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Original research article

Seafloor habitat, depth and diel patterns influencing prey encounter and hunting success in a large marine predator, the Australian fur seal

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ABSTRACT

Determining the environmental factors driving the foraging behaviour of marine top predators is crucial for assessing their ecological roles and resilience to environmental variability. This study examines the foraging strategies of female Australian fur seals (*Arctocephalus pusillus doriferus*; AUFS) during the austral autumn and winter (2008–2018) at Kanowna Island, south-eastern Australia, a region increasingly threatened by anthropogenic activities and environmental changes. Using animal-borne video cameras, GPS tracking, and dive behaviour loggers, encounters and captures of prey were analysed across 2022 recorded dives from 22 adult females provisioning pups. Benthic invertebrate cover was a key predictor of capture success, with the highest probabilities in densely covered areas, despite these not being the most frequently visited habitats. Encounter rates increased with depth, suggesting greater prey availability in deeper waters. Time of day significantly affected both encounters and captures with nocturnal periods showing the highest rates. These findings demonstrate that seafloor habitat complexity, depth and diel cycles simultaneously shape the prey fields of AUFS. The identification of specific habitat features linked to foraging behaviour improves the understanding of the ecological requirements of this central-place forager in a region undergoing rapid environmental change driven by anthropogenic pressures. Such insights are critical to anticipate potential impacts on prey availability and, consequently, on foraging efficiency and the ability of the species to adapt to future conditions.

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1. Introduction

Foraging behaviour in higher-order predators is shaped by complex interactions among habitat characteristics, biotic relationships such as competition and predation, and prey dynamics (Das et al., 2023; Lewis et al., 2006; Segev et al., 2021). Predators often adjust their foraging strategies in response to temporal and spatial fluctuations in prey availability (Hopcraft et al., 2005; Hugie and Dill, 1994; Thirgood et al., 2003). These behavioural adjustments could also reflect environmental conditions that influence prey accessibility and capture success, such as habitat structure and landscape features (prey catchability hypothesis; (Hopcraft et al., 2005).

Observational studies have provided valuable insights into terrestrial predators, revealing their complex foraging behaviours, strategies, prey preferences, interactions, and competition dynamics (Funston et al., 2001; Hayward et al., 2007; Smith et al., 2008). For instance, the foraging behaviour of raptors is driven by prey abundance, nest proximity, and interspecific competition, with specialists and generalists showing distinct responses to prey variability (Thirgood et al., 2003). Direct observations have been extensively used to study terrestrial predators such as wolves (*Canis lupus*), hyenas (*Crocuta crocuta*), lions (*Panthera leo*), cheetahs (*Acinonyx jubatus*) and wild dogs (*Lycaon pictus*), contributing substantially to the understanding of their foraging ecology (Carbone et al., 2005; Durant, 2000; Kolowski et al., 2007; MacNulty et al., 2007).

In the marine ecosystems, observational studies on marine top-order predators are less frequent due to the extended periods spent submerged and far from land, making direct observation foraging behaviour inherently difficult (Fedak et al., 2002; Luschi et al., 2003; Skomal et al., 2017). Biologging technologies, such as satellite tracking and dive recorders provide valuable information on movement and habitat use, facilitating the identification of the environmental conditions behind the foraging behaviour of cryptic species (Block, 2005; Cooke et al., 2012; Evans et al., 2013; Kooyman, 2004; Rutz and Hays, 2009). Environmental proxies such as sea surface temperature, chlorophyll-*a* concentration, and sediment composition have been used to infer prey availability (Guinet et al., 2001; Hickcox et al., 2022; Wynn-Simmonds et al., 2024). However, discrepancies between environmental proxies and predator behaviour highlight the need to better understand how fine scale habitat features influence prey fields and foraging outcomes.

To gain precise insights into the mechanisms underlying foraging outcomes, animal-borne camera systems have emerged as powerful tools for examining predator-prey interactions from the predator's perspective. Previous research using these systems, have revealed undocumented prey resources and unknown foraging social behaviour (Ponganis et al., 2000; Takahashi et al., 2008; Thiebot et al., 2017). When combined with biologging devices, a detailed identification of foraging locations, timing, and detailed information on the prey targeted could be obtained (Mattern et al., 2018; Parrish et al., 2000; Sutton et al., 2015). This fine-scale spatial information enables the integration of habitat data with foraging strategies, enhancing the understanding of the complex ecological drivers in species vital to marine ecosystem functioning (Alonso et al., 2018).

