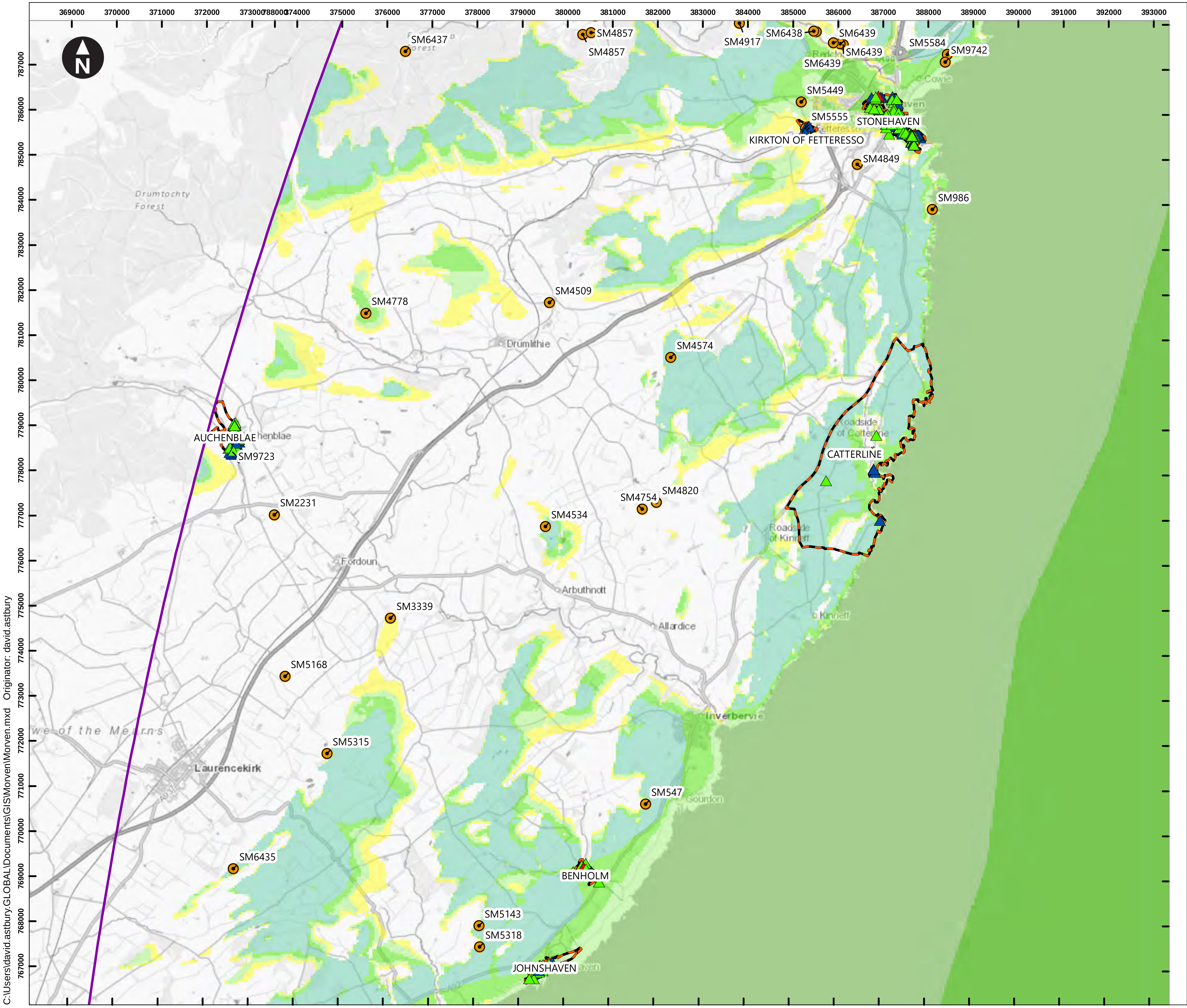
Client

Partners in UK offshore wind

Morven Offshore Wind Farm EIA
Scoping Report

Figure 12.4a
Designated Heritage Assets

March 2023



Key

- Landscape and Visual Study Area
- Scheduled Monument
- Category A Listed Building
- Category B Listed Building
- Category C Listed Building
- Conservation Area
- 1 to 25 turbines may be theoretically visible
- 26 to 50 turbines may be theoretically visible
- 51 to 75 turbines may be theoretically visible
- 76 to 101 turbines may be theoretically visible

0 1 2 3 4 Kilometers

Scale at A3: 1:80,263

Client

EnBW bp Partners in UK offshore wind

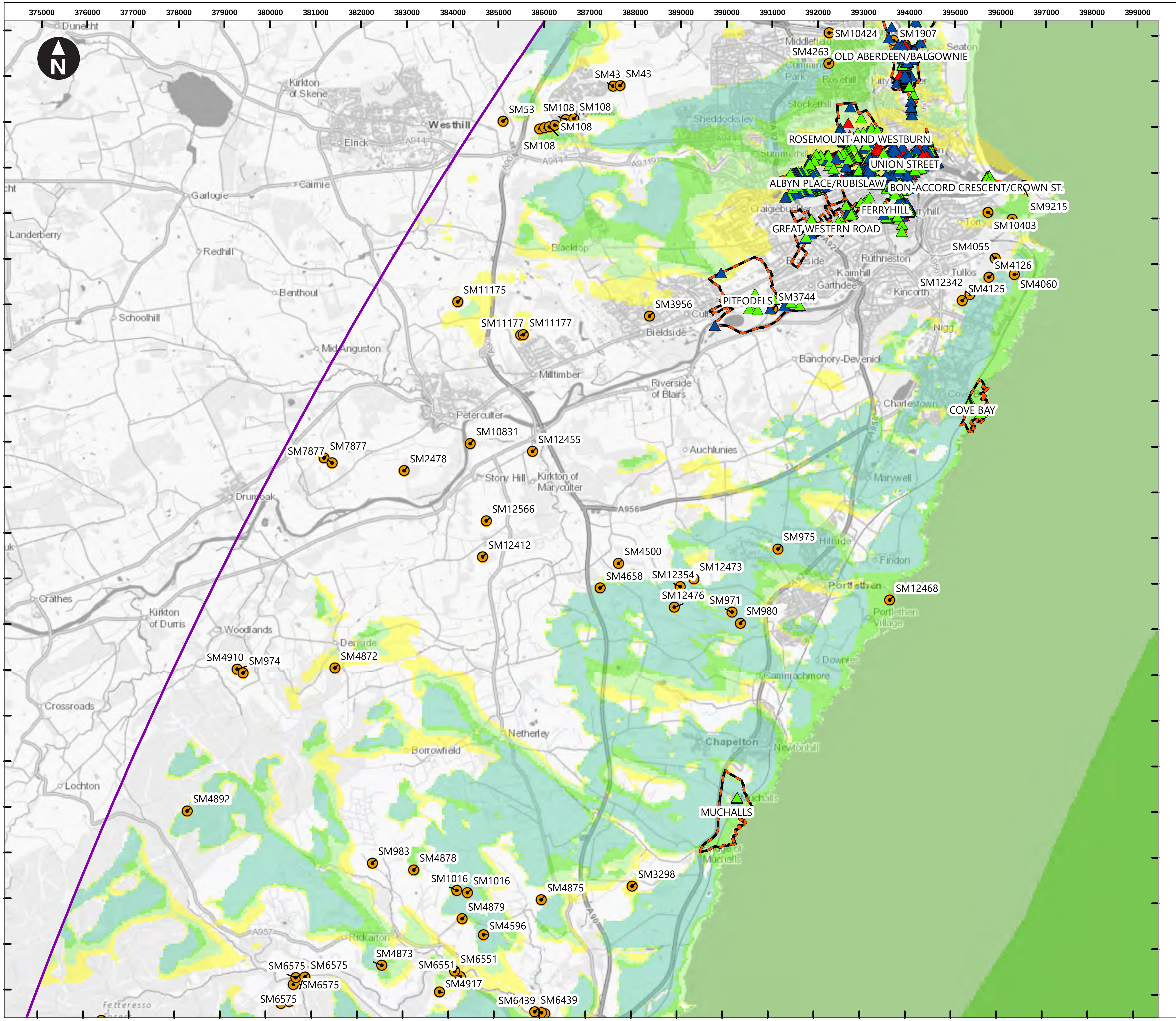
Morven Offshore Wind Farm EIA
Scoping Report

Figure 12.4b
Designated Heritage Assets

March 2023

wsp

C:\Users\david.astbury.GLOBAL\Documents\GIS\Morven\Morven.mxd Originator: david.astbury



Contains OS data © Crown Copyright and database right 2020 Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community

Client

EnBW bp Partners in UK offshore wind

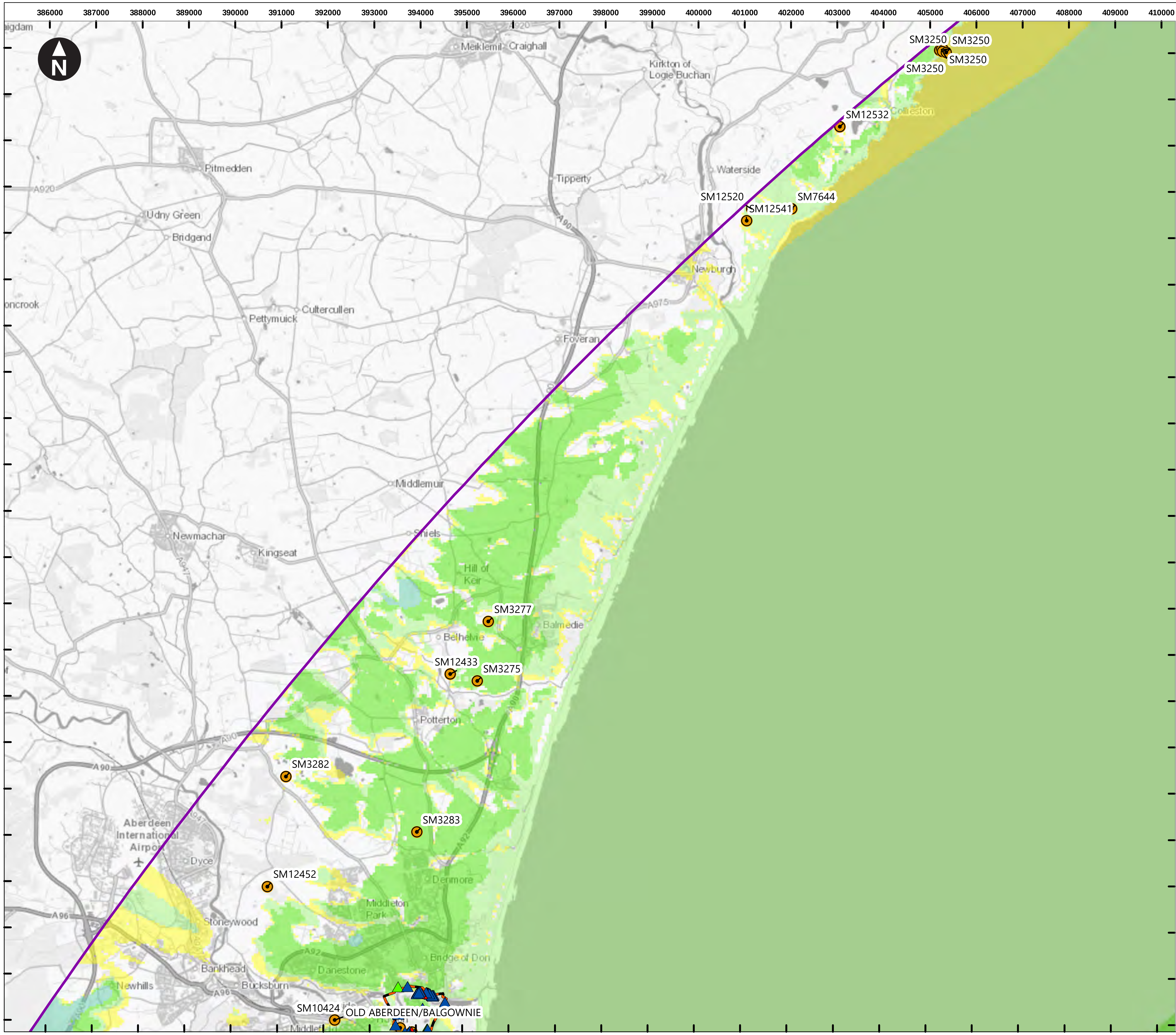
Morven Offshore Wind Farm EIA
Scoping Report

