

4.3.1.4 Current Commercial (Domestic) Fisheries

This section provides an overview of recent fisheries (mainly since 2010) including the composition of the harvest by species, recent changes in catch, locations of fishing activity, fishing gear and gear distribution, and overall harvesting seasonality. Following sub-sections then present a more detailed focus on the key species fisheries identified.

Harvest Composition and Recent Trends

As noted above, the species mix in the Study Area in more recent years has been predominantly shellfish (crustaceans and to a lesser extent mollusks), but also with an increasing proportion of groundfish. Table 4.39 provides recorded catch quantities and values for recent Study Area Unit Areas fisheries, based on the 2010 to 2015 average harvests and the latest available data from DFO for 2015. As discussed above, data for the most recent years - especially 2014 and 2015 - has been substantially redacted by DFO for confidentiality reasons and therefore they are not able to quantify accurately several of the important fisheries. For example, while the single year 2015 data in Table 4.39 and the composition of the Study Area harvests would seem to suggest that by 2015 the groundfisheries had all but ended again in the Study Area, this is not the case. Therefore, in the following sections about the domestic commercial fisheries, the data presenting 2010 – 2015 averages should be considered as more representative of the current situation since they include several years when the data were much less redacted. One important exception is the fishery for northern shrimp, which recently has been halted in the Study Area. This is discussed in the “Key Species” sub-section below.

Table 4.39 Key Species Harvests by Quantity and Value, Study Area Unit Areas 2010-2015 Average and 2015

Species	2010-15 Average Quantity (tonnes)	2010-15 Average Value (\$)	2015 Quantity (tonnes)	2015 Value (\$)
Crab, Queen/Snow	12,575.2	56,753,579	12,713.6	69,230,727
Shrimp, Pandalus Borealis	4,259.0	7,659,029	0	0
Yellowtail Flounder*	1,706.1	1,715,158	0	0
Turbot/Greenland Halibut*	1,183.2	4,300,089	650.0	2,451,536
Redfish*	953.5	1,374,781	0.5	337
Deep-sea Clams	419.6	563,550	0	0
American Plaice*	258.7	232,177	0	0
Atlantic Cod*	52.5	68,314	0	0
Groundfish Heads*	39.8	160,109	0	0
Greysole/Witch Flounder*	33.3	38,857	0	0
Atlantic Herring	31.9	7,886	0	0
Atlantic Halibut*	27.2	231,144	0	0
Grenadier, Rough-Head*	14.1	4,541	0	6
Capelin	5.1	1,048	0	0
Mackerel	2.4	1,042	0	0
Haddock*	2.3	2,510	0	0
All Other	3.5	4,562	0	0
Totals	21,567.4	73,118,375	13,364.1	71,682,606

* Classified by DFO as groundfish (demersal) species.

Figure 4.74 Species Composition of Harvest by Quantity, Study Area Unit Areas 2010-2015 Average

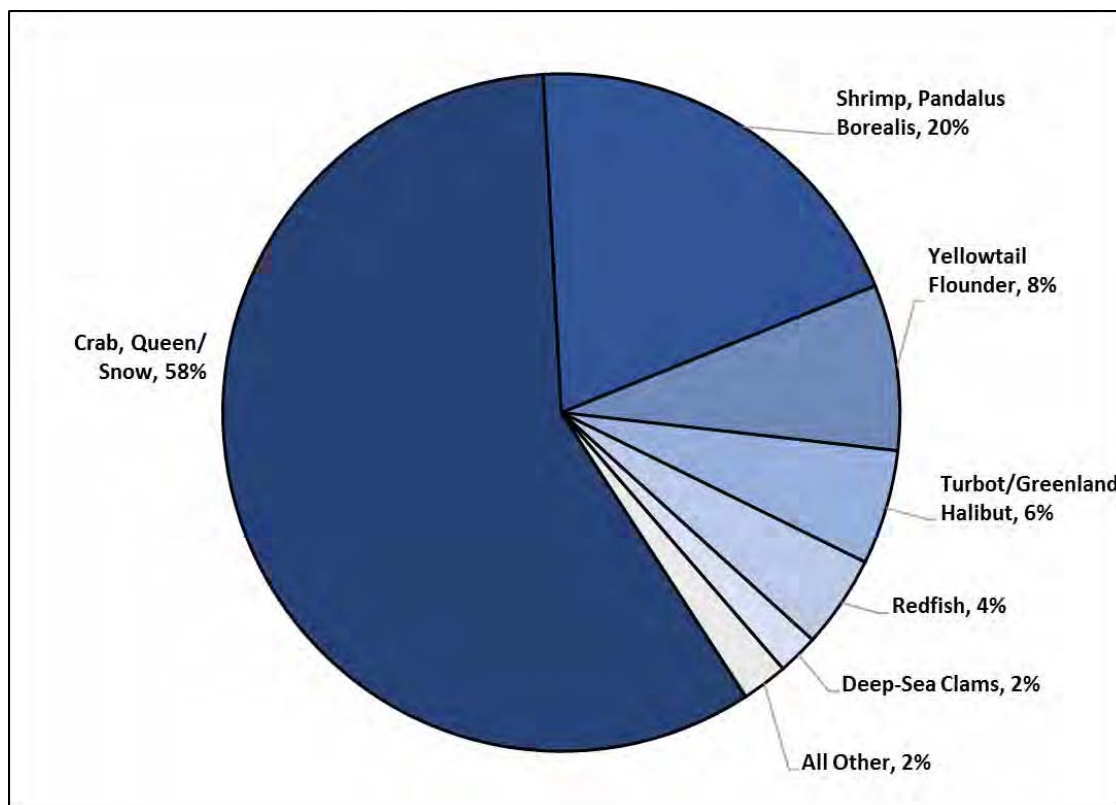


Figure 4.75 Species Composition of Harvest by Value, Study Area Unit Areas 2010-2015 Average

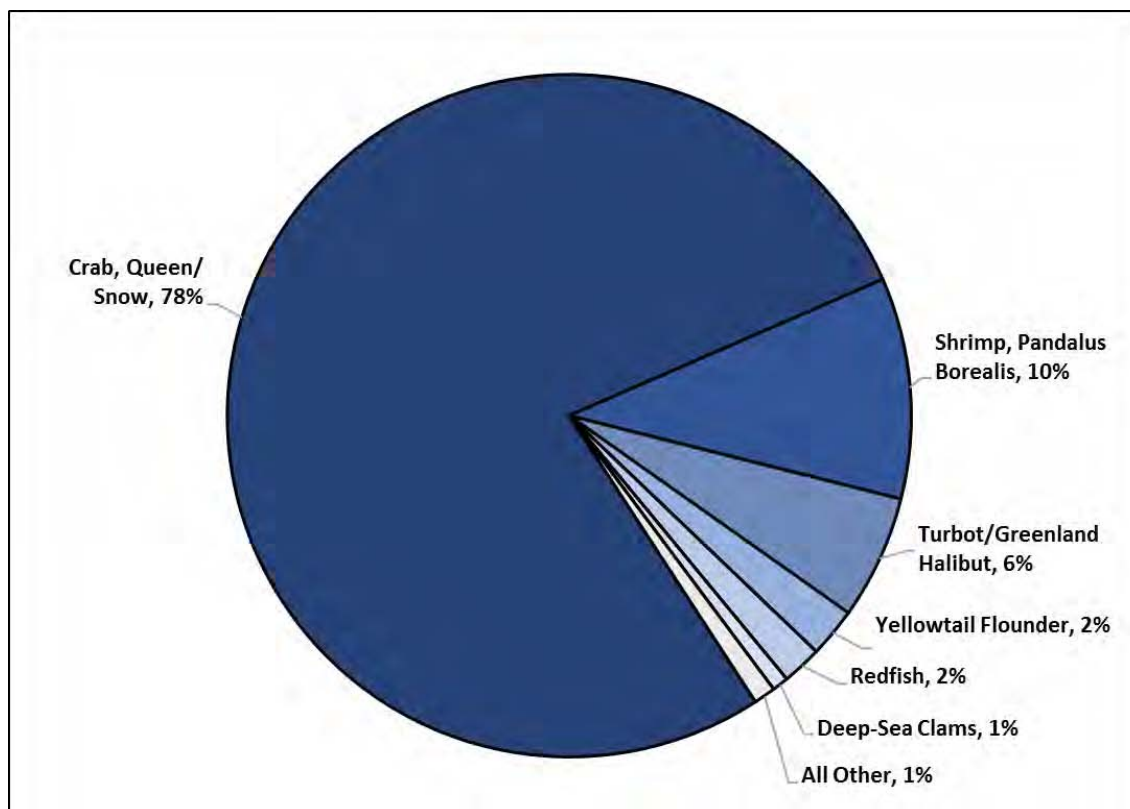


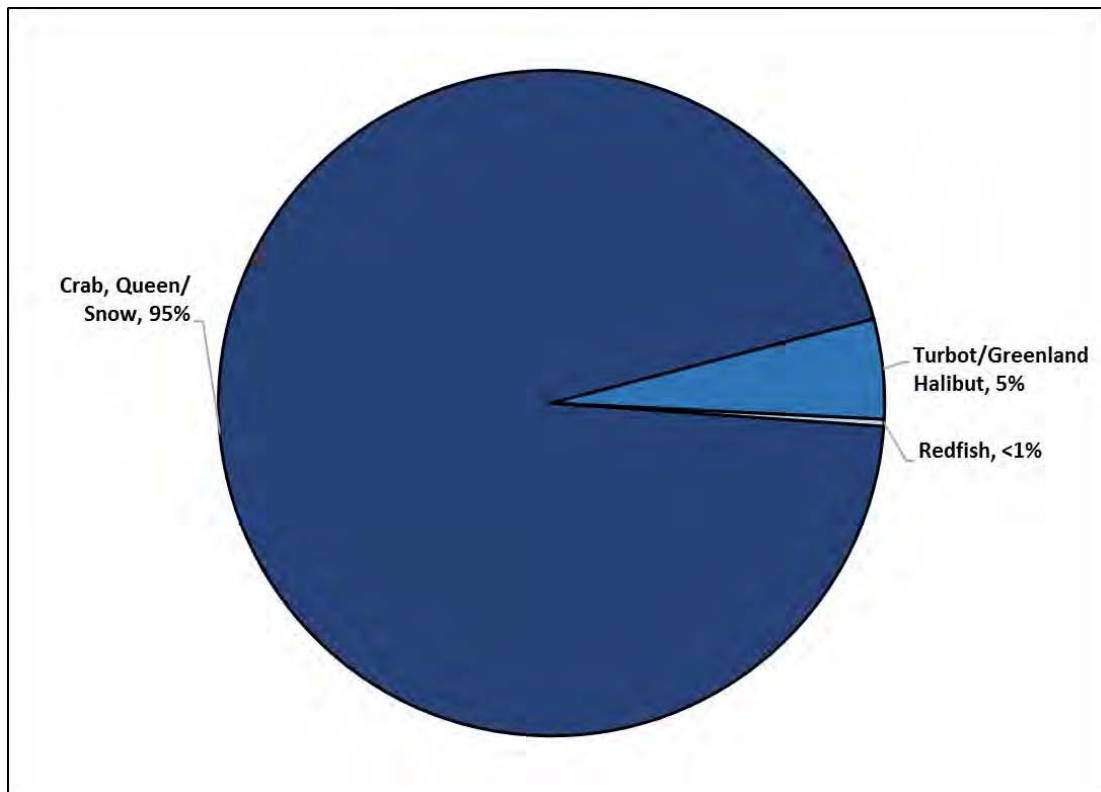
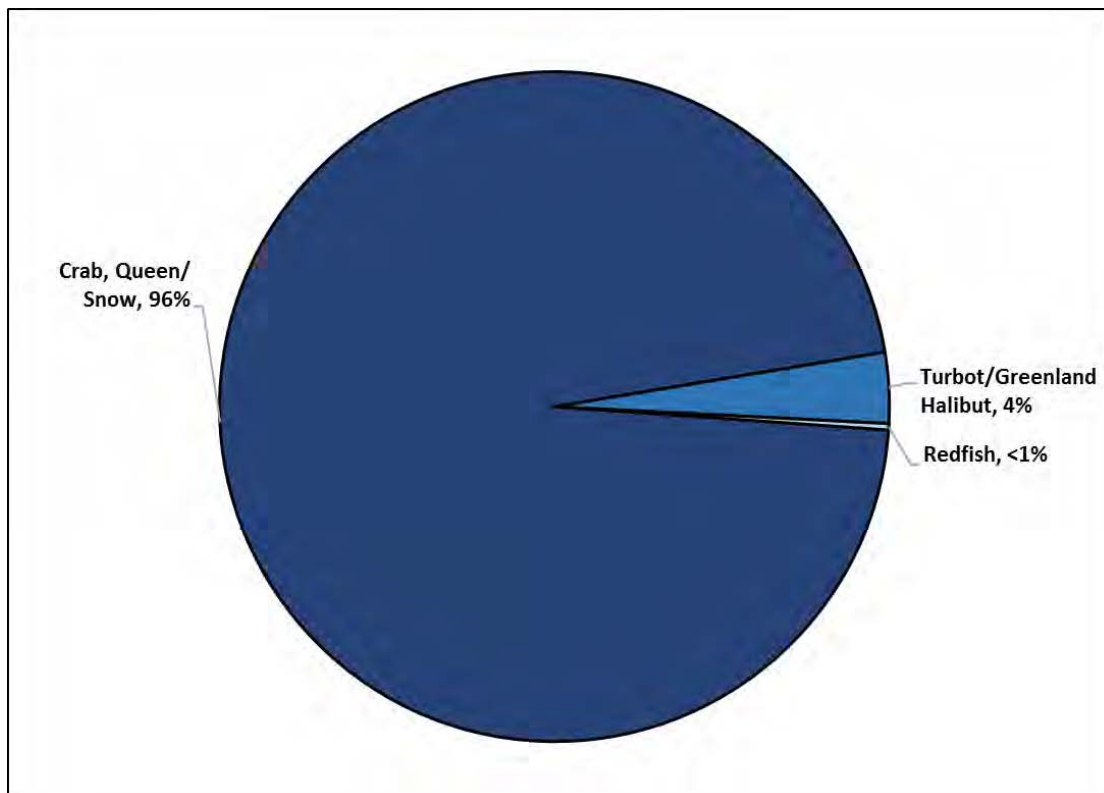
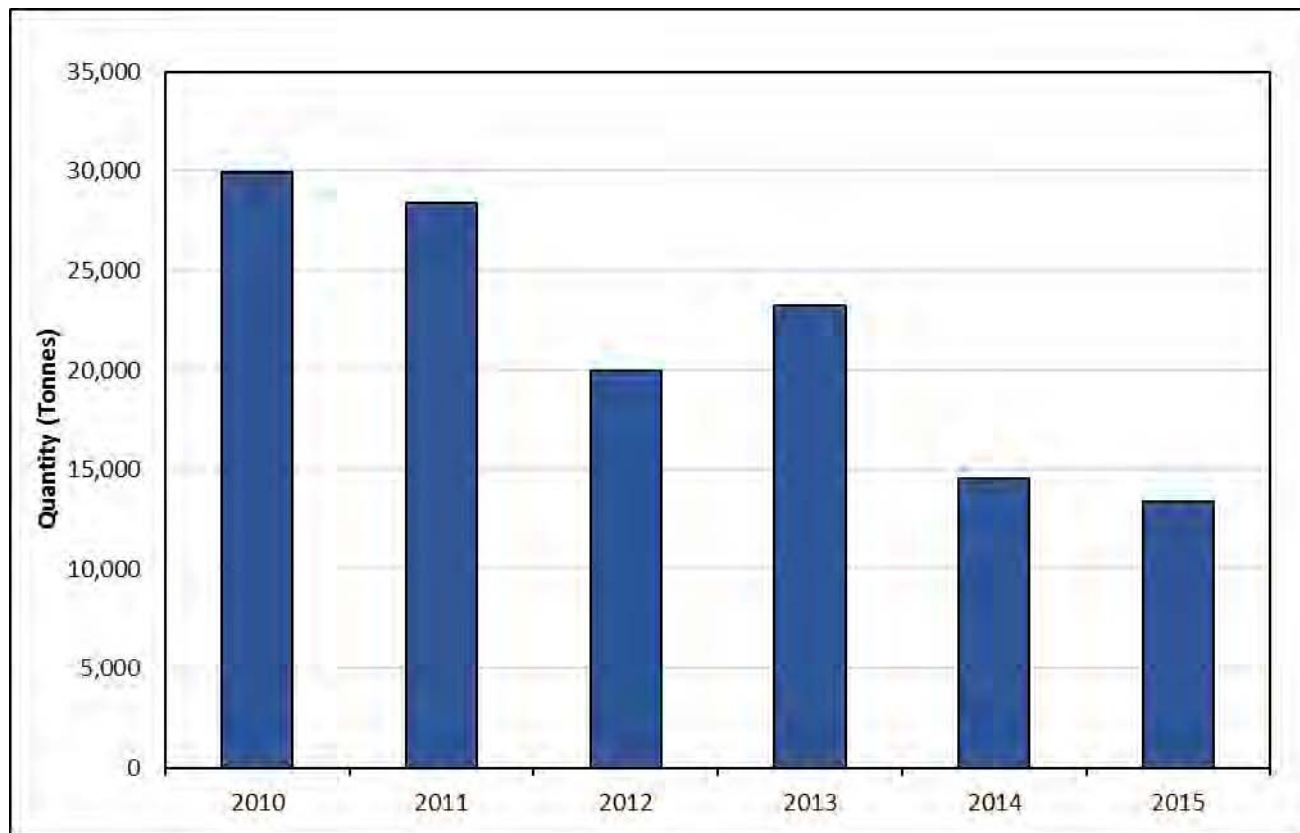
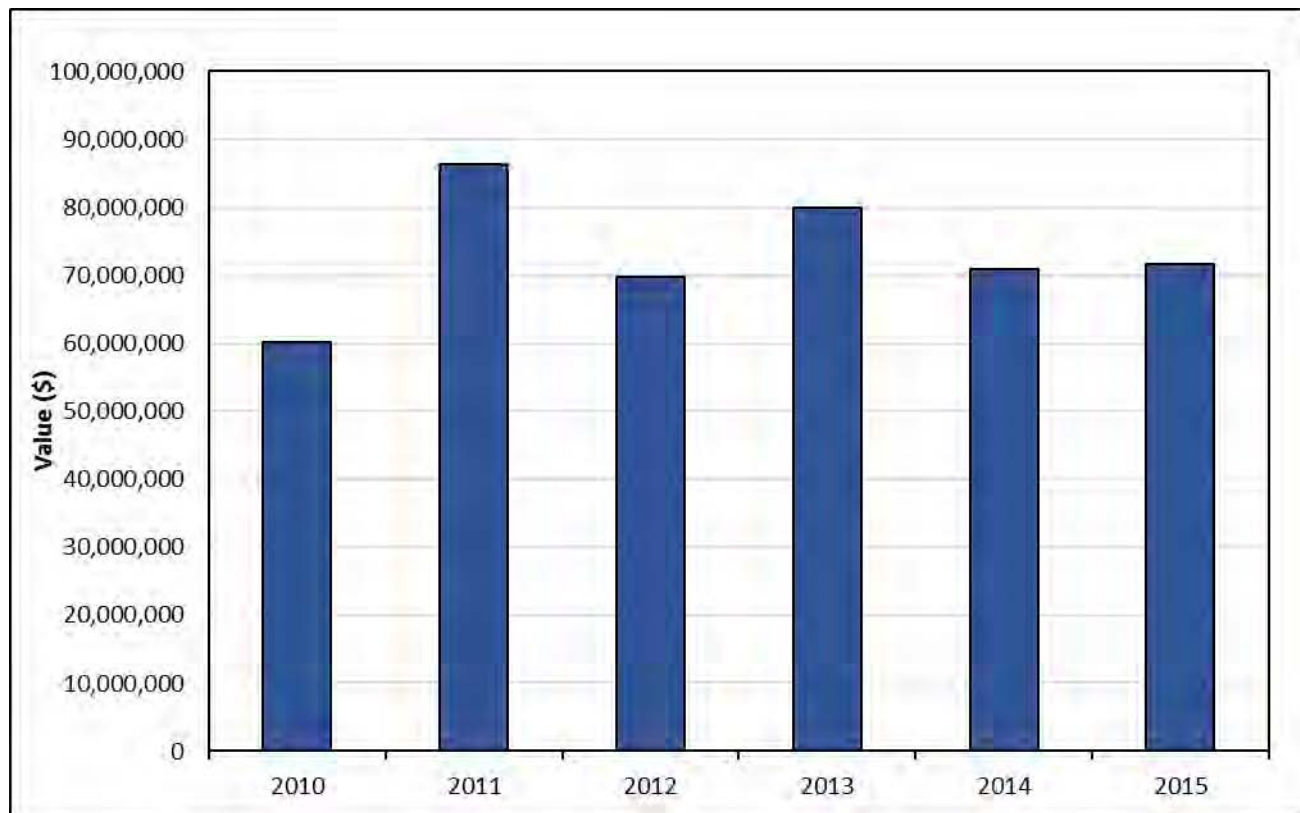
Figure 4.76 Species Composition of Harvest by Quantity, Study Area Unit Areas 2015**Figure 4.77 Species Composition of Harvest by Value, Study Area Unit Areas 2015**

Table 4.40 quantifies the catch data (quantity and value) for available years since 2010 – again noting that data for the most recent years (2014 and 2015) are most heavily redacted, so that the decline in quantities suggested for those years is not fully accurate. The comparatively stable overall value of the harvest in those years is owing to increasing species prices paid to fishing enterprises, particularly for snow crab, where the landed price per kilogram nearly doubled between 2010 and 2015. Figures 4.78 and 4.79 show graphically the annual changes in harvest quantities and values reported in the data.

Table 4.40 All Species Harvests Quantity and Value by Year, Study Area Unit Areas 2010-2015

Year	Quantity (tonnes)	Value (\$)
2010	29,930	60,102,700
2011	28,376	86,308,645
2012	19,928	69,842,319
2013	23,273	79,845,978
2014	14,533	70,928,001
2015	13,364	71,682,606
Average	21,567	73,118,375

Figure 4.78 All Species Harvests Quantity by Year, Study Area Unit Areas 2010-2015**Figure 4.79 All Species Harvests Value by Year, Study Area Unit Areas 2010-2015**

Harvesting Locations

Fish harvesting occurs – logically – where the targeted species is known or likely to occur, which in turn is primarily influenced by available habitat, including prey species. Consequently, the discussion and graphics for commercial species presented in Section 4.2.1 of this assessment are very relevant to an understanding of harvesting locations. Other factors affecting where fishing occurs are management regimes attached to licence conditions which specify for some fisheries where fishing is restricted, or closed to certain fleets.

Tables 4.41 and 4.42 indicate harvest quantities and values at the Unit Area level for the Study Area. As the data show, two of the included Unit Areas (3Lh and 3Li) account for nearly half of the domestic catch quantity and value, and these together with Unit Areas 3Lt and 3Ld reported 75 percent of the 2010-2015 average value of the harvest, and just under 80 percent in 2015. These Unit Areas are centred mainly on the outer shelf and shelf margin.

Table 4.41 All Species Harvests Quantity and Value by Study Area Unit Areas, 2010-2015 Average

Unit Area	Average Quantity (t) 2010-2015	Average Value (\$) 2010-2015	Average % of Total UA Quantities	Average % of Total UA Values
3Kk	9.2	6,435	0.0	0.0
3Ld	3,416.9	11,201,365	15.8	15.3
3Le	684.7	1,443,674	3.2	2.0
3Lh	3,142.2	14,256,641	14.6	19.5
3Li	6,750.3	20,229,311	31.3	27.7
3Lr	604.7	2,387,040	2.8	3.3
3Lt	2,067.0	9,324,163	9.6	12.8
3Ma	2.7	13,454	0.0	0.0
3Mb	0.1	92	0.0	0.0
3Mc	32.1	36,884	0.1	0.1
3Md	2.7	2,853	0.0	0.0
3Na	1,650.9	1,762,701	7.7	2.4
3Nb	1,555.2	6,444,297	7.2	8.8
3Nd	1,648.8	6,009,465	7.6	8.2
Total	21,567.4	73,118,375	100.0	100.0

Table 4.42 All Species Harvests Quantity and Value by Study Area Unit Areas, 2015

Unit Area	Quantity (t) 2015	Value (\$) 2015	2015 % of Total UA Quantities	2015 % of Total UA Values
3Kk	0.0	0	0.0	0.0
3Ld	2,012.7	9,869,432	15.1	13.8
3Le	27.1	147,653	0.2	0.2
3Lh	3,258.6	17,744,249	24.4	24.8
3Li	3,367.2	18,335,834	25.2	25.6
3Lr	405.1	2,206,141	3.0	3.1
3Lt	1,981.0	10,787,227	14.8	15.0
3Ma	0.0	0	0.0	0.0

Unit Area	Quantity (t) 2015	Value (\$) 2015	2015 % of Total UA Quantities	2015 % of Total UA Values
3Mb	0.0	0	0.0	0.0
3Mc	0.0	0	0.0	0.0
3Md	0.0	0	0.0	0.0
3Na	0.0	0	0.0	0.0
3Nb	1,391.2	7,575,434	10.4	10.6
3Nd	921.3	5,016,636	6.9	7.0
Total	13,364.1	71,682,606	100.0	100.0

Figure 4.80 below shows the recorded geographic distribution of domestic commercial fishing activity within and adjacent to the Study Area for the March to December period. This timeframe has been selected as it encompasses the planned temporal span of Project activities each year (April to November, see Section 2.6), while also providing a one month “buffer” on each side of this timeframe in order to be inclusive and conservative in the analysis

As indicated previously, the information provided in these maps is based on the geospatial data received from DFO. They show the general presence of recorded fishing activity for a series of 6 x 4 nautical mile “cells” that together comprise a map grid that covers the region.