The Australian fur seal (*Arctocephalus pusillus doriferus*; AUFS) is the largest resident marine top-order predator by biomass in south-eastern Australia. Female AUFS are central-place foragers, undertaking constrained trips within the relatively shallow and low-productivity waters of the Bass Strait basin (maximum depth ~80 m), due to the need to regularly return to provision their offspring (Arnould and Hindell, 2001; Kirkwood and Arnould, 2012; Kirkwood et al., 2010). Their diet consists of a wide array of prey, predominantly benthic/demersal species, including rock cod (*Pseudophycis* spp.), gurnards spp. (Family *Scorpaeniformes*), leatherjackets spp. (Family *Monacanthidae*), barracouta (*Thyrsites atun*) and cryptic species like octopus (pale octopus *Octopus berrima/-pallidus* and Maori octopus *Octopus maorum*). Pelagic prey such as jack mackerel (*Trachurus* spp.) and ocean jacket (*Nelusetta ayraudvi*) are consumed less frequent (Deagle et al., 2009; Hardy et al., 2017; Littnan et al., 2007). This dietary breadth reflects their ability to exploit a diverse range of prey types and ecosystems, which has been shown to vary across years in response to shifting oceanographic conditions (Kirkwood et al., 2008).

Foraging behaviour in female AUFS has been linked to individual traits such as sex and reproductive stage, prey availability and broad-scale habitat features, including depth and sediment type (Arnould et al., 2011; Kirkwood et al., 2008; Kliska et al., 2022; Page et al., 2005). These factors are likely to be affected by climate-driven changes and anthropogenic pressures, such as offshore wind farm development and the decommissioning of oil infrastructure (Hiscock et al., 2002; Perkins et al., 2022); Wong et al., 2025; Wong et al., 2023). In the Bass Strait region, projected oceanographic shifts include intensified wind-induced currents, warming temperatures, and alterations in seafloor sediment dynamics (Hobday and Lough, 2011; Liu et al., 2022; Liu et al., 2023). These changes are expected to modify nutrient availability, redistribute benthic invertebrate communities, and impact prey accessibility and distribution (Jenkins and Sutherland, 1997; Power et al., 1985). Short-term shifts in marine flora and fauna have already been documented (Last et al., 2011; Smale et al., 2011), along with dietary changes in AUFS during periods of stronger wind (Kliska et al., 2022).

Despite the ecological importance of AUFS and the ongoing transformations in benthic systems they rely on, fine-scale information on habitat structure and its influence on prey field dynamics remains scarce. Understanding these interactions is critical due to the anticipated intensification of environmental changes in Bass Strait. To address this knowledge gap, our study combines animal-borne video recording with high resolution global positioning system (GPS) tracking and dive behaviour logging to: 1) identify the environmental factors shaping prey encounters and captures; and 2) determine the habitat characteristics influencing these parameters in the preferred prey group of AUFS.

2. Methods

2.1. Ethics statement

All animal handling procedures for the present study were conducted in accordance with the regulations, guidelines and approval of the Deakin University Animal Ethics Committee (Approval A16/2008, A14/2011, B16/2014, B04/2017), and the Department of

Energy Environment and Climate Action (DEECA; Victoria, Australia) under Wildlife Research Permits (1000187, 10000706, 10001143, 10001672, 10002269, 10005362, 10007153, 10008286 and 10005848).

2.2. Study site, animal handling and instrumentation

The study was conducted at Kanowna Island (39° 10' S, 146° 18' E), the third largest colony of AUFS of the northern Bass Strait, south-eastern Australia (McIntosh et al., 2018); Fig. 1). During the austral autumn and winter (May-August) from 2008 to 2018, between 1 and 7 adult females provisioning pups were selected at random each year. This period coincides with peak lactation, when female provisioning pups experience their greatest nutritional demands (Arnould and Hindell, 2002; Gittleman and Oftedal, 1987; Oftedal, 1984). Females from this population have been found to forage mostly in central Bass Strait (Arnould and Hindell, 2001; Bartes et al., 2024).

Selected females were captured using a modified hoop-net (Fuhrman Diversified, Seabrook, Texas, U.S.A.) and anaesthetised with isoflurane via a portable gas anaesthetic delivery system (Stinger, Advanced Anaesthesia Specialists, Gladesville, NSW, Australia(Gales and Mattlin, 1998). Individuals were then weighed (± 0.5 kg) on a flat platform using a suspension scale (Salter, Australia), and morphometric measurements (standard length, axillary girth and flipper length) were recorded with a tape measure (± 0.5 cm). For identification, uniquely numbered plastic Super Tags (Dalton, Woolgoolga, Australia) were attached to the trailing edge of each fore-flipper.

Each female seal was instrumented with a video data logger, a GPS data logger, a dive behaviour data logger and a small VHF transmitter to facilitate relocation for recapture and device recovery (Table 1). All devices were securely attached in series to the dorsal fur behind the camera using quick-setting epoxy (Accumix 268, Huntsman, Texas, U.S.A.), minimising hydrodynamic drag (<2 % body mass, <1 % cross-sectional surface area; (Casper, 2009) while ensuring the seal's head remained within the field of view of the cameras. Following recovery from anaesthesia, individuals were left to resume normal behaviour. Females were recaptured after at least one foraging trip to sea, and devices were retrieved by cutting the fur beneath them. Data were downloaded onto portable computers in the field, and device batteries were recharged for redeployment on additional animals.