Figure 12.4c
Designated Heritage Assets

March 2023

wsp

C:\Users\david.astbury.GLOBAL\Documents\GIS\Morven\Morven.mxd Originator: david.astbury



C:\Users\david.astbury.GLOBAL\Documents\GIS\Morven\Morven.mxd Originator: david.astbury

Key

- Landscape and Visual Study Area
- Scheduled Monument
- Category A Listed Building
- Category B Listed Building
- Category C Listed Building
- Conservation Area
- 1 to 25 turbines may be theoretically visible
- 26 to 50 turbines may be theoretically visible
- 51 to 75 turbines may be theoretically visible
- 76 to 101 turbines may be theoretically visible

0 1 2 3 4 Kilometers

Scale at A3: 1:80,263

Client

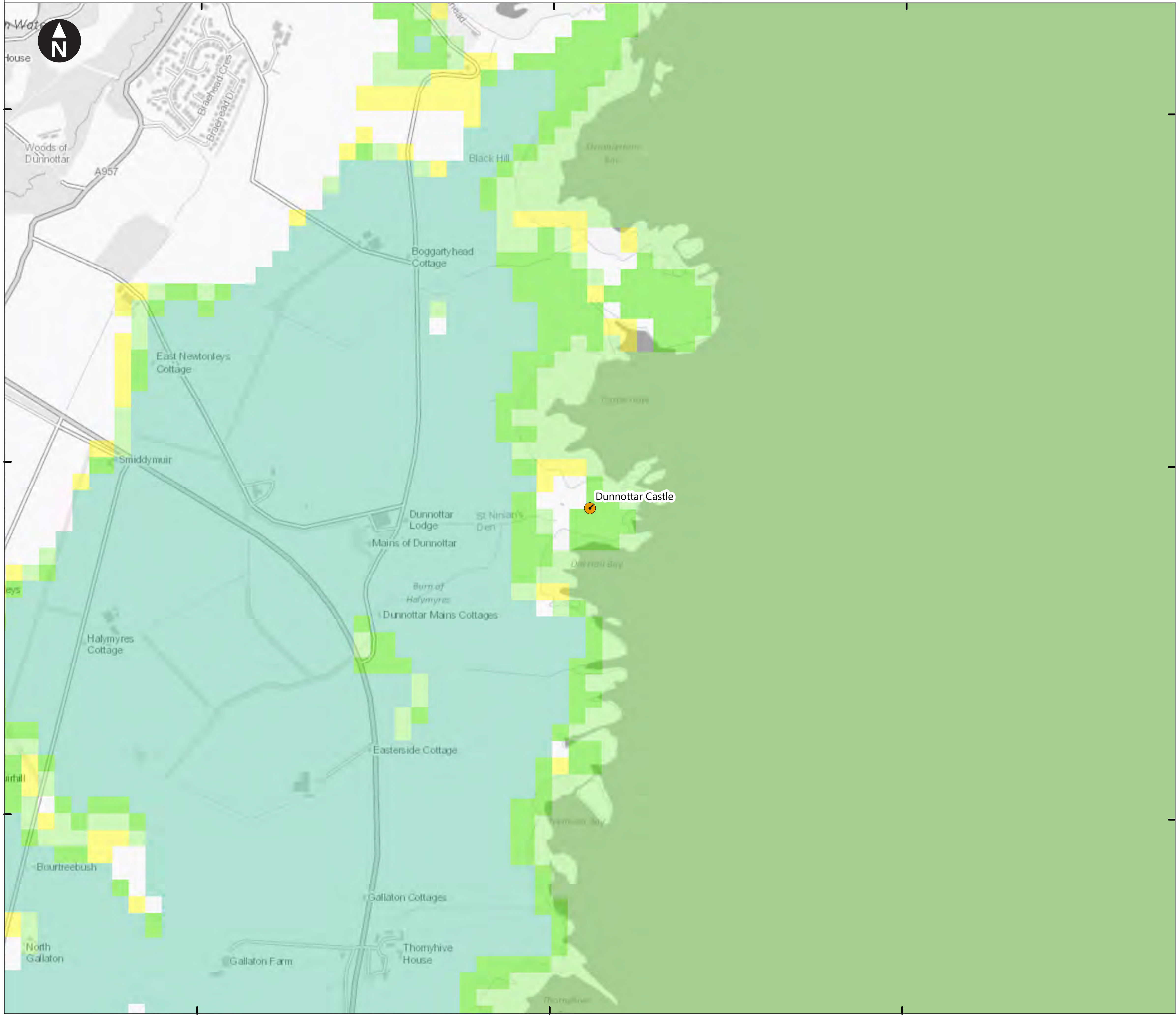
EnBW bp Partners in UK offshore wind

Morven Offshore Wind Farm EIA Scoping Report

Figure 12.4d
Designated Heritage Assets

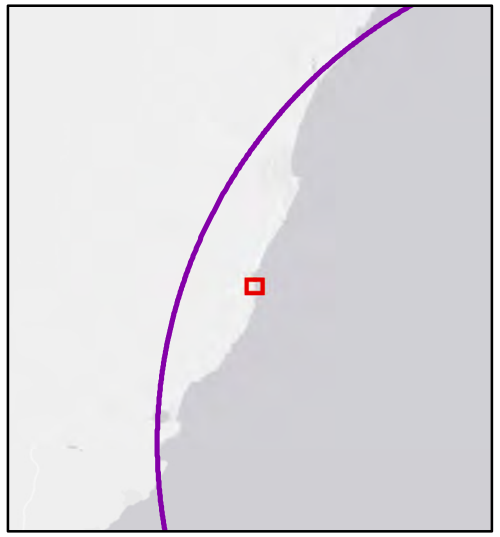
March 2023

wsp



Key

- Landscape and Visual Study Area
- Scheduled Monuments assessed
- Grade C Listed Building
- 1 to 25 turbines may be theoretically visible
- 26 to 50 turbines may be theoretically visible
- 51 to 75 turbines may be theoretically visible
- 76 to 101 turbines may be theoretically visible



0 0.1 0.2 0.3 0.4 Kilometers

Scale at A3: 1:10,546

Client

EnBW bp
Partners in UK offshore wind

Morven Offshore Wind Farm EIA
Scoping Report

Figure 12.5
Assessed Heritage Assets

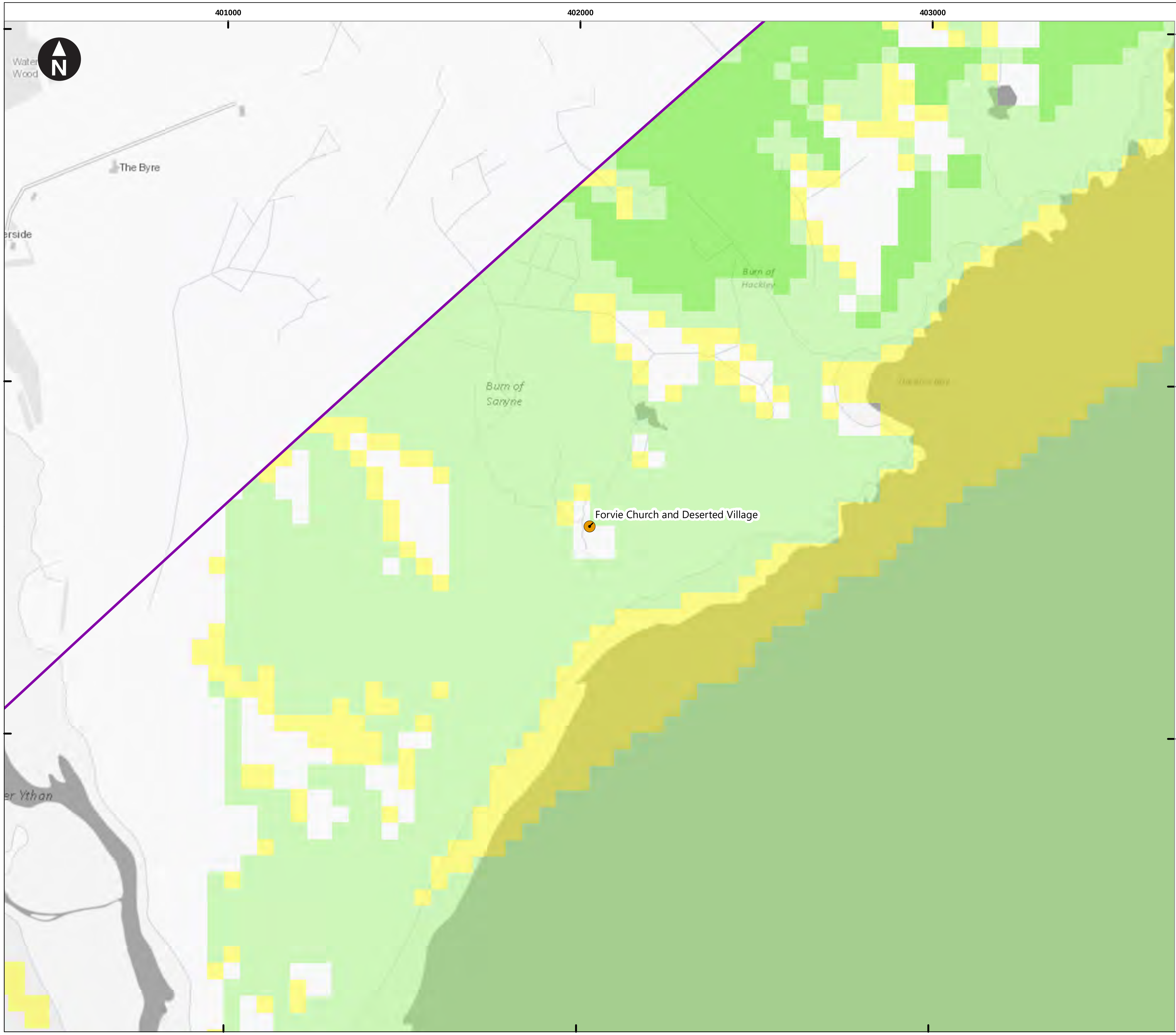
A

March 2023

wsp

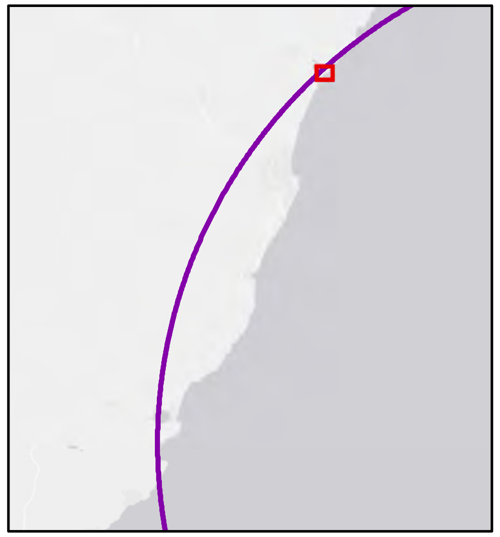
Morven_assessed

C:\Users\david.astbury.GLOBAL\Documents\GIS\Morven\Morven_assessed.mxd Originator: david.astbury



Key

- Landscape and Visual Study Area
- Scheduled Monuments assessed
- Grade C Listed Building
- 1 to 25 turbines may be theoretically visible
- 26 to 50 turbines may be theoretically visible
- 51 to 75 turbines may be theoretically visible
- 76 to 101 turbines may be theoretically visible