The information presented herein includes data for all years from 2010 to 2015, aggregated for all species, with more recent year colour overlying earlier years’ data locations for each “grid square”. Figure 4.81 uses the same data source but aggregates and colour-codes the number of records at each location, with a “hotter” colour indicating where more fishing activity reports occurred to give an indication of harvesting intensity. Figures 4.82 and 4.83 then show the same for 2015 alone. Further information on commercial fishing locations by gear type, month and season, and key species is provided in later sections.

Figure 4.80 Domestic Commercial Harvesting Locations, All Species, 2010-2015 (March to December)

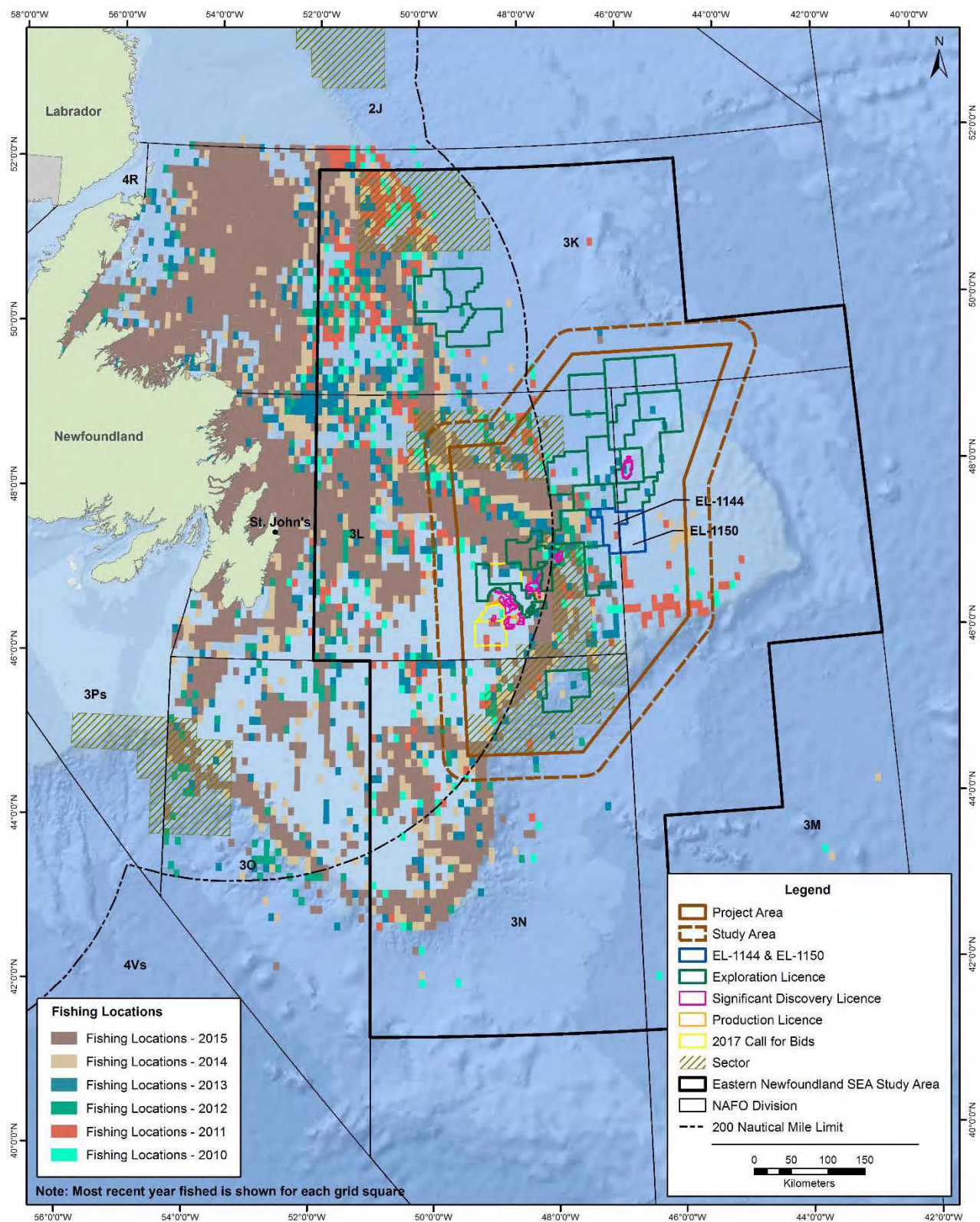


Figure 4.81 Domestic Commercial Harvesting Intensity by Locations, All Species, 2010-2015 (March to December)

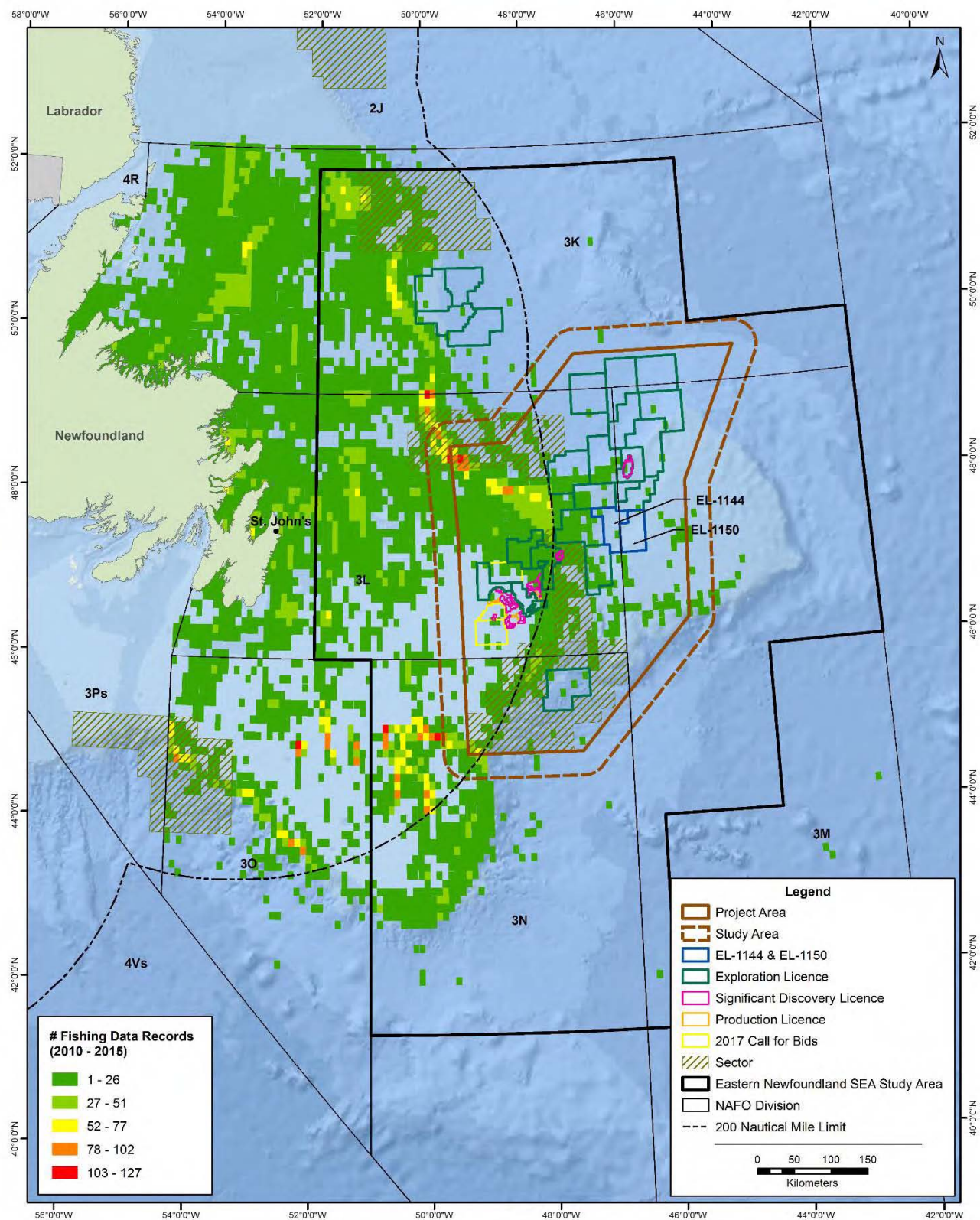


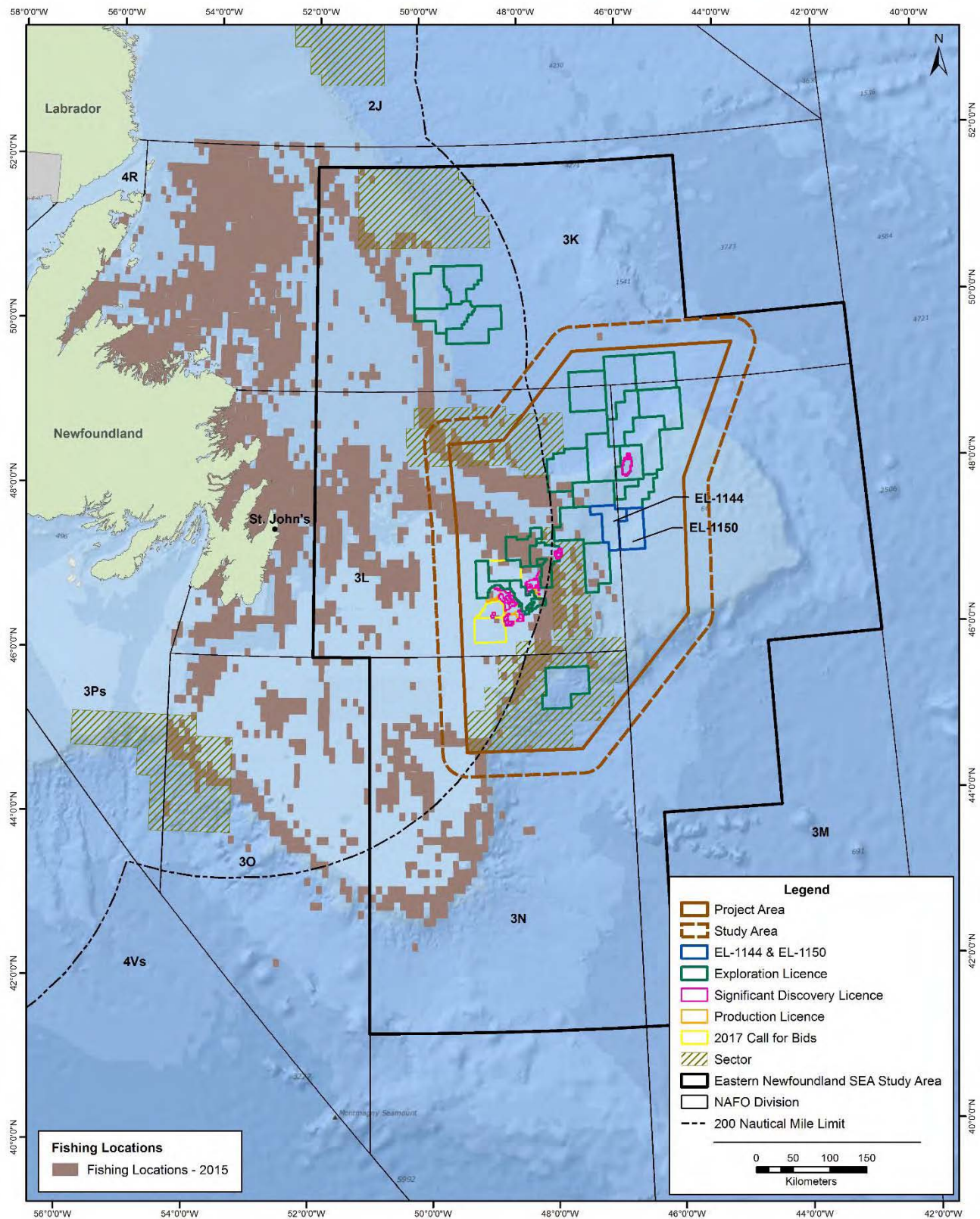
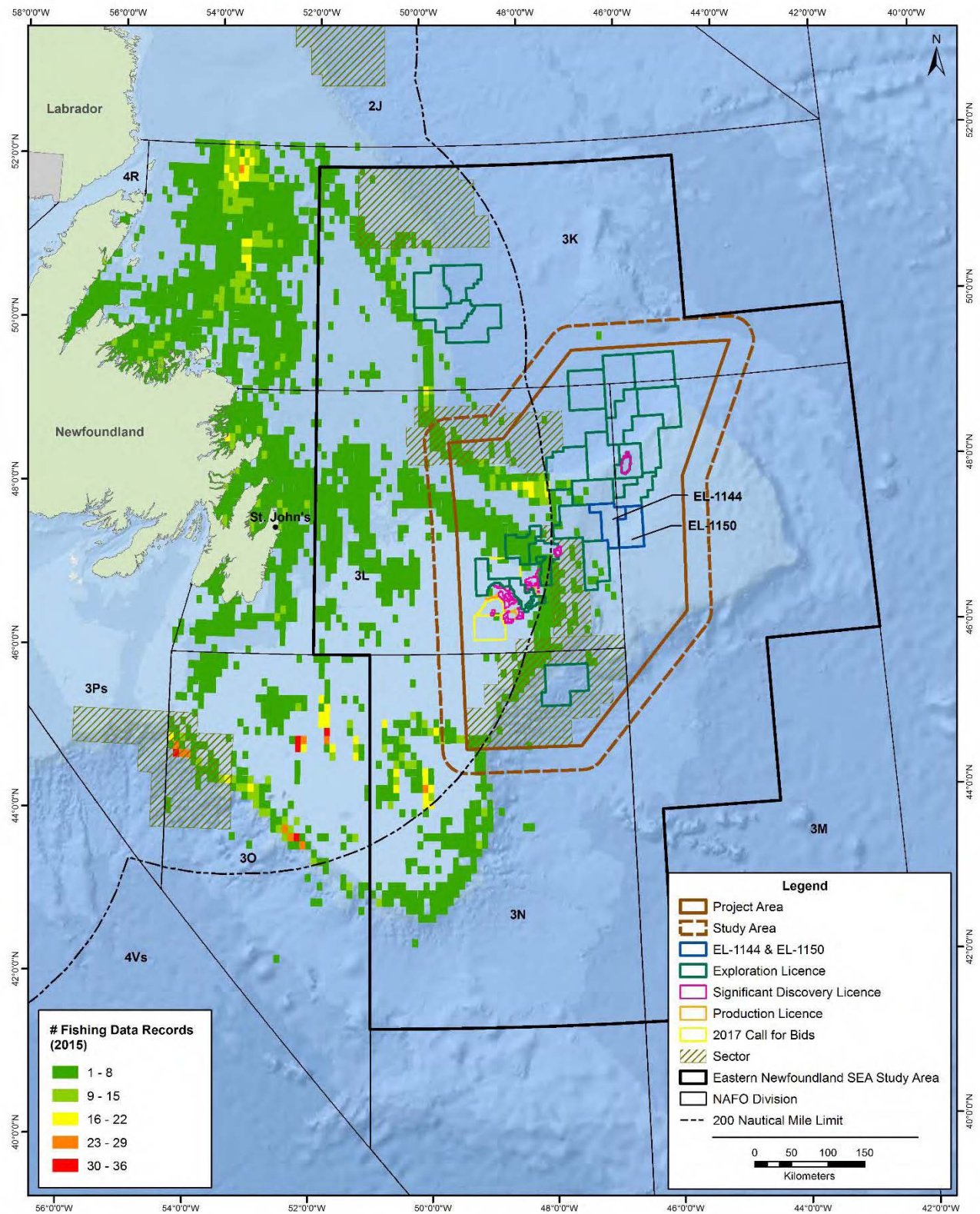
Figure 4.82 Domestic Commercial Harvesting Locations, All Species, 2015 (March to December)

Figure 4.83 Commercial Harvesting Intensity by Locations, All Species, 2015 (March to December)



Fishing Gear

Several of the fishing gears used in the Study Area (and in Atlantic Canada generally) are designed to target particular species, while others are less selective and may be used to target, or to collect as by-catch, many different species. Table 4.43 quantifies the average annual domestic harvest by gear and gear type (fixed or mobile) for 2010-2015, and Table 4.44 shows the reported gear from the 2015 DFO dataset. The substantial change from the 2010-2015 average to 2015 is partly the result of the increasingly redacted harvest data, but also reflects the closure of the shrimp fishery in the area.

The two kinds of gear that account for the largest part of the catch by both quantity and value (pots and shrimp trawl) are exclusively used to harvest individual species in the Study Area - pots for snow crab and trawls for northern shrimp, although these occasionally record a small number of by-catch species. Boat dredges also specifically target deep-sea clams. Other gears – most notably bottom (stern) otter trawls - catch a much wider variety of species, both directed and by-catch, including redfish, American plaice, turbot (also known as Greenland halibut), Atlantic halibut, Atlantic cod and various flounders.

Table 4.43 Harvests Quantity and Value by Fishing Gear Type, Study Area Unit Areas 2010-2015 Average

Fishing Gear	Average Quantity (t) 2010-2015	Average Value (\$) 2010-2015	Average % of Total Gear Quantities	Average % of Total Gear Values
<i>Fixed Gear</i>				
Pot	12,573	56,753,616	58.3	77.6
Gillnet	991	3,001,730	4.6	4.1
Longline	21	172,283	0.1	0.2
Total Fixed Gear	13,585	59,927,630	63.0	81.9
<i>Mobile Gear</i>				
Shrimp trawl	4,259	7,659,078	19.8	10.5
Bottom otter trawl	3,260	4,954,244	15.1	6.8
Dredge (boat)	421	566,556	2.0	0.8
Purse seine	25	7,061	0.1	0
Other Mobile	15	3,807	0.1	0
Total Mobile Gear	7,980	13,190,746	37.1	18.1
Total	21,567.4	73,118,375	100.0	100.0

Table 4.44 Harvests Quantity and Value by Fishing Gear Type, Study Area Unit Areas 2015

Fishing Gear	Quantity (t) 2015	Value (\$) 2015	% of Total Gear Quantities	% of Total Gear Values
Pot	12,714	69,230,727	95.1	96.6
Gillnet (set or fixed)	651	2,451,879	4.9	3.4
Totals	13,364	71,682,606	100.0	100.0

In general, fixed-gear fisheries present a greater potential for interaction with seismic equipment, most specifically for hydrophone streamers tangling with the gear, which is usually left unattended in the water while it fishes (or “soaks”) (see Section 5.9). For bottom-positioned gear, such as crab pots or halibut longlines, the gear-conflict risk is from encountering the cables which hold the surface buoys marking the

ends of sets or fleets of gear on the ocean bottom. For surface set gear, such as large pelagic longlines that float very near the surface, and may extend for dozens of miles, the potential for interaction is somewhat greater. Conversely, the potential for mobile gear interaction is very low if the seismic and fishing boats communicate at sea as they are required to do, since mobile gear is always tended, towed by or operated from a ship at sea.

The following maps show domestic harvesting locations by fixed gear (Figures 4.84) and by mobile gear (Figure 4.85) for all years 2010-2015, March to December. Note that although the redacted datasets provided by DFO containing quantity and value data do not show numbers for mobile gear in 2015, the geolocational database does indicate mobile gear harvesting locations for that year.

The maps contained in Figures 4.86 and 4.87 show the same locational data, but sequenced by three-month periods to provide an understanding of how the gear types and locations may vary by season. As they indicate, fixed gear harvesting is much more widespread during the April to September period, while the mobile gear fisheries locations tend to be fairly widespread through all quarters of the year.

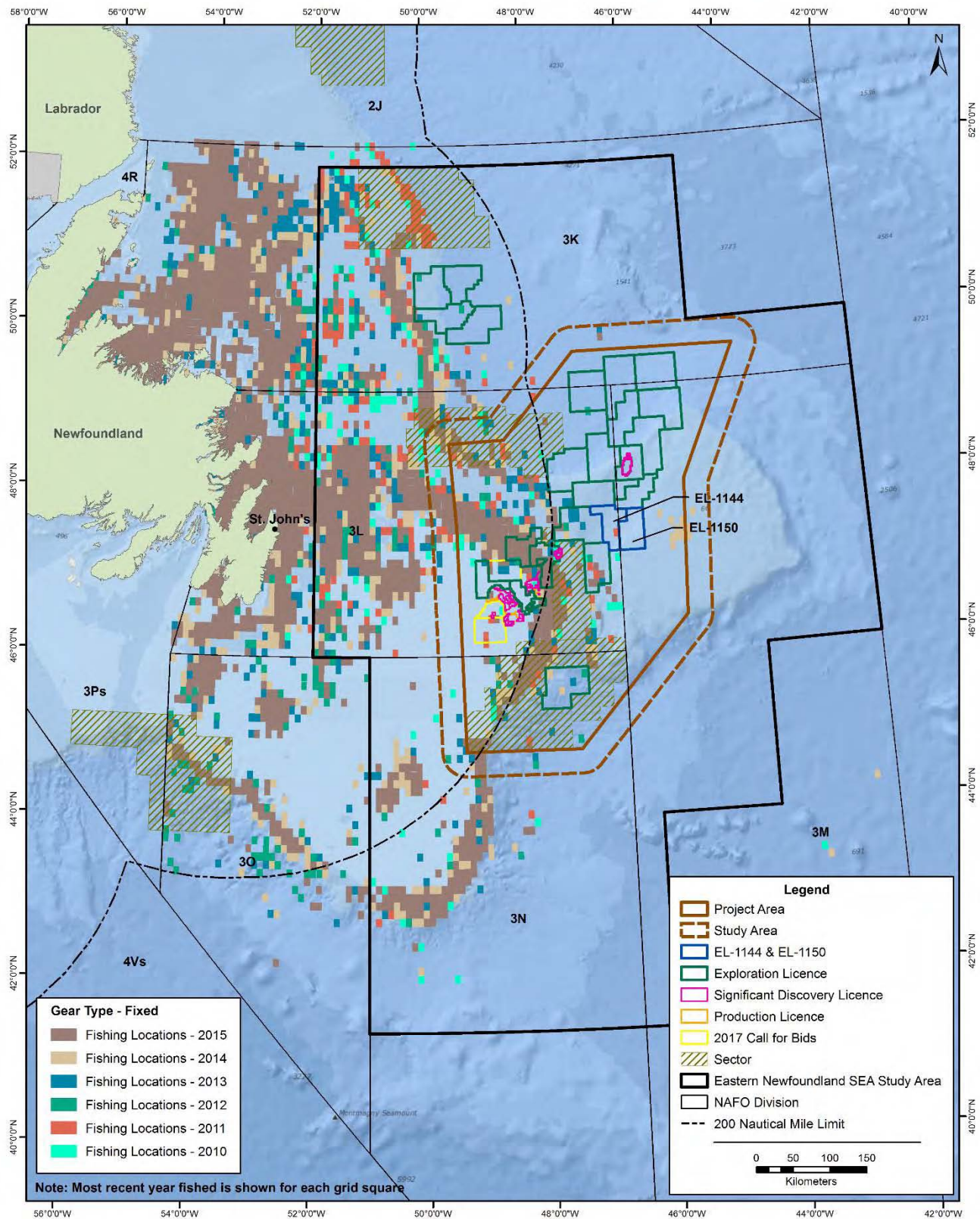
Figure 4.84 Fixed Gear Harvesting Locations, 2010-2015 (March to December)