GPS and TDR loggers were programmed to record location every 15 min and depth every second. To maximise the duration of video data collection and to conserve battery life, Crittercams were programmed to activate 24 h after the deployment, triggered when the animal was at a depth of 40 m, and then operating on a 1-hour on and 3-hour off duty cycle. Video data loggers recorded only when the seal descended below this depth and stopped once it ascended above 40 m. This depth cut-off was determined based on the benthic foraging ecology of AUFS and the depth (>45 m) of central Bass Strait where they mostly forage (Arnould and Kirkwood, 2007; Bartes et al., 2024; Kirkwood and Arnould, 2012) to maximise battery life while minimising the risk of missing foraging dives. During daytime dives, the cameras recorded high-definition, wide-angle video at depths of up to 100 m, even in low ambient light conditions. For nighttime dives, the cameras were programmed to activate onboard near-infra-red LED beams, illuminating the field of view within a 5 m range. Although near-infra-red light may have some effect on prey behaviour(Heaslip and Hooker, 2008), the visual sensitivity of diving marine mammals decreases at longer wavelengths as an adaptation for aquatic vision, limiting potential biases (Levenson et al., 2006; Lythgoe and Partridge, 1989). Using this light source was necessary to ensure effective data collection on nocturnal foraging

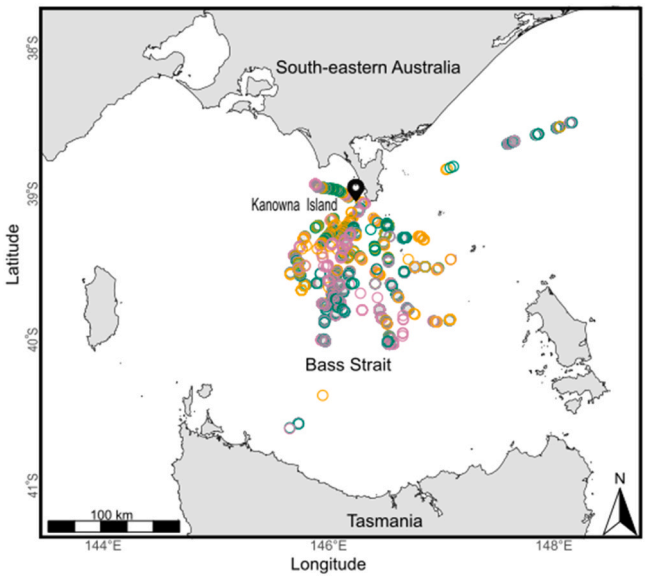

Fig. 1. Foraging areas of adult female Australian fur seals provisioning pups from the third-largest breeding colony, Kanowna Island (black location marker), in Bass Strait, south-eastern Australia, showing locations of benthic dives without prey encounters (orange), with prey capture (green) and without prey capture (pink dots).

Table 1
Specifications of different data logging devices used in female Australian fur seals from Kanowna Island.

Device	Model/Version	Manufacturer	Dimensions (cm)	Weight (g)
Video Data Logger	Crittercam; Gen 5.7	National Geographic Society, Washington, D. C., USA	23 × 5.7	800
Video Data Logger	CATS-DC; v6–5.7.0	Customised Animal Tracking Solutions, Moffat Beach, Australia	8.0 × 11.0 × 4.5	180
Video Data Logger	BBC custom-built cameras; v1	Mr ROV, Bristol, UK	13.0 × 5.0 × 4.5	240
GPS data Logger	F1G	Sirtrack, Havelock North, New Zealand	10.0 × 2.8 × 5.2	117
Dive Behaviour Data Logger	MK10	Wildlife Computers, Washington, D.C., USA	7.4 × 5.7 × 3.6	120
Relocation Logger	VHF Transmitter	Sirtrack, Havelock North, New Zealand	1.0 × 2.0 × 3.0	25

behaviour, as its absence would have restricted the ability to record feeding activity during night-time dives. The CATS-DC and BBC video data loggers were programmed for continuous recording durations of one hour and two hours, respectively, starting at 10:00 AEST and 14:00 AEST each day upon the animal's entry into the water, without a depth threshold, and operating until battery depletion.

