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The Former Pelagic Longline Fishery of a Large-Scale Marine Protected Area

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Received: 6 September 2024 | **Revised:** 19 December 2024 | **Accepted:** 29 January 2025

Funding: This work was funded by the Ascension Island Government, the UK Government's Blue Belt Programme, and a Darwin Initiative grant (DPLUS063) awarded to Ascension Island Government Conservation & Fisheries Directorate (SW and AR). CK was funded via a doctoral training grant awarded as part of the UKRI AI Centre for Doctoral Training in Environmental Intelligence (UKRI grant number EP/S022074/1). KM acknowledges support of the Convex Seascape Survey, Oceans 5, and the Wildlife Conservation Society Congo Programme.

Keywords: Ascension Island | automatic identification systems | bigeye tuna (*Thunnus obesus)* | bycatch | historic fishing | LSMPA

ABSTRACT

The establishment of large-scale marine protected areas (LSMPAs) has emerged as one of the defining trends in ocean conservation over recent decades. To assess the potential benefits of such designations, it is necessary to understand the nature of the threats that have been excluded. Here, we summarise over 25 years of historical catch and effort data for a pelagic longline fishery that formerly operated within the recently designated LSMPA surrounding Ascension Island (UK), using data compiled from logbooks and observer programmes. Licenced fishing by foreign vessels (primarily flagged to Taiwan and Japan) operated intermittently in the Ascension Island exclusive economic zone (EEZ) between 1988 and 2016, with catch peaking at over 5000 t $year^{-1}$ in the early 1990s. Bigeye tuna (*Thunnus obesus*) was the dominant species targeted (76% of total catch weight) whilst oceanic sharks (e.g. blue shark *Prionace glauca*) and other predatory pelagic finfish (e.g. longnose lancetfish *Alepisaurus ferox*) appear to have presented a sizable bycatch risk, accounting for 37% of total individuals caught in local observer data. The fishery displayed strong seasonality, with two thirds of activity occurring between December and March and was consistently concentrated in the northwest of the EEZ. This distribution closely aligns with recent satellite-derived vessel tracking data which suggests that a regional longline fishing hotspot remains in the high seas area adjacent to the northwest of the Ascension Island MPA. Our results suggest that predatory pelagic fish and sharks will be the most direct beneficiaries of the Ascension Island MPA, although the high mobility of these species may lessen any conservation impacts, given intense the fishing effort in adjacent high seas areas. While illegal fishing remains a potential threat, the spatiotemporal predictability of the historic fishery may be useful in identifying areas of elevated risk for targeted enforcement in this large, remote MPA.

1 | Introduction

Industrial fishing provides a global economic output of $119 billion, with vessels flagged to higher income countries responsible for approximately 97% of revenue generated (McCauley et al. 2018). These countries have invested substantially in maintaining their industrial fleets, including through subsidies for fuel and modernisation programmes

(Schuhbauer et al. 2020). Improved efficacy and capacity have resulted in unsustainable fishing practices, with most nations that support an industrial fishing sector having exhausted fish stocks within their own exclusive economic zones (EEZs) which generally extends to 200 nautical miles from the coast (Swartz et al. 2010). As these fleets have ventured into increasingly distant waters to maintain catch rates, pervasive overexploitation has led to annual global fisheries catch declines for over a quarter of a century (Pauly and Zeller 2016; Skerritt et al. 2023). Over 40% of global marine catch is thought to be bycatch as industrial fishing generally utilises indiscriminate trawling, netting and longlining gear types resulting in the widespread depletion of a multitude of taxa including marine mammals, turtles and seabirds which present no commercial value (Davies et al. 2009; Lewison et al. 2014; Mucientes et al. 2022).

The designation of marine protected areas (MPAs), which limit human activities within defined geographic spaces, has become a popular tool for combatting biodiversity loss and fisheries catch declines (Halpern 2003). Currently, MPAs cover approximately 30 million km^2 (~8%) of the global ocean (Marine Conservation Institute, 2025); however, it is estimated that at least 30% MPA coverage is needed by 2030 to restore healthy seas (CBD 2022). As governments strive to meet area-based conservation targets, a notable trend has been the implementation of large-scale MPAs (LSMPAs; areas >100,000 km^2) (Leenhardt et al. 2013). LSMPAs now account for 75% of global MPA coverage (~22 million km^2) with most designated in remote island locations and overseas territories that host small human populations (Devillers et al. 2015; Jones and De Santo 2016). Consequently, fishing activity within these regions prior to MPA establishment is primarily conducted by distant-water fleets targeting large pelagic species destined for high-value foreign markets (Schiller et al. 2018).

Highly protected LSMPAs can offer ecosystem wide protection and improved ecological connectivity, with highly mobile species afforded extended protection across their ranges (Toonen et al. 2013; White et al. 2017; O'Leary et al. 2018). However, critics argue that some LSMPAs have been strategically placed in areas of low commercial value to help countries meet protection targets with minimal resistance, whilst others question the ability to enforce regulations over such vast spatial scales (De Santo 2020; Collins et al. 2023; Relano and Pauly 2023). To properly evaluate the conservation benefits of LSMPA designation, as well as ongoing threats from non-compliance, it is first necessary to understand the nature and scale of the activities that have been excluded (Curnick et al. 2020; White et al. 2020; Magris 2021). However, such studies are often challenged by limited accessibility or availability of historic records lodged in government or industry reports and archives.

In this paper, we synthesise available data on the pelagic longline fishery that formerly operated within a recently designated LSMPA surrounding the remote UK Overseas Territory of Ascension Island in the tropical Atlantic Ocean. With the exception of some small-scale inshore recreational and sports fishing (which is still permitted within 12 nm of the island), pelagic longlining was the only extractive industry that historically occurred within the Ascension Island EEZ. The closure of this industrial fishery in 2019 was therefore the most direct impact of MPA designation. However, while some data on the former fishery have been collated in economic studies (Muench et al. 2022) and government reports (Reeves and Laptikvoksky 2014), there is currently no coherent synthesis on the chronology, catch and distribution of the fishery. Here, we assess how total reported catch and effort varied across the lifetime of the fishery, summarise available data on catch composition and evaluate the spatial and seasonal distributions of historic fishing activity. We also track the movement of the regional longline fleet in recent years using satellite-derived automatic identification system (S-AIS) data to validate historic logbook data and assess residual risk to the MPA from illegal fishing.

2 | Methods

2.1 | Study Area and Policy Context

Ascension Island (7°56′S, 14°22′W) is a small (97 km^2), isolated volcanic island located in the tropical Atlantic Ocean (Figure 1), with an EEZ covering 445,390 km^2. This area has been highlighted as a biodiversity hotspot harbouring numerous endemic species and supporting large communities of seabirds, turtles, sharks, tuna and other pelagic fish at important life history stages (Roberts et al. 2002; Weber et al. 2014, 2017, 2021; Richardson et al. 2018; Thompson et al. 2021; Townhill et al. 2021).