0 0.1 0.2 0.3 0.4 Kilometers

Scale at A3: 1:10,546

Client

EnBW bp Partners in UK offshore wind

Morven Offshore Wind Farm EIA
Scoping Report

Figure 12.5
Assessed Heritage Assets

B

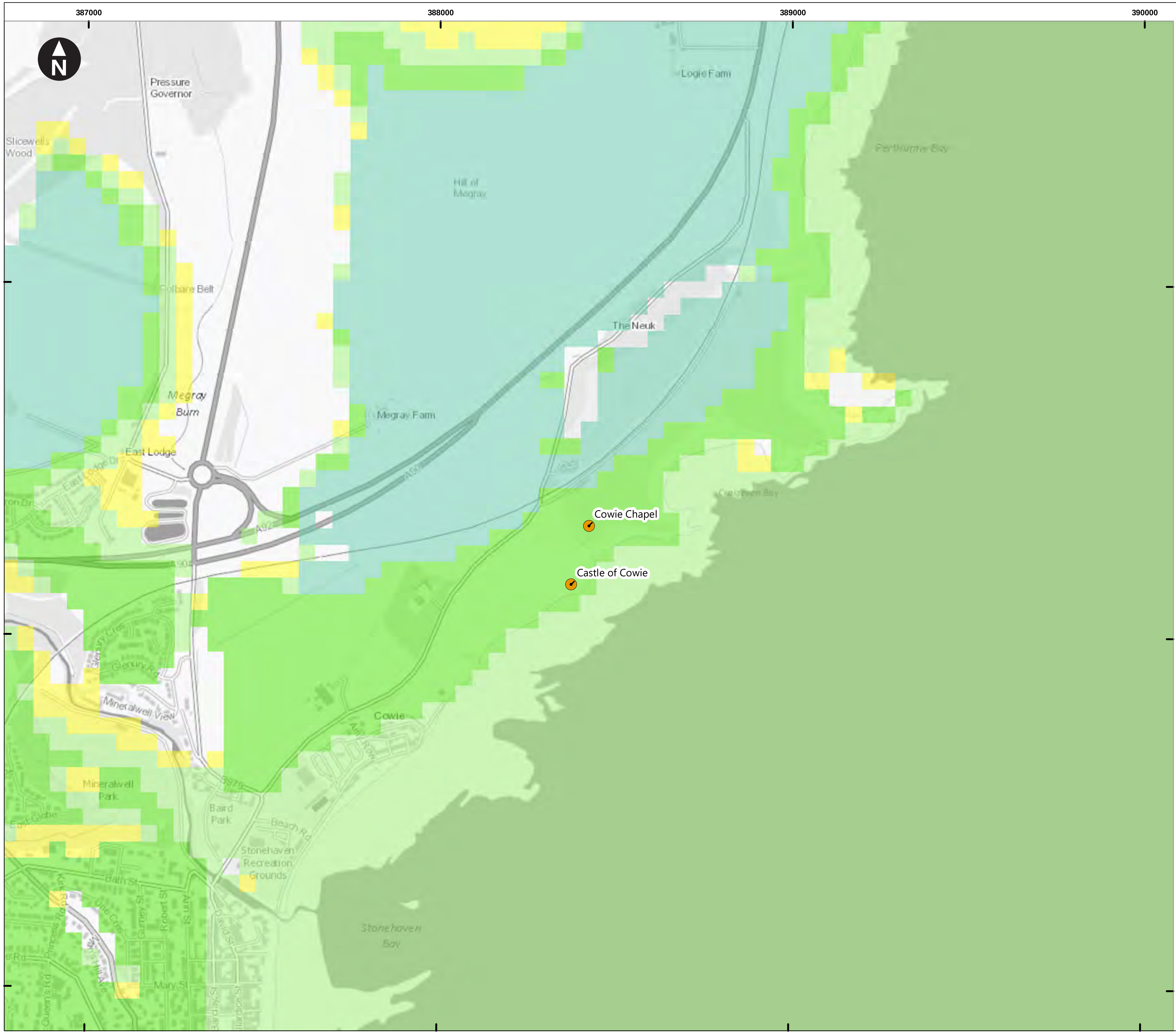
March 2023

wsp

Morven_assessed

C:\Users\david.astbury.GLOBAL\Documents\GIS\Morven\Morven_assessed.mxd Originator: david.astbury

C:\Users\david.astbury.GLOBAL\Documents\GIS\Morven\Morven_assessed.mxd Originator: david.astbury



Key

Landscape and Visual Study Area

Scheduled Monuments assessed

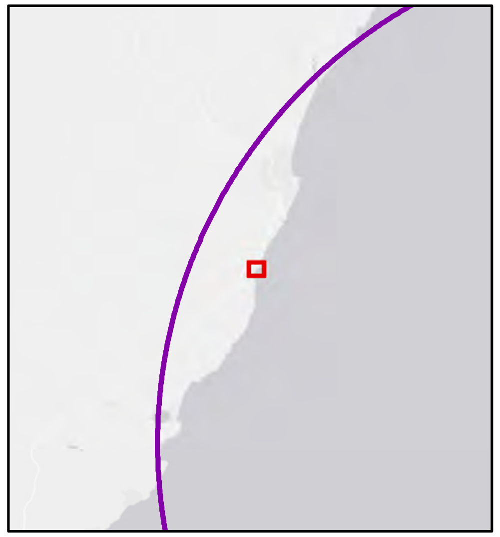
Grade C Listed Building

1 to 25 turbines may be theoretically visible

26 to 50 turbines may be theoretically visible

51 to 75 turbines may be theoretically visible

76 to 101 turbines may be theoretically visible



0 0.1 0.2 0.3 0.4 Kilometers

Scale at A3: 1:10,546

Client

Partners in UK offshore wind

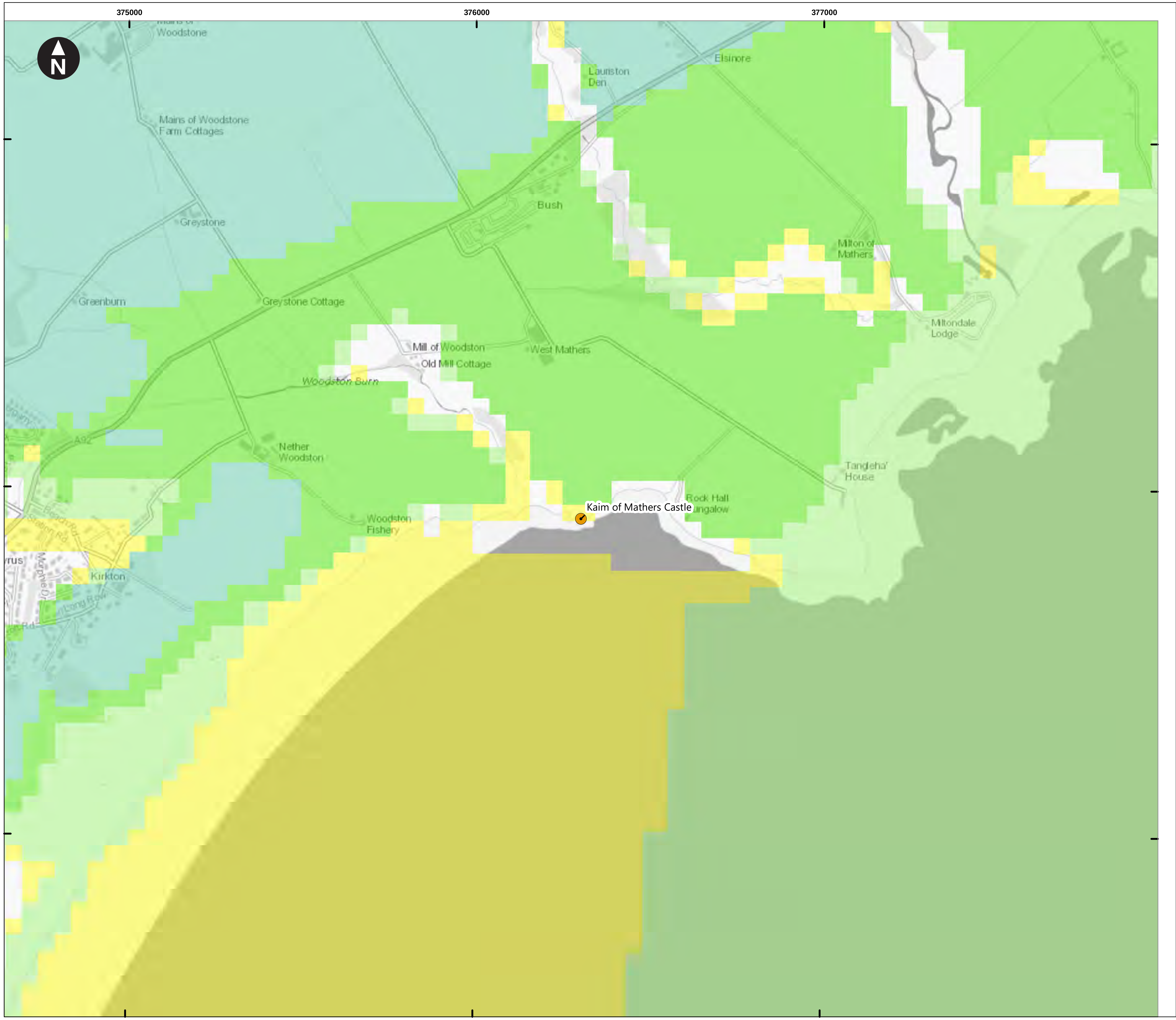
Morven Offshore Wind Farm EIA Scoping Report