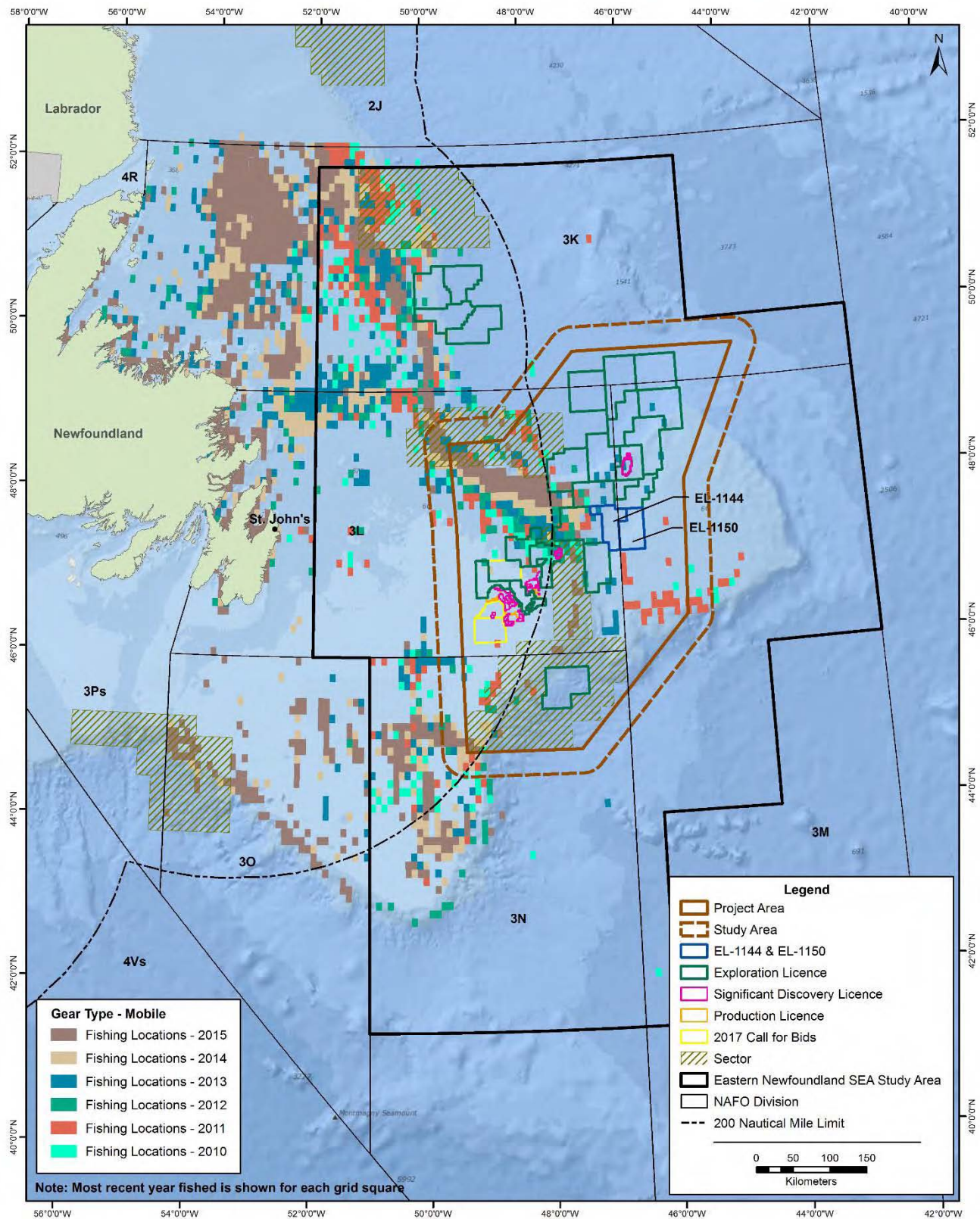
Figure 4.85 Mobile Gear Harvesting Locations, 2010-2015 (March-December)

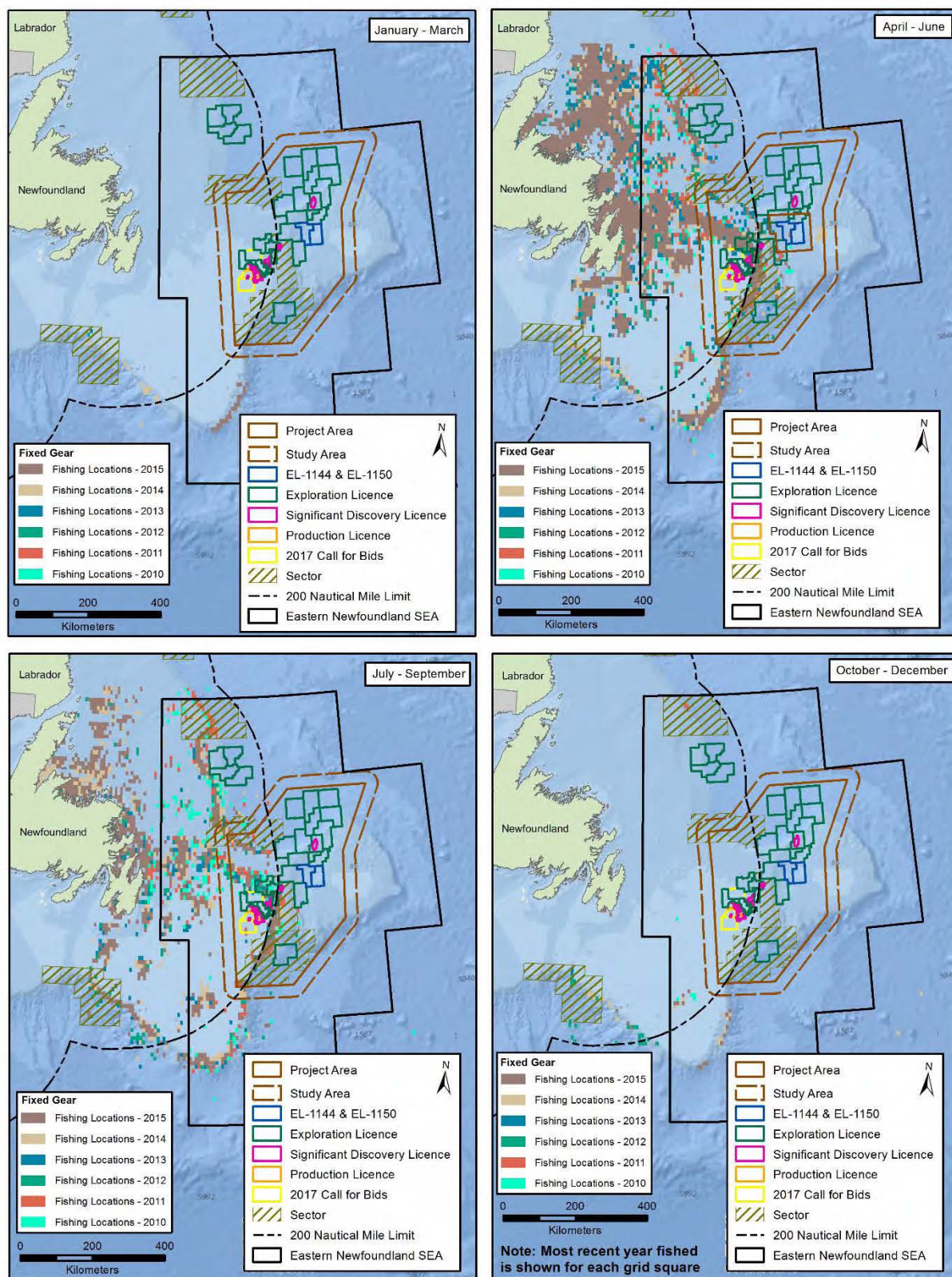
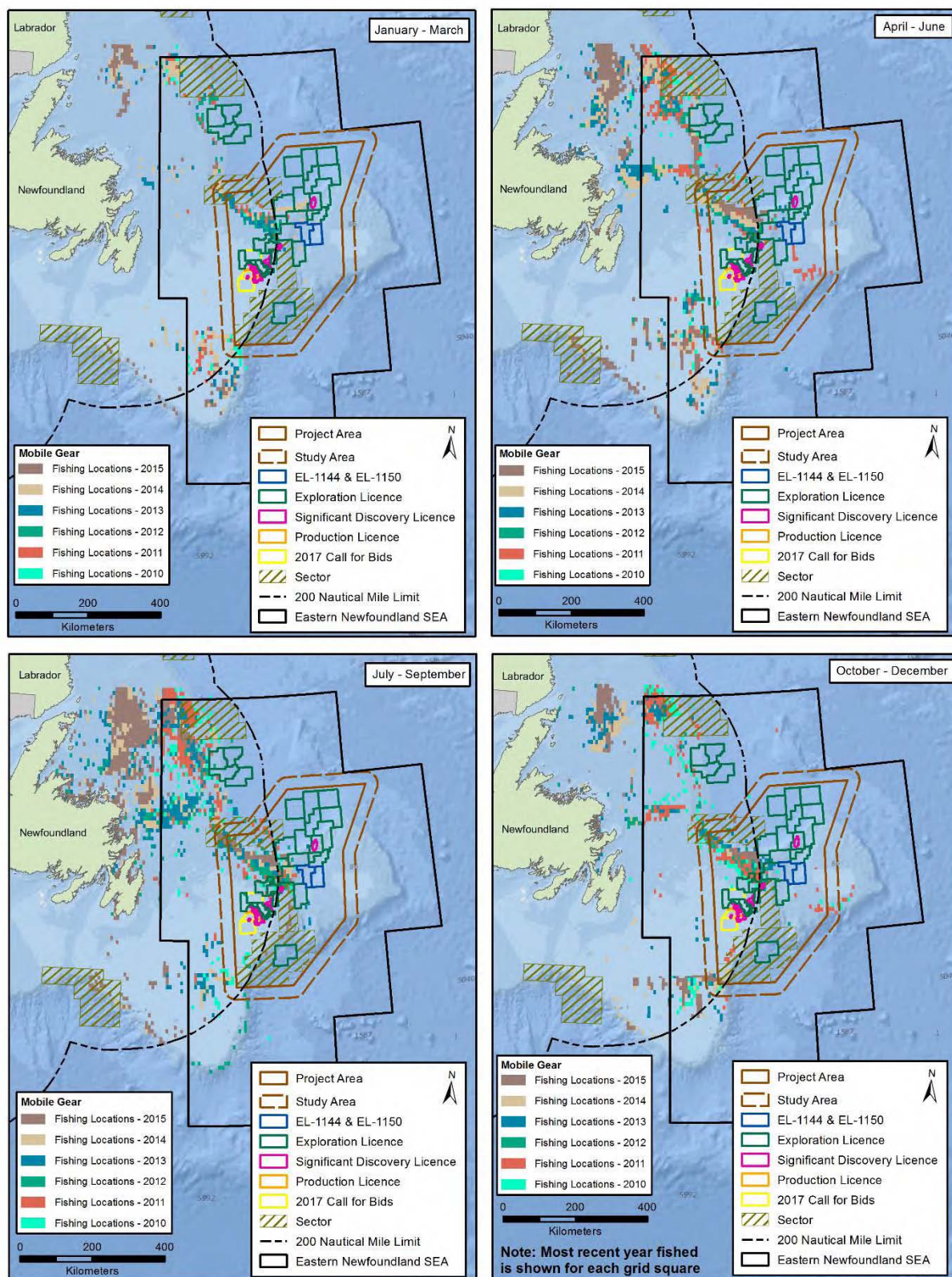
Figure 4.86 Fixed Gear Harvesting Locations, by Quarter, 2010-2015

Figure 4.87 Mobile Gear Harvesting Locations, by Quarter, 2010-2015

Seasonality

As the previous maps demonstrate, fishing activity and locations can vary substantially throughout the year, particularly for fixed-gear harvesters. The timing of the various fisheries depends on many factors, such as open and closed management seasons, market cycles, individual fishing enterprise business decisions and priorities, the availability of the targeted resource at the time, and – understandably – the weather. The last factor is especially important for smaller fishing vessels and for fixed-gear fisheries.

While some Study Area fisheries (such as for several groundfish species and deep-sea clams) are open year-round, others (most importantly, for snow crab) have a well-defined open season, although slightly variable from year to year but usually within the April to July period in this area.

The following graphs (Figures 4.88 to 4.91) show the reported domestic harvest quantity and value by month (for the 2010-2015 averages and for 2015). In general, most harvesting from January to April and October to December employs mobile gear, while the summer months are dominated by fixed gear fisheries, mainly for snow crab. The sub-sections on the key species fisheries (below) provide more detailed information about the nature and timing of those fisheries.

The maps that follow (Figures 4.92 – 4.101) also show the location of harvesting activity by month (March through December) using the same locational datasets described above. Figure 4.102 then indicates the fishing intensity levels by quarter using the same methods as previously.

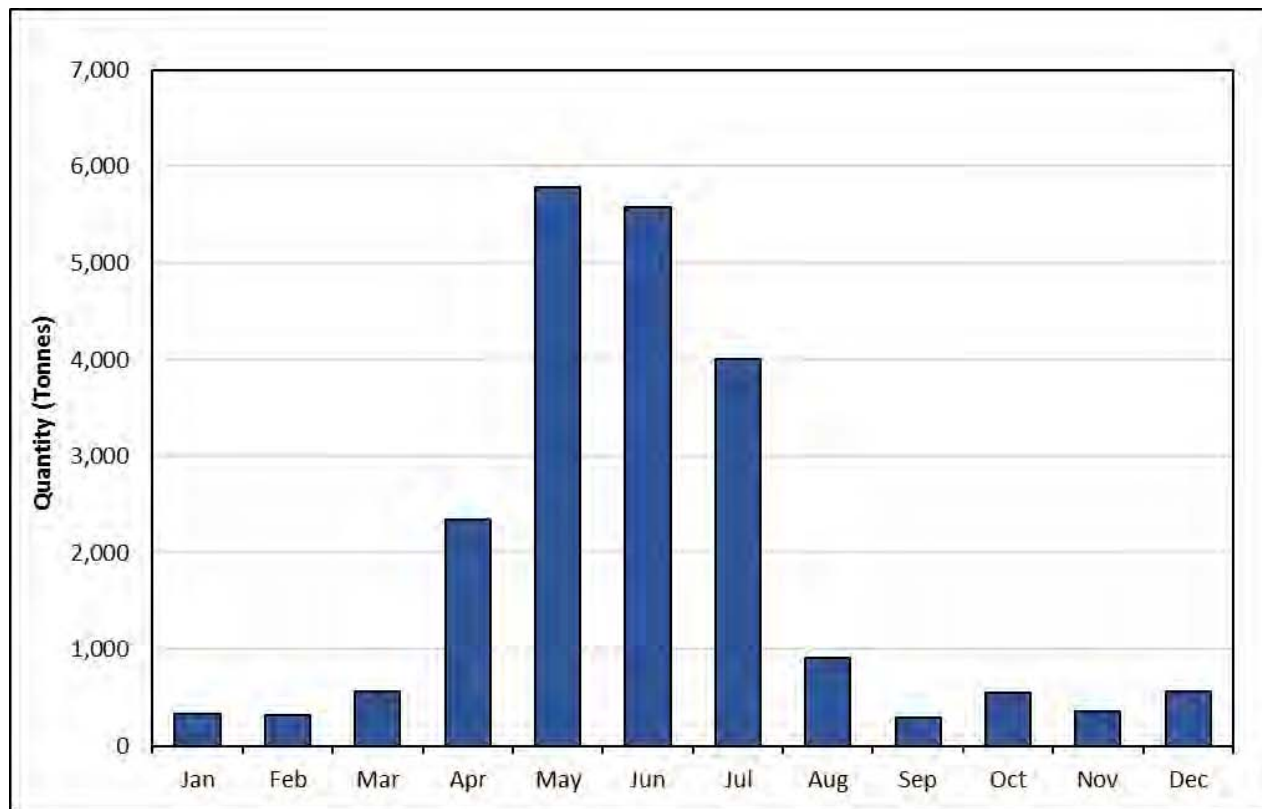
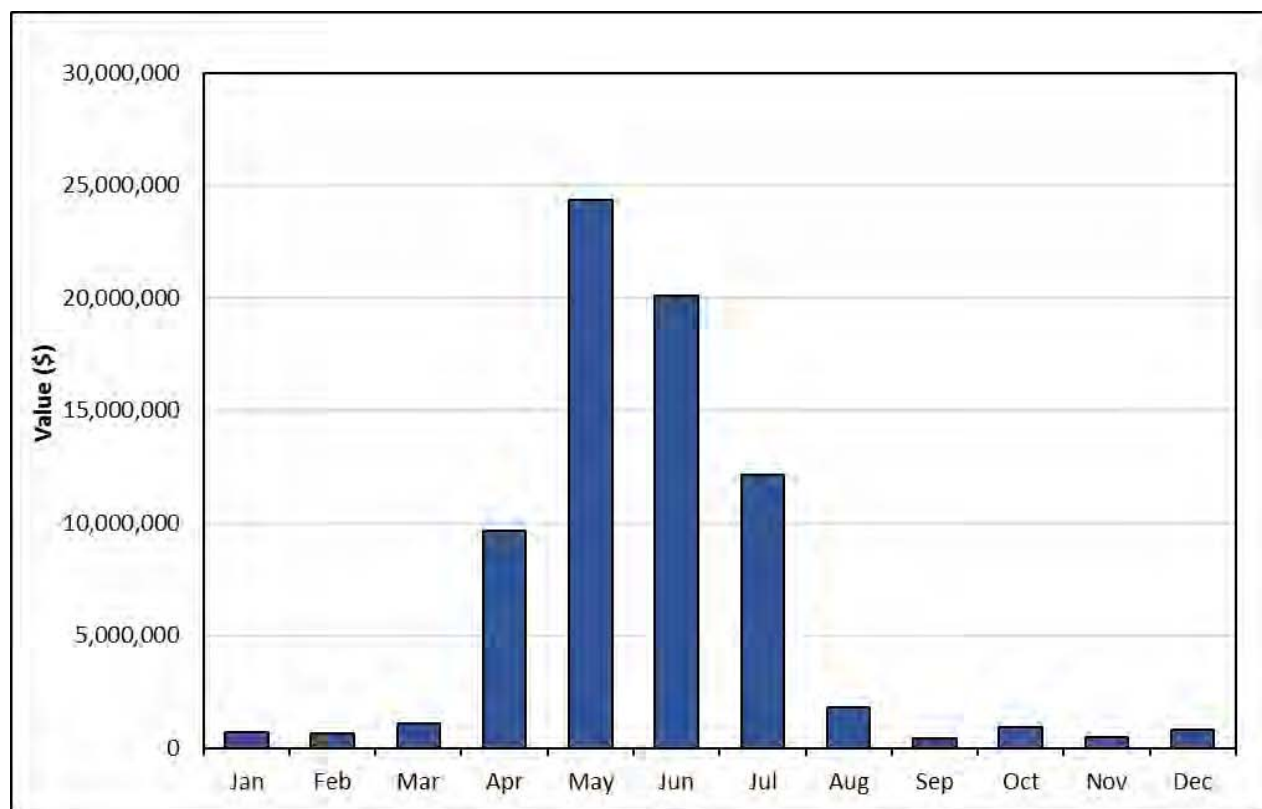
Figure 4.88 All Species, Study Area Unit Areas Quantity of Harvest by Month, 2010-2015 Average**Figure 4.89 All Species, Study Area Unit Areas Value of Harvest by Month, 2010-2015 Average**

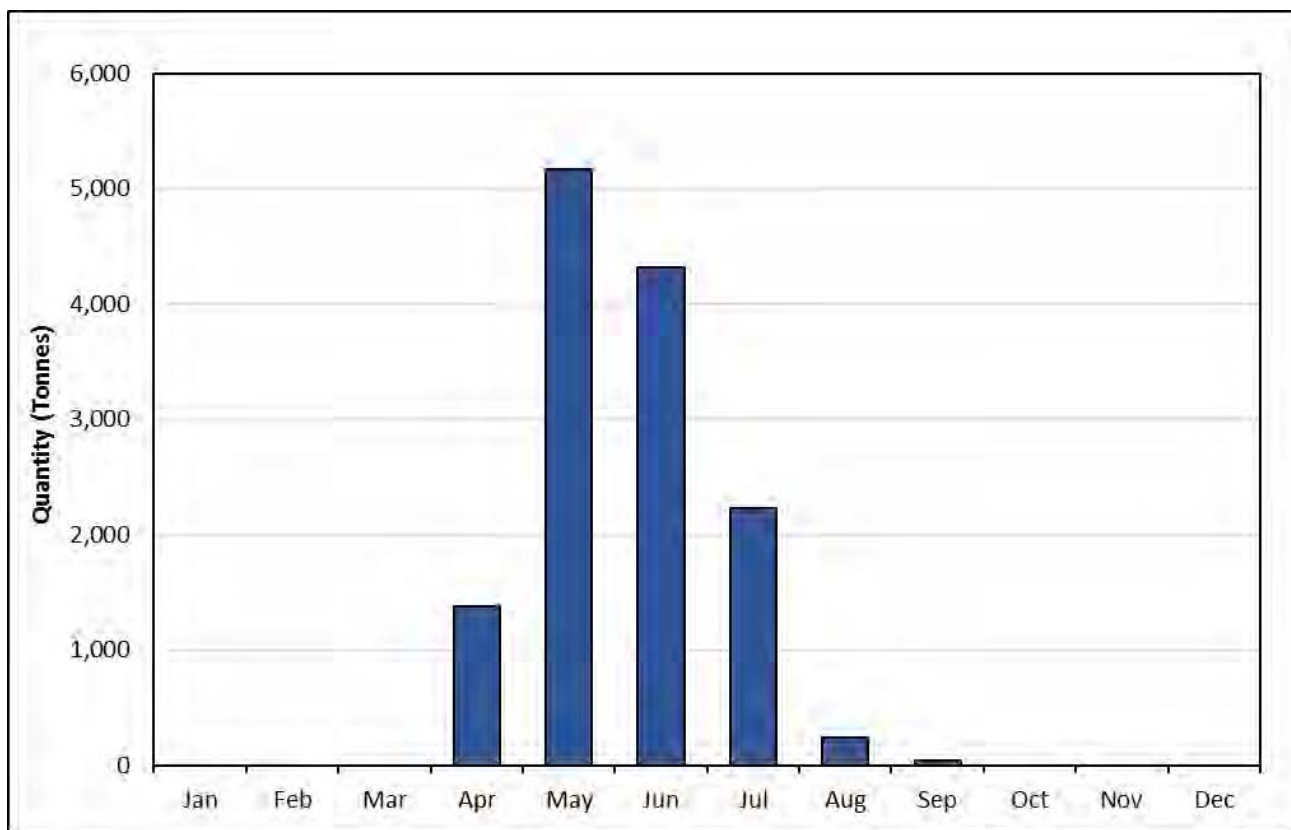
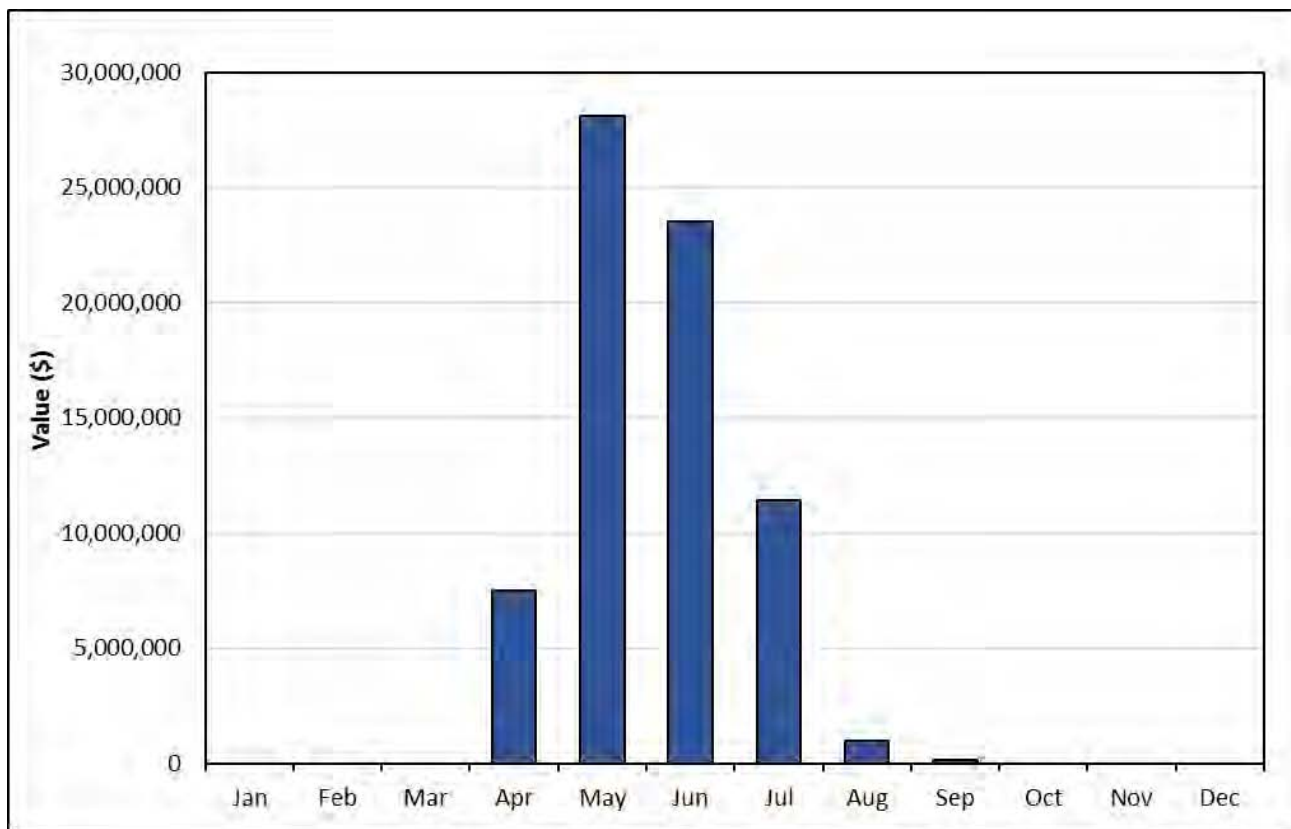
Figure 4.90 All Species, Study Area Unit Areas Quantity of Harvest by Month, 2015**Figure 4.91 All Species, Study Area Unit Areas Value of Harvest by Month, 2015**