The EEZ has been subject to industrial fishing from distant-water fleets since the mid-twentieth century when Japanese and Taiwanese vessels commenced pelagic longlining operations in the region (RSPB 2017; Appleby et al. 2021). In 1988, a licencing system was introduced to regulate growing fishing pressure which was managed out of St. Helena until the fishery was closed in February 2006 to transfer management to the Ascension Island Fisheries Council (Muench et al. 2022). The fishery temporarily reopened in October 2010 but closed again at the beginning of 2014 to review and update fisheries legislation and consider proposals for the implementation of an MPA (Rowlands et al. 2019). In 2015, the fishery reopened under more stringent licensing conditions, which included a requirement to take local observers, enhanced vessel safety requirements, and prohibited industrial fishing in the southern half of the EEZ and within 50 nm of Ascension Island (Burns, Hawkins, and Roberts 2020). As a result, only two licences were issued for the 2015–2016 season with licensing suspended from 2016 onwards. In August 2019, a decision was taken to permanently prohibit industrial fishing activity within the entirety of the EEZ, culminating in the establishment of the Ascension Island MPA (Rowlands et al. 2019; Ascension Island Government 2021).

2.2 | Historical Fishing Data

A licensing condition for vessels fishing within the Ascension Island EEZ from 1988 to 2013 was the submission of exit reports which detailed the weight and composition of catch (Reeves and Laptikvoksky 2014). Exit reports required vessels to report species specific weights (tonnes) for three species of tuna (albacore, *Thunnus alalunga*; bigeye, *Thunnus obesus*; yellowfin, *Thunnus albacares*) and five species of billfish

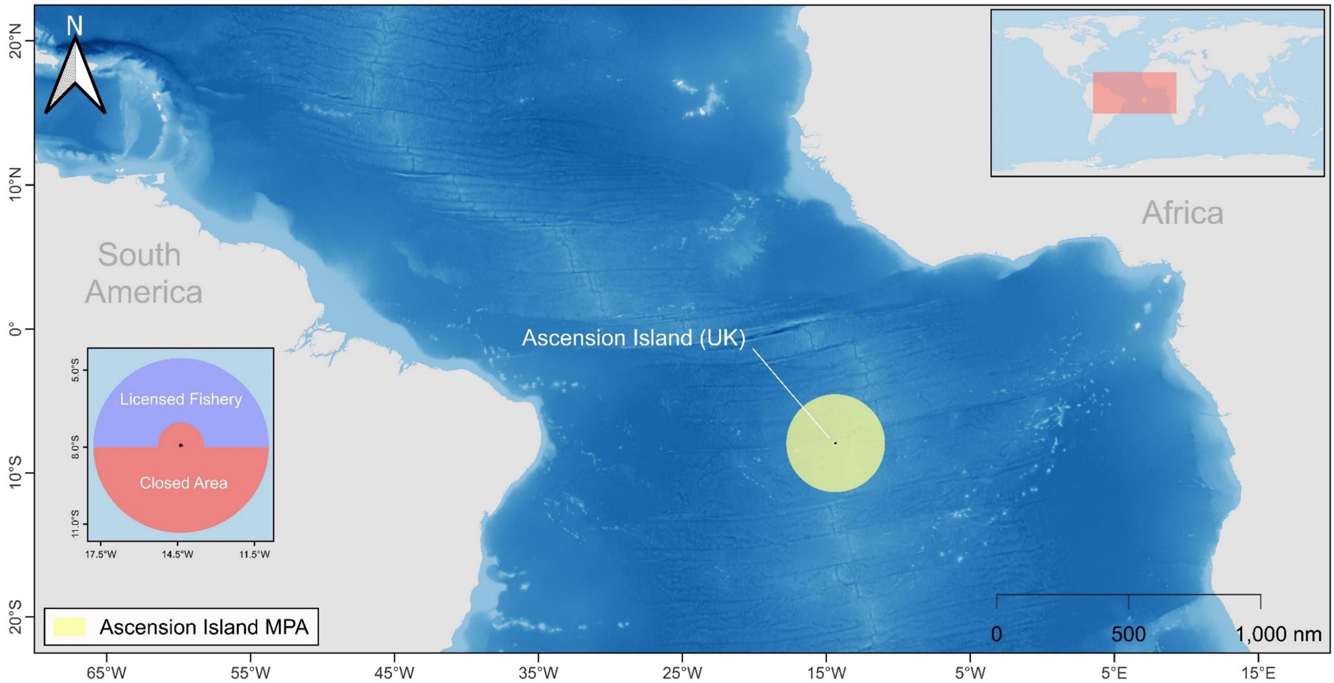

FIGURE 1 | Map of the Ascension Island marine protected area (MPA), designated in 2019, within the tropical Atlantic Ocean. The MPA covers the entire Ascension Island exclusive economic zone (EEZ). *Inset*, map of the Ascension Island EEZ fishing zones during a partial closure that was in effect from 2015 to 2019.

(swordfish, *Xiphias gladius*; sailfish, *Istiophorus albicans*; striped marlin, *Kajikia audax*; black marlin, *Istiompax indica*; and blue marlin, *Makaira nigricans*) whilst all other species were grouped as 'other' (Reeves and Laptikvoksky 2014). Exit reports were replaced with enhanced catch reporting requirements in 2015 when the fishery reopened which required vessels to provide details of catch, effort and temporal and spatial information for every longline set. Catch composition from the 2015–2016 season was standardised to the catch categories listed in 1988–2013 exit reports to ensure reporting consistency across the entirety of the licenced fishery. The total weight of each species was calculated from combining all reports across the lifetime of the fishery. This was divided by the total weight of all catch over the same period to derive the proportions of each species in the catch composition.

Exit reports also detailed the exit date and the total number of fishing days spent within the Ascension Island EEZ. Data for the 2015–2016 season has been aggregated to fishing days to provide a standardised effort metric across the entirety of the licenced fishery. The number of fishing days provided by each report was aggregated by the year that the report was submitted whilst annual catch was calculated by aggregating the total weight of all species that had been reported. As the data was recorded at the level of individual vessels, in years where fishing was conducted by numerous vessels, the total days fished surpassed the total number of days in a year. Total annual catch and catch per unit effort (CPUE) of tuna species was also calculated as these were the primary targets of the fishery (see Results). The number of licences issued to vessels annually was obtained from Ascension Island Government (AIG) statistics (reported in Muench et al. 2022) and compared to the number of vessels that actively fished within Ascension Island EEZ each year by identifying the number of unique call signs that submitted at least one report within each year to ascertain effort by the registered fleet. Licence years typically ran from 1 September to 31 August and are grouped according to year sold, not necessarily in which fishing occurred.

Annual variation in licenced uptake, effort, tuna catch and CPUE were analysed using generalised additive models (GAMs) implemented through the 'mgcv' package (Wood 2003) in R 4.3.0 (R Core Team 2023). In all fitted GAMs, response variables were modelled as a smooth function (thin plate spline) of year, using a log link function and Tweedie error distribution. The significance of the overall interannual trend was assessed using p values from Wald tests estimated internally by 'mgcv' (Wood 2013). However, as GAMs utilise nonlinear smoothers to model responses, significant relationships may exist over only a portion of covariate space. Therefore, to identify periods of significant change, the 'derivative' function in the R package 'gratia' was used (Simpson 2024) to identify regions of the fitted splines where the 95% simultaneous confidence intervals around the first derivatives (i.e. slopes) did not overlap zero.