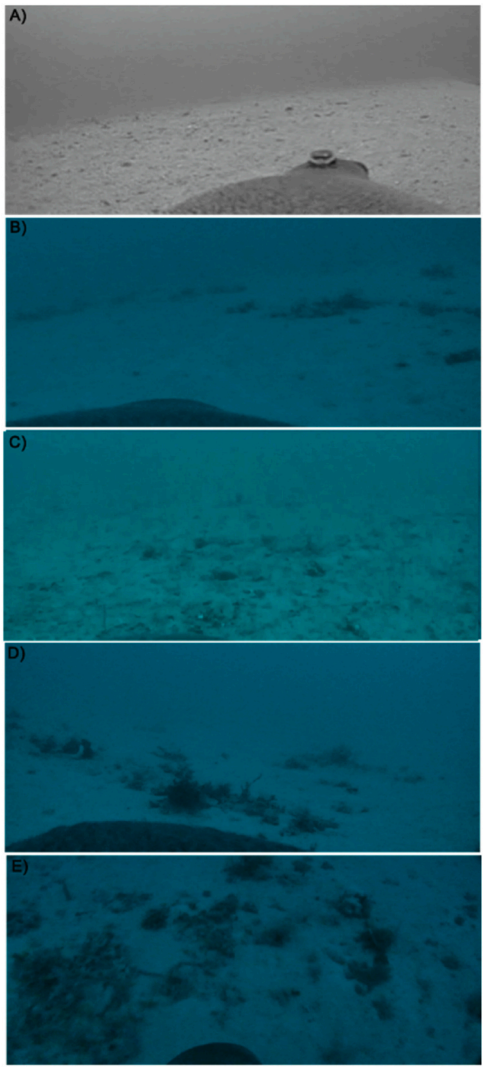

Fig. 2. Representative still images from videos of female Australian fur seals videos showing the five categories of benthic sessile invertebrate cover: A) Trace, B) Sparse, C) Sparse- Medium D) Medium, E) Dense.

2.3. Data processing

Dive and GPS data were temporally and spatially synchronised with the video file analysis outputs using Eonfusion software (Myriax Pty Ltd), enabling the integration of depth, location, and behavioural observations for each recorded event. The duration of each encounter event, instances of multiple prey encounters within a single dive, capture success, time of day (day, night and crepuscular) and location of capture (i.e., seafloor or water column) were recorded. Observed prey encounter events were defined as 2 stages: (i) prey encounter: the seal moved its head towards a prey item; and (ii) prey capture and handling: the seal was seen with the prey in its mouth and was observed consuming it at the seafloor, or returning to the ocean surface with it (where we assumed that it was consumed there).

Each video file was examined for prey encounter or capture events, with prey types grouped into demersal fish, pelagic fish, cephalopods and elasmobranchs (see Supplementary Material). Where possible, the genus or species was determined (Gomon et al., 2008). For each dive, the cover of the benthic sessile invertebrates was described, and the dive depth was recorded. Benthic sessile invertebrate cover consisted of mainly ascidians, bryozoans, porifera and octocorals, which, due to variable quality in the video, were later grouped together and categorised into five cover categories (Fig. 2): trace (<5 % cover), sparse (5–25 % cover), sparse-medium (25–50 % cover), medium (50–75 % cover), and dense (>75 % cover). Prey encounter rates were calculated as the proportion of dives in which a prey item was observed relative to the number of total dives, and prey capture rates were calculated as the proportion of successful events relative to the number of prey encounters for each category.

2.4. Data analysis

Exploratory analysis was conducted following the protocols described by Zuur et al. (2010) to assess data structure and distribution, and to select the most appropriate statistical framework. To identify the variables influencing prey encounters and captures, which were classified as binary responses (presence/absence), generalised linear mixed models (GLMMs) were fitted using a binomial family with a logit link function, including individuals as a random effect (Bates et al., 2015). Model analyses were performed with the *lme4* package version 1.1–35.5 (Bates et al., 2015). Predictor variables comprised depth (continuous), time of the day (three factors: day, crepuscular, night) and sessile invertebrate cover categories (five factors: trace, sparse, sparse-medium, medium, dense). Invertebrate cover and time of the day were categorised to align with the ecological characteristics of both prey and AUFS (Arnould

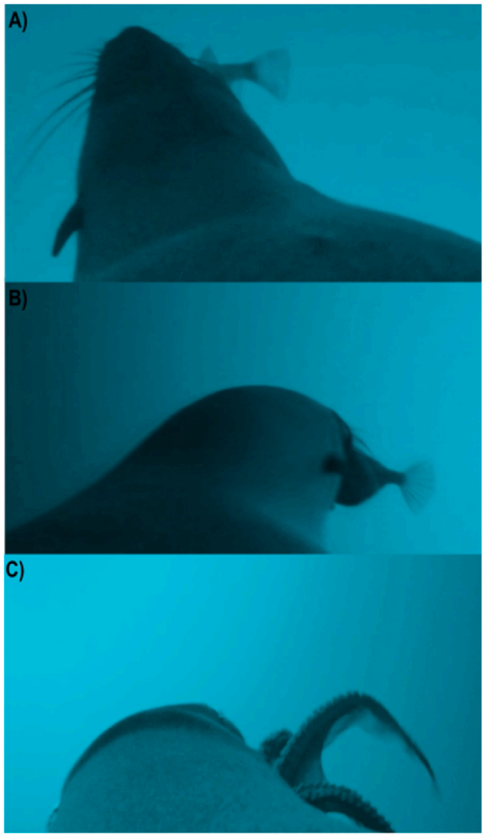

Fig. 3. Representative images from videos recorded by animal-borne video data loggers showing the capture of a demersal teleost (A & B) and an octopus (C) by a female Australian fur seal (see Supplementary Material for an example video).

and Hindell, 2001; Hoskins and Arnould, 2013; Matheson et al., 2017).