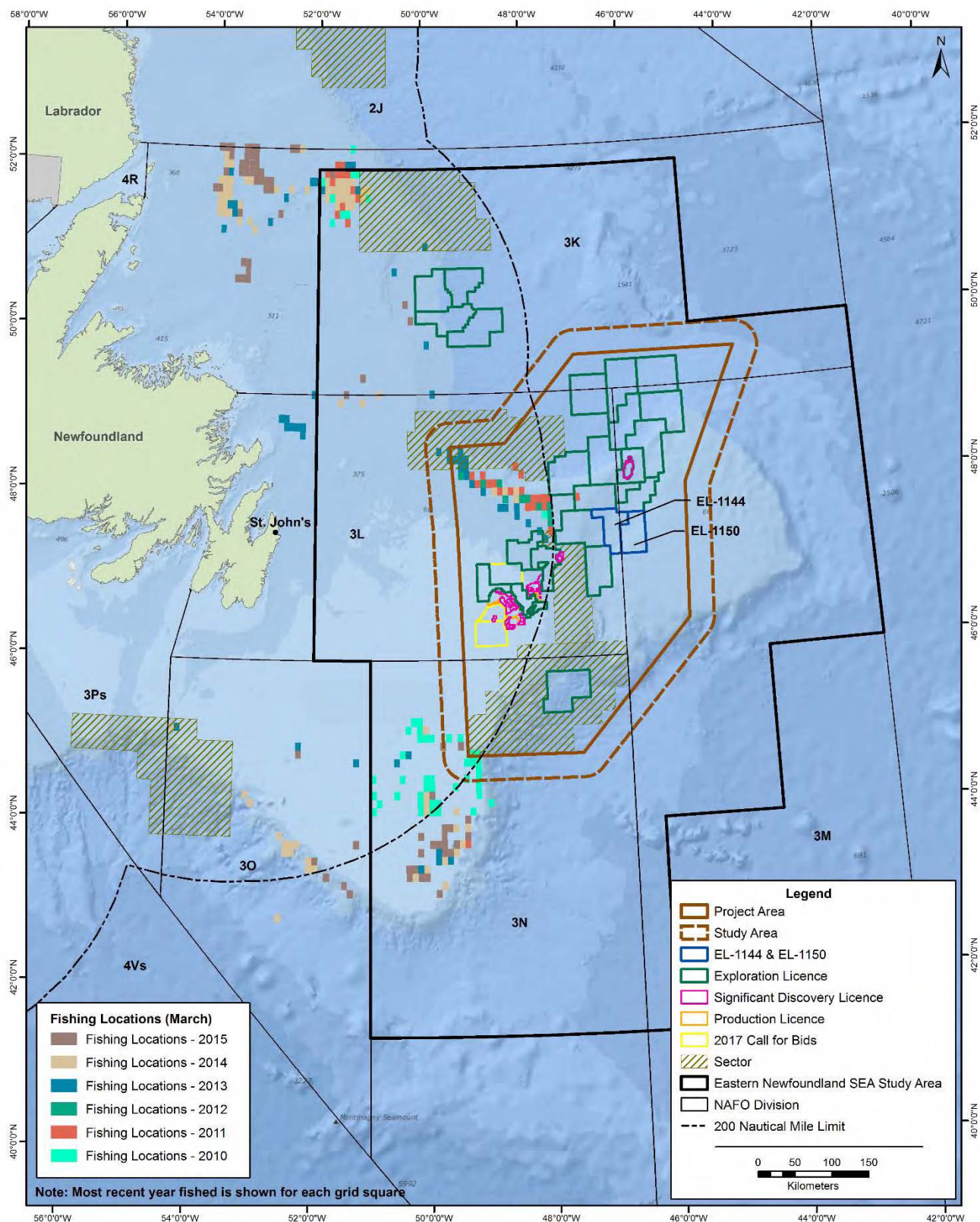
Figure 4.92 All Species Harvesting Locations, March 2010 – 2015

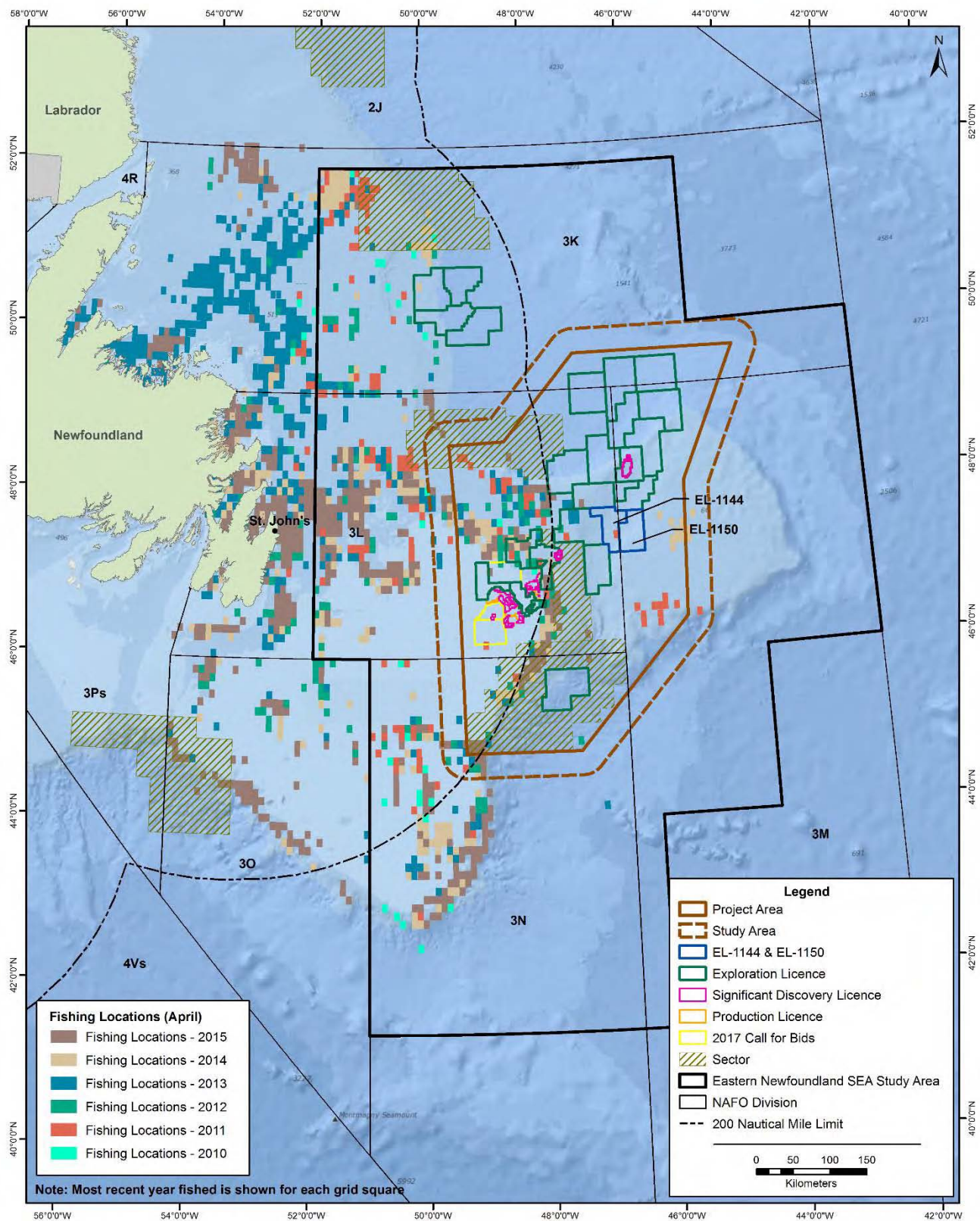
Figure 4.93 All Species Harvesting Locations, April 2010 – 2015

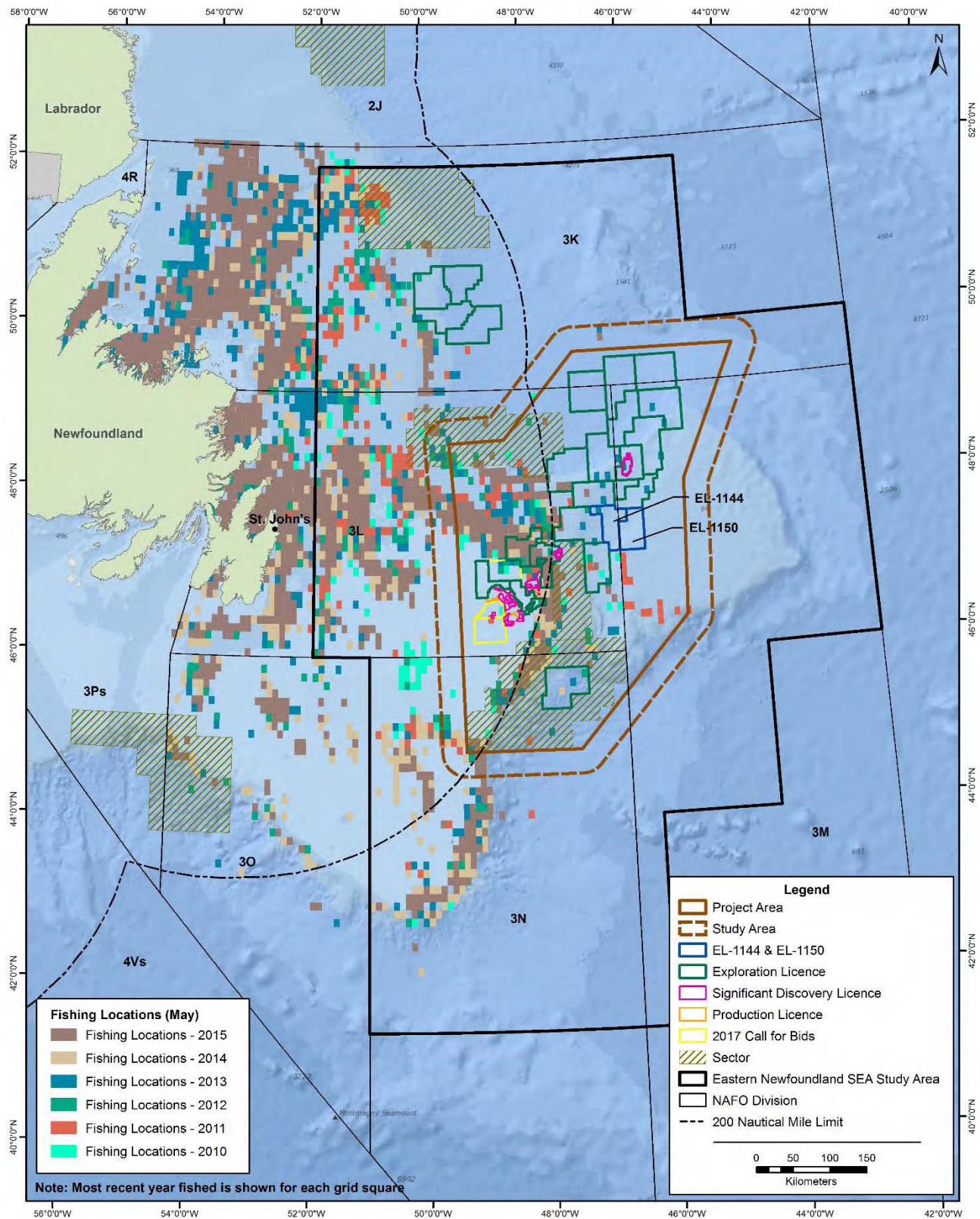
Figure 4.94 All Species Harvesting Locations, May 2010 - 2015

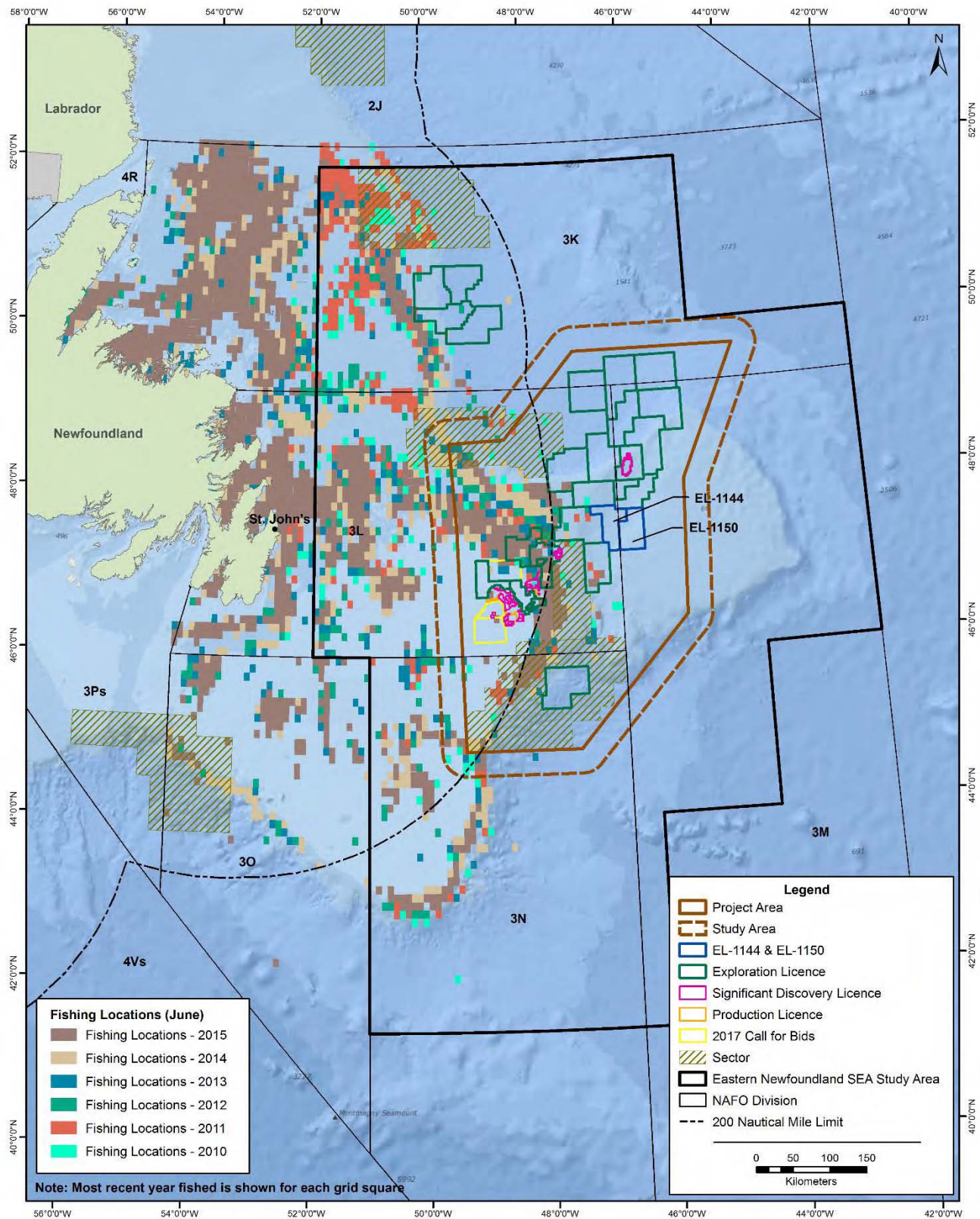
Figure 4.95 All Species Harvesting Locations, June 2010 - 2015

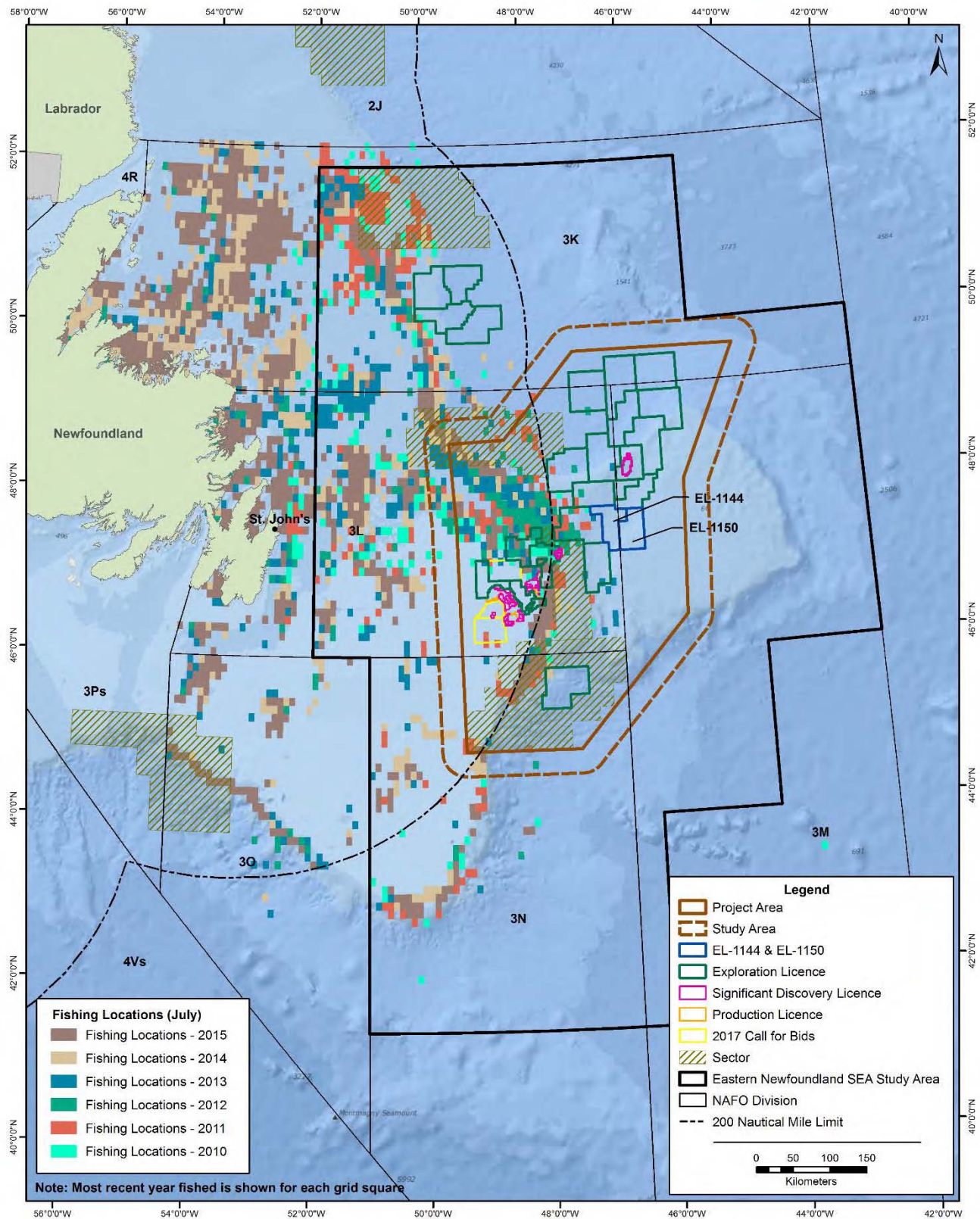
Figure 4.96 All Species Harvesting Locations, July 2010 - 2015

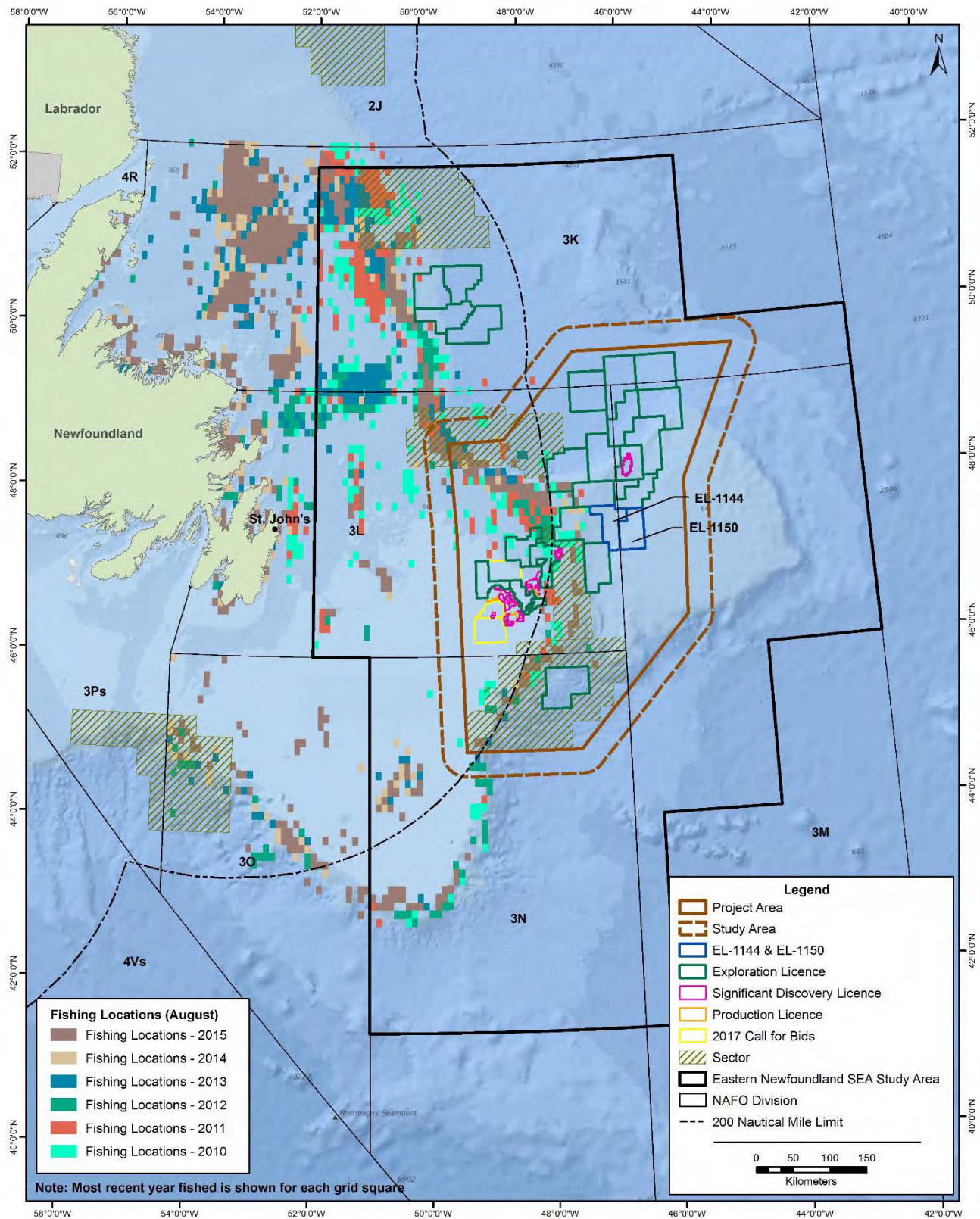
Figure 4.97 All Species Harvesting Locations, August 2010 - 2015

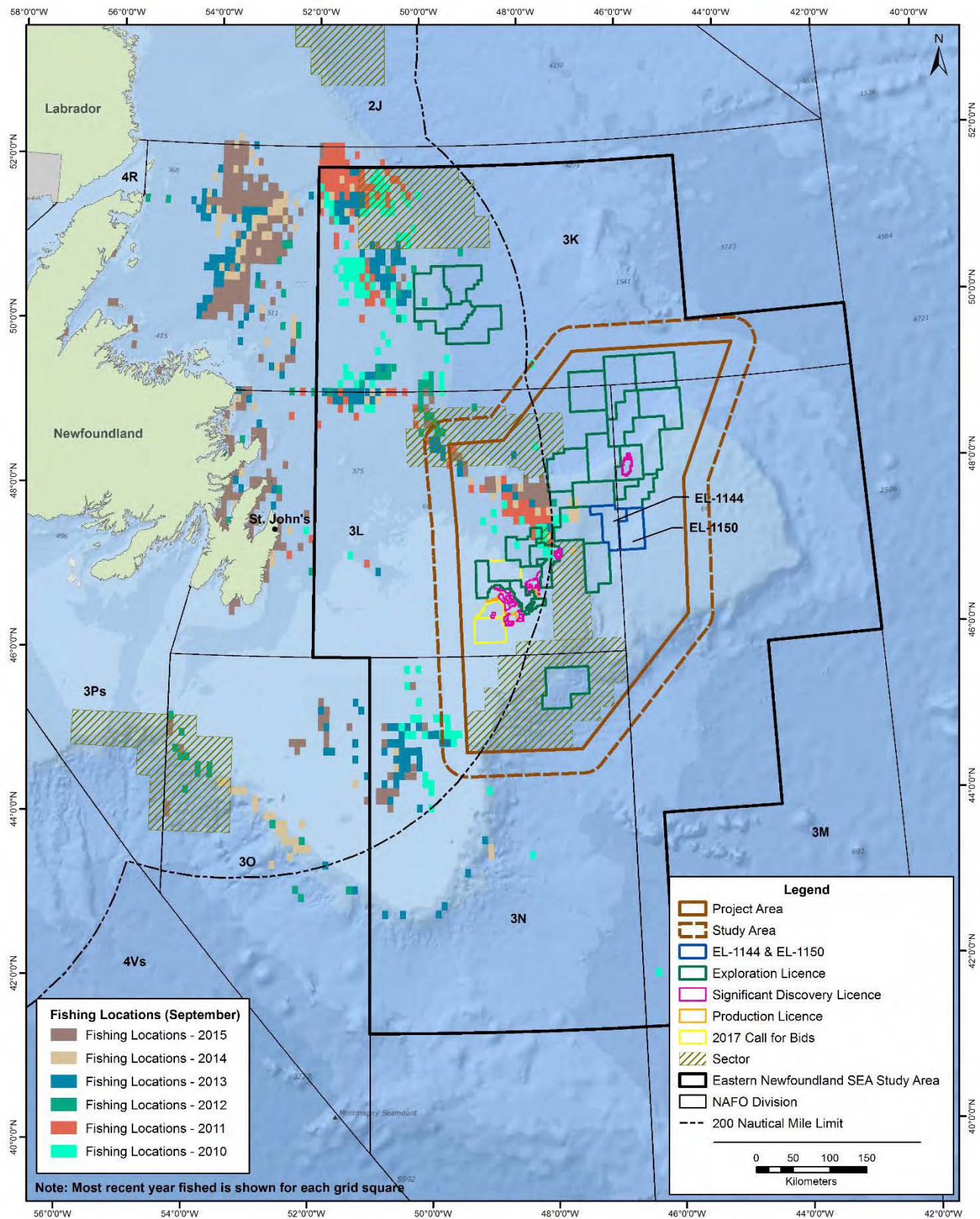
Figure 4.98 All Species Harvesting Locations, September 2010 - 2015