A further licencing condition required vessels fishing within the Ascension Island EEZ to submit Weekly Catch Position Reports (WCPRs) which detailed the approximate position, number of fishing days and accumulated catch weight of each vessel per week (Reeves and Laptikvoksky 2014). Substantial differences in the number of vessels submitting WCPRs with that recorded by exit reports and licence sales in some early years of the fishery (especially 1990) suggests that the WCPR archive may be incomplete for analysing temporal trends in catch and effort (Figure S1). Consequently, only information on the fishing month and position was extracted from these data. For the 2015–2016 season where spatial data was submitted for each longline set, the centroid of all longline set positions within each week was calculated to ensure consistency in reporting frequency. Spatial analysis was conducted by aggregating catch (tonnes) and effort (fishing days) into 0.25° grid cells (28 × 28 km resolution at the equator) across the Ascension Island EEZ. However, from 1988 to 2013, vessels were only required to provide one position per week despite having the engine power to cover a much larger area and using longlines that range from 90 to 125 km in length (Huang 2013). It is also likely that position data was recorded at the time of the WCPR completion rather than the centre of fishing activity and so may provide a displaced estimate of both catch and effort. Consequently, Gaussian smoothing (a type of low pass filter) was used to preserve broad patterns whilst removing high frequency 'noise' associated with stochastic distributions inherent in WCPR position data. This applied a kernel smoothing function which calculated the weighted average for each cell based on a circular area encompassing the neighbouring five cells (equating to a distance of ~ 140 km; or maximum longline length). CPUE was then calculated by dividing smoothed total catch by smoothed total fishing days for each grid cell for every month and year.

2.3 | Local Observer Data

Following reforms to fisheries licensing legislation in 2015, vessels fishing in the Ascension Island EEZ were required to accept local observers who were contracted by the AIG from an independent agency. An observer was deployed upon one vessel at sea from the AIG patrol vessel from 11 February 2016 to 20 February 2016 and directly observed 4784 of 18,955 hooks (25%). This represented 14% (9 days) of the total number of fishing days conducted by the licenced fleet (65 days). Observer catch data was documented at a much higher taxonomic resolution than exit reports (generally species specific) and recorded both retained and discarded species. This helped to corroborate and contextualise earlier exit report data, in particular the composition of the 'other' category and provided insights into non-commercial bycatch species that were not recorded in exit reports.

2.4 | Satellite AIS Data

The low spatial and temporal resolution of WCPR data (one position per week) provides only a coarse indication of the historic distribution of commercial fishing activity within

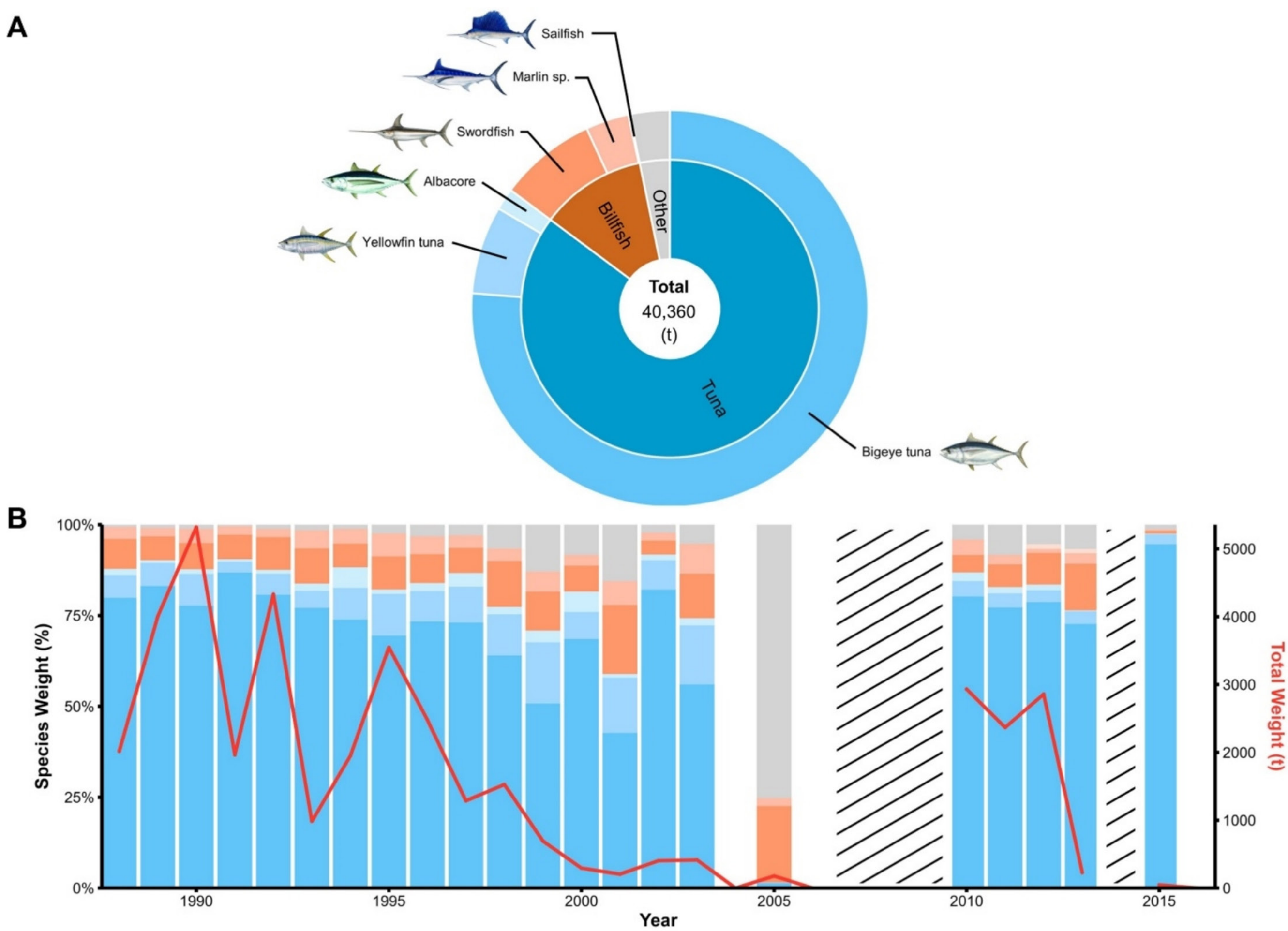

FIGURE 2 | Catch composition of the licenced pelagic longline fishery in the Ascension Island exclusive economic zone based on exit report (1988–2013) and set report (2015–2016) data. (A) Proportions of total weight recorded between 1988 and 2016. (B) Annual percentages of species in catch composition (bars) and total catch (tonnes; red line) from 1988 to 2016. Dashed lines represent years of licenced fishery closure. Species images; ©Diane Rome Peebles, ©Marc Dando.