The optimal model was selected based on Akaike Information Criterion weights (AICc-wi; (Burnham et al., 2011); (Wagenmakers and Farrell, 2004), retaining the model with the highest support. Model assumptions and performance were assessed through residual diagnostics using *DHARMa* package version 0.4.7, which confirmed the absence of overdispersion, zero-inflation, or deviations from expected residual distribution (Hartig, 2016). Model accuracy and discrimination were evaluated using predicted versus observed plots and ROC curve analyses, showing a strong model fit. To further assess the significance of fixed effects in the GLMMs, Type III ANOVA was performed using the *car* package version 3.1–3 (Fox et al., 2007). Estimated marginal means (EMMeans) were computed and plotted using the *emmeans* package version 1.10.6 (Lenth et al., 2025) to facilitate pairwise comparisons and interpret the effects of categorical variables. All statistical analyses were conducted using R Statistical environment version 4.3.1 (R Core, 2023)

3. Results

Foraging behaviour was recorded in 22 adult females provisioning pups from Kanowna Island, which weighed between 50.5 and 98 kg and measured 132–171 cm in total length (see supplementary material Table A1). A total of 84.5 h of videos were analysed. During 2022 recorded dives (Figs. 2), 1,186 prey occurred, and 715 were captured, with individual rates ranging from 20 % to 100 % (Fig. 3A-C). The footage from the instrumented females primarily recorded dives over the seafloor with sparse and sparse-medium sessile invertebrate cover, at depths ranging from 45 to 85 m in central Bass Strait (Fig. 2). These habitats also had the highest prey encounters with lower capture success rates (57.2 % and 62.2 %, respectively). In contrast, regions with dense invertebrate cover had lower prey encounters (2.8 %) and maximal capture success (79.3 %). Trace areas accounted for 5.8 % of encounters and showed the lowest capture rate (35.9 %). Dives were recorded throughout the day, with the majority of recordings occurring at night, followed by daytime and crepuscular periods. Prey encounters and captures followed a similar overall pattern across the day, with the highest proportions recorded at night (62.1 % of encounters, 66.1 % capture rate). Although daytime accounted for a higher proportion of encounters (24.9 %) compared to crepuscular periods (12.9 %), capture success was lower (46.7 % vs. 54.2 %, respectively).

The prey observed consisted primarily of demersal teleosts, which accounted for 92.6 % of all encounters, with 59.7 % resulting in successful captures (Table 3). Pelagic teleost represented a smaller proportion of the observations (3.7 % encountered) with a capture success rate of 45.4 %. Cephalopods and elasmobranchs were the least frequently observed prey but showed the highest capture rates, with 100 % of cephalopods encounters and 70.6 % of the elasmobranchs resulting in successfully captures. Among the dominant demersal teleosts, 19 % were unidentifiable, and the most represented identifiable groups were Scorpaeniformes (mainly gurnards) and *Tetraodontiformes* (mainly leatherjackets).

Prey composition varied with invertebrate abundance and time of the day, with benthic fish consistently being the most frequent encountered and captured group across all the categories of both variables. Teleosts were predominantly found at night in sparse (benthic fish) and sparse-medium (pelagic fish) invertebrate cover. Cephalopods and elasmobranchs were primarily encountered and captured during the day, also in sparse and sparse-medium, respectively (Table 2).

The best supported model describing pry encounter and capture responses included different combinations of the predictor variables. For prey encounter, the top ranked model (AIC*c-wi*= 0.58) included the three covariates and for prey capture the best-supported model (AIC*c-wi*= 0.65) included time of the day and invertebrate cover. The GLMMs revealed that female AUFS had significantly higher prey encounter and capture rates at night (see supplementary material, Table A2, A3), followed by lower rates during crepuscular and daytime periods, with only daytime dives showing a significant effect ($p < 0.05$; Table A2; Fig. 4A, C). Prey encounters increased with water depth ($p < 0.05$; Fig. 4B), and prey capture with invertebrate abundance ($p < 0.05$; Fig. 4D). The highest capture rates occurred in areas with dense cover, while all the other categories showed significantly lower probabilities of prey capture. Given the high representation of teleosts and the low occurrence of other prey groups in the dives, prey encounter and capture success models were not conducted for individual prey groups.

4. Discussion

Predator foraging strategies are driven by complex ecological interactions between prey dynamics and environmental features, which influence prey accessibility and capture success. Identifying the habitat characteristics that shape fine-scale foraging is essential to understanding how habitat changes may alter individual foraging decisions. The present study examined how benthic habitat structure, depth, and diel patterns affect prey encounter and capture success in adult female AUFS provisioning pups. Each factor was found to impact prey dynamics differently. Given the projected short and long-term environmental shifts in central Bass Strait, significant alterations in preferred benthic habitat composition are likely (Last et al., 2011; Marzloff et al., 2018; Perkins et al., 2022; Wong et al., 2025; Wong et al., 2023). Such changes could reduce the quality and availability of foraging areas, ultimately compromising prey accessibility and foraging efficiency in AUFS, with potential consequences for population dynamics.