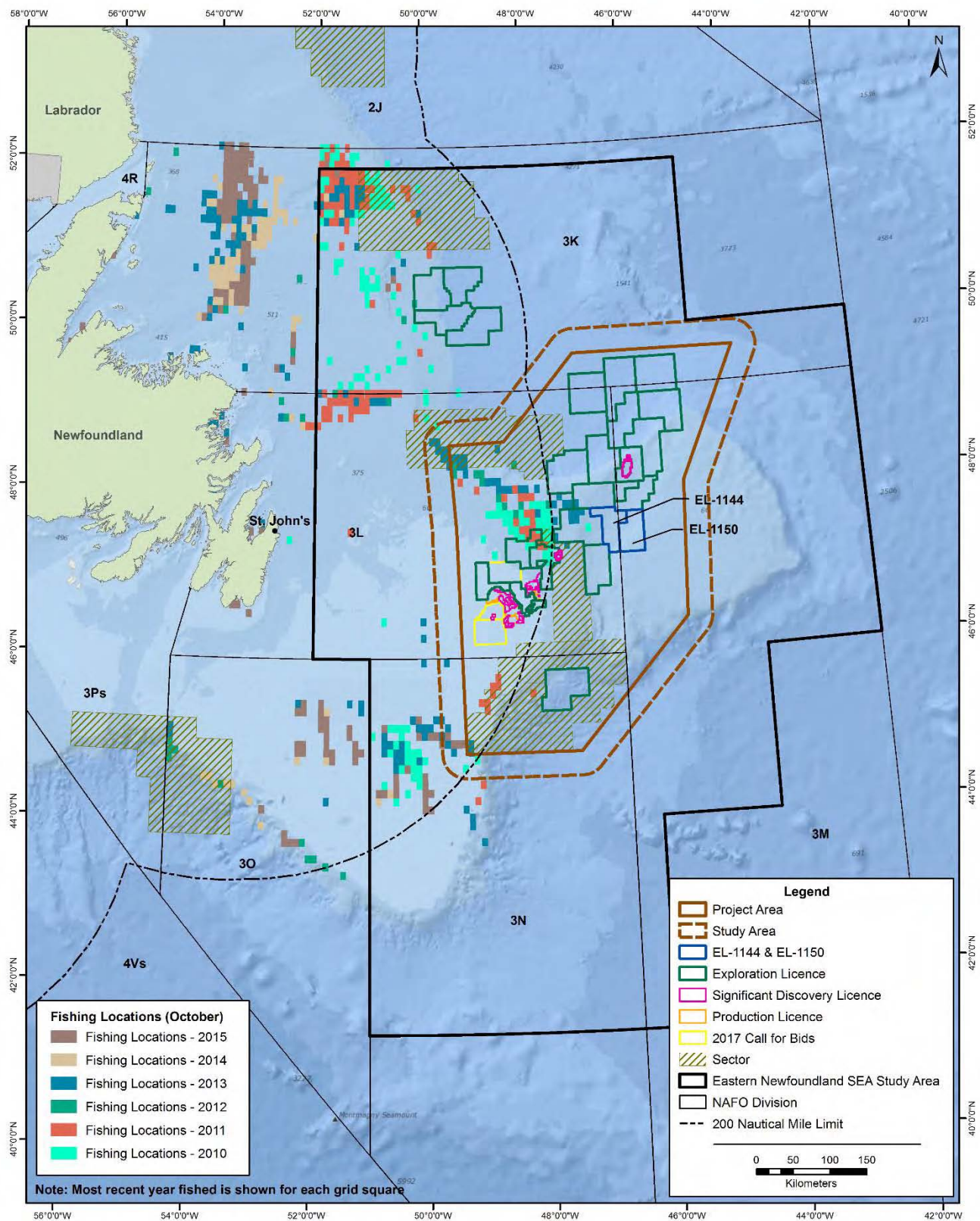
Figure 4.99 All Species Harvesting Locations, October 2010 - 2015

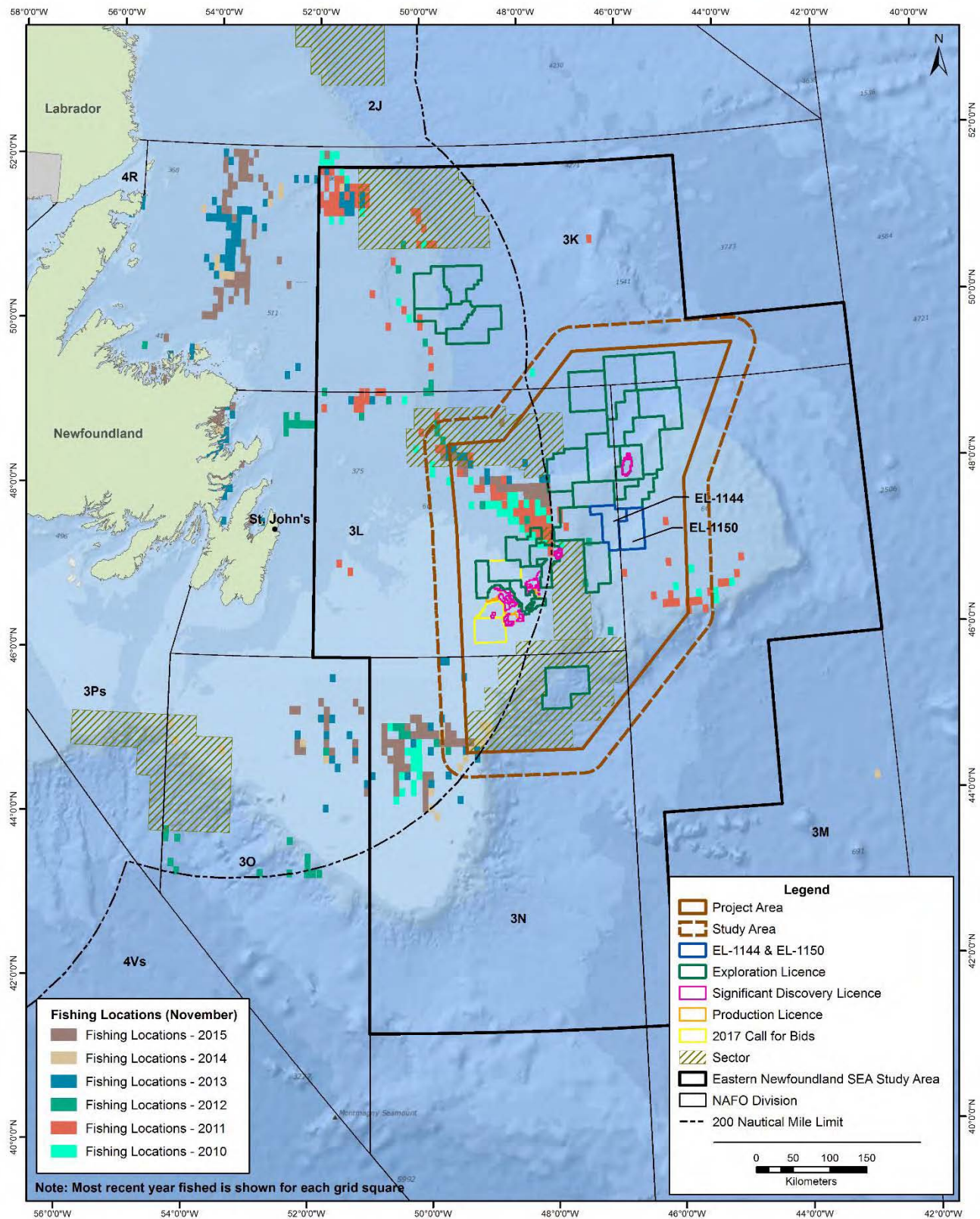
Figure 4.100 All Species Harvesting Locations, November 2010 - 2015

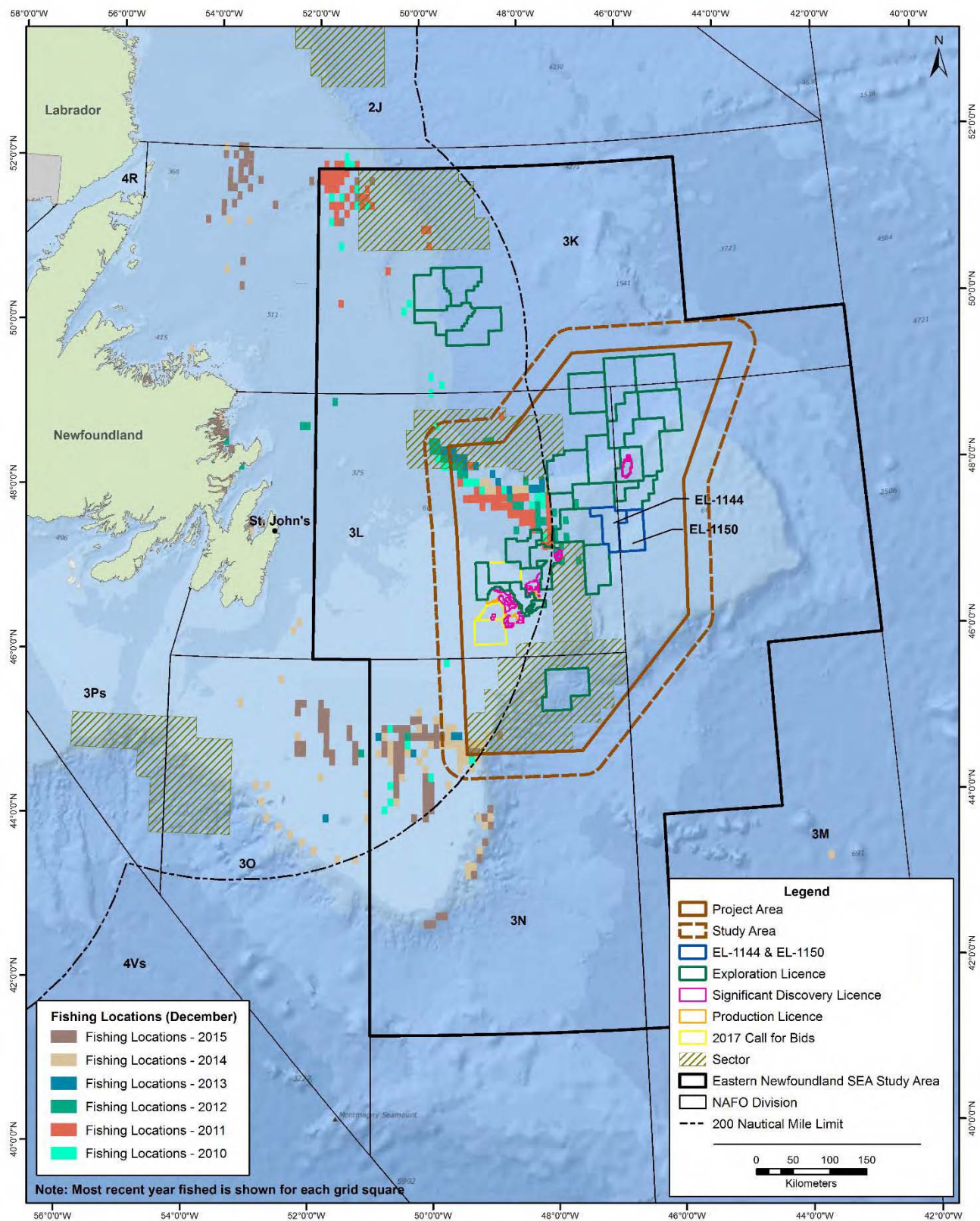
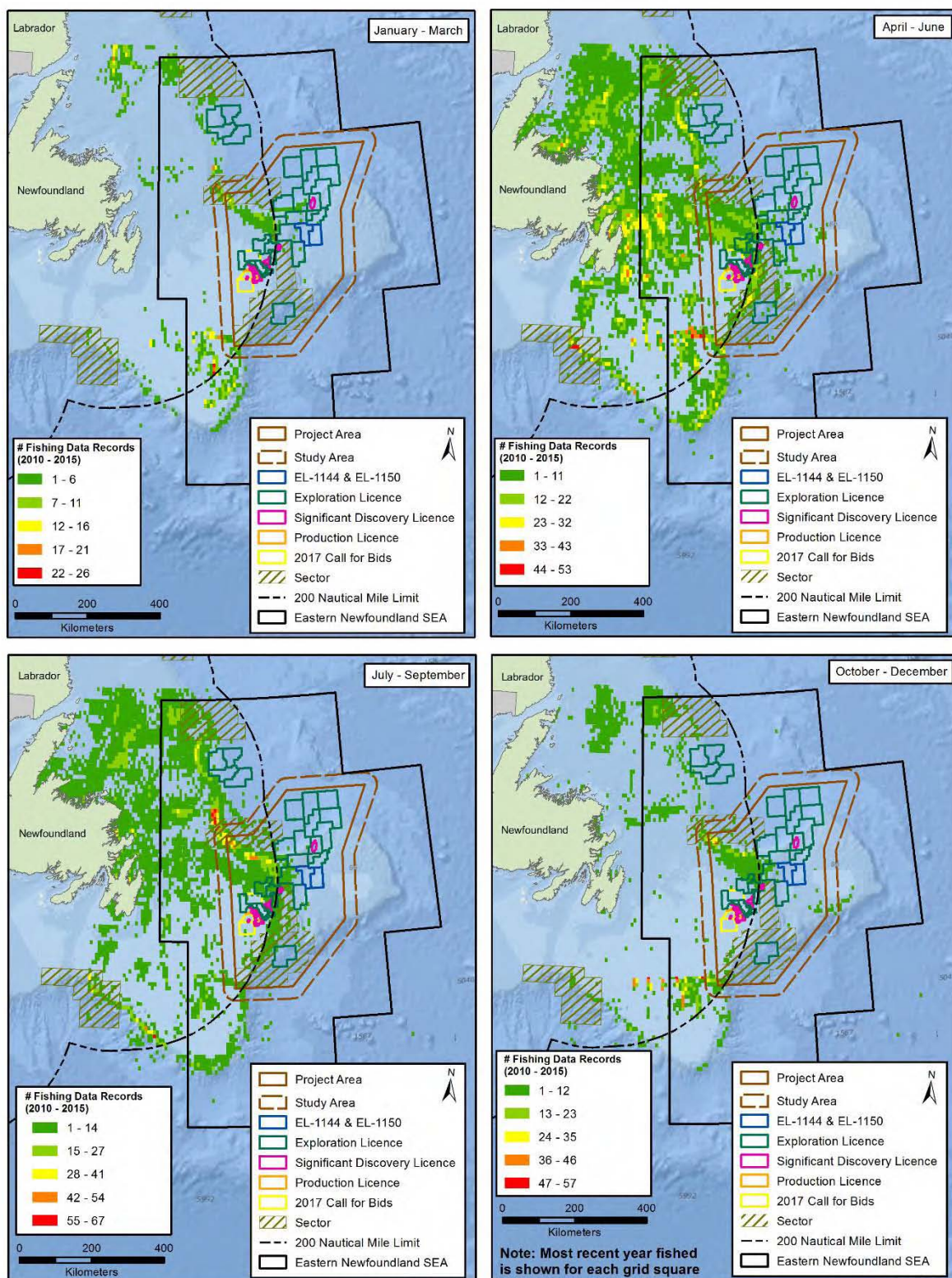
Figure 4.101 All Species Harvesting Locations, December 2010 – 2015

Figure 4.102 Commercial Harvesting Intensity by Locations, All Species, by Quarter 2010-2015

Key Fisheries

As previous sections have shown, the fisheries in the Study Area Unit Areas have been dominated by shellfish (primarily snow crab and northern shrimp), but also with important deep-sea clam catches in terms of both quantity and value since the 1990s. During the 2010 to 2015 period, snow crab made up approximately 58 percent of the area's harvest by weight in those years but 78 percent of the landed value. Northern shrimp had been the next most important species (20 percent of quantity and 10 percent of value) but that fishery has now been closed in the Study Area for an indefinite period. Other than deep-sea clams, nearly all the other catches have been groundfish, some in directed fisheries (such as yellowtail flounder and redfish) and others as an allowed by-catch (like American plaice or Atlantic cod in most areas).

The following section provides some additional information about these key fisheries and some others that are less economically important over all, but may be more prone to seismic interactions (particularly gear conflict). For various harvest quantities and values referenced in this section, please refer to the earlier and associated Tables and Figures.

Snow/Queen Crab

As described, the snow crab fishery is now the most substantial fishery within the Study Area and in most other parts of the region. Since the 1990s groundfish closures, it has continued to increase in relative importance, which has been emphasized recently by stronger prices, so that in 2015 snow crab accounted for more than 95 percent of the Study Area catch by both quantity and value. In that year, there were about 2,600 licence holders within several vessel fleets around the province, operating under management measures that included trap limits, quotas, trip limits, designated fishing areas, onboard vessel monitoring systems (VMS) for the offshore fleets, and limited seasons. For 2016, season dates were set for April 4 to July 31 in Division 3NLOP, though the time was extended until early August in some areas. The set dates for 2017 were April 6 to July 31 (DFO 2016d, 2017c).

Crab fishing gear is typically set in 50 to 600 m water depths, most from boats less than 20 m in length. It consists of conical baited crab pots (traps) that are weighted on the sea floor and attached to surface buoys by ropes/lines, often in strings with many traps between buoys. Snow crab gear strings may have a "highflyer" radar reflector at one end and a large buoy at the other end. A 50-60 trap string may range in length from 1.8 km to 2.3 km long. Traps may be left unattended several days or longer if weather makes it difficult to retrieve the catch (DFO 2013c, 2016d). Because of the possibility of a seismic streamer snagging buoys or lines, there is a potential for interactions with seismic surveys if both activities were to occur together in time and location.

Although the 2015 season marked an all-time high in 3LNO offshore snow crab catches with landings of 28,750 tonnes, science surveys late that year indicated potential problems with pre-recruits and biomass in several areas. For 2016, there was a total allowable catch (TAC) of 33,486 tonnes for all of Division 3LNO, which was an overall six percent reduction from 2015, and in management zones beyond 200 nautical mile EEZ, the reduction was 20 percent. In early 2017 DFO reported more serious concerns about the stock status, indicating that 3LNO biomass had declined to an historic low, down 74 percent from 2015-2016 in some management areas (DFO 2016d, 2016e; Navigator 2017).

The 2017 TAC and management area quotas were announced in April after extensive consultation between DFO and the fishing Industry; the outcome was a further reduction from 2016, by 46 percent in areas outside the EEZ and 23 percent in other areas (DFO 2017b). Table 4.45 shows the 2015 and 2017 quotas for the relevant crab fisheries management areas.

Table 4.45 Study Area Snow Crab Quotas for 2015 and 2017

Management Area	Description	Quota (tonnes) 2015	Quota (tonnes) 2017	Percent Change from 2015
8B	Southern Avalon (offshore)	800	640	-20%
MS/EX	Mid-shore extended	3,780	3,024	-20%
3L EX	Between 170 and 200 miles	2,822	2,117	-25%
3L 200	3L Outside 200 miles	2,053	985	-52%
3N 200	3N Outside 200 miles	2,527	1,011	-60%
3NO 200	3NO Outside 200 miles (> 65' boats)	920	368	-60%
Total		12,902	8,145	-37%

Source: DFO 2015, 2017b

Figure 4.103 show the annual snow crab harvest (available data) for 2010-2015, and Figures 4.104 indicates the timing of the harvest.

As Figure 4.105 shows, the fishery has been widespread along parts of the Newfoundland Shelf, the Flemish Pass, and the northern, eastern and southern edges of the Grand Banks. DFO research also indicates that the upper slopes in the northern half of the Study Area are amongst the most productive in terms of quantity per trip (Mullowney et al 2016).