the Ascension Island EEZ between 1988 and 2016. To assess the plausibility of these estimated distributions, we compared historic fishing effort to contemporary longlining activity in the high seas surrounding Ascension Island EEZ, using high-resolution vessel monitoring data obtained from Global Fishing Watch (GFW; Kroodsma et al. 2018). Daily gridded longline effort data (0.01° = 1.1 km resolution at the equator) were obtained for the tropical Atlantic Ocean (22° N–22° S) for the period 2014–2023 and merged to calculate cumulative fishing effort for each cell. GFW uses S-AIS vessel-tracking data (which is mandatory for vessels over 300 t under international maritime law) coupled with machine learning algorithms to identify and map gear-type-specific fishing behaviour (Kroodsma et al. 2018). S-AIS coverage has only been available in the Atlantic Ocean since 2012 and is sparse prior to 2014, so cannot provide data on legal fishing activity inside the Ascension Island EEZ, which had largely ceased by this time (McCauley et al. 2016). Nevertheless, assuming that the regional fleet and métier has remained relatively constant, contemporary longlining effort in adjacent high seas areas may provide a useful validation of historic data from vessels operating within the Ascension Island EEZ, as well as an indication of areas at elevated risk from illegal fishing inside the MPA.

3 | Results

3.1 | Catch Composition

According to exit reports from 1988 to 2013 and set reports from 2015 to 2016, a total of 439 different vessels legally fished in the Ascension Island EEZ between 1988 and 2016, accounting for 33,720 fishing days and catching a combined total of 40,360 t.

These data indicate that tuna species accounted for 85% of total landings in the Ascension Island EEZ fishery whilst billfish equated to 12% (Figure 2A). The fishery was dominated by bigeye tuna, which represented 76% of landings by weight, with swordfish (8%) and yellowfin tuna (7%) being the main secondary catch. Other identified tuna and billfish species comprised 6.6% of retained catch (black marlin, 3%; albacore, 2%; blue marlin, 1%; striped marlin, 0.5%; sailfish, 0.1%) while 'other species', for which no further taxonomic information was recorded, represented the remaining 3% (Figure 2A). Annually disaggregated reports indicate that catch composition remained relatively stable across the lifetime of the fishery (Figure 2B), although with a gradual decline in the proportion of bigeye tuna landed from the late 1990s and early 2000s. The high proportion of other species present in 2005 is more likely a reflection of low fishing

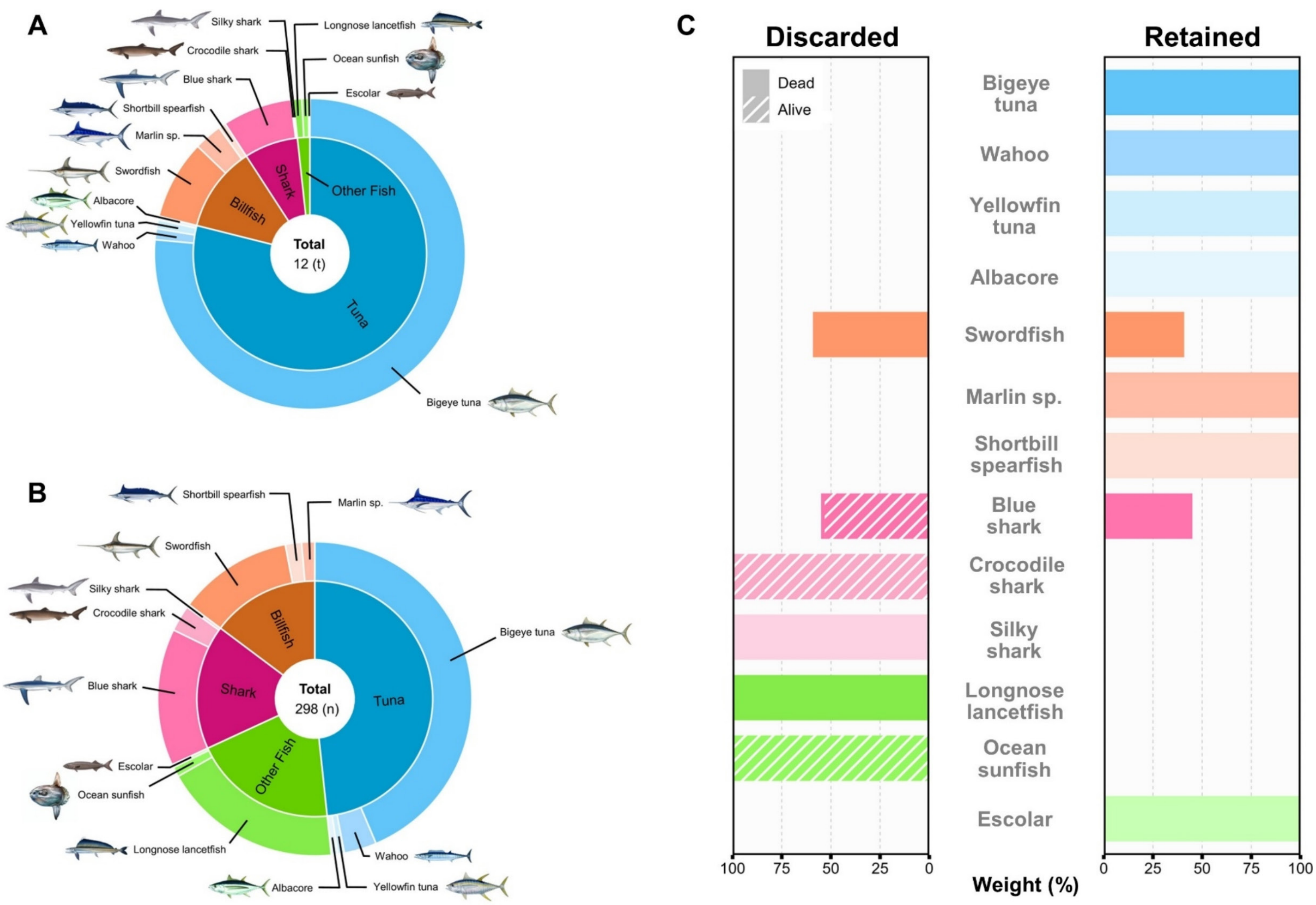

FIGURE 3 | Catch composition of the licenced pelagic longline fishery in the Ascension Island exclusive economic zone based on 2016 observer data. (A) Proportions of total weight (tonnes) recorded. (B) Proportions of individuals recorded. (C) Percentages of species retained and discarded. Species images; ©Diane Rome Peebles, ©Marc Dando, ©R.Swainston/Anima. fish, ©Getty Images, ©Shuttershock.

effort rather than shifts in catch composition dynamics before the closure of the fishery in 2006 as upon reopening in 2010, the proportion of bigeye tuna landed increased to levels comparable to the late 1980s and early 1990s.