The video recordings enabled direct observation of a subset of benthic dives within individual foraging trips. Although the recorded dives represented only a portion of each foraging trip, their coverage across different seafloor types and the full depth range of benthic diving, combined with the high foraging consistency reported in AUFS females (Kernaleguen et al., 2014; Kernaléguen et al., 2016), suggest that our observations are representative of broader foraging patterns. The recordings provided valuable insights into the habitat preferences of prey and contributed to the ecological understanding of this species.

Table 2
Summary of the number of preys encountered and captured by adult female Australian fur seals across invertebrate abundance categories and time-of-day periods. Numbers in parentheses indicate the number of preys captured in each category; parentheses are omitted where no captures occurred; n = sample size.

Prey Type	Prey Encounter (n)	Prey Capture (n)	Invertebrate cover (n)					Time of the day (n)		
			Trace	Sparse	Sparse-Medium	Medium	Dense	Day	Crepuscular	*Night*
Benthic teleost	1098	656	64 (23)	453 (259)	437 (272)	115 (79)	29 (23)	274 (128)	142 (77)	682 (451)
Pelagic teleost	44	20	4 (2)	15 (4)	22 (12)	3 (2)	0	17 (12)	2	2 (8)
Cephalopod	27	27	2 (2)	11(11)	10 (10)	3 (3)	1 (1)	19 (19)	2 (2)	6 (6)
Elasmobranch	17	12	0	7 (6)	10 (6)	0	0	10 (8)	2	5 (4)

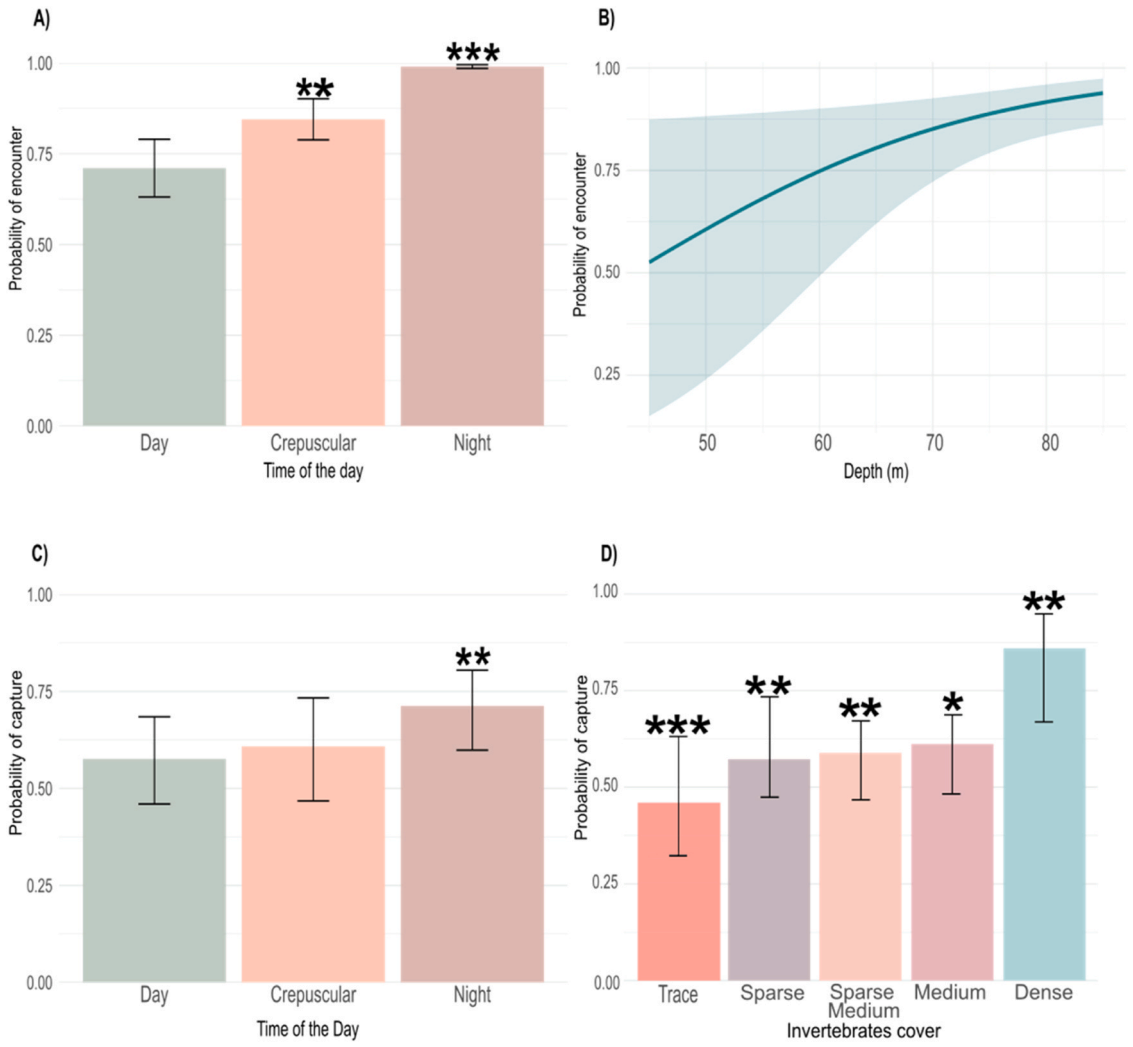

Fig. 4. Probability of encounter and capture for the model of prey encounter (A, B), prey capture (C, D) from the best GLMM model. Panels A, C, and D show estimated means with standard errors, while panel B displays the 95 % confidence interval around the effect of water depth. Asterisks indicate categories that differ significantly from the reference level. (* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$).