Figure 12.5
Assessed Heritage Assets

C

March 2023

Morven_assessed



Key

Landscape and Visual Study Area

Scheduled Monuments assessed

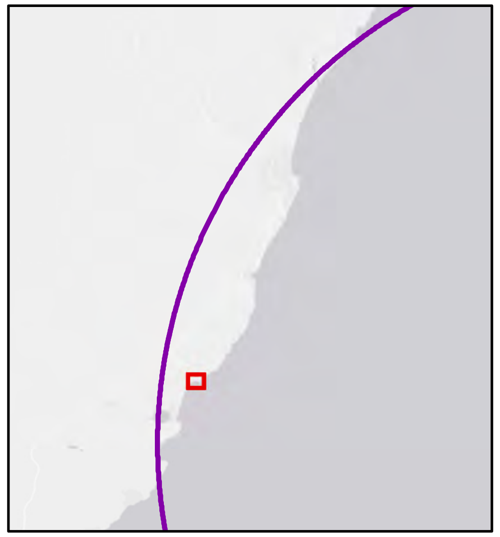
Grade C Listed Building

1 to 25 turbines may be theoretically visible

26 to 50 turbines may be theoretically visible

51 to 75 turbines may be theoretically visible

76 to 101 turbines may be theoretically visible



0 0.1 0.2 0.3 0.4 Kilometers

Scale at A3: 1:10,546

Client

EnBW bp
Partners in UK offshore wind

Morven Offshore Wind Farm EIA
Scoping Report

Figure 12.5
Assessed Heritage Assets

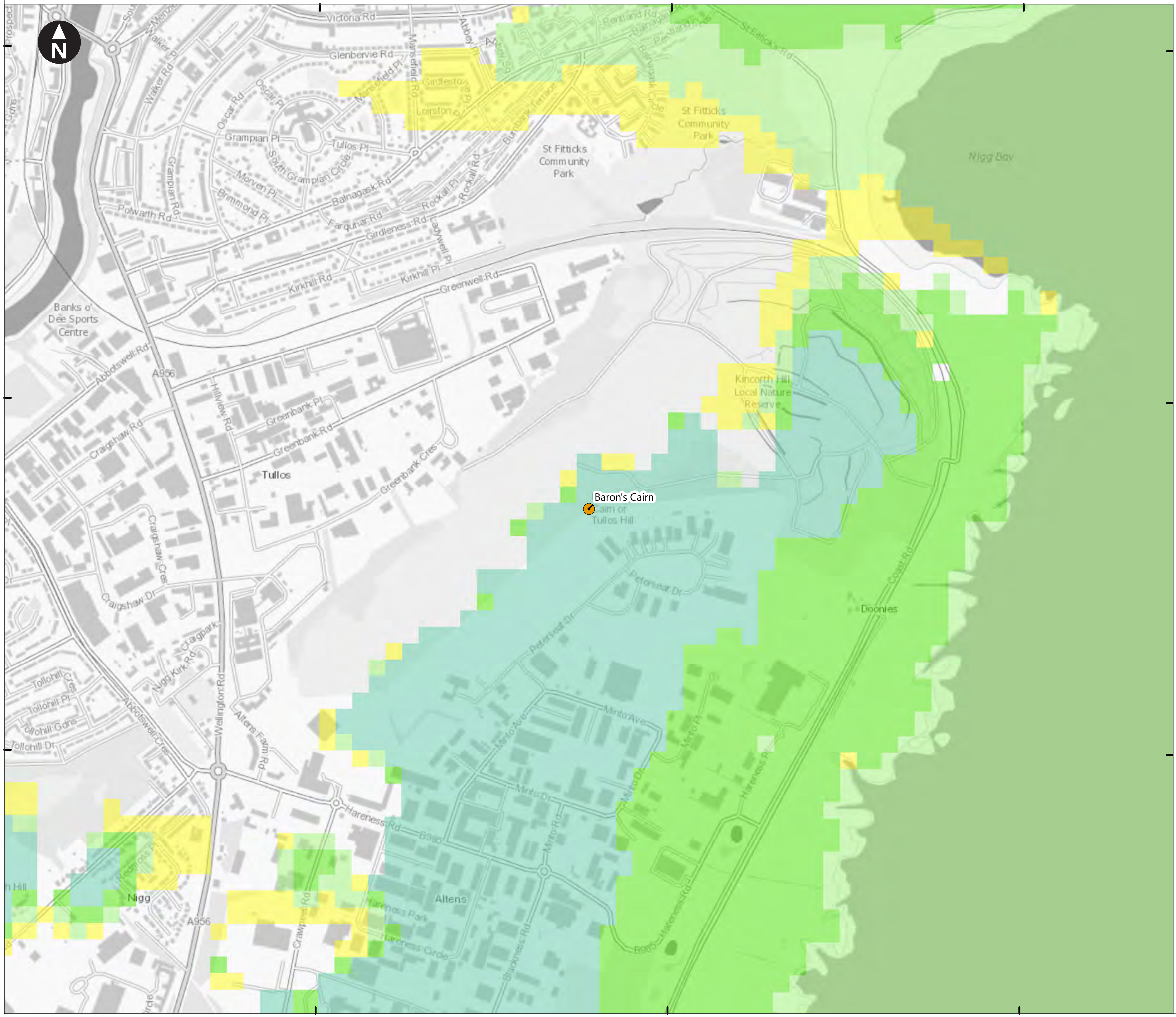
D

March 2023

wsp

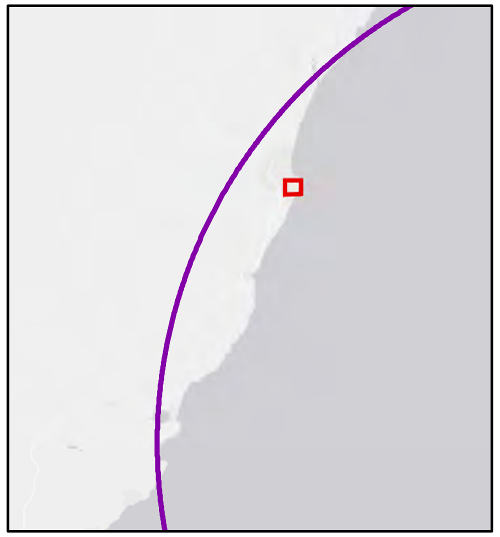
C:\Users\david.astbury.GLOBAL\Documents\GIS\Morven\Morven_assessed.mxd Originator: david.astbury

Morven_assessed



Key

- Landscape and Visual Study Area
- Scheduled Monuments assessed
- Grade C Listed Building
- 1 to 25 turbines may be theoretically visible
- 26 to 50 turbines may be theoretically visible
- 51 to 75 turbines may be theoretically visible
- 76 to 101 turbines may be theoretically visible



0 0.1 0.2 0.3 0.4 Kilometers

Scale at A3: 1:10,546

Client

EnBW bp Partners in UK offshore wind

Morven Offshore Wind Farm EIA
Scoping Report

Figure 12.5
Assessed Heritage Assets

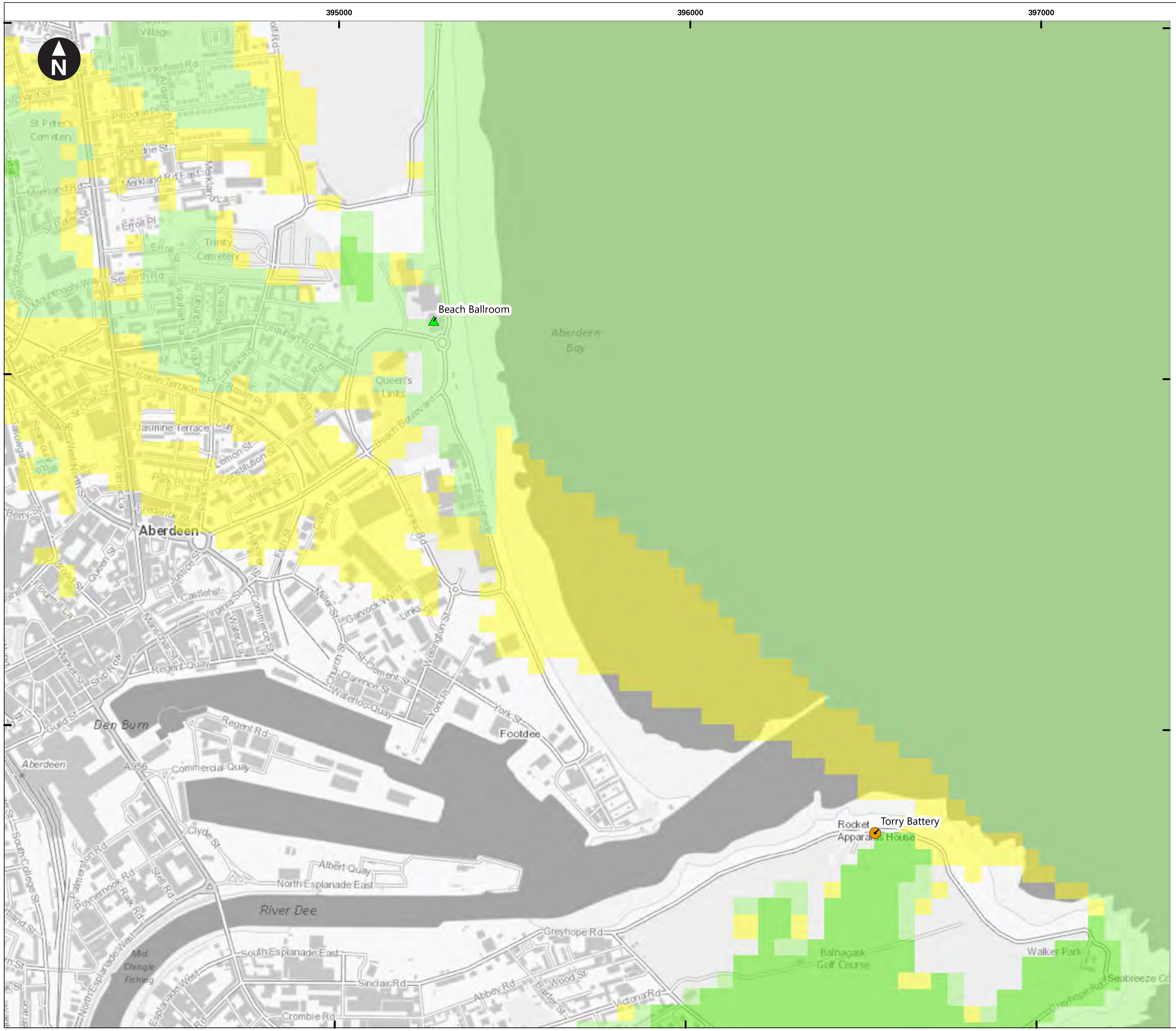
E

March 2023

wsp

C:\Users\david.astbury.GLOBAL\Documents\GIS\Morven\Morven_assessed.mxd Originator: david.astbury

Morven_assessed



Key

Landscape and Visual Study Area

Scheduled Monuments assessed

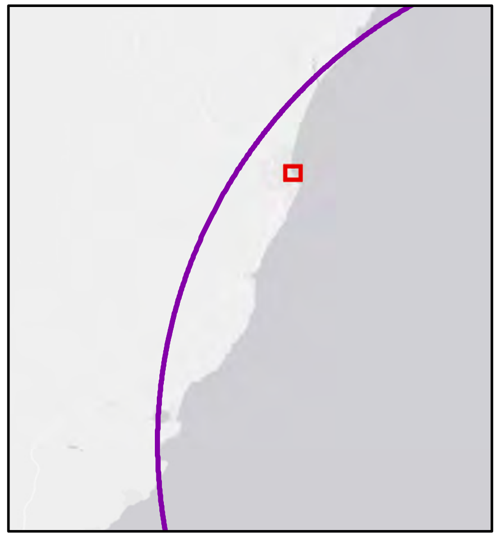
Grade C Listed Building

1 to 25 turbines may be theoretically visible

26 to 50 turbines may be theoretically visible

51 to 75 turbines may be theoretically visible

76 to 101 turbines may be theoretically visible



0 0.1 0.2 0.3 0.4 Kilometers

Scale at A3: 1:10,546

Client

EnBW bp

Partners in UK offshore wind

Morven Offshore Wind Farm EIA
Scoping Report

Figure 12.5
Assessed Heritage Assets

F

March 2023

wsp

C:\Users\david.astbury.GLOBAL\Documents\GIS\Morven\Morven_assessed.mxd Originator: david.astbury

Morven_assessed

13 Appendix 13 - Gazetteer of Marine Archaeology Identified within the Desktop Data

Table 13.1: Gazetteer of known marine archaeology within the Marine Archaeology Study Area

Data has been compiled from the United Kingdom Hydrographic Office (UKHO), Historic Environment Scotland (HES) and Historic Environment Records (HER) datasets as described in chapter 9.4: Marine Archaeology of the Scoping Report. Data is presented in WGS84 UTM30N.

ID	Name	Easting WGS84 30N	Northing WGS84 30N	Latitude WGS84 (DDM)	Longitude WGS84 (DDM)	Description
UKHO3630 HES322380	Unknown	609116.6796	6293115.15	56° 46.151' N	1° 12.882' W	Upright, collapsed, bow north, slight scour at stern. Recorded by HES as possible obstruction.
UKHO3606 HES322394/325117 NP84NE0001	Ailsa	646955.5117	6275877.71	56° 36.244' N	0° 36.359' W	Steamship. Captured by a German submarine and then scuttled 30 miles east northeast of Bell Rock.
UKHO3598 HES324312	Unknown	623226.0188	6296514.091	56° 47.771' N	0° 58.942' W	Extends 20m west from stern. Recorded by HES as possible obstruction.
UKHO3518 HES324310	Unknown	626006.3585	6278664.443	56° 38.111' N	0° 56.738' W	Small, upright wreck. Scour extends 10m all around. Recorded by HES as possible obstruction.
UKHO3476 HES324516	Unknown	613720.2823	6302854.584	56° 51.332' N	1° 08.105' W	Upright, intact, bows east northeast. Recorded by HES as possible obstruction.
UKHO3107 HES322378	Unknown	623735.1249	6289935.391	56° 44.219' N	0° 58.633' W	Small, degraded wreck in area of east to west sandwaves. Recorded by HES as possible obstruction.

14 Appendix 14 - Gazetteer of Recorded Losses Identified within the Desktop Data

Table 14.1: Gazetteer of recorded losses within the Marine Archaeology Study Area

Data has been compiled from the Historic Environment Scotland (HES) and Historic Environment Records HER datasets as described in of chapter 9.4: Marine Archaeology of the Scoping Report. Data is presented in WGS84 UTM30N.

ID	Name	Easting WGS84 30N	Northing WGS84 30N	Description	Archaeological period
HES200463 NP56NW0001	Bosphorus	611993.0519	6294704.27	The iron paddle steam trawler Bosphorus, under Captain Ballard, in ballast, foundered approximately 37 miles southeast of Girdle Ness on the 5 May 1904.	Modern
HES248583 NP73SE0001	Competitor	638459.66	6263083.647	On the 28 November 1852, the schooner Competitor, of Leith, with a crew of five men under Captain Cairns, carrying a cargo of wheat from Hamburg for Aberdeen, was abandoned about 70 miles east of Montrose in a sinking state. The crew were picked up by a gall.	19th Century
HES322393/314103	Titan	632019.3284	6262387.708	20th century steam trawler.	Modern
HES322397	Valiant	624780.0819	6270813.067	Motor fishing vessel.	Modern
HES324917	Unknown 1920	622182.6647	6281850.487	Craft (possible).	Modern
HES327606	Unknown 1921	648343.405	6271229.575	Craft (possible).	Modern

15 References

15.1 Appendix 1: Transboundary Screening

Furness, R.W. (2015). Non-breeding season populations of seabirds in UK waters: Population sizes for Biologically Defined Minimum Population Scales (BDMPS). Natural England Commissioned Report No 164. Scottish Government, 2018

Scottish Government (2018). The Marine Scotland Consenting and Licensing Guidance for Offshore Wind, Wave and Tidal Energy Applications.