Broadly similar patterns in catch composition were evident in local observer data collected in 2016, with tuna and billfish comprising 79% and 12% of total catch weight respectively (Figure 3A). Sharks represented 7% of catch, with blue sharks

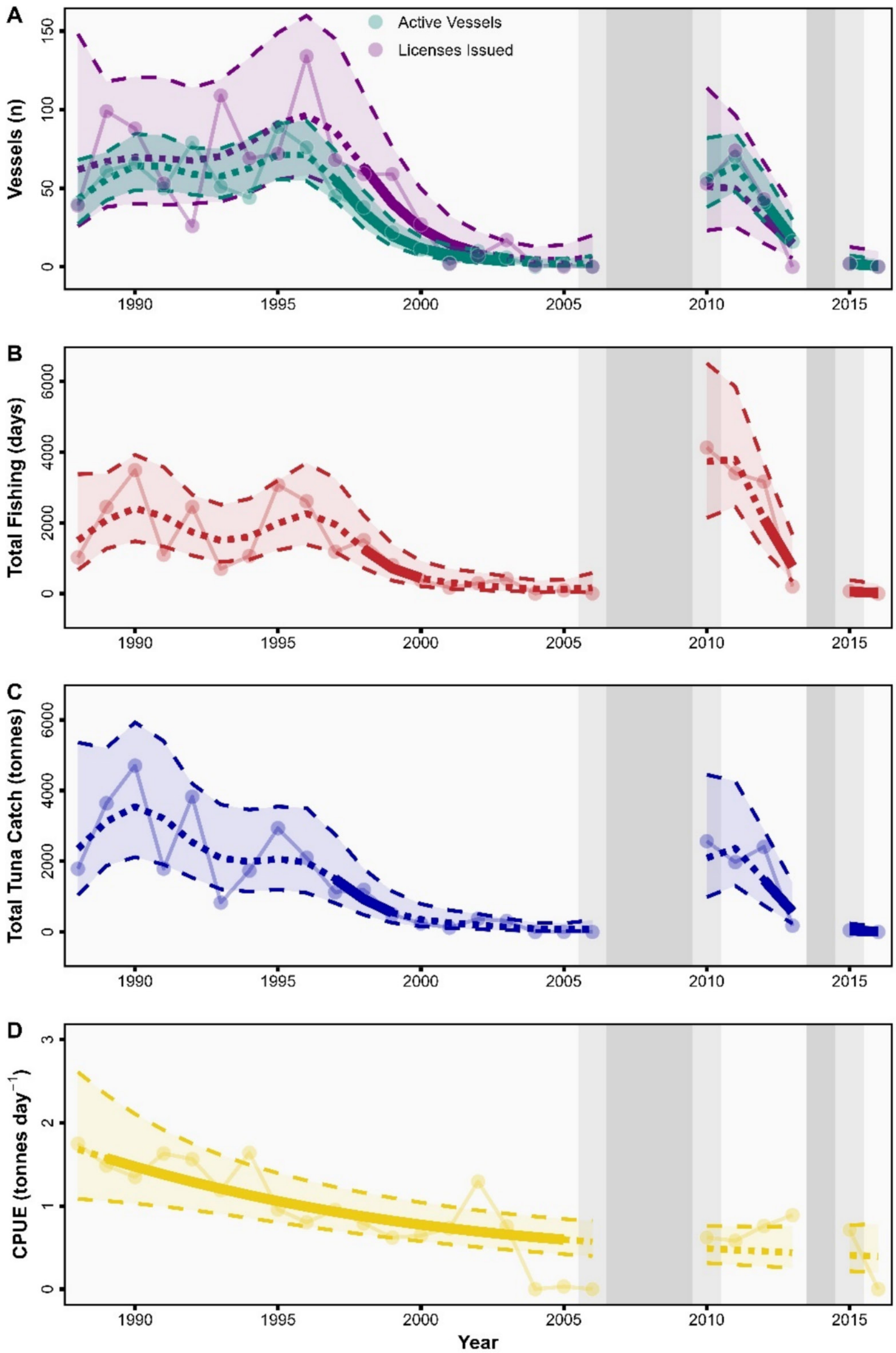

FIGURE 4 | Annual time series of the licenced pelagic longline fishery of Ascension Island exclusive economic zone between 1988 and 2016. (A) The total annual number of vessels actively fishing based on vessels submitting at least one exit (1988–2013) or set (2015–2016) report and the total number of licences sold (taken from Muench et al. 2022). (B) The total annual fishing effort in days taken from exit and set reports. (C) The total annual fishing catch in tonnes of tuna species taken from exit and set reports. (D) The annual catch per unit effort (CPUE) based on dividing the total annual catch by the total annual fishing effort. Trendlines are thin plate regression splines from fitted generalised additive models (GAMs) with 95% confidence intervals (shaded area). Bold sections of splines demonstrate significant change based on the simultaneous confidence intervals around the first derivatives. The dark grey section represents when the fishery was closed for an entire year whilst the lighter grey represents when the fishery was closed for at least part of the year.

Prionace glauca accounting for 97% of this group whilst other species of pelagic finfish equated to 2% of catch weight including longnose lancetfish *Alepisaurus ferox* (1%), ocean sunfish *Mola mola* (1%) and Escolar *Lepidocybium flavobrunneum* (0.2%) (Figure 3A). The percentage of billfish in the catch composition was relatively consistent when assessed by individuals caught (15%); however, tuna catch was greatly reduced (48%) (Figure 3B). In contrast, pelagic finfish increased to 20% mainly due to an abundance of longnose lancetfish (18%) whilst the percentage share of sharks rose to 17% predominantly driven by an increase in blue sharks (14%) (Figure 3B). Seabird, turtle and marine mammal species were not observed to have interacted with the fishery.

Observer data demonstrated that 100% of all tuna species were retained after capture alongside all species of marlin, shortbill spearfish *Tetrapturus angustirostris* and Escolar. Conversely, all silky shark *Carcharhinus falciformis* and longnose lancetfish were discarded dead whilst 100% of crocodile shark *Pseudocarcharias kamoharai* and ocean sunfish were reportedly returned alive. Approximately 40% of swordfish were retained with the remaining 60% discarded dead, whilst 45% of blue shark were retained with the vast majority of the 55% discarded returned alive (Figure 3C).

3.2 | Temporal Trends in Fishing Activity and CPUE

In the first decade of the fishery, the annual number of vessels actively fishing the Ascension Island EEZ varied between 40 in 1988 and 89 in 1995 (Figure 4A) with the total number of fishing days ranging from 699 in 1993 to 3487 in 1990 (Figure 4B) and catch fluctuating between lows of 832 t in 1993 and peaks of 4704 t in 1990 (Figure 4C). However, despite high inter annual variability, CPUE displayed a relatively stable decline from 1.75 t day^{-1} in 1988 to 0.95 t day^{-1} in 1997 (Figure 4D).