4.1. Habitat features shaping prey encounter and capture

The video data revealed a diverse prey assemblage, with higher encounter rates of demersal fish, and fewer observations of pelagic species, elasmobranchs, and cephalopods, consistent with previous dietary records (Deagle et al., 2009; Hume et al., 2004; Kirkwood et al., 2008). However, cephalopods showed the highest capture rates, suggesting a greater vulnerability to predation. Some of the observed cryptic species (e.g., gurnards, leatherjackets, octopus; (Kernaléguen et al., 2016; Kliska et al., 2022; Page et al., 2005) are known to inhabit shallow and mesopelagic reefs (Krueck et al., 2019; Williams et al., 2019), where they forage and seek shelter within complex structures (Jenkins and Sutherland, 1997; Park et al., 2017). Comparable reef features appeared in the footage, including sand-inundated areas with sparse to moderate sessile invertebrate cover and occasional zones of higher structural complexity. While cryptic prey may reduce their movements or hide within these habitats (Power et al., 1985; Stein and Magnuson, 1976; Werner et al., 1983) their structural complexity may provide predictable foraging opportunities for female AUFS by promoting prey aggregation and supporting reef-associated fish assemblages (Choat and Ayling, 1987; Jenkins and Sutherland, 1997; Moore et al., 2009; Sward et al., 2019).

Invertebrate cover was positively correlated with prey capture rates but had no effect on encounter frequency. Although habitats with dense invertebrate cover reported the highest capture rates, they were among the least visited. The limited use of these habitats contrasts with earlier findings, which suggested that female AUFS return to similar areas to maximise prey detection, indicating that these productive areas should have been more frequented (Salzeri et al., 2024; Zhang and Richardson, 2007). This could demonstrate that prey capture efficiency may not solely drive the selection of foraging grounds. Other ecological factors such as prey behaviour,

detectability, and habitat use, may play a crucial role in shaping the foraging decisions. Previous studies in terrestrial ecosystems have shown that detectability can influence foraging patterns, with improved efficiency in areas where prey are hard to encounter (Hopcraft et al., 2005). For instance, Serengeti lions (*Panthera leo*) exhibit greater hunting success in dense vegetation, where concealment allows them to approach prey undetected, despite higher prey abundance and visibility in open grasslands (Hopcraft et al., 2005). Similarly, invertebrate cover may reduce prey vigilance or limit escape responses increasing vulnerability and enabling female AUFS to capture unsuspecting prey before they disperse or hide.

Depth lacked effect on prey capture rates but significantly increased the probability of prey encounters, indicating that it may influence prey availability rather than foraging efficiency. Greater depth has been linked to enhanced foraging performance in marine top predators (Huon et al., 2015; Mattern, 2020) and may be associated with the spatial and temporal predictability of prey, given the increase in benthic species diversity with depth in Bass Strait (Coleman et al., 1997; Henkel et al., 2014; Kailola, 1993). Notably, the depths range recorded in this study reflect the maximum forging depths available in Bass Strait (Newell, 1961), suggesting that AUFS exploit the deepest available habitats to optimise foraging opportunities while balancing the energetic cost of travelling long distances to provision pups (Arnould and Hindell, 2001). Although these areas have been reported as preferentially foraging grounds (Bartes et al., 2024), females often perform rapid benthic scanning while increasing depth due to physiological constraints (Andrews and Enstipp, 2016; Salzeri et al., 2024; Zimmer et al., 2010). Such fast-paced searching could compromise prey capture particularly when targeting cryptic species that exhibit effective escape responses or require extended handling time that exceeds oxygen limits (Meyers et al., 2021).

Prey encounter and capture rates increased during the night, which may reflect diel patterns in prey ecology and behaviour. Studies on demersal fish assemblages have found higher diversity and abundance of fish at night, which has been linked to their cryptic daytime habits (Matheson et al., 2017). Reduced visibility at night may have further prevented these fish from detecting and reacting to approaching female AUFS in time to escape into their hiding place. The nocturnal behaviour of the prey species could increase their susceptibility to predation by AUFS, which forage along the seafloor at night, potentially taking advantage of prey with reduced vigilance or mobility. Additional ecological and behavioural factors such as environmental conditions, predator-prey interactions, or intra-specific competition may also shape prey field and need further investigation to provide a more comprehensive understanding.