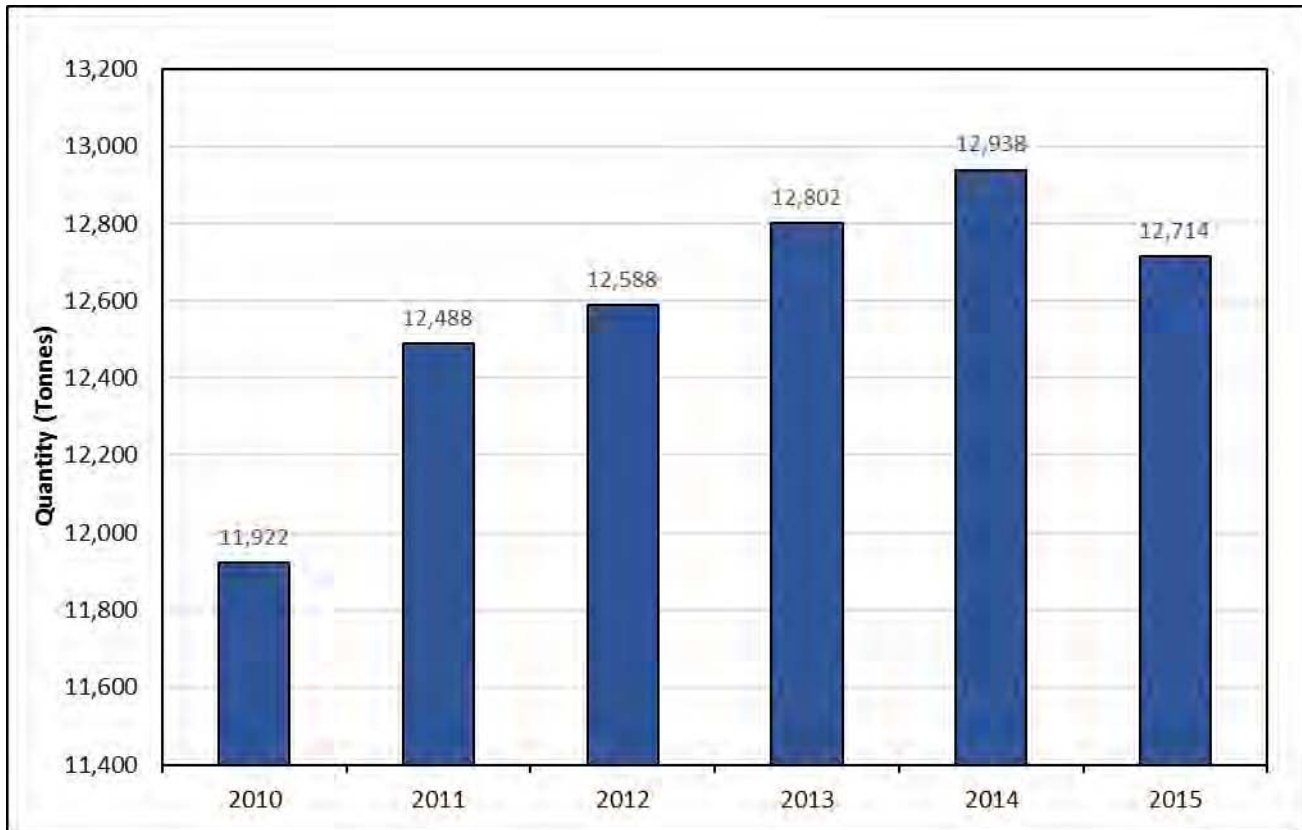
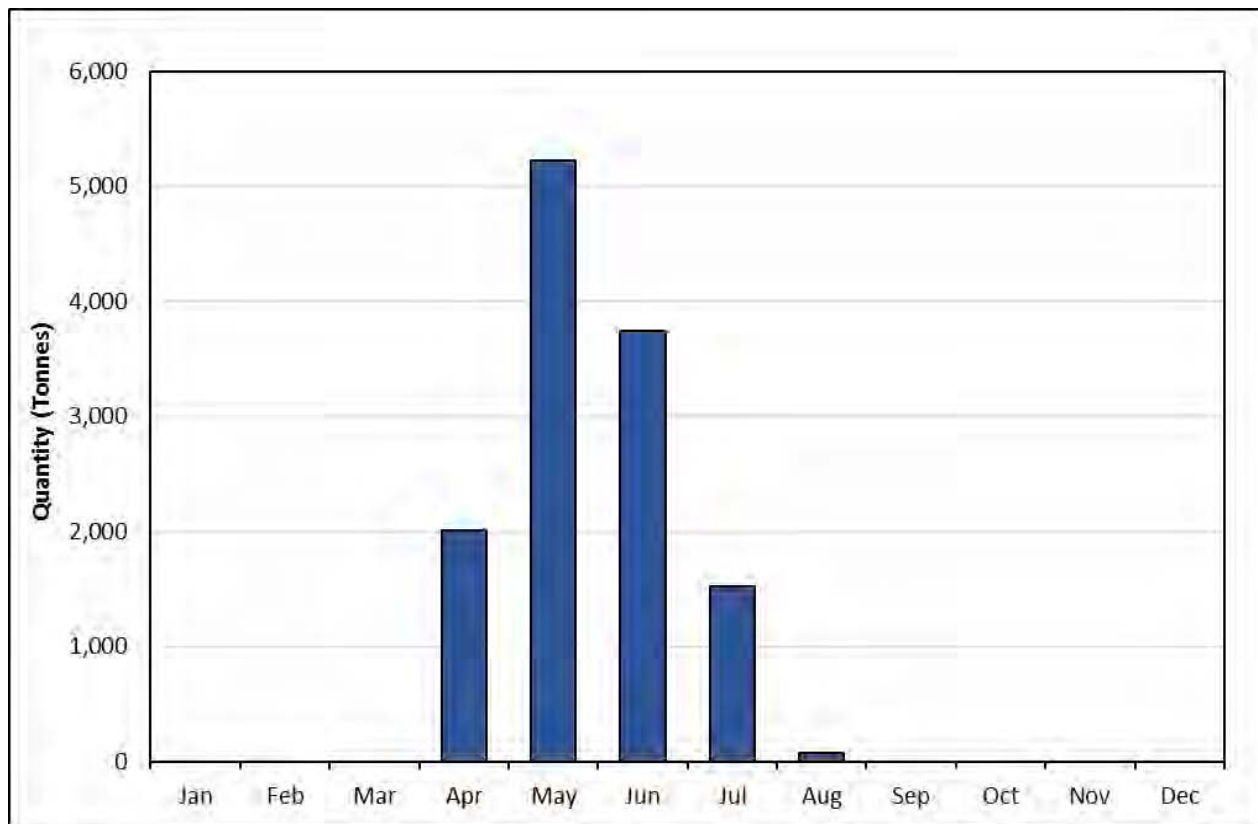
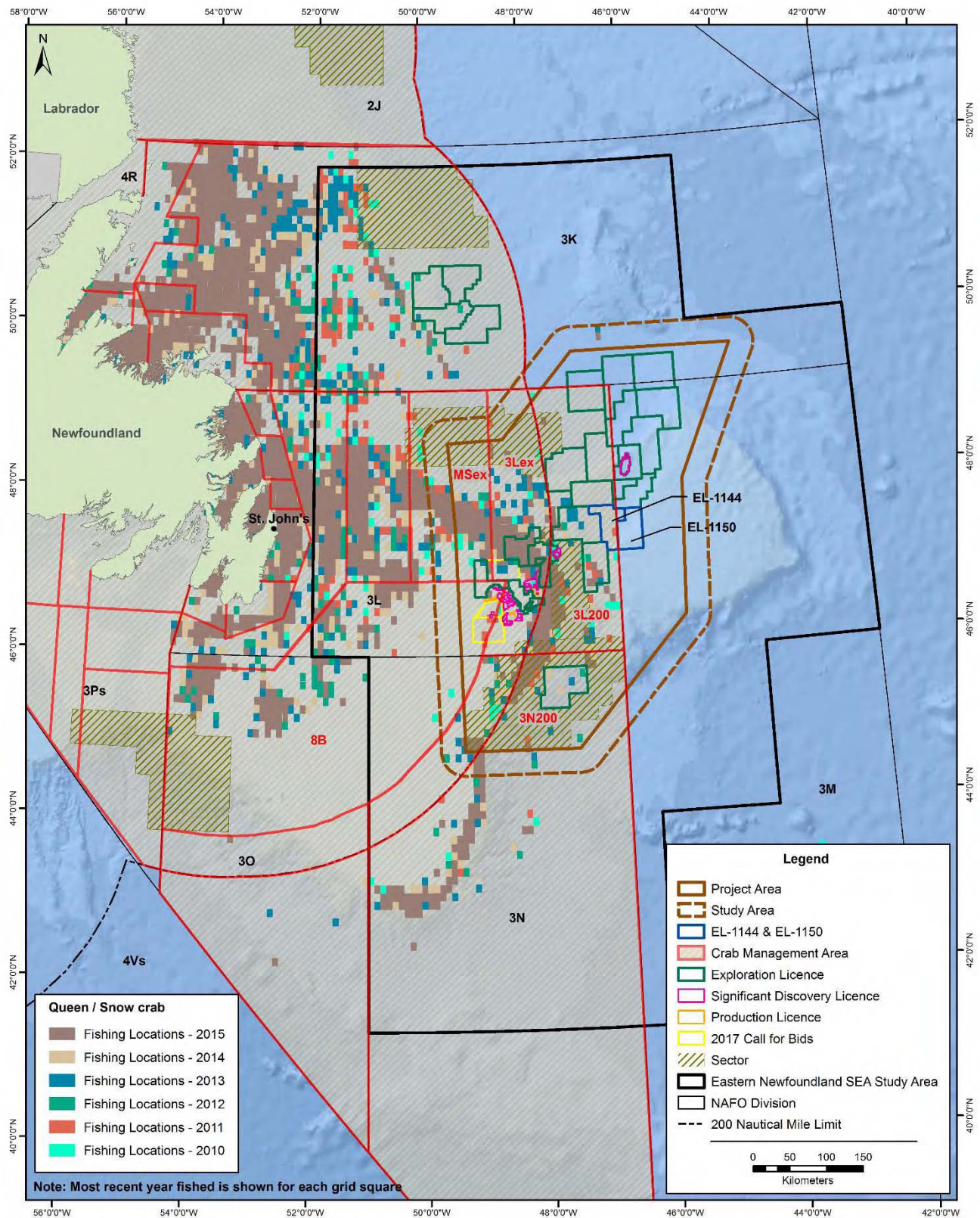
Figure 4.103 Snow/Queen Crab, Study Area Unit Areas Quantity of Harvest by Year, 2010-2015**Figure 4.104 Snow/ Queen Crab, Study Area Unit Areas Quantity of Harvest by Month, 2010-2015 Average**

Figure 4.105 Harvesting Locations Snow Crab (March - December, 2010-2015)

Northern Shrimp

Until 2013- 2014, the Northern shrimp (*Pandalus borealis*) fishery had been one of the most important commercial species harvests in the Study Area, as it continues to be in more northern fishing areas. Although the harvest was directed primarily towards Northern shrimp, other kinds (particularly striped shrimp, *Pandalus montagui*) were also taken in smaller quantities. Beginning in 2009, Division 3L (Shrimp Fishing Area 7) quotas were drastically reduced on an annual basis, from more than 20,000 tonnes that year to 5,085 tonnes in 2012 and just 1,415 tonnes in 2014, the last year that shrimp fishing was permitted in the area (DFO 2009, 2012c, 2014c; Parrill 2016). In a recent report, DFO (2016f) states, “Departmental scientific advice indicates the size of the Northern shrimp biomass has been trending downwards as much as 70% to 90% over the last 6-7 years. Decreases are greatest at the southern end of the range off of Newfoundland and Labrador where the inshore fleet has access”. Adjacent stocks on the Flemish Cap have been under NAFO moratorium since 2011 (see Commercial Fishing by Foreign Countries, below) (NAFO 2016c).

Harvesting in offshore areas has been conducted using dedicated shrimp trawls (stern otter-type or beam), towed at or near the sea floor, and typically extending more than 300 m behind the ship (DFA 2001). The tow duration is dependent on the catch rate; if it is high then the tow length is less. The offshore ships typically try to maintain a fill level in the cod end for maximum quality. For the larger ships, tows can be typically about three hours, travelling at speeds of 3-4 knots, depending on the processing rate of the on-board facilities (R. Ellis, pers. comm. 2014).

Conservation measures include minimum trawl mesh sizes, bycatch minimizing devices and monitoring by fisheries observers. Otter and beam trawls utilize a minimum mesh size of 40 mm and are required to have a Nordmore Grate to minimize bycatch of groundfish and other shellfish. The fishery is monitored by at-sea observers that supervise the vessel for by-catch, gear restrictions, and closed time provisions (DFO 2010c).

Figure 4.106 shows the annual northern shrimp harvest within the Study Area Unit Areas for 2010-2015, and Figure 4.107 indicates the timing of the harvest over this period, for quantities by month of harvest. Figure 4.108 shows aggregated harvesting locations for March to December during those years.

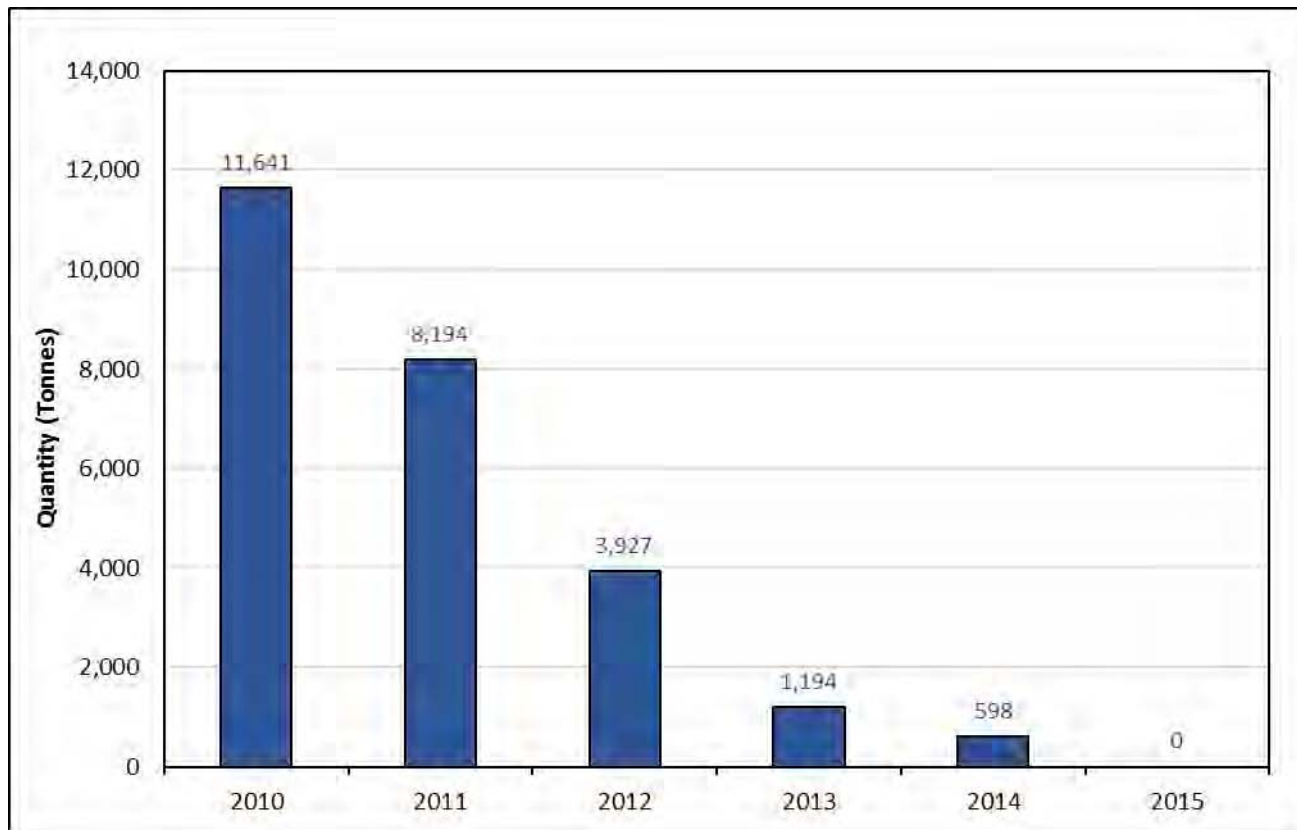
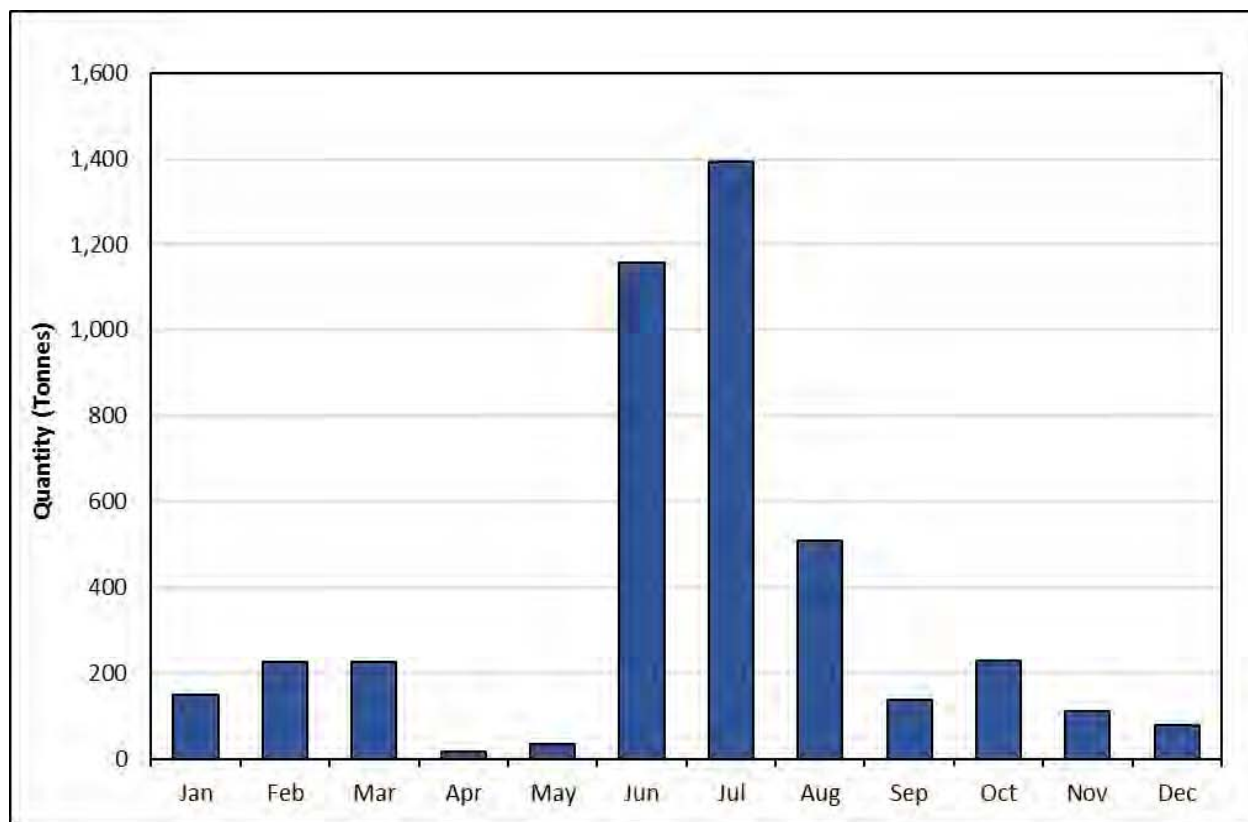
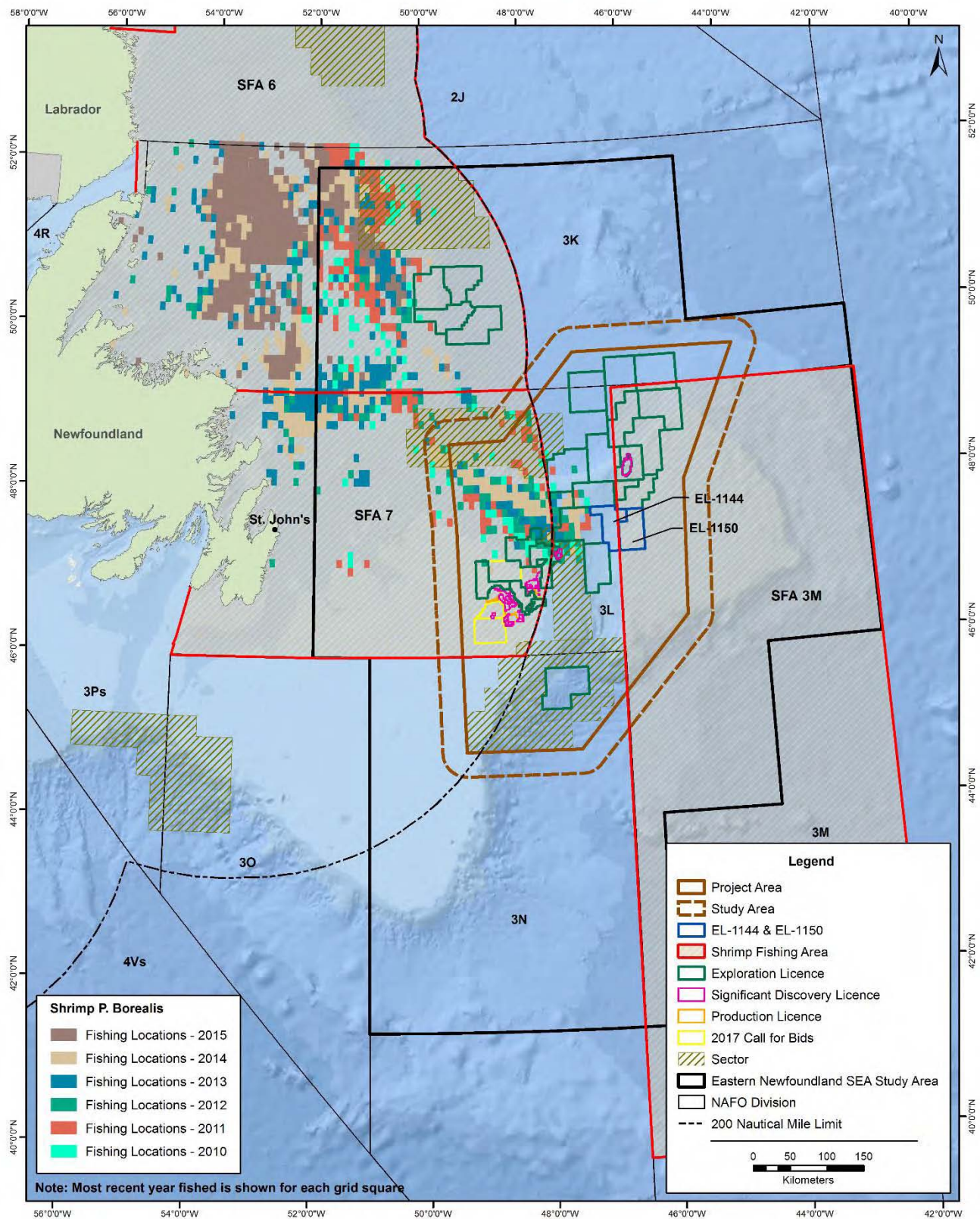
Figure 4.106 Northern Shrimp, Study Area Unit Areas Quantity of Harvest by Year, 2010-2015**Figure 4.107 Northern Shrimp, Study Area Unit Areas Quantity of Harvest by Month, 2010-2015 Average**

Figure 4.108 Harvesting Locations Northern Shrimp (March - December, 2010-2015)

Deep-Sea Clams

Deep-sea clam fishing within or near the Study Area takes place primarily on the eastern Grand Bank shelf, and to a lesser degree on the south-eastern slope near the tail of the bank. The fishery targets Arctic/Stimpson's surf clams, under quota, but also takes other shellfish species, such as Greenland cockles and propeller clams, as non-quota by-catches. The other primary fishing ground for these species is the Banquereau Bank area on the eastern Scotian Shelf. Both areas are managed under a common plan with a single overall TAC. The fishery may be conducted year-round and utilizes large factory-freezer vessels equipped with hydraulic dredges for harvesting. The gear, which operates by fluidizing the seafloor material with high-power water jets and allowing the underlying clams to be scooped into the dredge baskets, is generally used at depths of 45 m to 100 m on sandy bottoms (DFO 2010d; 2016f; Roddick 2005, 2013; Roddick et al 2011).

Fisheries management approaches for the offshore fishery are limited licences, the annual TAC, full dockside monitoring, logbooks and VMS onboard the harvesting ships. For 2017, the annual overall TAC has been set at 38,756 tonnes, which is the same as for 2016 (DFO 2016g; 2017c).

In the past, the full TAC was never taken, and harvesting operations sometimes alternated between the Newfoundland grounds and Nova Scotia, with the Nova Scotia clam beds being somewhat more economically productive in those years. However, in 2015 Clearwater Seafoods Limited Partnership (which holds the licences for both areas) launched a new purpose-built factory at-sea vessel, the *Belle Carnell*, to harvest the Grand Bank areas each year and to extend the effective operating season. Consequently, in 2016 for the first time, the full TAC was harvested and similar levels of harvesting are expected in future years (Clearwater 2017; C. Boyd, pers comm 2017).

Figure 4.109 shows the annual deep-sea clam harvest reported by DFO within the Study Area Unit Areas for 2010-2015, and Figure 4.110 indicates the timing of the harvest over this period, by quantity and month of harvest, based on those data. As noted, because of substantial data redaction, these data represent only a portion of the actual harvesting conducted. However, Clearwater reported clam sales of \$84.4 million in 2015 (both areas) and expected that the addition of the new ship could increase sales by 50 percent from that number (Clearwater 2016a; 2016b).

Figure 4.111 shows aggregated general areas of harvesting over the last 10 to 15 years, based on historical DFO data. Although there is overlap with the Study Area and Project Area, there is a low likelihood of interaction with a seismic ship since the gear is deployed directly from the ship, which is moving at a slow speed during harvesting, and communications can be maintained and the harvesting ship avoided.