Derivative analysis of fitted GAMs indicated that the mean annual number of vessels actively fishing significantly declined ($F_{7.9} = 13.8$, $p < 0.001$) between 1997 and 2003 reducing from 56 (95% confidence interval [CI] 42–74) to 3 (95% CI 2–7). Similarly, the predicted number of licences issued also significantly declined ($F_{6.62} = 5.7$, $p = 0.001$) between 1998 and 2002 reducing from 63 (95% CI 37–110) to 9 (95% CI 4–22). A slow decline continued until the closure of the fishery with an estimated 2 (95% CI 1–7) vessels active and 6 (95% CI 2–20) licences issued in 2006 (Figure 4A). As a result, fishing effort and tuna catch also experienced a significant decline during this period with mean annual effort decreasing from 1221 (95% CI 719–2215) days in

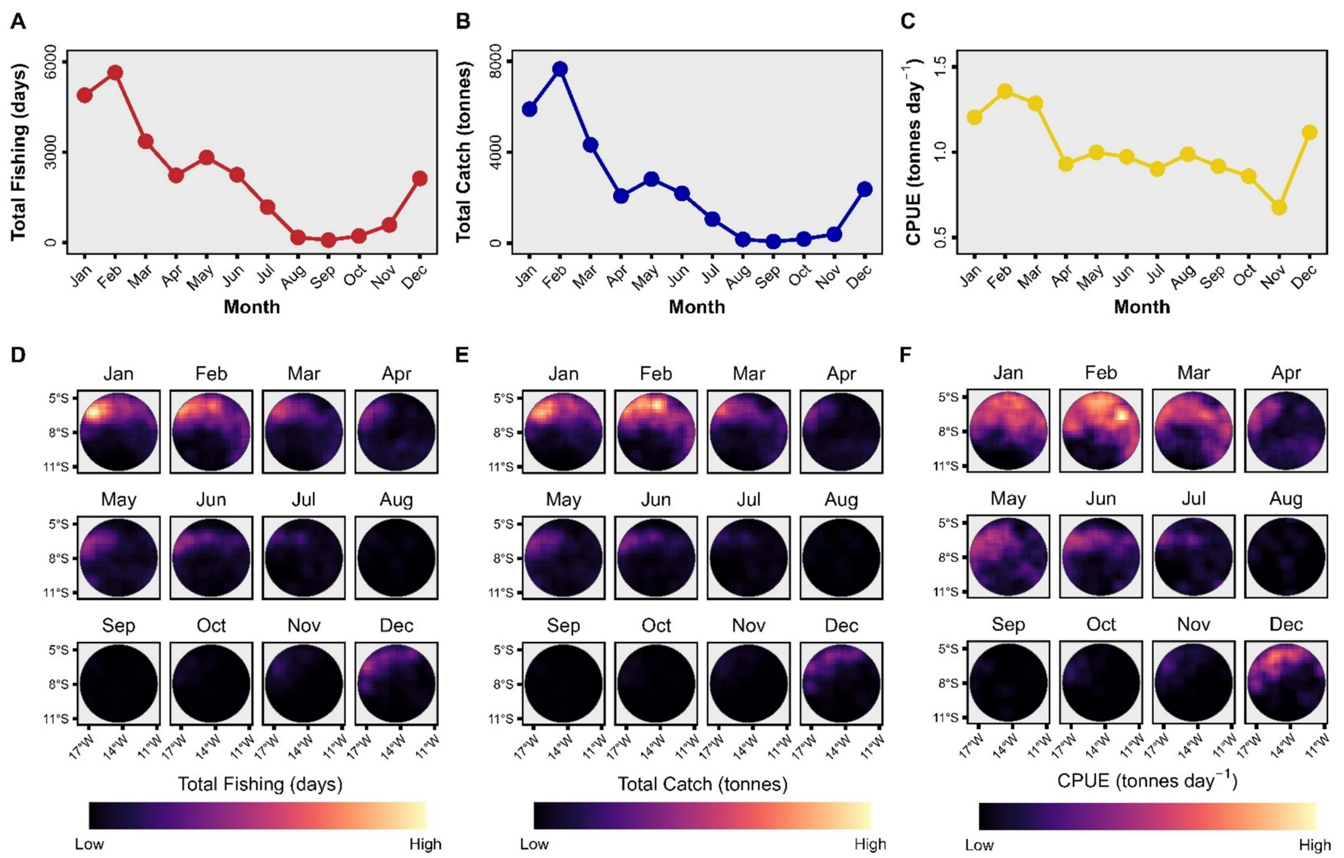

FIGURE 5 | Monthly time series of the licenced pelagic longline fishery of Ascension Island exclusive economic zone from 1988–2016. (A) Total fishing effort in days taken from weekly catch position reports 1988–2013 (WCPRs) and set reports 2015–2016. (B) Total catch in tonnes taken from exit reports 1988–2013 and set reports 2015–2016. (C) Monthly catch per unit effort (CPUE), calculated by dividing the total monthly catch by the total monthly fishing effort. (D) Spatial distribution of relative fishing effort per 0.25° grid cell from WCPR and set report data. (E) Spatial distribution of relative total catch per 0.25° grid cell from WCPR and set report data. (F) Spatial distribution of relative catch per unit effort (CPUE) based on dividing the catch of each grid cell by the fishing effort.

1998 to 432 (95% CI 204–918) in 2000 ($F_{7,43} = 7.15$, $p < 0.001$) and mean tuna catch decreasing from 1500 t in 1997 (95% CI 817–2754) to 544 t (95% CI 258–1148) in 1999 ($F_{7,27} = 8.36$, $p < 0.001$). Effort and catch in subsequent years continued to diminish with an estimated 161 (95% CI 45–578) days fished and 86 t (95% CI 22–334) landed in 2006 (Figure 4B,C). The onset of declining licence sales, effort and catch was preceded by an extended significant decrease in mean annual CPUE of tuna, ($F_{1,43} = 6.80$, $p = 0.005$), which fell from 1.49 t day^{-1} in 1989 (95% CI 1.06–2.34) until the first closure period reaching 0.60 t day^{-1} in 2005 (95% CI 0.42–0.84) (Figure 4D).

Following the reopening of the fishery in 2010, effort and catch rebounded, with 2010 (3731 days; CI 2138–6512) and 2011 (3793 days; CI 2458–5852) recording the highest number of fishing days over the lifetime of fishery (Figure 4B). However, the recovery of tuna CPUE was less pronounced, with the mean CPUE for the period 2010 to 2015 (0.71 t day^{-1}; 95% CI 0.27–0.76) below CPUE prior to the first period of significant decline in effort (Figure 4D).

3.3 | Spatial Distribution and Seasonality

Monthly analysis of WCPR data revealed high seasonality in fishing activity within the Ascension Island EEZ with 63% of total effort and 69% of total catch between 1988 and 2016 occurring from December to March and peaking in February (effort 22%, 5640 fishing days; catch 26%, 7654 t). CPUE was also found to be highest during this period with a mean of 1.24 t day^{-1} compared to a mean of 0.86 t day^{-1} between August and November, when just 4% of total effort and 3% of total catch occurred (Figure 5A–C). Fishing activity was heavily concentrated in the northern half of the EEZ