Woodward, I., Thaxter, C.B., Owen, E. and Cook, A.S.C.P. (2019). Desk-based revision of seabird foraging ranges used for HRA screening. Report of work carried out by the British Trust for Ornithology on behalf of NIRAS and The Crown Estate. BTO Research Report No. 724.

Wright, L.J., Ross-Smith, V.H., Massimino, D., Dadam, D., Cook, A.S.C.P. and Burton, N.H.K. (2012). Assessing the risk of offshore windfarm development to migratory birds designated as features of UK Special Protection Areas (and other Annex I species). Strategic Ornithological Support Services. Project SOSS-05. BTO Research Report No. 592.

WWT Consulting and MacArthur Green (2014). Strategic assessment of collision risk of Scottish offshore wind farms to migrating birds. [Online]. Available at: https://www.gov.scot/publications/scottish-marine-freshwater-science-volume-5-number-12-strategic-assessment/ (Accessed March 2023).

15.2 Appendix 2: Designed in Measures and Mitigation Log

No references in this appendix.

15.3 Appendix 3: Summary of Scoping Workshop Consultation

ABPmer (2022). Spatial Squeeze in Fisheries, Final Report, ABPmer Report No. R.3900. A report produced by ABPmer for NFFO & SFF, June 2022.

Blyth-Skyrme, R.E. (2010). Options and opportunities for marine fisheries mitigation associated with windfarms. Final report for Collaborative Offshore Wind Research into the Environment contract FISHMITIG09. COWRIE Ltd, London

CIEEM (2018, Updated 2022). Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine. Chartered Institute of Ecology and Environmental Management, Winchester.

FLOWW (Fishing Liaison with Offshore Wind and Wet Renewables Group) (2014). FLOWW Best Practice Guidance for Offshore Renewables Developments: Recommendations for Fisheries Liaison.

FLOWW (Fishing Liaison with Offshore Wind and Wet Renewables Group) (2015). FLOWW Best Practice Guidance for Offshore Renewables Developments: Recommendations for Fisheries Disruption Settlements and Community Funds.

Glasson et al. (2018). Guidance on assessing the socio-economic impacts of Offshore Wind Farms. [Online]. Available at: best-practice-guidance---final-oct-2020.pdf (vattenfall.com) (Accessed May 2023)

Graham, I. M., Merchant, N. D., Farcas, A., Barton, T. R., Cheney, B., Bono, S., & Thompson, P. M. (2019). Harbour porpoise responses to pile-driving diminish over time. Royal Society Open Science, 6(6), 190335.

International Cable Protection Committee. (2009). Fishing and Submarine Cables Working Together. Stephen C. Drew & Alan G. Hopper, February, 2023.

JNCC, NRW, DAERA, NIEA, NE and SNH. (2022). Joint SNCB Interim Displacement Advice Note. [Online]. Available at: https://data.jncc.gov.uk/data/9aecb87c-80c5-4cfb-9102-39f0228dcc9a/joint-sncb-interim-displacement-advice-note-2022.pdf (Accessed May 2023).

NatureScot (2020). Seasonal Periods for Birds in the Scottish Marine Environment. Short Guidance Note

Popper, A.N., Hawkins, A.D., Fay, R.R., Mann, D.A., Bartol, S., Carlson, T.J., Coombs, S., Ellison, W.T., Gentry, R.L., Halvorsen, M.B., Løkkeborg, S., Rogers, P.H., Southall, B.L., Zeddies, D.G. and Tavolga, W.N. (2014). ASA S3/SC1.4 TR-2014 Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards committee S3/SC1 and registered with ANSI. American National Standards Institute. Springer, Cham. pp.33-51. Version 2. October 2020.

Scottish Government (2022a). Defining 'Local Area' for assessing the impact of offshore renewable and other marine developments. [Online]. Available at: Marine Scotland: Defining 'Local Area' for assessing impact of offshore renewables and other marine developments - Guidance Principles (www.gov.scot) (Accessed May 2023).

Scottish Government (2022b), General Advice for Socio-Economic Impact Assessment Marine Analytical Unit, Marine Scotland. [Online] Available at: Highly Protected Marine Areas: Socio-Economic Impact Assessment - Methodology Report (www.gov.scot) (Accessed May 2023).

Searle, K., Mobbs, D., Daunt, F. Butler, A. (2019). A Population Viability Analysis Modelling Tool for Seabird Species. [Online]. Available at: http://publications.naturalengland.org.uk/publication/4926995073073152 (Accessed May 2023).

Southall, B., Finneran, J. J., Reichmuth, C., Nachtigall, P. E., Ketten, D. R., Bowles, A. E., Ellison, W. T., Nowacek, D., and Tyack, P. (2019) Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. Aquatic Mammals 45:125-232.

UKFEN. (2012). Best practice guidance for fishing industry financial and economic impact assessments.

UK Government. (2022), The Green Book: Appraisal and Evaluation in Central Government. [Online] Available at: https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-governent/the-green-book-2020 (Accessed May 2023).

UK Government. (2020). UK Offshore Wind Sector Deal. Available at: https://www.gov.uk/government/publications/offshore-wind-sector-deal/offshore-wind-sector-deal (Accessed May 2023)

Wade, H.M., Masden, E.A., Jackson, A.C. and Furness, R.W. (2016). Incorporating data uncertainty when estimating potential vulnerability of Scottish seabirds to marine renewable energy developments. *Marine Policy*, *70*, pp.108-113.

Whyte, K. F., D. J. F. Russell, C. E. Sparling, B. Binnerts and G. D. Hastie. (2020). Estimating the effects of pile driving sounds on seals: Pitfalls and possibilities. *The Journal of the Acoustical Society of America.* 147(6): 3948.

Xodus Group. (2022). Good Practice Guidance for assessing fisheries displacement by other licensed marine activities: Literature Review. Report for Scottish Government.

15.4 Appendix 4: Draft Stakeholder Engagement Plan

No references in this appendix.

15.5 Appendix 5: Underwater Sound Methodology Statement

[NMFS] National Marine Fisheries Service (US). (2018). 2018 Revision to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. US Department of Commerce, NOAA. NOAA Technical

Memorandum NMFS-OPR-59. 167 p. Available at: https://media.fisheries.noaa.gov/dam-migration/tech_memo_acoustic_guidance_(20)_(pdf)_508.pdf.

[NOAA] National Oceanic and Atmospheric Administration (US). (2019). ESA Section 7 Consultation Tools for Marine Mammals on the West Coast (webpage), 27 Sep 2019. Available at: (https://www.fisheries.noaa.gov/west-coast/endangered-species-conservation/esa-section-7-consultation-tools-marine-mammals-west.

Bailey, H., B. Senior, D. Simmons, J. Rusin, G. Picken, and Thompson, P.M. (2010). Assessing underwater noise levels during pile-driving at an offshore windfarm and its potential effects on marine mammals. Marine Pollution Bulletin 60(6): 888-897. https://doi.org/10.1016/j.marpolbul.2010.01.003.

Bellmann, M.A., May, A., Wendt, T., Gerlach, S., Remmers, P., and Brinkmann, J. (2020). Underwater noise during percussive pile driving: Influencing factors on pile-driving noise and technical possibilities to comply with noise mitigation values. Supported by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit (BMU)), FKZ UM16 881500. Commissioned and managed by the Federal Maritime and Hydrographic Agency (Bundesamt für Seeschifffahrt und Hydrographie (BSH)), Order No. 10036866. Edited by the itap GmbH. https://www.itap.de/media/experience_report_underwater_era-report.pdf.

Boisseau, O., T. McGarry, S. Stephenson, R. Compton, A.-C. Cucknell, C. Ryan, R. McLanaghan, and A. Moscrop. (2021). Minke whales Balaenoptera acutorostrata avoid a 15 kHz acoustic deterrent device (ADD). Marine Ecology Progress Series 667: 191-206.

Buckingham, M.J. (2005). Compressional and shear wave properties of marine sediments: Comparisons between theory and data. Journal of the Acoustical Society of America 117: 137-152. https://doi.org/10.1121/1.1810231.

Carnes, M.R. (2009). Description and Evaluation of GDEM-V 3.0. US Naval Research Laboratory, Stennis Space Center, MS. NRL Memorandum Report 7330-09-9165. 21 p. Available at: https://apps.dtic.mil/dtic/tr/fulltext/u2/a494306.pdf.

Cheong, S.-H., L. Wang, P. Lepper, and S. Robinson. (2020). Characterisation of Acoustic Fields Generated by UXO Removal Phase 2 (BEIS Offshore Energy SEA Sub-Contract OESEA-19-107). Document Number NPL Report AC 19. NPL.

Collins, M.D. (1993). A split-step Padé solution for the parabolic equation method. Journal of the Acoustical Society of America 93(4): 1736-1742. Available at: https://doi.org/10.1121/1.406739.

Ellison, W.T. and A.S. Frankel. (2012). A common sense approach to source metrics. In Popper, A.N. and A.D. Hawkins (eds.). The Effects of Noise on Aquatic Life. Volume 730. Springer, New York. pp. 433-438. Available at: https://doi.org/10.1007/978-1-4419-7311-5_98.

EMODnet Bathymetry Consortium. (2020). EMODnet Digital Bathymetry (DTM) (webpage). EMODnet Bathymetry Consortium. Available at: https://doi.org/10.12770/18ff0d48-b203-4a65-94a9-5fd8b0ec35f6.

Finneran, J.J. and A.K. Jenkins. (2012). Criteria and thresholds for U.S. Navy acoustic and explosive effects analysis. SPAWAR Systems Center Pacific, San Diego, CA, USA. 64 p.

Fisher, F.H. and V.P. Simmons. (1977). Sound absorption in sea water. Journal of the Acoustical Society of America 62(3): 558-564. Available at: https://doi.org/10.1121/1.381574.

Hamilton, E.L. (1980). Geoacoustic modeling of the sea floor. Journal of the Acoustical Society of America 68(5): 1313-1340. Available at: https://doi.org/10.1121/1.385100.

Harris, C.M. (1998). Handbook of Acoustical Measurements and Noise Control. American Institute of Physics. Available at: https://books.google.co.uk/books?id=BLa0tAEACAAJ.

Holzer, T.L., M.J. Bennett, T.E. Noce, and J.C. Tinsley. (2005). Shear-Wave Velocity of Surficial Geologic Sediments in Northern California: Statistical Distributions and Depth Dependence. Earthquake Spectra 21(1): 161-177. Available at: https://doi.org/10.1193/1.1852561.

Martin, S.B., K. Lucke, and D.R. Barclay. (2020). Techniques for distinguishing between impulsive and non-impulsive sound in the context of regulating sound exposure for marine mammals. Journal of the Acoustical Society of America 147(4): 2159-2176. Available at: https://doi.org/10.1121/10.0000971.

Otani, S., Y. Naito, A. Kato, and A. Kawamura. (2000). Diving behavior and swimming speed of a free-ranging harbor porpoise, Phocoena phocoena [Note]. Marine Mammal Science 16(4): 811-814. Available at: https://doi.org/10.1111/j.1748-7692.2000.tb00973.x.

Pile Dynamics, Inc. (2010). GRLWEAP. Available at:https://www.pile.com/.

Popper, A.N., A.D. Hawkins, R.R. Fay, D.A. Mann, S. Bartol, T.J. Carlson, S. Coombs, W.T. Ellison, R.L. Gentry, *et al*. (2014). Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. ASA S3/SC1.4 TR-2014. SpringerBriefs in Oceanography. ASA Press and Springer. Available at: https://doi.org/10.1007/978-3-319-06659-2.

Porter, M.B. and Y.C. Liu. (1994). Finite-element ray tracing. In: Lee, D. and M.H. Schultz (eds.). International Conference on Theoretical and Computational Acoustics. Volume 2. World Scientific Publishing Co. pp. 947-956.