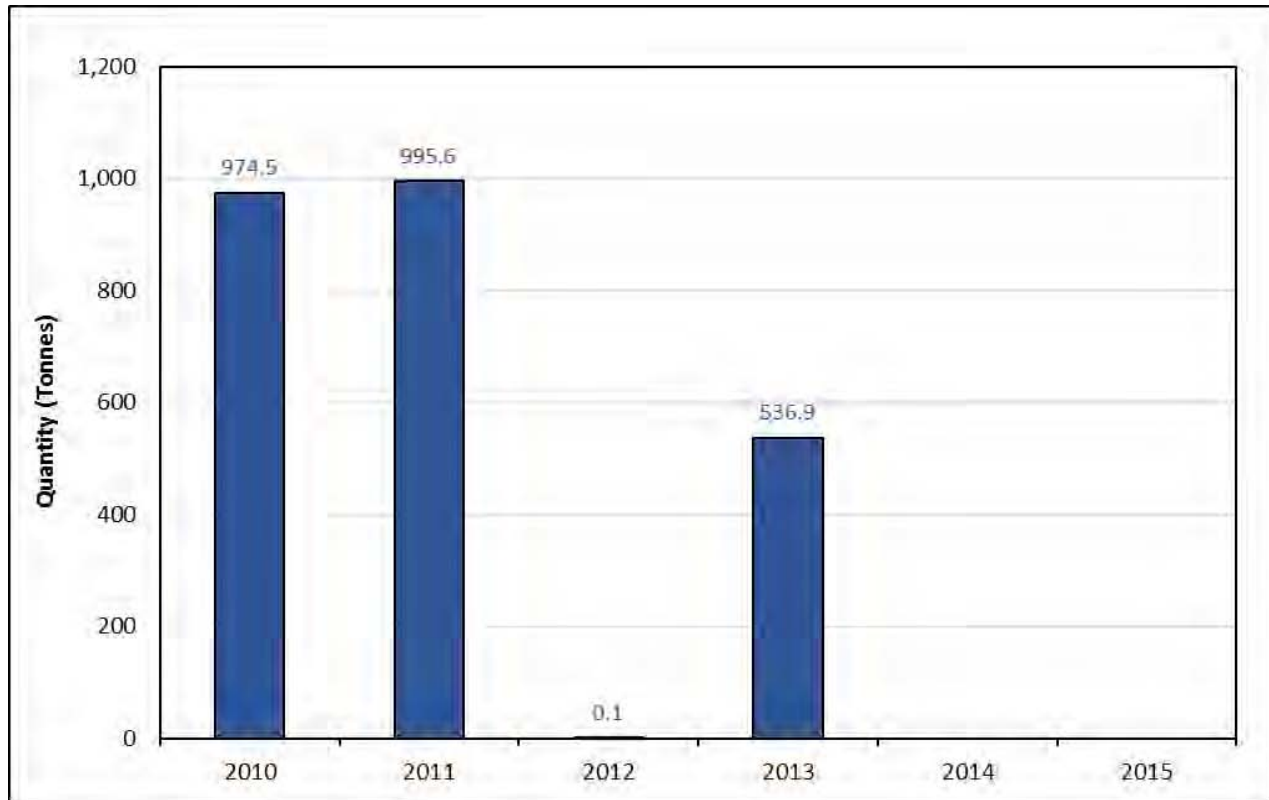
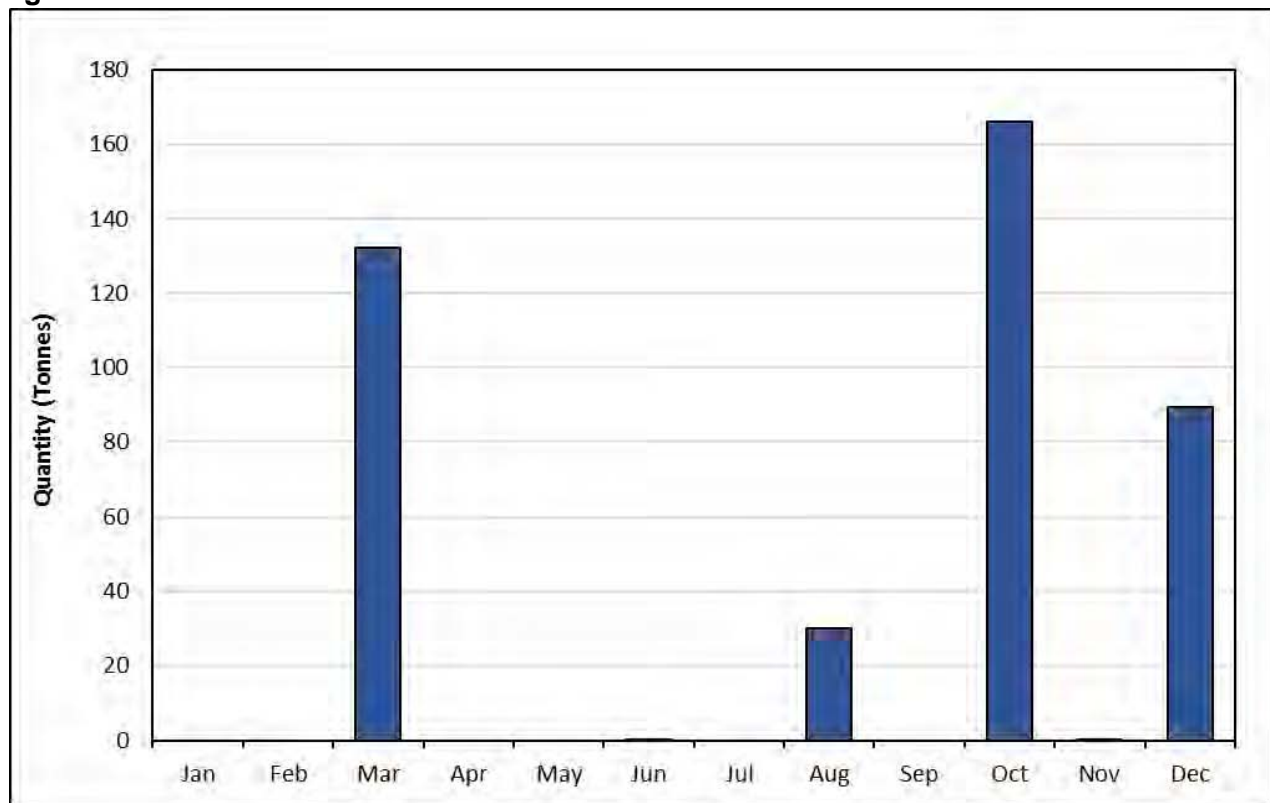
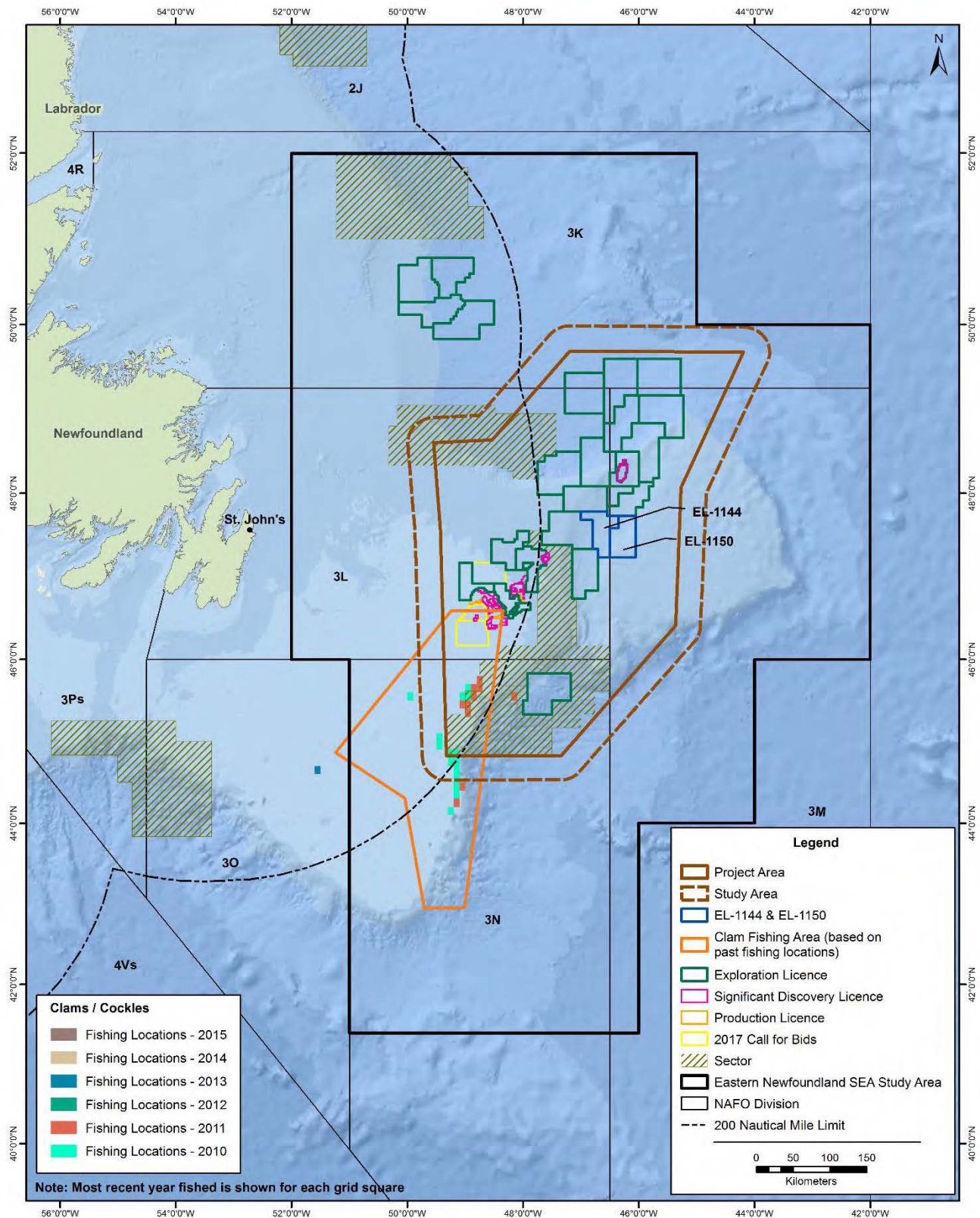
Figure 4.109 Deep-Sea Clams, Study Area Unit Areas Quantity of Harvest by Year, 2010-2015**Figure 4.110 Deep-Sea Clams, Study Area Unit Areas Quantity of Harvest by Month, 2010-2015 Average**

Figure 4.111 Harvesting Locations Deep-Sea Clams (March - December, 2010-2015 + General)

Groundfish

This section provides additional information about six important groundfish fisheries that are likely to continue to occur within the Study Area during the temporal scope of this assessment. These are the five most important groundfish species by quantity of harvest (based on the DFO datasets), ranging from 7.9 percent (Yellowtail flounder) to 0.2 percent (Atlantic cod) of the total Study Area Unit Areas domestic harvest between 2010 and 2015. The sixth groundfish species is Atlantic halibut which is included here because of its relatively high value and the type of fixed gear used most often for this fishery. Together, these and all other groundfish species typically make up about 20 percent of the Study Area Unit Areas harvest by quantity and 11 percent by value in recent years, though until the 1990s they constituted nearly 100 percent of the catch particularly in areas distant from shore.

Groundfish harvesting in the area is managed partly by DFO and partly by NAFO, which also manages these species fisheries by foreign nations (see Section 4.3.1.8). The data referenced in this section is for Canadian domestic harvesting, although harvesting seasons and methods are similar for all participants. For most species (with the exception of Greenland and Atlantic halibuts), the predominant gear used is mobile trawl and many are harvested together either in directed fisheries or as limited by-catch harvests for those fisheries under continuing moratorium or where set quotas have been reached. The 2016 quotas and status of these fisheries is shown in Table 4.46.

Table 4.46 Status and 2016 Quotas for Key Groundfish Species

Groundfish Species	Area	Status	2016 Quota (tonnes)
Yellowtail flounder	3LNO	Directed fishery	16,575
Turbot/ Greenland halibut	3LMNO	Directed fishery	1,644
Redfish	3LMN	Directed fishery	4,930
American Plaice	3LMN	Moratorium (by-catch only)	-
Atlantic Cod	3LMN	Moratorium (by-catch only), except 3M	111
Atlantic Halibut	Scotian Shelf to S Grand Banks	By-catch only in 3L; directed fishery elsewhere	3,039

Source: Based on DFLR (2017); NAFO (2016d); D. Kulka pers comm (2017)

As noted, harvesting is largely (76 percent, 2010-2015) mobile gear, almost exclusively stern otter trawl, most towed behind large ships. Of the fixed gear fisheries, nearly all (98 percent) are set gillnets (mainly Turbot/Greenland halibut) with the remainder being longlines (mainly for Atlantic halibut). As stated previously, fixed gear is usually of greater concern for seismic surveying because of its potential for streamer conflicts (with the gear itself or surface buoys) and because it may be more difficult to locate at sea.

The following graphs show the recent variations in landings by year (Figure 4.112) and average monthly catches (Figure 4.113) based on the DFO-supplied data; note again that owing to data redaction the 2014 and 2015 annual figures are not considered to be complete for most species. As the monthly graph indicates, groundfish harvesting occurs in the area year-round, although the greatest concentrations have been during the spring and early summer months (May to July) when more than half of the catches were taken. For the fixed gear fisheries, nearly all the fish (98 percent) was taken between June and August with the majority (71 percent) caught in July.

Figure 4.112 Key Groundfish Species, Study Area Unit Areas Quantity of Harvest by Year, 2010-2015

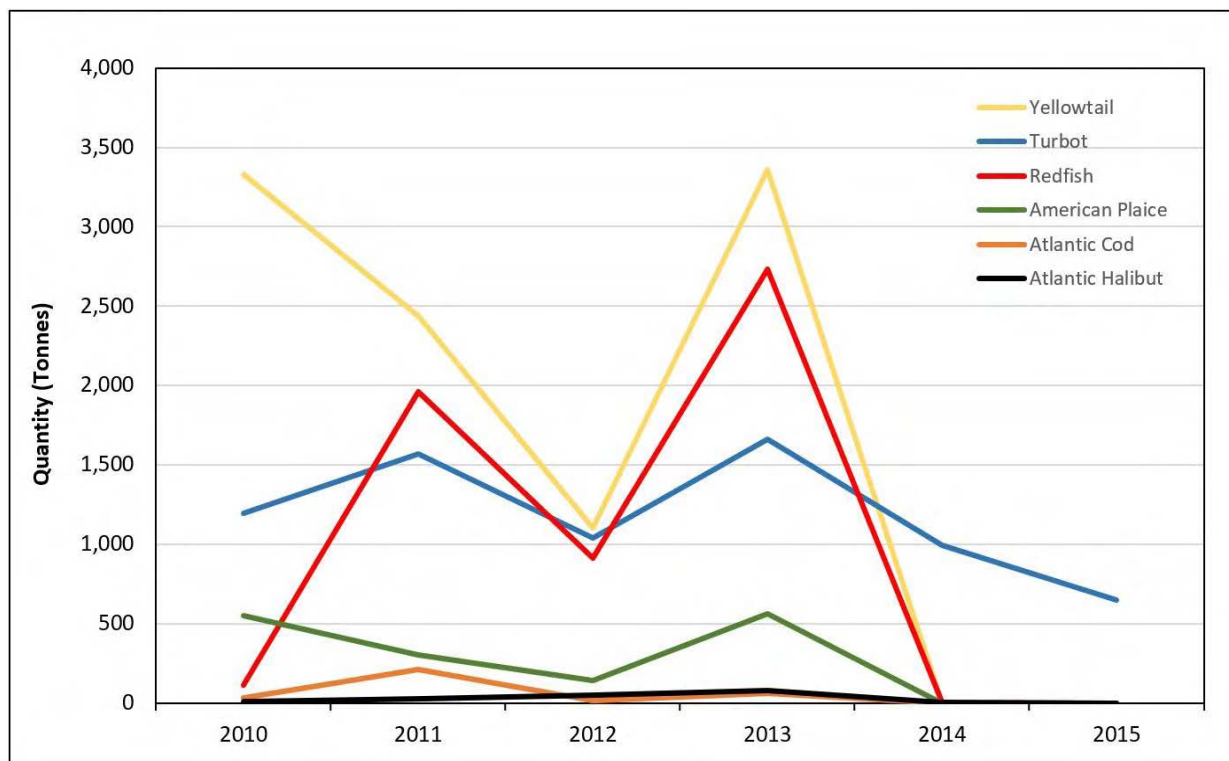
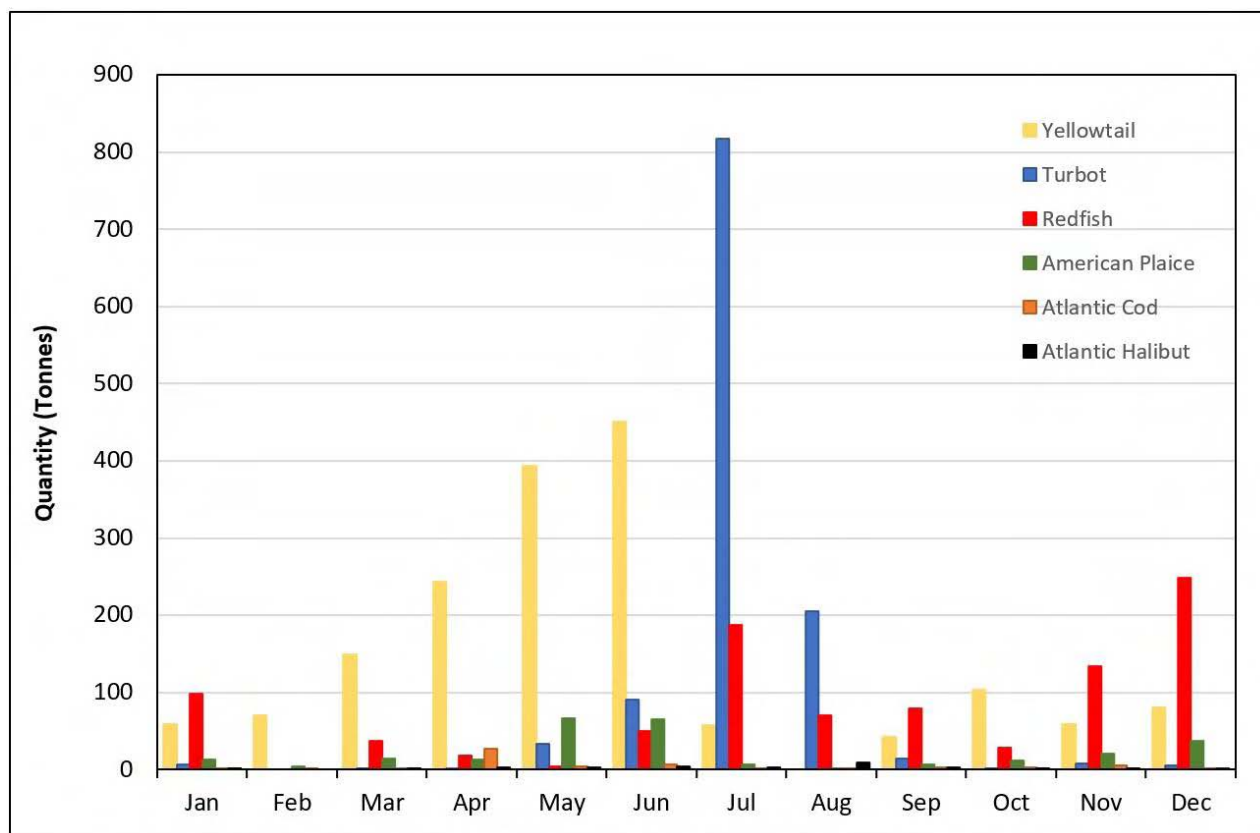


Figure 4.113 Key Groundfish, Study Area Unit Areas Quantity of Harvest by Month, 2010-2015 Average



Yellowtail Flounder. This species made up the largest component of the Study Area Unit Area groundfish harvest, accounting for nearly 40 percent of the total groundfish landings by quantity and 21 percent by value (7.9 percent and 2.3 percent over all Study Area Unit Area species) for the 2010-2015 period. The directed quota fishery uses exclusively stern otter trawl, which also take restricted amounts of Atlantic cod and other groundfish species, such as American plaice (NAFO 2016e). As the map in Figure 4.114 indicates, domestic yellowtail harvesting is concentrated on the southern Grand Banks near the tail, mainly in NAFO Divisions 3N and 3O, mostly in waters shallower than 93 m, although a small amount occurs to the north in 3L. Within the current areas of interest, the main concentration of activity occurs between the southwestern Study Area and the Project Area boundaries.

Turbot/Greenland Halibut. The turbot (Greenland halibut) fishery made up approximately 28 percent of the total quantity of groundfish landings in the Study Area Unit Areas (2011-2015) but 53 percent of their value, owing to the higher average prices paid for this species (5.5 percent and 5.9 percent over all species). Like yellowtail, this is a directed quota fishery but most is taken using fixed gear gillnets (82 percent), with the remainder in stern trawls, except for small incidental amounts in longline fisheries, which were once the main harvesting method. The directed turbot fishery also harvests restricted amounts of Atlantic cod and American plaice by-catch, and is also taken as by-catch in other directed fisheries. Fixed gillnets are weighted to the sea floor at the bottom of the nets and held up in the water column by a series of floats attached to a headline and operate by entangling the fish as they attempt to swim through. The nets are often deployed in series (fleets), and are marked by surface buoys, which present the potential for seismic streamer contact. As the map in Figure 4.115 indicates, Study Area harvesting (both gillnets and bottom otter trawls) is concentrated on outer margins and slopes of the Grand Banks, stretching through the Study Area from south to north, but with a greater concentration in the north. The otter trawl harvests tend to be by larger vessels (greater than 30 m) with the gillnet fishery generally using smaller boats (less than 20 m) (Brodie et al 2010). Most of the harvesting has been between June and August with the great majority (70 percent) taken during July. The catches from late fall to early spring are taken in the otter trawl fishery.

Redfish. There are three redfish (also known as ocean perch) species in the North Atlantic - *Sebastes fasciatus* (Acadian redfish), *S. mentella* (deepwater redfish) and *S. marinus* (golden redfish) - but catches are recorded together because of difficulties with identification and separation and are reported collectively as “redfish” in the fisheries data. The directed fishery for redfish in Divisions 3L and 3N was under moratorium from 1998 to 2009 but began again with a small quota (TAC) in 2010, which has increased substantially since then (NAFO 2016f; Parrill 2016).

It is now the third most productive groundfish fishery in the Study Area Unit Areas, accounting for just over 22 percent of the groundfish harvest by quantity and 17 percent by value, 2010-2015 (4.4 and 1.9 percent overall). The fishery is managed using TACs, minimum fish sizes, dockside monitoring, at-sea observer coverage and bycatch protocols. There are also closure periods in place to protect migration, redfish fertilization and larval extrusion periods (Goetting 2010; DFO 2016h).

Although a directed fishery, some redfish are also taken as by-catch in other directed fisheries (such as turbot), and both cod and turbot are taken as redfish by-catch (NAFO 2016f). Virtually all the redfish catches are harvested with bottom otter trawls, with less than one percent reported from gillnet by-catches. As indicated in above, the harvest occurs year-round with nearly half being taken between November and January, though a substantial fishery has occurred in July as well (based on 2010-2015 DFO data). As the map in Figure 4.116 shows, it is harvested in similar areas as turbot, along and near the shelf edge, and around the Flemish Cap.

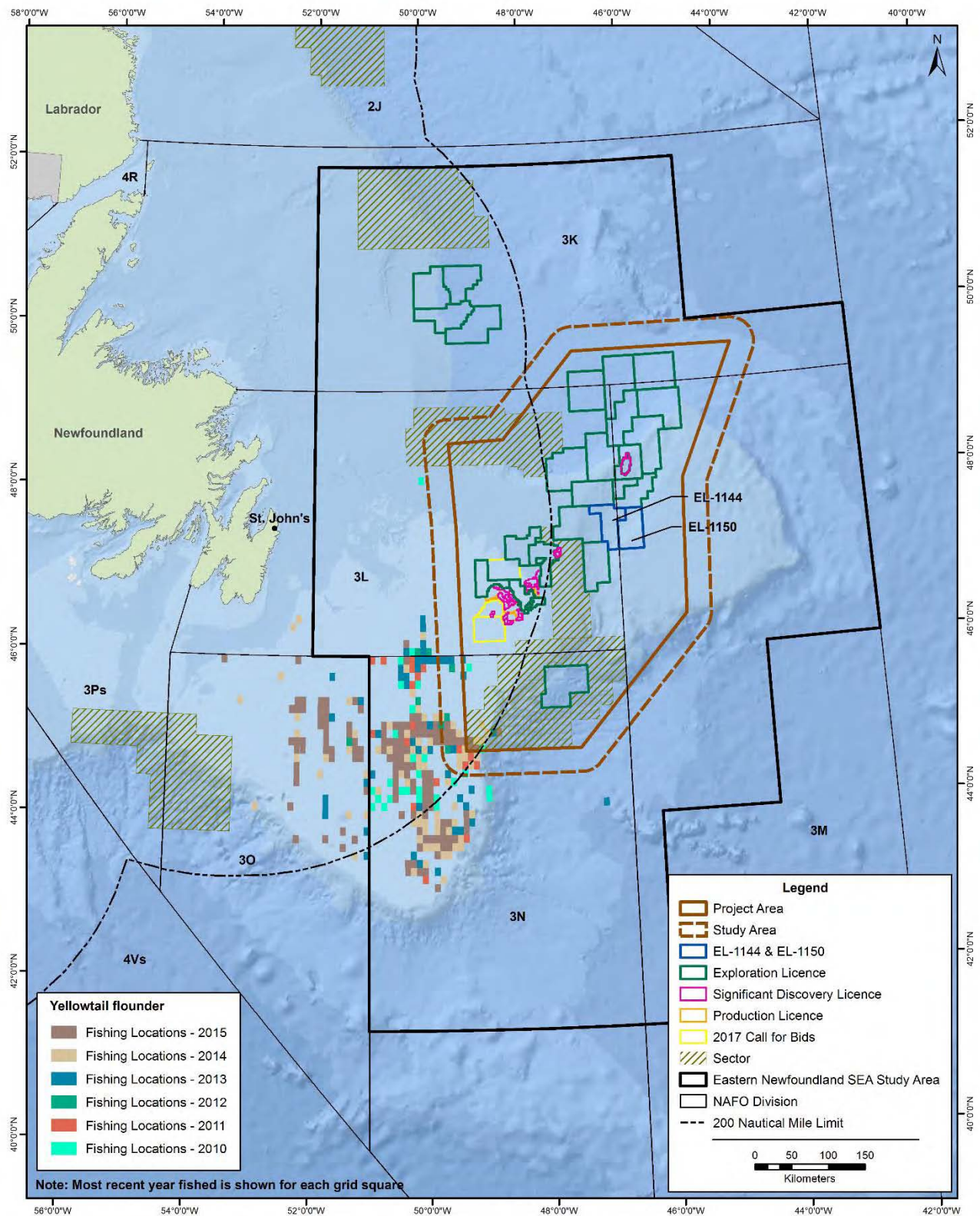
Figure 4.114 Harvesting Locations Yellowtail Flounder (March - December, 2010-2015)