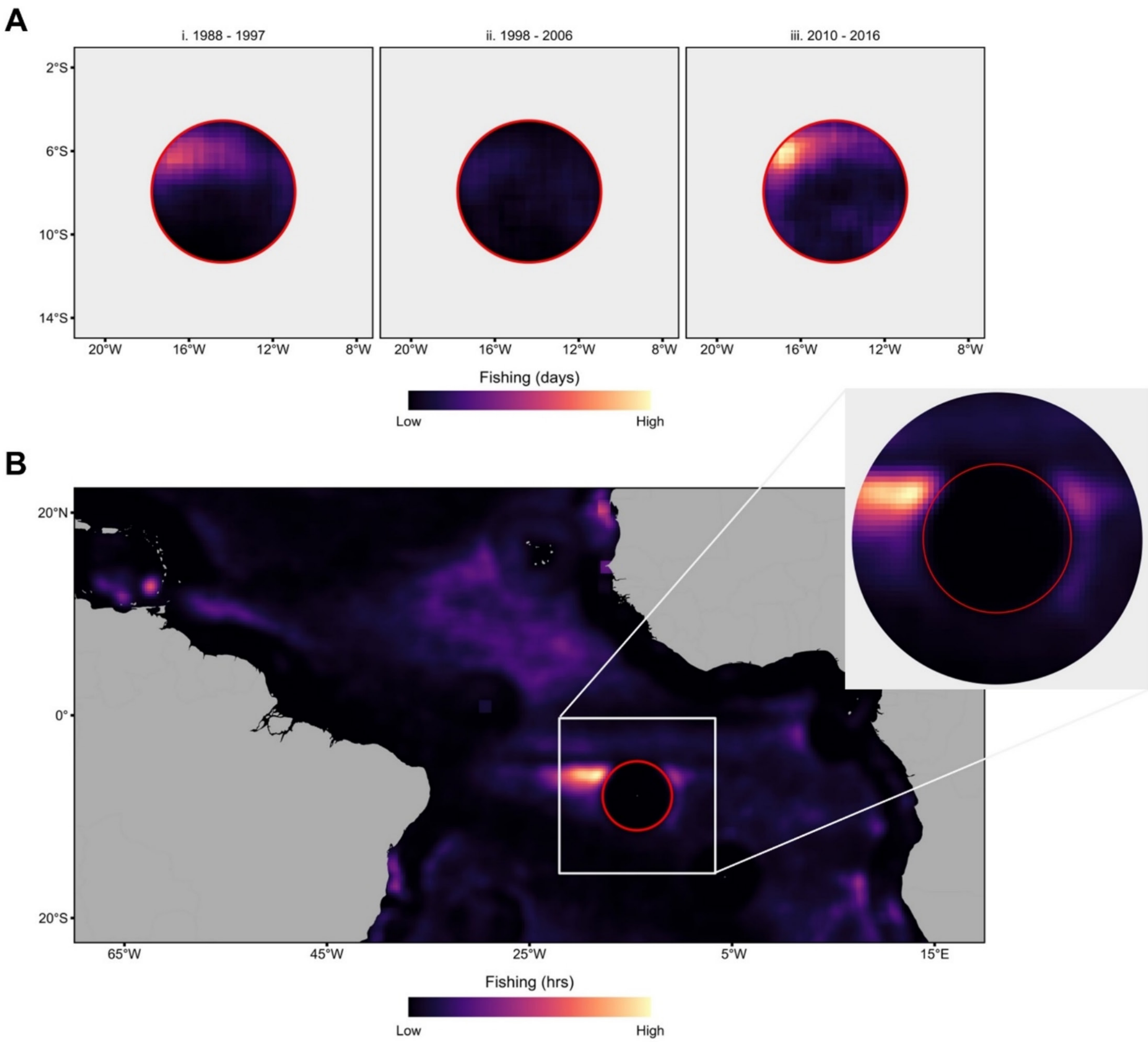

FIGURE 6 | Comparison of effort for the licenced pelagic fishery of the Ascension Island exclusive economic zone with the wider tropical Atlantic Ocean. (A) Map of total fishing days from 1988 to 2016 based on weekly catch position and set reports. (B) Map of total fishing hours at 0.25° resolution from 2014 to 2023 based on automated identification system data from Global Fishing Watch. *Inset*, close up of MPA and 200 nm buffer zone. Red circle represents MPA boundary.

with the northwest emerging as the centre of activity during the peak fishing period of December to March (Figure 5D–F). This spatial distribution was consistent across the lifetime of the fishery (Figures S1–S3 and 6A). Analysis of fishing effort in the surrounding 200 nm of high seas using AIS data demonstrated that the area adjacent to the northwest of the EEZ also received the vast majority of fishing (Figure 6B); however, effort peaked in December for this region (Figure S4).

4 | Discussion

This study presents the first detailed synthesis of historic commercial fishing activity in the Ascension Island EEZ and can be used to aid assessments of the conservation benefits of a large scale fully protected MPA going forward, as well as addressing residual threats from illegal fishing.

Logbook data indicate that the main fishing activity was the targeting of bigeye tuna by Japanese and Taiwanese flagged vessels operating in the far northwest of the EEZ. Licence uptake appears to have been primarily driven by demand for bigeye tuna within the Japanese sushi and sashimi market (Muench et al. 2022), whilst yellowfin tuna and albacore may have been secondarily targeted for the canned market (Muench et al. 2022). The remainder of the catch consisted of billfish, particularly swordfish and marlin, and an unspecified 'other' fraction. Enhanced catch reporting from 2015 onwards revealed that only the weight of retained catch was recorded in vessel logbooks. Therefore, the 'other' fraction may have comprised of additional retained species recorded in local observer data, which was primarily blue shark along with smaller numbers of several pelagic finfish species (e.g. shortbill spearfish, escolar and wahoo). Blue shark and escolar are commonly associated with incidental capture in tuna longline fisheries and known to be retained by the wider Taiwanese distant water fleet (Huang and Liu 2010; Huang 2011; Jaiteh et al. 2021; Wang et al. 2021; Pan et al. 2024).

Compared to the regional Taiwanese longline fleet in the tropical Atlantic Ocean (data from Huang et al. 2009), local observer data indicate that catch from the Ascension Island fishery consisted of a higher proportion of bigeye tuna (76% vs. 41%), a similar proportion of billfish (12% vs. 10%), and a lower yield of sharks (7% vs. 22%) and other fish (2% vs. 13%), suggesting that it was either more targeted or had lower bycatch rates. Local observers also recorded a significantly higher proportion of 'other' catch (11%) compared to logbook data submitted by vessels (3%). This difference is most likely indicative of historic underreporting as discards of non-commercial bycatch species would have been absent from logbook data. Notes from the official observer report suggest that there may have been high levels of discards even amongst commercially valuable species such as swordfish and blue shark as only larger specimens were retained due to catch limits set by the International Convention of the Conservation of Atlantic Tuna (ICCAT). As only 0.03% of the fishing days conducted by the licenced fishery were independently observed, the scale and species composition of discards are largely unknown. Consequently, the footprint of the fishery will most likely have been substantially larger than suggested by historic logbook data.