Ross, D. (1976). Mechanics of Underwater Noise. Pergamon Press, NY, USA.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene, Jr., D. Kastak, D.R. Ketten, J.H. Miller, *et al*. (2007). Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. Aquatic Mammals 33(4): 411-521. Available at: https://doi.org/10.1578/AM.33.4.2007.411.

Southall, B.L., D.P. Nowaceck, P.J.O. Miller, and P.L. Tyack. (2016). Experimental field studies to measure behavioral responses of cetaceans to sonar. Endangered Species Research 31: 293-315. Available at: https://doi.org/10.3354/esr00764.

Southall, B.L., J.J. Finneran, C.J. Reichmuth, P.E. Nachtigall, D.R. Ketten, A.E. Bowles, W.T. Ellison, D.P. Nowacek, and P.L. Tyack. (2019). Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. Aquatic Mammals 45(2): 125-232. Available at: https://doi.org/10.1578/AM.45.2.2019.125.

Southall, B.L., D.P. Nowacek, A.E. Bowles, V. Senigaglia, L. Bejder, and P.L. Tyack. (2021). Marine Mammal Noise Exposure Criteria: Assessing the Severity of Marine Mammal Behavioral Responses to Human Noise. Aquatic Mammals 47(5): 421-464. Available at: https://doi.org/10.1578/AM.47.5.2021.421.

Teague, W.J., M.J. Carron, and P.J. Hogan. (1990). A comparison between the Generalized Digital Environmental Model and Levitus climatologies. Journal of Geophysical Research 95(C5): 7167-7183. https://doi.org/10.1029/JC095iC05p07167.

Thompson, D., A. Brownlow, J. Onoufriou, and S. Moss. (2015). Collision risk and impact study: field tests of turbine blade-seal carcass collisions. Report to Scottish Government MR 7(3): 1-16.

15.6 Appendix 6: Marine Protected Area Screening

British Waterfowl Association (2022). Common Eider (Somateria mollissima), Available at: https://www.waterfowl.org.uk/wildfowl/true-ducks/common-eider/#:~:text=Like%20many%20sea%20ducks%2C%20eiders,sometimes%20a%20little%20further%20inland, (Accessed March 2023).

JNCC (2018). Supplementary Advice on Conservation Objectives for Firth of Forth Banks Complex Nature Conservation MPA, Available at: https://data.jncc.gov.uk/data/92fb7e5e-5e68-4e66-bde3-afd9c27d6b14/FFBC-3-SACO-v1.0.pdf. (Accessed on: 20 March 2023).

JNCC. (2020). Statements on Conservation Benefits, Condition & Conservation Measures for Firth of Forth Banks Complex Nature Conservation MPA, Available at: https://data.jncc.gov.uk/data/92fb7e5e-5e68-4e66-bde3-afd9c27d6b14/FFBC-4-ConservationStatements-v1.0.pdf (Accessed March 2023).

Marine Scotland. (2013). Nature Conservation Marine Protected Areas: Draft Management Handbook.

Milne, H. (1965). Seasonal movements and distribution of Eiders in Northeast Scotland, Bird Study, 12:3, 170-180

RSPB. (2022). Eider Duck Facts, Available at: https://www.rspb.org.uk/birds-and-wildlife/wildlife-guides/bird-a-z/eider/. (Accessed March 2023).

15.7 Appendix 7: Marine Mammals Methodology Statement

Anderwald, P. (2009). Population genetics and behavioural ecology of North Atlantic minke whales (*Balaenoptera acutorostrata*), Durham University.

Arso Civil, M., Quick, N., Mews, S., Hague, E., Cheney, B.J., Thompson, P.M. and Hammond, P.S. (2021). Improving understanding of bottlenose dolphin movements along the east coast of Scotland. Final report. Report number SMRUC-VAT-2020-10 provided to European Offshore Wind Deployment Centre (EOWDC), March 2021 (unpublished).

Bailey, Helen, Bridget Senior, Dave Simmons, Jan Rusin, Gordon Picken, and Paul M. Thompson. (2010). 'Assessing Underwater Noise Levels during Pile-Driving at an Offshore Windfarm and Its Potential Effects on Marine Mammals'. Marine Pollution Bulletin 60 (6): 888–97.

Boisseau, Oliver, Tessa McGarry, Simon Stephenson, Ross Compton, Anna-Christina Cucknell, Conor Ryan, Richard McLanaghan, and Anna Moscrop. (2021). 'Minke Whales Balaenoptera Acutorostrata Avoid a 15 KHz Acoustic Deterrent Device (ADD)'. Marine Ecology Progress Series 667: 191–206.

Booth, C.G, Heinis, F. and Harwood J. (2019). Updating the Interim PCoD Model: Workshop Report - New transfer functions for the effects of disturbance on vital rates in marine mammal species. Report Code SMRUC-BEI-2018-011, submitted to the Department for Business, Energy and Industrial Strategy (BEIS), February 2019 (unpublished).

Booth, C.G. and Heinis, F. (2018). Updating the Interim PCoD Model: Workshop Report - New transfer functions for the effects of permanent threshold shifts on vital rates in marine mammal species. Report Code SMRUC-UOA-2018-006, submitted to the University of Aberdeen and Department for Business, Energy and Industrial Strategy (BEIS), June 2018 (unpublished).

Brandt, M. J., A. Diederichs, K. Betke and G. Nehls (2011). Responses of harbour porpoises to pile driving at the Horns Rev II offshore wind farm in the Danish North Sea. Marine Ecology Progress Series 421: 205-216.

Cheney, B., P. M. Thompson, S. N. Ingram, P. S. Hammond, P. T. Stevick, J. W. Durban, R. M. Culloch, S. H. Elwen, L. Mandleberg, V. M. Janik, N. J. Quick, V. Islas-Villanueva, K. P. Robinson, M. Costa, S. M. Eisfeld, A. Walters, C. Phillips, C. R. Weir, P. G. Evans, P. Anderwald, R. J. Reid, J. B. Reid, and B. Wilson. (2013). Integrating multiple data sources to assess the distribution and abundance of bottlenose dolphins Tursiops truncatus in Scottish waters. Mammal Review 43:71-88.

Díaz-López, B. and J. A. B. Shirai. (2009). "Mediterranean common bottlenose dolphins' repertoire and communication use." Dolphins: Anatomy, behavior, and threats: 129-148.

Graham, I. M., Merchant, N. D., Farcas, A., Barton, T. R., Cheney, B., Bono, S., and Thompson, P. M. (2019). Harbour porpoise responses to pile-driving diminish over time. Royal Society Open Science, 6(6), 190335.

Gunnlaugsson, T. (1989). Report on Icelandic minke whale surfacing rate experiments in 1987., Rep. int. Whal. Commn. 435-436.

Harwood, J., King, S., Schick, R., Donovan, C. and Booth, C. (2014). A protocol for implementing the interim population consequences of disturbance (PCoD) approach: quantifying and assessing the effects of UK offshore renewable energy developments on marine mammal populations. Report number SMRUL-TCE-2013-014. Scottish Marine and Freshwater Science, 5(2).

Heinänen, S. and Skov, H. (2015). The identification of discrete and persistent areas of relatively high harbour porpoise density in the wider UK marine area. Joint Nature Conservation Committee.

IAMMWG. (2022). Updated abundance estimates for cetacean Management Units in UK waters. JNCC Report No. 680 (Revised March 2022), JNCC Peterborough, ISSN 0963- 8091.

JNCC (2010a). Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise. August 2010. Available: Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise (jncc.gov.uk). (Accessed March 2022).

JNCC (2010b). JNCC guidelines for minimising the risk of injury to marine mammals from using explosives. Joint Nature Conservation Committee, Aberdeen, UK.

Judd, A. (2012). Guidelines for data acquisition to support marine environmental assessments of offshore renewable energy projects. Center for Environment, Fisheries, and Aquaculture Science. Available at: http://www. marinemanagement. org. uk/licensing/groups/documents/orelg/e5403. pdf.

Lockyer, C. and R. J. Morris. (1986). "The history and behaviour of a wild, sociable bottlenose dolphin (Tursiops truncatus) off the north coast of Cornwall." Aquatic Mammals 12(1): 3-16.

Lockyer, C. and R. Morris. (1987). "Observations on diving behaviour and swimming speeds in a wild juvenile." Tursiops truncatus. aquat mamm 13(1): 31-35.

Lohrengel, K., Evans, P. G. H., Lindenbaum, C. P., Morris, C. W., and Stringell, T. B. (2018). Bottlenose Dolphin Monitoring in Cardigan Bay 2014- 2016, NRW Evidence Report No: 191. Available: www.naturalresourceswales.gov.uk. (Accessed October 2022).

Louis, M., A. Viricel, T. Lucas, H. Peltier, E. Alfonsi, S. Berrow, A. Brownlow, P. Covelo, W. Dabin and R. Deaville (2014). "Habitat-driven population structure of bottlenose dolphins, *Tursiops truncatus*, in the N orth-E ast A tlantic." Molecular Ecology 23(4): 857-874.

Mannocci L., J.J. Roberts, and P.N. Halpin. (2018). Development of Exploratory Marine Species Density Models in the Mediterranean Sea. Final Report. Report prepared for Naval Facilities Engineering Command, Atlantic under Contract No. N62470-15-D-8006, Task Order TO37, by the Duke University Marine Geospatial Ecology Lab, Durham, North Carolina. March 2018.

Mate, B. R., K. A. Rossbach, S. L. Nieukirk, R. S. Wells, A. Blair Irvine, M. D. Scott and A. J. Read. (1995). Satellite-monitored movements and dive behavior of a bottlenose dolphin (*Tursiops truncatus*) in Tampa Bay, Florida. Marine Mammal Science 11(4): 452-463.

McGarry, T., Boisseau, O., Stephenson, S., and Compton, R. (2017). Understanding the Effectiveness of Acoustic Deterrent Devices (ADDs) on Minke Whale (*Balaenoptera acutorostrata*), a Low-Frequency Cetacean. Chepstow: The Carbon Trust.

National Marine Plan Inspectorate (NMPi) (2022). Marine Scotland. Available at: https://marinescotland.atkinsgeospatial.com/nmpi/default.aspx?availablelayers=1535. (Accessed: November 2022).

NMFS. (2005). 'Scoping Report for NMFS EIS for the National Acoustic Guidelines on Marine Mammals'. National Marine Fisheries Service.

National Marine Fisheries Service. (2016). Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-55, 178 p.

NOAA (2018) 2018 Revision to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0). NOAA Technical Memorandum NMFS-OPR-59. National Oceanic and Atmospheric Administration.

Ørsted Hornsea Project Three Ltd. (2018). Hornsea Project Three Offshore Wind Farm Environmental Statement: Volume 5, Annex 4.1 – Marine Mammal Technical Report. May 2018. 143pp.

Otani, S., Y. Naito, A. Kato and A. Kawamura. (2000). Diving behavior and swimming speed of a free-ranging harbor porpoise, *Phocoena phocoena*. Marine Mammal Science 16(4): 811-814.

Otani, S., Y. Naito, A. Kawamura, M. Kawasaki, S. Nishiwaki and A. Kato (1998). Diving behavior and performance of harbor porpoises, *Phocoena phocoena*, in Funka Bay, Hokkaido, Japan. Marine mammal science 14(2): 209-220.

Paxton, C., L. Scott-Hayward, and E. Rexstad. (2014). Statistical approaches to aid the identification of Marine Protected Areas for minke whale, Risso's dolphin, white-beaked dolphin and basking shark. Scottish Natural Heritage Commissioned Report No. 594., Scottish Natural Heritage Commissioned Report No. 594.

Paxton, C., L. Scott-Hayward, M. Mackenzie, E. Rexstad, and L. Thomas. (2016). Revised Phase III Data Analysis of Joint Cetacean Protocol Data Resources.

R Core Team (2022). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/.

Rasmussen, M. H., Akamatsu, T., Teilmann, J., Vikingsson, G. and Miller, L. A. (2013). Biosonar, diving and movements of two tagged white-beaked dolphin in Icelandic waters. Deep Sea Research Part II: Topical Studies in Oceanography, 88, 97-105.