4.2. Implications of environmental change on prey encounter and capture in AUFS

Identifying the fine-scale habitat characteristics that influence prey encounters and capture success in female AUFS is essential for understanding how environmental change may affect their foraging in a region increasingly threatened by human-induced disturbances (Wernberg et al., 2011). One of the most pressing concerns is the projection of climatic trends for the area, including rising sea temperatures and intensified wind-induced currents (Hobday and Lough, 2011; Liu et al., 2022; Liu et al., 2023), which may alter ecosystem dynamics. These factors are expected to contribute to nutrient depletion, seafloor erosion, and shifts in sediment mobility (Jenkins and Sutherland, 1997; Power et al., 1985), ultimately affecting the distribution of key benthic invertebrates such as bryozoans, ascidians, porifera, and octocorals that were frequently observed in this study's video footage. While these projections indicate long-term environmental shifts, short-term ones have already been recorded, including the redistribution of biodiversity (Last et al., 2011; O'Hara and Poore, 2000; Smale et al., 2011; Tuya et al., 2008; Tuya et al., 2008; Wernberg et al., 2003), disrupting ecosystem balances and leading to habitat loss (Last et al., 2011). Additionally, dietary adjustments have already been observed in female AUFS during periods of stronger winds, reflected in prey preferences patterns (Kliska et al., 2022), which is expected in generalists populations. Since environmental shifts are forecasted, further modifications in prey selection are likely, potentially impacting specialised individuals (Bolnick et al., 2003) that rely on prey species becoming less available.

In addition to anticipated climate-driven environmental changes, south-eastern Australia south-eastern Australia hosts substantial seafloor infrastructure from oil and gas operations (Advisian, 2020; Cullinane and Gourvenec, 2017), much of which is nearing decommissioning and overlaps with proposed large-scale offshore wind farm developments (Hickcox et al., 2022). Previous studies have suggested that these infrastructure may be important foraging habitats for AUFS (Arnould et al., 2015) and other predators (e.g. Phoca vitulina and Halichoerus grypus; (Russell et al., 2014). By providing structural complexity, artificial hard substrates can enhance local invertebrate biodiversity and support small fish and cephalopods (Bombace et al., 1994; Paxton et al., 2020), ultimately altering the ecosystem dynamics. As a result, any removal or addition of such structures could impact the prey field of AUFS, potentially affecting the foraging efficiency of the adult females provisioning pups.

In summary, the present study reveals fine-scale foraging behaviour in breeding female AUFS. Prey encounter and capture success of sampled individuals were influenced by sessile invertebrate cover, time of the day, and depth. While the video data captured a small proportion of the total foraging behaviour of a relatively small number of individuals, it provided valuable insights into their fine-scale habitat preferences, information crucial for understanding the small-scale variables that can affect prey encounters and capture in AUFS. Such insights are particularly valuable for understanding the fine-scale environmental variables that shape prey dynamics in AUFS and may help anticipate how these relationships could be disrupted under future environmental change. Future research focusing on the role of these variables in shaping prey behaviour will be essential for understanding their relationship with the benthic environment, which is increasingly threatened by anthropogenic activities.

Ethics statement

All animal handling procedures for the present study were conducted in accordance with the regulations, guidelines and approval of the Deakin University Animal Ethics Committee (Approval A16/2008, A14/2011, B16/2014, B04/2017), and the Department of

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CRediT authorship contribution statement

Jacquomo Monk: Writing – review & editing, Validation, Methodology, Conceptualization. **Saia N. Bartes:** Writing – review & editing, Writing – original draft, Validation, Methodology, Investigation, Data curation, Conceptualization. **John P.Y. Arnould:** Writing – review & editing, Supervision, Resources, Project administration, Funding acquisition, Conceptualization. **Kyler Abernathy:** Software, Resources. **Daniel Ierodiaconou:** Writing – review & editing, Investigation. **Holly J. Lourie:** Writing – review & editing, Methodology. **Andrew J. Hoskins:** Writing – review & editing, Methodology, Data curation. **Nicole Dorville:** Writing – review & editing, Methodology, Data curation. **Alastair M.M. Baylis:** Writing – review & editing, Data curation, Conceptualization. **Jayson Semmens:** Software, Resources, Funding acquisition. **Mark A. Hindell:** Resources, Funding acquisition.

Declaration of Competing Interest

The authors declare no competing interests.

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Author contributions

S.N.B., J.P.Y.A. and J.M conceived the ideas and designed the methodology; J.P.Y.A. and A.J.H. collected the data; S.N.B., J.M., A. M.M., H.J.L. and N.D.A. analysed the data; S.N.B., J.P.Y.A., M.A.H., A.M.M.B, A.J.H., N.D.A., D.I., J.S., and K.A.: provided resources and assisted in the interpretation of the results. S.N.B. led the writing of the manuscript. All authors contributed critically to the manuscript preparation and gave final approval for publication.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.gecco.2025.e03712.

Data availability

The authors do not have permission to share data.

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