As reported elsewhere (Gallagher et al. 2014; Xia et al. 2023), foraging ecology and depth use appear to have been significant in affecting the risk of incidental capture in longline gears targeting bigeye tuna in the Ascension Island EEZ. Swordfish and blue shark that dominated the secondary catch both have vertical ranges that substantially overlap with that of bigeye tuna in this region, with significant proportions of diurnal foraging spent in mesopelagic waters at 200–450 m depth (Madigan et al. 2021). While local studies are lacking, other common bycatch species such as crocodile shark, longnose lancetfish, escolar, and ocean sunfish are also reported to regularly use this depth range in warm water environments (Nakamura and Parin 1993; Romanov et al. 2008; Romanov and Zamorov 2008; Potter 2010). Notably, although the Ascension Island EEZ supports regionally significant populations of green turtles and seabirds (Weber et al. 2014; Weber and Weber 2020), no bycatch of these taxa was reported by local observers. While observer coverage was limited, this finding is consistent with evidence that green turtles and tropical seabirds (e.g. frigatebirds and boobies) have low susceptibility to capture in deep-set longline gears targeting bigeye tuna (Huang 2015).

In addition to catch composition, historic fishing data can also provide valuable information on the spatiotemporal distribution of effort, as a proxy for target species abundance or to map areas of high illegal fishing risk (Marriott et al. 2014; Dunn and Curnick 2019). In the case of the Ascension Island EEZ, analysis of weekly vessel positions show that effort and catch was predictably concentrated in the far northwest of the EEZ during the austral summer (December–March). Further work is needed to establish the environmental drivers of high fishing effort (and presumably increased bigeye tuna catches) in this region. However, this distribution was highly consistent over the lifetime of the fishery and corresponds with recent S-AIS data, which shows that a regional hotspot of pelagic longlining persists in high seas areas adjacent to where the historic fishery once operated. This 'fishing-the-line' behaviour is a cause for concern given the proximate location of the MPA and the history of non-compliance from the distant water fleet with international management measures in this region (Chen 2012; Huang, Chang, and Shyue 2021). Knowledge of the location of former fishing grounds can therefore provide useful information for enforcement planning, as expensive vessel patrols or satellite tasking can be targeted and scheduled to coincide with areas and periods of increased illegal fishing risk (e.g. in the northwest of the Ascension EEZ between December and March).

While catch composition and the distribution of fishing activity in the Ascension Island EEZ remained relatively constant over time, annual licence sales varied significantly over the lifetime of the fishery and can provide valuable insights into the economic factors that contributed to its eventual closure (see Muench et al. 2022). Historic data show that vessel licence registrations, catch and effort entered a period of sustained decline in the late 1990s and was preceded by a significant reduction in tuna CPUE in the Ascension EEZ beginning in the late 1980s. While the CPUE estimates calculated here are relatively coarse and unstandardised, this trajectory mirrors regional CPUE trends reported for bigeye tuna (Matsumoto, Yokoi, and Satoh 2020; ICCAT 2023) and corresponds with the onset of global marine fisheries decline (Pauly and Zeller 2016). Partly in response to concerns over stock declines, a fishing quota for bigeye tuna was imposed on the regionally dominant Taiwanese fleet in 1998 that restricted Atlantic catch to 16,500 MT per year (ICCAT 1997; Chen 2012). Together with falling consumer demand and import value for bigeye tuna in the principle Japanese market (Muench et al. 2022), these factors may have progressively eroded the profitability of the Ascension Island EEZ fishery resulting in reduced licence uptake.

A temporary resurgence in the fishery occurred upon reopening in 2010, with vessel registrations and CPUE increasing from pre-closure levels. This could be attributed to accumulation of fish stocks (either real or anticipated) during the closure period, with fleets aware of this through spillover benefits that have been shown to accrue in the waters surrounding MPAs (Medoff, Lynham, and Raynor 2022). However, since CPUE estimates generated here are unstandardised, increases may also reflect unmeasured changes in fishing methodology (e.g. number of hooks, soak time, longline length, fishing depth) or environmental conditions. When the fishery reopened following the second closure period in 2015 under stricter licence conditions, the requirement to carry an observer and increased licence fees, licence sales had dropped back to pre-2006 levels of 0–2 per year. The declining profitability of the fishery and reduced revenue from licence sales was a crucial factor in the economic case for the designation of the Ascension Island MPA (Muench et al. 2022), highlighting the value of historic data for contextualising contemporary conservation decision-making.

As with any industry dataset, fishing logbook data can suffer from inherent limitations, including self-reporting bias (Sampson 2011), coarse spatial and temporal resolution, and coverage limited to areas accessed by fishing fleets (Walters 2003). However, this study contributes to a growing literature showing that, if used appropriately and corroborated with other sources, such data can provide valuable insights into the management and potential conservation benefits of MPAs (Dunn and Curnick 2019; Curnick et al. 2020; Griffiths et al. 2022; Medoff, Lynham, and Raynor 2022). In the case of the Ascension Island EEZ, catch data indicate that several species of pelagic finfish, sharks, billfish and tuna were most directly impacted by the fishery and are therefore expected to be the most direct beneficiaries of its closure. Many of these species remain subject to unsustainable levels of exploitation in the wider region (ICCAT 2023) and in need of effective conservation measures. However, they are also highly mobile which presents challenges for protection even in very large MPAs (Conners et al. 2022; Hampton et al. 2023), particularly given high fishing effort on the boundaries of many LSMPAs and the associated risk of illegal encroachment (Kellner et al. 2007; Boerder, Bryndum-Buchholz, and Worm 2017; Cabral et al. 2017). Knowledge of the spatiotemporal distribution of historic fishing activity may assist with the latter by enabling targeted surveillance and enforcement, although this assumes that vessels engaged in illegal activity continue to behave in a similar way to former licenced fleets, which is increasingly uncertain as target species redistribute in response to climate change (Townhill et al. 2021). The recent adoption of the high seas biodiversity treaty which provides a framework for the implementation of marine protected areas in these regions presents a longer-term opportunity to link LSMPAs in the tropical Atlantic Ocean to create transboundary protected corridors that may be more beneficial for highly migratory species (Kachelriess 2023).

As the global coverage of LSMPAs continues to increase to meet international conservation targets, there is a growing need for cost effective ways to monitor both the benefits of such closures and remaining threats to marine ecosystems across broad spatial scales. However, whilst some efforts have been made to incorporate data from prior licenced fisheries to inform the management of LSMPAs (Dunn and Curnick 2019; Curnick et al. 2020), this resource remains underutilised. This study has shown how vessel logbook data can provide valuable insights into the former biodiversity impacts and future illegal fishing risk of a commercial fishery operating in one such LSMPA, providing a template that could be applied at other sites.

Author Contributions

CK, KM and SW conceived the analyses. JB, AR, VL, SR, NW and SW were responsible for data collection and collation. CK, KM and SW analysed the data. CK produced the figures and first draft, and all authors reviewed and edited the manuscript.

Acknowledgements

The authors are grateful to fisheries observers contracted from capfish and the crew of the M/V Extractor for their assistance in observer deployments. We would also like to thank Diane Peebles and Marc Dando for allowing free access to their catalogues of species images. For the purpose of open access, the author has applied a Creative Commons Attribution (CC BY) licence to any Author Accepted Manuscript version arising from this submission.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

Logbook data is proprietary property of the Ascension Island Government and is subject to use under permit.

Ethics and Permit Approval

Ethical approval was not required for this work. Logbook data was permitted for use by the Ascension Island Government. Species imagery was permitted by copyright owners and duly acknowledged where appropriate in the manuscript.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.