Russell, D.J., Hastie, G.D., Thompson, D., Janik, V.M., Hammond, P.S., Scott-Hayward, L.A., Matthiopoulos, J., Jones, E.L. and McConnell, B.J. (2016). Avoidance of wind farms by harbour seals is limited to pile driving activities. Journal of Applied Ecology, 53(6), pp.1642-1652.

Scott-Hayward, L., Oedekoven, C., Mackenzie, M. and Walker C.G. (2013). MRSea package (version 0.0.1): Statistical Modelling of bird and cetacean distributions in offshore renewables development areas. University of St Andrews: Contract with Marine Scotland: SB9 (CR/2012/05)

Seagreen Wind Energy Ltd (2012). Environmental Statement - Volume 1 - Main Text - Seagreen Alpha and Bravo Offshore Wind Farms.

Sinclair, R. R., Sparling, C. E., and Harwood, J. (2020). Review Of Demographic Parameters And Sensitivity Analysis To Inform Inputs And Outputs Of Population Consequences Of Disturbance Assessments For Marine Mammals. Scottish Marine and Freshwater Science, 11(14).

Southall, B. L., A. E. Bowles, W. T. Ellison, J. J. Finneran, R. L. Gentry, C. R. Greene Jr, D. Kastak, D. R. Ketten, J. H. Miller and P. E. Nachtigall (2008). "Marine mammal noise-exposure criteria: initial scientific recommendations." Bioacoustics 17(1-3): 273-275.

Southall, Brandon L., James J. Finneran, Colleen Reichmuth, Paul E. Nachtigall, Darlene R. Ketten, Ann E. Bowles, William T. Ellison, Douglas P. Nowacek, and Peter L. Tyack. (2019). 'Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects'. Aquatic Mammals 45 (2): 125–232.

SSE. (2023). Berwick Bank Wind Farm Environmental Impact Assessment (EIA). Available at: https://berwickbank-eia.com/. (Accessed March 2023).

Taylor, B.L. and DeMaster, D.P. (1993). Implications of non-linear density dependence. Marine Mammal Science, 9(4): 360 – 371.

Teilmann, J., C. T. Christiansen, S. Kjellerup, R. Dietz and G. Nachman (2013). "Geographic, seasonal, and diurnal surface behavior of harbor porpoises." Marine mammal science 29(2): E60-E76.

Thompson, D., A. Brownlow, J. Onoufriou, and S. Moss. (2015). 'Collision Risk and Impact Study: Field Tests of Turbine Blade-Seal Carcass Collisions'. Report to Scottish Government MR 7 (3): 1–16.

Thompson, D., Hammond, P. S., Nicholas, K. S. and Fedak, M. A. (1991). Movements, Diving and Foraging Behaviour of Grey Seals (Halichoerus Grypus). Journal of Zoology, 224(2), 223-232.

van Beest, F. M., J. Teilmann, R. Dietz, A. Galatius, L. Mikkelsen, D. Stalder, S. Sveegaard and J. Nabe-Nielsen (2018). Environmental drivers of harbour porpoise fine-scale movements. Mar Biol 165(5): 95.

Waggitt, J.J., Evans, P.G., Andrade, J., Banks, A.N., Boisseau, O., Bolton, M., Bradbury, G., Brereton, T., Camphuysen, C.J., Durinck, J. and Felce, T. (2020). Distribution maps of cetacean and seabird populations in the North-East Atlantic. Journal of Applied Ecology, 57(2), pp.253-269.

Wilson, B., Batty, R. S., Daunt, F. and Carter, C. (2007). Collision risks between marine renewable energy devices and mammals, fish and diving birds. Report to the Scottish Executive. Scottish Association for Marine Science, Oban.

15.8 Appendix 8: Offshore Ornithology Yield 1 data (15 months)

Anderson, H.B., Evans, P.G.H., Potts, J.M., Harris, M.P. and Wanless, S., (2013). The diet of Common Guillemot (Uria aalge) chicks at colonies in the UK, 2006-2011: evidence for changing prey communities in the North Sea. Ibis, 156(1). 23-34.

Balmer, D.E., Gillings, S., Caffrey, B.J., Swann, R.L., Downie, I.S. and Fuller, R.J., (2013). Bird Atlas 2007-11: the breeding and wintering birds of Britain and Ireland. Thetford: BTO

Bolton, M., Sheehan, D., Bolton, S., Bolton, J. A. and Bolton J. R., (2017). Resurvey reveals arrested population growth of the largest UK colony of European storm-petrels Hydrobates pelagicus, Mousa, Shetland. Seabird Group.

Borrmann, R.M., Phillips, R.A., Clay, T.A. and Garthe, S., (2019). High foraging site fidelity and spatial segregation among individual great black-backed gulls. Journal of Avian Biology, 50. https://doi.org/10.1111/jav.02156

Brown, A. and Grice, P., (2005). Birds in England. Poyser, London.

Chivers, L., Lundy, M., Colhoun, K., Newton, S. and Reid N., (2012). Diet of black-legged kittiwakes (Rissa tridactyla) feeding chicks at two Irish colonies highlight the importance of clupeids. Bird Study, 59(3). 363-367.

Clay, T., Small, C., Tuck, G., Pardo, D., Carneiro, A., Wood, A., Croxall, J., Crossin, G. and Phillips, R., (2019). A comprehensive large-scale assessment of fisheries bycatch risk to threatened seabird populations. Journal of Applied Ecology, 56(8). 1882-1893.

Fayet, A., Clucas, G., Anker-Nilssen, T., Syposz, M. and Hansen, E., (2021). Local prey shortages drive foraging costs and breeding success in a declining seabird, the Atlantic puffin. Journal of Animal Ecology, 90(5). 1152-1164.

Harris, M.P., Anker-Nilssen, T., McCleery, R.H., Erikstad, K.E., Shaw, D.N., and Grosbois, V., (2005). Effect of wintering area and climate on the survival of adult Atlantic puffins Fratercula arctica in the eastern Atlantic. Marine Ecology Progress Series, 297. 283-296.

Hume, R., Still, R., Swash, A., Harrop, H. and Tipling, D., (2016). Britain's Birds: An identification guide to the birds of Britain and Ireland. Woodstock: Princeton University Press.

JNCC. (2021). Fulmar. Available at: https://jncc.gov.uk/our-work/northern-fulmar-fulmarus-glacialis/. (Accessed April 2022).

JNCC. (2021a). Grey Seal. Available at: https://sac.jncc.gov.uk/species/S1364/). (Accessed March 2022).

JNCC (2021b). Harbour Seal. Available at: https://sac.jncc.gov.uk/species/S1365/). (Accessed March 2022).

JNCC, (2021c). Seabird Population Trends and Causes of Change: 1986–2019 Report. Joint Nature Conservation Committee, Peterborough. Available at: https://jncc.gov.uk/our-work/smp-report-1986-2019). (Accessed March 2022).

JNCC. (2018). Red-throated Diver Energetics Project 2018 Field Season Report. Available at: https://helda.helsinki.fi/bitstream/handle/10138/321363/JNCC_Report_627_v2.1_Revised_WEB.pdf?sequence=1. (Accessed April 2022).

Magnusdottir, E., Leat, E.H.K., Bourgeon, S., Strøm, H., Petersen, A., Phillips, R.A., Hanssen, S.A., Bustnes, J.O., Hersteinsson, P. and Furness, R.W., (2012). Wintering areas of Great Skuas Stercorarius skua breeding in Scotland, Iceland, and Norway. Bird Study, 59(1). 1-9. DOI: 10.1080/00063657.2011.636798

Marine Traffic. (2022). Available at: https://www.marinetraffic.com/en/data/?asset_type=ports. (Accessed March 2022).

NatureScot, 2020a . Outer Firth of Forth and St Andrews Bay Complex SPA. Available at: https://sitelink.nature.scot/site/10478. (Accessed March 2022).

NatureScot, 2020b . Forth Islands SPA. Available at: https://sitelink.nature.scot/site/8500. (Accessed March 2022).

NatureScot, 2020c . Firth of Forth SPA. Available at: https://sitelink.nature.scot/site/8499. (Accessed March 2022).

NatureScot, 2020d . Isle of May SAC. Available at:https://sitelink.nature.scot/site/8278. (Accessed March 2022).

NatureScot, 2020e . Fowlsheugh SPA. Available at: https://sitelink.nature.scot/site/8505. (Accessed March 2022).

NatureScot, 2020f . Buchan Ness to Collieston Coast SPA. Available at: https://sitelink.nature.scot/site/8473. (Accessed March 2022).

NatureScot, 2020g . Ythan Estuary, Sands of Forvie and Meikle Loch SPA. Available at: https://sitelink.nature.scot/site/8592. (Accessed March 2022).

NatureScot, 2020h-k. St Abb's Head to Fast Castle SPA. Available at: https://sitelink.nature.scot/site/8579. (Accessed March 2022).

Rae, S., Jones, M.G.W., Stewart, F. and Tingay, R. (2009). Counts of spring passage Golden Plover Pluvialis apricaria in north Lewis. Ringing & Migration, 24(4). 253-258. DOI: 10.1080/03078698.2009.9674399.

Russell, D.J., Morris, C.D., Duck, C.D., Thompson, D. and Hiby, L. (2019). Monitoring long-term changes in UK grey seal pup production. Aquatic Conservation: Marine and Freshwater Ecosystems, 29. 24-39.

Russel, A. (2017). Conflicts Facing Seal Populations in the UK. Wildlife Articles.

Sea Watch Foundation. (2021). Available at: https://www.seawatchfoundation.org.uk/3a-north-east-scotland/. (Accessed March 2022).

Sparling, C.E., (2012). Seagreen Firth of Forth Round 3 Zone Marine Mammal Surveys. Report number SMRUL-ROY-2012-006 to Royal Haskoning and Seagreen Wind Energy Ltd.

Thaxter, C.B., Lascelles, B., Sugar, K., Cook, A.S.C.P., Roos, S., Bolton, M., Langston, R.H.W. and Burton, N.H.K., (2012). Seabird foraging ranges as a preliminary tool for identifying candidate Marine Protected Areas. Biological Conservation, 156. 53-61.

Wernham, C., Toms, M., Marchant, J., Clark, J., Siriwardena, G. and Baillie, S., (2002). The migration atlas: movements of the birds of Britain and Ireland. T & AD Poyser.

15.9 Appendix 9: Offshore Ornithology Methodology Statement

Alerstam T, Rosén M, Bäckman J, Ericson PGP, Hellgren, O. (2007) Flight speeds among bird species: Allometric and phylogenetic effects. PLoS Biol 5(8): e197. doi:10. 1371/journal.pbio.0050197

Band, B. (2012). Using a collision risk model to assess bird collision risks for offshore windfarms. [Online]. Available at: https://www.bto.org/sites/default/files/u28/downloads/Projects/Final_Report_SOSS02_Band1ModelGuidance.pdf (Accessed March 2023).

Bowgen, K., & Cook, A. S. C. P. (2018). Bird collision avoidance: Empirical evidence and impact assessments. BTO Report to JNCC.

BTO. (2021). Seabird Monitoring Programme. [Online]. Available at: https://app.bto.org/seabirds/public/data.jsp (Accessed March 2023).

Butler, A., Carroll, M., Searle, K., Bolton, M., Waggitt, J., Evans, P., Daunt, F. (2020). Attributing seabirds at sea to appropriate breeding colonies and populations. Scottish Marine and Freshwater Science, 11(8).

Cefas. 2010. Strategic review of offshore wind farm monitoring data associated with FEPA licence conditions – annex 4: underwater noise., Cefas report ME1117.

CIEEM. 2019. Guidelines for ecological impact assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine. September 2018 Version 1.1 - updated September 2019. Chartered Institute of Ecology and Environmental Management, Winchester.

Cleasby, I.R., Owen, E., Wilson, L., Wakefield, E.D., O'Connell, P. and Bolton, M. (2020). Identifying important at-sea areas for seabirds using species distribution models and hotspot mapping, Biological Conservation 241: 108375.

Furness, R.W. (2015). Non-breeding season populations of seabirds in UK waters: Population sizes for Biologically Defined Minimum Population Scales (BDMPS). Natural England Commissioned Report No 164.

Garthe, S and Hüppop, O. (2004). Scaling possible adverse effects of marine wind farms on seabirds: developing and applying a vulnerability index, Journal of Applied Ecology 41: 724-734.