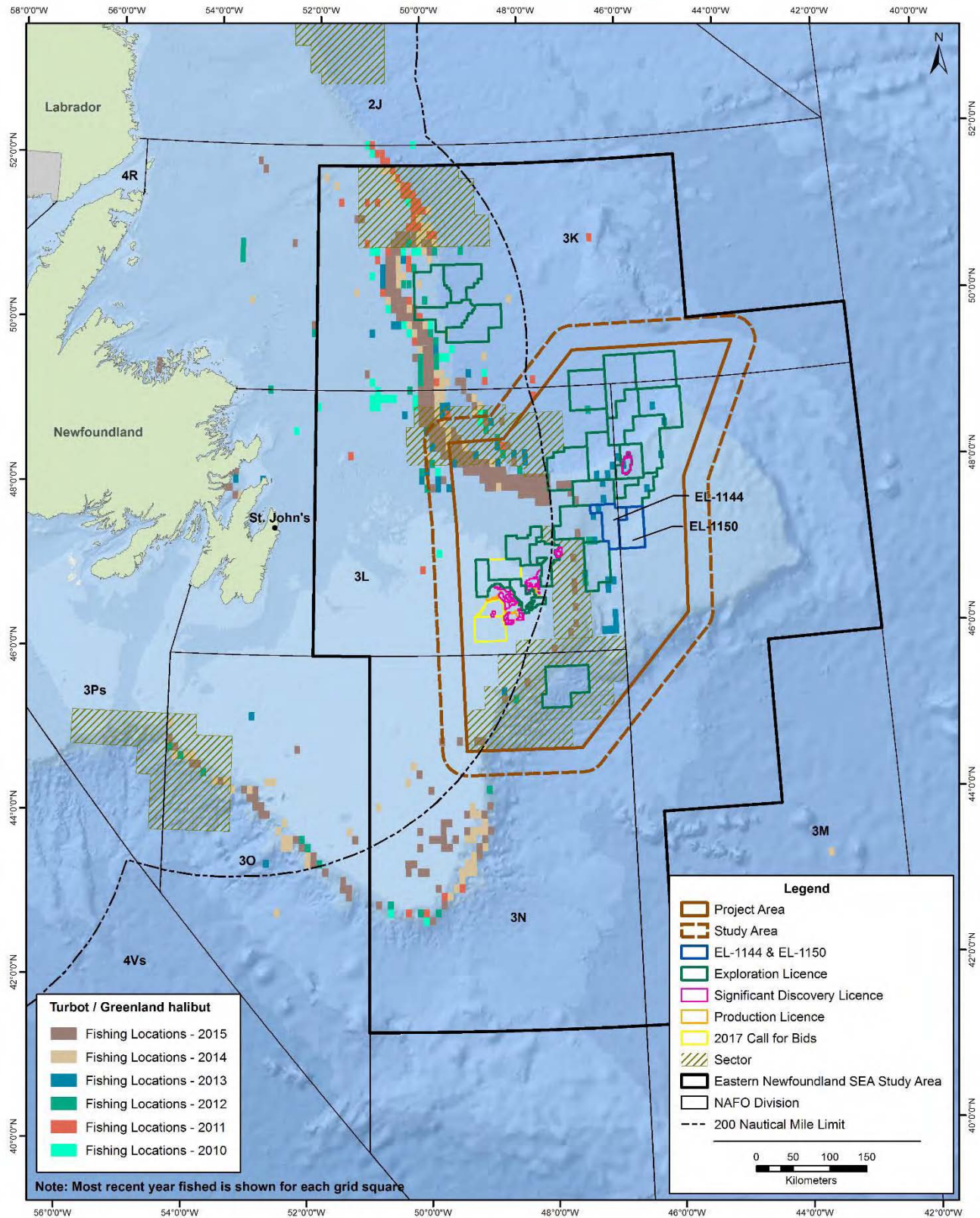
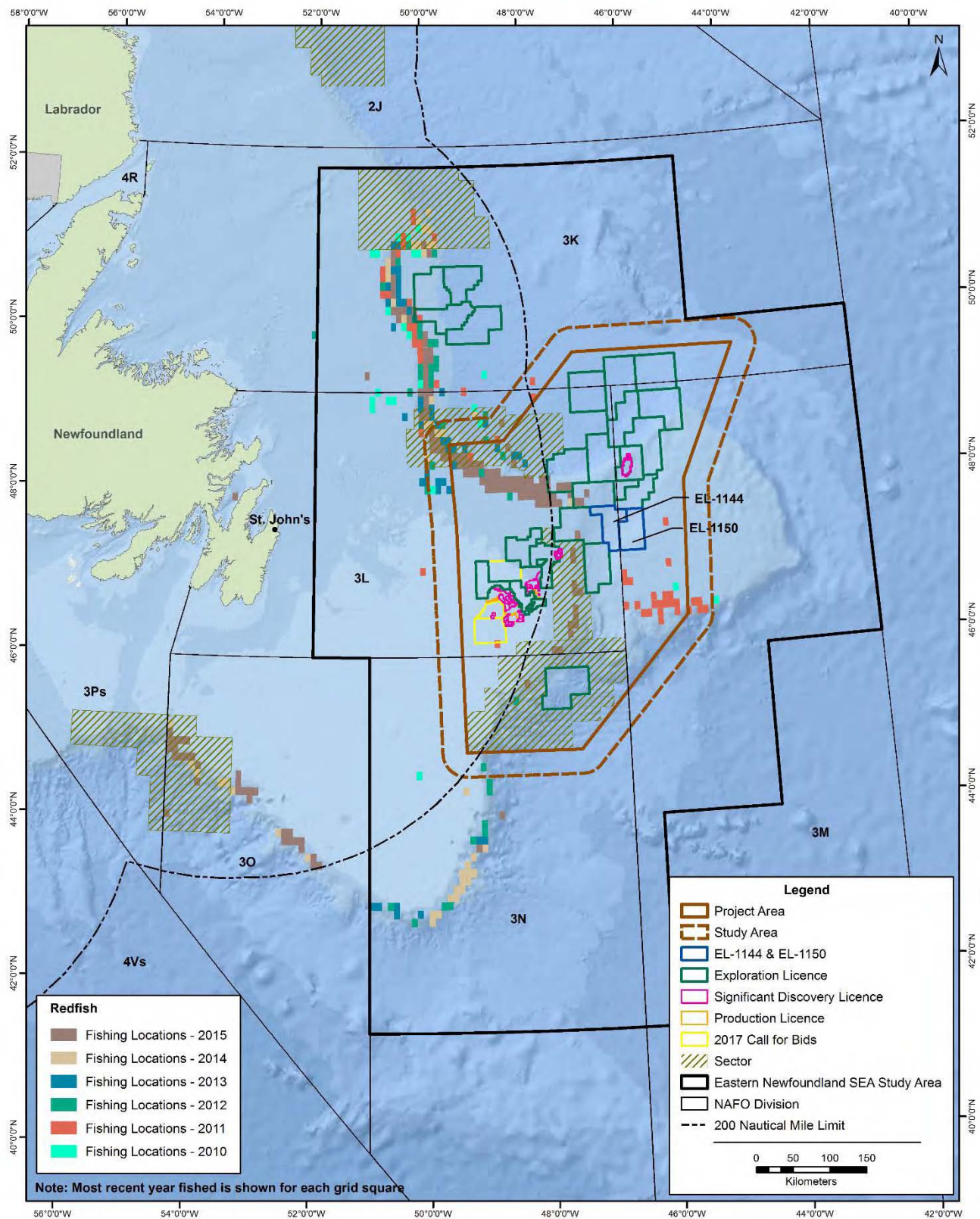
Figure 4.115 Harvesting Locations Turbot/Greenland Halibut (March - December, 2010-2015)

Figure 4.116 Harvesting Locations Redfish (March - December, 2010-2015)

American Plaice. The American plaice fishery has been under moratorium since 1995 after very high catch levels in the 1970s and 1980s, although a small amount of bycatch retention is now permitted. This occurs mainly in the directed yellowtail, turbot, redfish and 3M cod fisheries. Although the stock has increased slightly in recent years it continues to be considered in poor condition (NAFO 2016g; Parrill 2016). Within the Study Area Unit Areas, American plaice made up approximately six percent of the groundfish catches by quantity and three percent by value, 2010-2015, and 1.2 and 0.3 percent overall. Catches are almost entirely taken by bottom stern otter trawl and – as by-catches of other mobile trawl fisheries – occur in the same locations and at the same times as the directed groundfish fisheries, year-round (though lower July – September), mainly on and near the shelf margins and the Flemish Cap within the Study Area (Figure 4.117).

Atlantic Cod. Once the most important fishery (of all species) in the Grand Banks and northwest Atlantic, within the Study Area it has been limited to by-catch landings since the 1990s in most areas although a small directed Canadian fishery was reinstituted in Division 3M (on the Flemish Cap) in 2010 (NAFO 2016d). Based on the 2010-2015, Atlantic cod made up 1.2 percent of the groundfish catch by quantity and 0.8 percent by value, or 0.2 and 0.1 percent of the all-species fisheries. In the Study Area, by-catches may occur in the yellowtail, redfish and turbot fisheries, and in the shrimp fishery. In terms of gear, the harvest data show that the cod catch was evenly divided between bottom stern otter trawls and shrimp trawls, though with the closure of shrimp fishing in the Study Area, including on the Flemish Cap, this source of cod by-catch will have been halted as well.

Although recent surveys have suggested that some of the moratorium stocks may be recovering, the latest 2J3KL cod stock assessment recommended no lifting of the existing closures in the Study Area. It states, “The stock has increased considerably over the past decade, but remains within the critical zone,” and concluded that “At current levels of SSB [spawning stock biomass] the stock is considered to have suffered serious harm and the ability to produce good recruitment is seriously impaired. When the stock is at such a low level management actions should focus on promoting increases in SSB until the stock is more resilient to the effects of fishing” (DFO 2016h). As with other primarily by-catch fisheries, Atlantic cod harvesting occurs in similar locations to the directed fisheries (Figure 4.118), and at similar times, with harvesting occurring year round, though half the recorded annual amount was taken during April in the 2010-2015 period.

Atlantic Halibut. Within the Study Area Unit Areas Atlantic halibut accounted for 0.6 percent of the groundfish catch by quantity but 2.8 percent of it by value (2010-2015), or 0.1 and 0.3 percent of all area fisheries. In the region, the fishery for this large groundfish (sometimes reaching more than 300 kg in mass) is divided into two stocks that include the Gulf of St Lawrence (4RST) and the Scotian Shelf and Southern Grand Bank Region (3NOPs3VWX5ZC). Halibut are captured in both directed fisheries and as by-catch (Trzcinski et al 2011). Fishing activity in recent years has largely been focused along the Laurentian Channel, southern Grand Bank and the northeast Newfoundland Shelf edge usually in waters 60 m or more deep (Figure 4.119). As the DFO data indicate, nearly 75 percent of the Study Area catch is taken on longlines, with nearly all the rest harvested in bottom trawls. The harvest is focused mainly in the Study Area Unit Areas during the six months between April and September, when 87 percent of the catch occurred.

The longline component of the halibut fishery uses sets of hooked gear which is set along the sea floor often for two to five km, with moorings on either end marked with buoys and floats (This Fish 2013). Like other buoyed fixed gear, there is a potential for contact with seismic streamers if occurring in the same location at the same time.

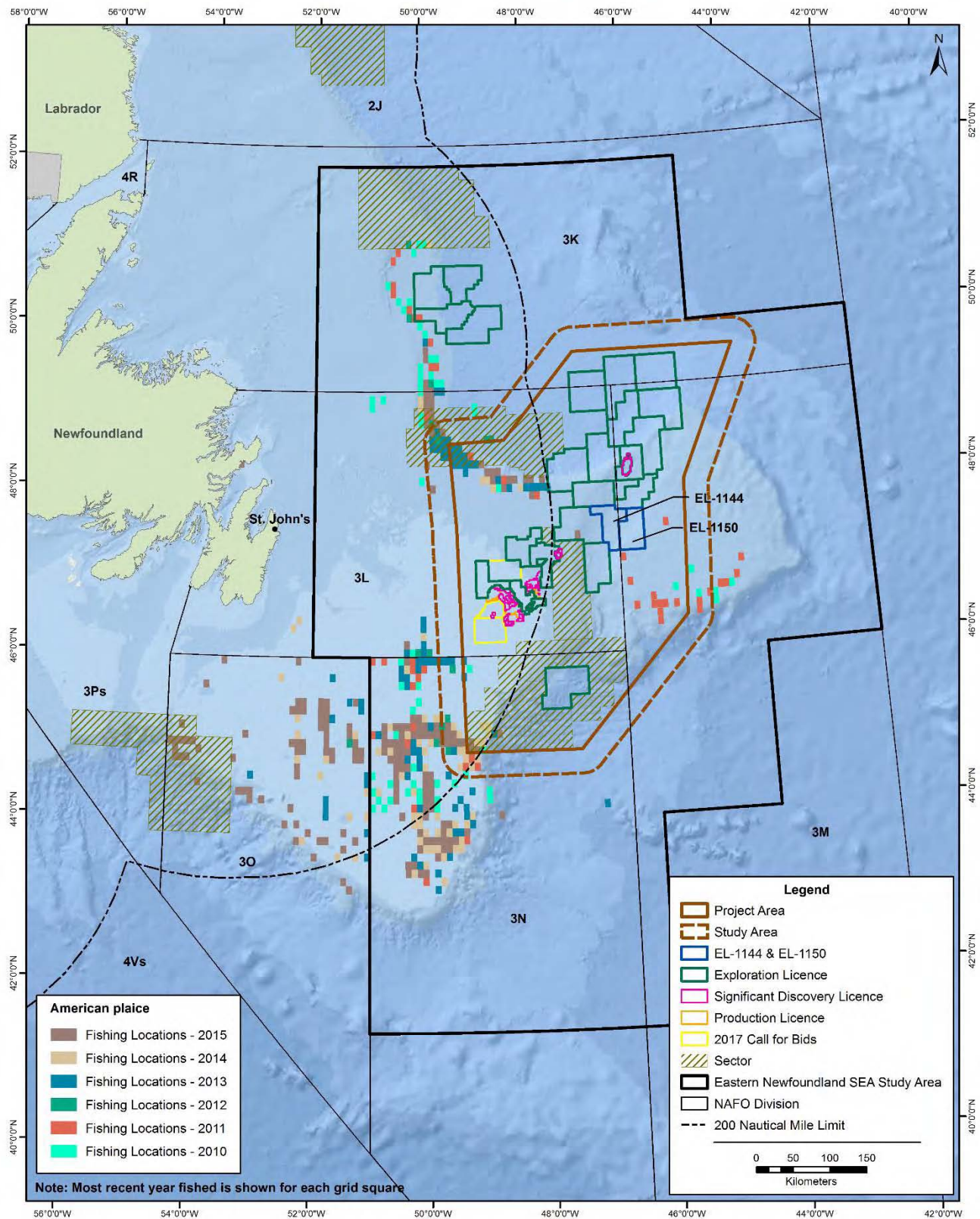
Figure 4.117 Harvesting Locations American Plaice (March - December, 2010-2015)

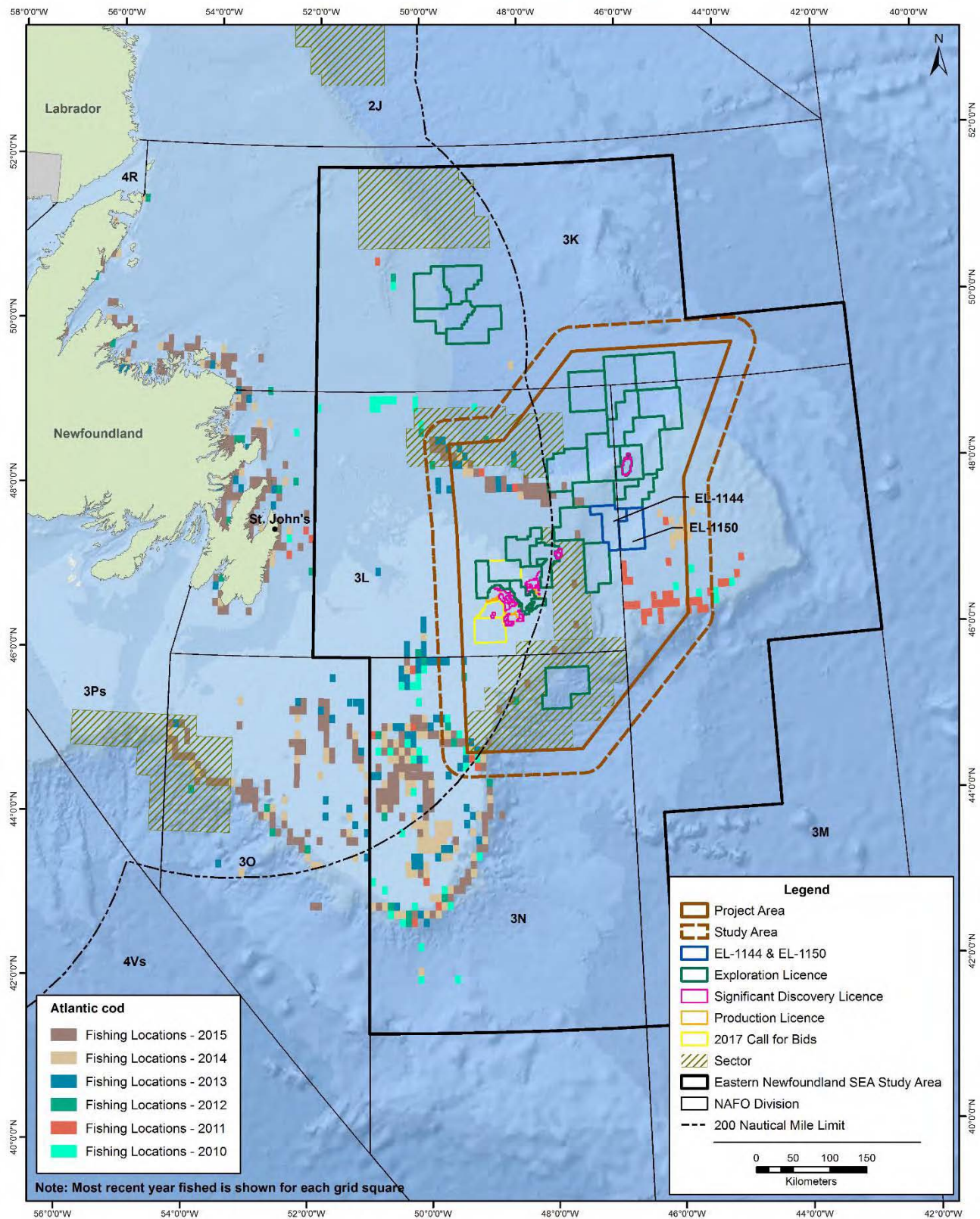
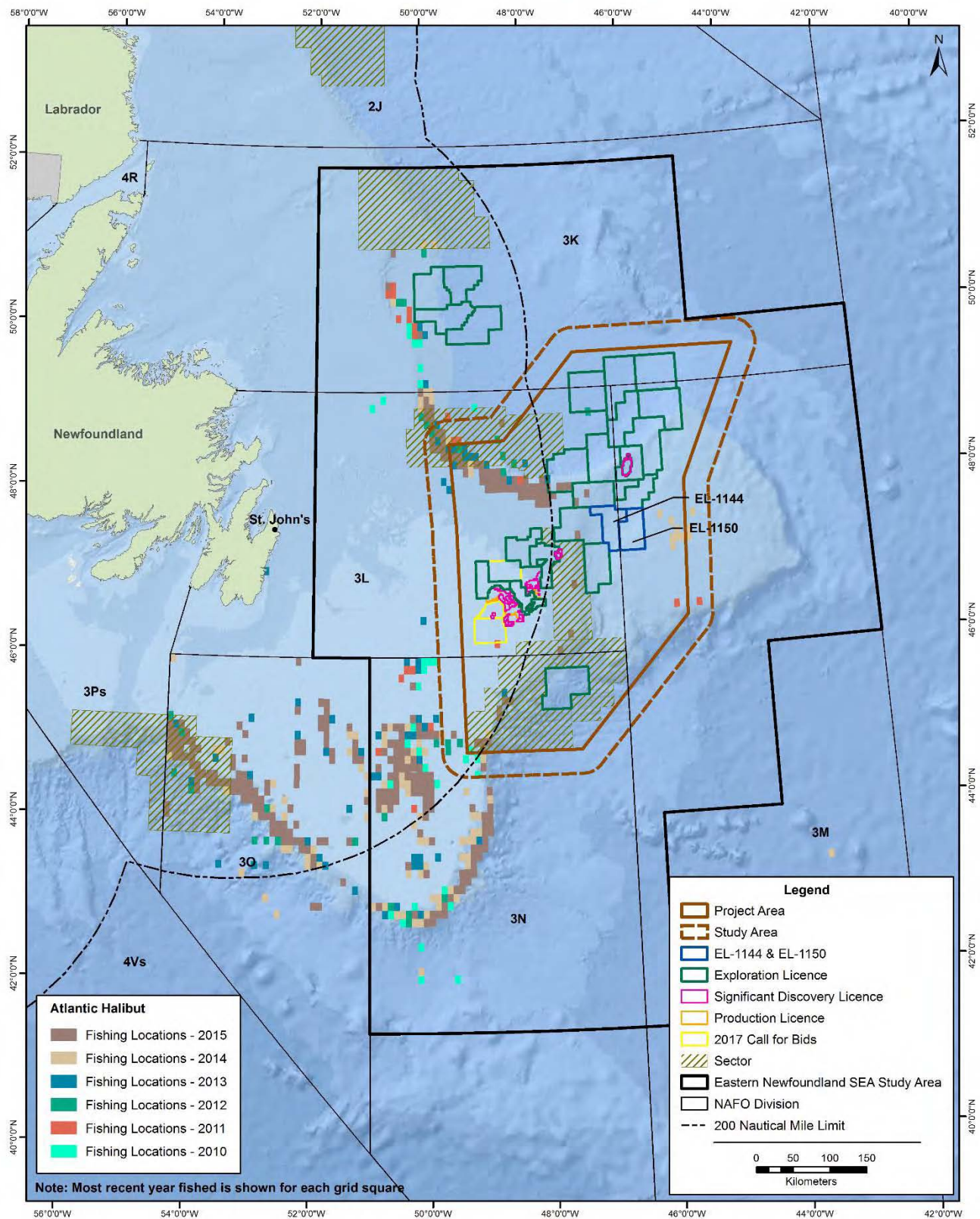
Figure 4.118 Harvesting Locations Atlantic Cod (March - December, 2010-2015)

Figure 4.119 Harvesting Locations Atlantic Halibut (March - December, 2010-2015)

Swordfish, Tunas and Sharks. Although low in terms of Study Area Unit Area quantity, these high-value fisheries have been harvested with similar gear in the Study Area, often together (directed or as bycatch) in offshore areas. They occur in similar zones (focused on the shelf break or in deeper waters to the south and east (Figure 4.120), and use similar longline gear. Most fishing effort for these species has been concentrated in the Maritimes Region but some harvesters follow the fish eastwards to and around the Grand Bank and the Flemish Cap, and this may increase in the future. Although different gear may be used to harvest these species in some areas (e.g., rod and reel for tunas, and harpoons for swordfish), the dominant use of large pelagic longlines poses a potential for conflicts with seismic ships and their towed gear (especially hydrophone streamers). These longlines may be very long (with mainlines trailing 60 km or more behind the boat) and float near the ocean surface. Along the length of the mainline there are hundreds of shorter lines (gangions) with baited hooks on the ends. Typically, swordfish longlines are set out for a day or less and then pulled back aboard the ship with its catch; preferred “soak” time is at night when fish are most active. Mainlines are usually marked with buoys and highflyers, but may still be difficult to observe in darkness, heavy swells or fog. In recent years, many fishers have been using automatic identification system transmitter placed along the length of the longlines, so that they will appear with vessel ID information on electronic chart displays on board ships (T. Atkinson pers comm. 2017).

The fishery in Atlantic Canada has been conducted primarily on the edges of Georges Bank and the Scotian Shelf and to a lesser extent on the Grand Bank, from April to December (DFO 2013d). TACs are assigned by the International Commission for the Conservation of Atlantic Tuna (ICCAT). Nearly all the active fishing licences are held in the Maritimes Region; two longline licences held in Newfoundland and Labrador have not been active in recent years (DFO 2013d, 2013e; J. Boland pers comm. 2017). DFO reported total landings of 1,579 tonnes of swordfish worth \$12.9 million in 2015, all by Nova Scotia-based enterprises (DFO 2016i). While domestic swordfish harvesting levels have been relative low in the Newfoundland and Labrador Region – compared to landings from Georges Bank and the Scotian Shelf in the Maritimes Region – less favourable conditions to the southwest are expected to lead to more effort in waters around the Grand Banks and Flemish Cap in coming years. Typically, the movement from the Scotian Shelf to the Grand Bank occurs in mid- to late July, depending on fishing conditions in the west, and some harvesters may continue fishing in the east until late fall. With various transfers from foreign fleets, the current annual quota for Canadian vessels is approximately 2,000 tonnes (T. Atkinson pers comm April 2017). International fishing for swordfish also occurs outside the Canadian EEZ (ICCAT 2013a).

The fishery for tunas within the Study Area occurs primarily in the waters off the southwestern Grand Bank. Tunas harvested include bluefin, bigeye and albacore. They are captured as part of a directed fishery and as bycatch in other fisheries, such as swordfish (DFO 2014d). ICCAT assigns Canada a quota for harvesting bluefin tuna. For 2015, DFO reported Atlantic Canadian landings of 879 tonnes valued at \$6.26 million (DFO 2016j). Tuna are harvested between spring and late fall, with most landings between late July and late September (DFO 2014e). International fishing for tuna also occurs outside the EEZ; however, the resolution of available data does not allow for spatial comparisons of fishing effort and harvest rates within the Study Area (ICCAT 2013a).

Shark fisheries in Atlantic Canadian waters are currently under DFO moratorium but, in the past, targeted porbeagle, blue and shortfin mako sharks in the waters from the Scotian Shelf, and eastward to the southwestern Grand Bank, off St. Pierre Bank and along the Laurentian Channel. These are conducted almost exclusively using pelagic longline gear (D. Hart pers. comm. 2014; T. Atkinson 2017). Although these fisheries are closed, a limited shark survey is planned on the Grand Banks in 2017 (see Section 4.3.1.9).

Figure 4.120 Harvesting Locations Swordfish, Tunas and Sharks (March - December, 2010-2015)