Horswill, C. & Robinson, R.A. 2015. Review of seabird demographic rates and density dependence, JNCC Report No: 552, JNCC, Peterborough, ISSN 0963-8901.

JNCC, CWW, NIEA, Natural England, SNH (2014). Joint Response from the Statutory Nature Conservation Bodies to the Marine Scotland Science Avoidance Rate Review. [Online]. Available at: https://www.webarchive.org.uk/wayback/archive/20210630103015mp_/https:/www.nature.scot/sites/default/files/2018-02/SNCB%20Position%20Note%20on%20avoidance%20rates%20for%20use%20in%20collision%20risk%20modelling.pdf (Accessed March 2023).

JNCC, NRW, DAERA, NIEA, NE and SNH (2022). Joint SNCB Interim Displacement Advice Note. [Online]. Available at: https://data.jncc.gov.uk/data/9aecb87c-80c5-4cfb-9102-39f0228dcc9a/joint-sncb-interim-displacement-advice-note-2022.pdf (Accessed March 2023).

Johnston, A., Cook, A.S.C.P., Wright, L.J., Humphreys, E. and Burton, N.H.K. (2014). Modelling flight heights of marine birds to more accurately assess collision risk with offshore wind turbines. Journal of Applied Ecology. 51. pp. 31-41.

MacGregor, R.M., King, S., Donovan, C.R., Caneco, B. and Webb, A. (2018). A Stochastic Collision Risk Model for Seabirds in Flight. [Online]. Available at: https://www2.gov.scot/Resource/0053/00536606.pdf (Accessed January 2023).

Marine Scotland (2017). Marine Scotland - Licensing Operations Team. Scoping Opinion. Addendum: Ornithology. THE ELECTRICITY WORKS (ENVIRONMENTAL IMPACT ASSESSMENT) (SCOTLAND) REGULATIONS 2017 (AS AMENDED). THE MARINE WORKS (ENVIRONMENTAL IMPACT ASSESSMENT) (SCOTLAND) REGULATIONS 2017 (AS AMENDED). SCOPING OPINION FOR THE PROPOSED SECTION 36 CONSENT AND ASSOCIATED MARINE LICENCE APPLICATION FOR THE REVISED INCH CAPE OFFSHORE WINDFARM AND REVISED INCH CAPE OFFSHORE TRANSMISSION WORKS – ORNITHOLOGY ASPECTS ONLY. [Online]. Available at: https://marine.gov.scot/data/inch-cape-offshore-windfarm-revised-design-scoping-opinion (Accessed March 2023).

Marine Scotland (2022). Marine Scotland - Licensing Operations Team. Scoping Opinion adopted by the Scottish Ministers under: The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017 The Marine Works (Environmental Impact Assessment) Regulations 2007 and The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017. Berwick Bank Offshore Wind Farm. [Online]. Available at: https://marine.gov.scot/sites/default/files/scoping_opinion_8.pdf (Accessed February 2023).

Mitchell, P.I., Newton, S.F., Ratcliffe, N. and Dunn, T.E. (2004). Seabird populations of Britain and Ireland. (London: T. and AD Poyser).

NatureScot (2020). Seasonal Periods for Birds in the Scottish Marine Environment. Short Guidance Note Version 2. October 2020.

NatureScot (2023a). Guidance Note 5: Guidance to support Offshore Wind Applications: Recommendations for marine bird population estimates. [Online]. Available at: https://www.nature.scot/professional-advice/planning-and-development/planning-and-development-advice/renewable-energy/marine-renewables/advice-marine-renewables-development (Accessed February 2023).

NatureScot (2023b). Guidance Note 7: Guidance to support Offshore Wind Applications: Marine Ornithology - Advice for assessing collision risk of marine birds. [Online]. Available at: https://www.nature.scot/professional-advice/planning-and-development/planning-and-development-advice/renewable-energy/marine-renewables/advice-marine-renewables-development (Accessed February 2023).

NatureScot (2023c). Guidance Note 8: Guidance to support Offshore Wind Applications: Marine Ornithology Advice for assessing the distributional responses, displacement and barrier effects of Marine birds. [Online]. Available at: https://www.nature.scot/professional-advice/planning-and-development/planning-and-development-advice/renewable-energy/marine-renewables/advice-marine-renewables-development (Accessed February 2023).

NatureScot (2023d). Guidance Note 3: Guidance to support Offshore Wind applications: Marine Birds - Identifying theoretical connectivity with breeding site Special Protection Areas using breeding season foraging ranges. [Online]. Available at: https://www.nature.scot/doc/guidance-note-3-guidance-support-offshore-wind-applications-marine-birds-identifying-theoretical (Accessed February 2023).

NatureScot. (2023e). Guidance Note 11: Guidance to support Offshore Wind Applications: Marine Ornithology - Recommendations for Seabird Population Viability Analysis (PVA). [Online]. Available at: https://www.nature.scot/professional-advice/planning-and-development/planning-and-development-advice/renewable-energy/marine-renewables/advice-marine-renewables-development (Accessed July 2023).

OSPAR. (2008). OSPAR Guidance on Environmental Considerations for Offshore Wind Farm Development. (Reference number: 2008-3). Available at: http://www.vliz.be/imisdocs/publications/ocrd/224682.pdf. Accessed January 2023.

Ozsanlav-Harris, L., Inger, R. and Sherley, R. (2023). Review of data used to calculate avoidance rates for collision risk modelling of seabirds. [Online]. Available at: https://hub.jncc.gov.uk/assets/de5903fe-81c5-4a37-a5bc-387cf704924d (Accessed May 2023).

Pennycuick, C.J. (1987). Flight of seabirds. Seabirds: Feeding Ecology and Role in Marine Ecosystems.

Robinson, R.A. (2005). Bird Facts: profiles of birds occurring in Britain and Ireland. BTO Research Report No. 407.

Searle, K.R., Mobbs, D.C., Butler, A., Furness, R.W., Trinder, M.N. and Daunt, F. (2018). Finding out the Fate of Displaced Birds. Scottish Marine and Freshwater Science Vol 9 No 8, 149pp.

Searle, K., Mobbs, D., Daunt, F. Butler, A. (2019). A Population Viability Analysis Modelling Tool for Seabird Species. [Online]. Available at: http://publications.naturalengland.org.uk/publication/4926995073073152 (Accessed March 2023).

Searle, K., Butler, A., Bogdanova, M. and Daunt, F. (2020). Scoping Study - Regional Population Viability Analysis for Key Bird Species CR/2016/16. Scottish Marine and Freshwater Science Vol 11 No 10, 118pp. DOI:10.7489/12327-1.

Skov, H., Heinänen, S., Norman, T., Ward, R.M., Méndez-Roldán, S. and Ellis, I., (2018). ORJIP Bird Collision and Avoidance Study. Final report – April 2018. [Online]. Available at: https://prod-drupal-files.storage.googleapis.com/documents/resource/public/orjip-bird-collision-avoidance-study_april-2018.pdf. (Accessed January 2023).

Stanbury, A., Eaton, M., Aebischer, N., Balmer, D., Brown, A., Douse, A., Lindley, P., McCulloch, N., Noble, D., and Win I. 2021. The status of our bird populations: the fifth Birds of Conservation Concern in the United Kingdom, Channel Islands and Isle of Man and second IUCN Red List assessment of extinction risk for Great Britain. British Birds 114: 723-747. [Online]. Available at: https://britishbirds.co.uk/sites/default/files/BB_Dec21-BoCC5-IUCN2.pdf (Accessed March 2023).

Wade, H.M., Masden, E.A., Jackson, A.C., and Furness, R.W. (2016). Incorporating data uncertainty when estimating potential vulnerability of Scottish seabirds to marine renewable energy developments. Marine Policy 70:108-113.

Wakefield, E.D., Owen, E., Baer, J., Carroll, M.J., Daunt, F., Dodd, S.G., Green, J.A., Guilford, T., Mavor, R.A., Miller, P.I., Newell, M.A., Newton, S.F., Robertson, G.S., Shoji, A., Soanes, L.M., Votier, S.C., Wanless, S. and Bolton, M. (2017). Breeding density, fine-scale tracking, and large-scale modeling reveal the regional distribution of four seabird species. Ecological Applications 27(7): 2074-2091.

Woodward, I., Thaxter, C.B., Owen, E. and Cook, A.S.C.P. (2019). Desk-based revision of seabird foraging ranges used for HRA screening. Report of work carried out by the British Trust for Ornithology on behalf of NIRAS and The Crown Estate. BTO Research Report No. 724.

Woodward, I., Aebischer, N., Burnell, D., Eaton, M., Frost, T., Hall, C., Stroud, D. and Noble, D. (2020). Population estimates of birds in Great Britain and the United Kingdom. British Birds. 113 (2), pp. 69-104.

Wright, L.J., Ross-Smith, V.H., Massimino, D., Dadam, D., Cook, A.S.C.P. and Burton, N.H.K. (2012). Assessing the risk of offshore windfarm development to migratory birds designated as features of UK Special Protection Areas (and other Annex I species). Strategic Ornithological Support Services. Project SOSS-05. BTO Research Report No. 592.

WWT Consulting and MacArthur Green (2014). Strategic assessment of collision risk of Scottish offshore wind farms to migrating birds. [Online]. Available at: https://www.gov.scot/publications/scottish-marine-freshwater-science-volume-5-number-12-strategic-assessment/ (Accessed March 2023).

15.10 Appendix 10: Commercial fisheries: Methodology Statement

ABPmer. (2022). Spatial Squeeze in Fisheries, Final Report, ABPmer Report No. R.3900. A report produced by ABPmer for NFFO & SFF, June 2022.

Blyth-Skyrme, R.E., (2010). Options and opportunities for marine fisheries mitigation associated with windfarms. Final report for Collaborative Offshore Wind Research into the Environment contract FISHMITIG09. COWRIE Ltd, London.

FLOWW (Fishing Liaison with Offshore Wind and Wet Renewables Group) (2014). FLOWW Best Practice Guidance for Offshore Renewables Developments: Recommendations for Fisheries Liaison.

FLOWW (Fishing Liaison with Offshore Wind and Wet Renewables Group). (2015). FLOWW Best Practice Guidance for Offshore Renewables Developments: Recommendations for Fisheries Disruption Settlements and Community Funds.

International Cable Protection Committee. (2009). Fishing and Submarine Cables Working Together. Stephen C. Drew & Alan G. Hopper, February 23.

Marine Scotland. (2022). Good Practice Guidance for assessing fisheries displacement by other licensed marine activities: Literature Review. Report for Scottish Government.

UKFEN. (2012). Best practice guidance for fishing industry financial and economic impact assessments.

15.11 Appendix 11: Seascape, Landscape and Visual, and Onshore Historic Environment Methodology Statement

Aberdeenshire Local Development Plan (2023). Appendix 13: Aberdeenshire Special Landscape Areas. Available at Aberdeenshire Local Development Plan 2023 – Aberdeenshire Council.

NatureScot. (2005). An assessment of the sensitivity and capacity of the Scottish seascape in relation to offshore windfarms. Commissioned Report No.103. Available at: https://www.nature.scot/doc/naturescot-commissioned-report-103-assessment-sensitivity-and-capacity-scottish-seascape-relation.

NatureScot. (2019). Landscape Character Assessment. Available at: https://www.nature.scot/professional-advice/landscape/landscape-character-assessment.

15.12 Appendix 12: Seascape, Landscape and Visual and Onshore Historic Environment Wirelines and Zones of Theoretical Visibility

Aberdeenshire Local Development Plan. (2023). Appendix 13: Aberdeenshire Special Landscape Areas Available at: Aberdeenshire Local Development Plan 2023 - Aberdeenshire Council.

Scottish Natural Heritage. (2005). An assessment of the sensitivity and capacity of the Scottish seascape in relation to offshore windfarms. Commissioned Report No.103. Available at: https://www.nature.scot/doc/naturescot-commissioned-report-103-assessment-sensitivity-and-capacity-scottish-seascape-relation.

Scottish Natural Heritage. (2019). Landscape Character Assessment. Available at: https://www.nature.scot/professional-advice/landscape/landscape-character-assessment.

15.13 Appendix 13: Gazetteer of Marine Archaeology Identified within the Desktop Data

No references in this appendix.

15.14 Appendix 14: Gazetteer of Recorded Losses Identified within the Desktop Data

No references in this appendix.