Fishing effort in predicted coral habitat in the eastern Bering Sea

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Council request

At their October 2015 meeting, the Council requested the AFSC: 1) provide updated data on the distribution, intensity, and depth of fishing effort in locations of both known and predicted coral abundance; and 2) provide, in the Ecosystem Considerations chapter of the annual SAFE report, a) changes in coral frequency, composition, and distribution in the trawl survey; and b) changes in trawl and fixed gear effort in areas of model predicted coral abundance. Here we report the distribution and intensity of pelagic trawl and non-pelagic trawl fishing in predicted coral habitat in the eastern Bering Sea. The remaining information will be provided in the Ecosystem Chapter of the next annual SAFE report (fall 2016).[2]

We previously analyzed all existing data on the canyons and surrounding areas and input a subset of these data into scientific models (Sigler et al., 2015). The models produced predictions of where coral was likely to occur, both inside and outside eastern Bering Sea canyons. We subsequently deployed underwater cameras from a research vessel to pinpoint areas of coral concentration, placing our cameras into the water at 250 randomly selected locations along the Bering Sea slope and canyons in late summer 2014 (Rooper et al., 2015). The camera survey results validated our previous modelling and analysis work and confirmed that most coral habitat (for the species that predominantly grow on hard, rocky bottom) occurs inside Pribilof Canyon and along the Bering Sea slope to the west of Pribilof Canyon. In general, coral densities throughout the camera survey area were low even where they occurred. This is not surprising as the eastern Bering Sea seafloor contains little of the rocky habitat that is conducive to coral growth.

Methods

In this report, we present fishing events, fishing effort, and seafloor contact by year within predicted coral habitat in the eastern Bering Sea. The analysis was conducted using the Fishing Effects (FE) model which was developed to estimate disturbance from fishing activities in Essential Fish Habitat (for FE model details see Section 11 in the 2016 EFH Review Document).

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[2] Relative catch-per-unit-effort (CPUE) values currently are reported for sponges and sea whips for the eastern Bering Sea shelf survey, but not corals because corals are rarely encountered on the Bering Sea shelf (Zador 2015). For the eastern Bering Sea slope survey, relative CPUE values for corals, sponges, and sea whips have not been reported previously in the Ecosystem Chapter, but their reporting is planned for the 2016 SAFE report.

This model is partitioned into 5 km X 5 km grid cells. A fishing event is defined as a single deployment and retrieval of fishing gear. The term “fishing event” differs from the term “fishing effort”, which is the total area fished, accounting for overlap of fishing activities. Bottom contact accounts for the proportion of fishing effort that actually contacts the seafloor (i.e., the total area contacted). The statistic describing “fishing event” is expressed as a number (e.g., the number of pelagic trawl tows in predicted coral habitat in 2003).

The spatial extent of fishing activities was provided in the Catch-in-Areas (CIA) database with VMS-Obs-UnObs-Lines provided by the Analytical Team, NOAA Fisheries Alaska Region. Each line feature in the CIA database is a spatially explicit representation of a historical fishing event for 2003-2014. Each line was buffered with the best approximation of the nominal width of the gear (derived from gear attributes available in the CIA database). The areas covered by these buffered lines represent fishing effort.

The buffered lines were intersected with the standard (5 km X 5 km) grid overlay, creating a nominal area swept for each fishing event within each grid cell. The nominal area swept values also were adjusted for bottom contact. Fishing effort and bottom contact were summed within grid cells, accounting for overlap. These summed areas were divided by the size of predicted coral habitat within each grid cell and expressed as percentages. For example, fishing effort for pelagic trawling is expressed as the percent of predicted coral habitat where pelagic trawling occurred for each grid cell and bottom contact is expressed as the percent of predicted coral habitat where bottom contact for pelagic trawling occurred for each grid cell. The term “All gears” refers to results that combine non-pelagic trawls, pelagic trawls, hook and line, pots, and jigs.

Results

Fishing events

Annually, 2% of fishing events in the eastern Bering Sea have occurred in predicted coral habitat since 2003 (Figure 1). Values for pelagic trawls have decreased from 3-5% during 2003-2007 to 1-2% during 2008-2014. Values for non-pelagic trawls and pots have consistently remained below 1%. Values for hook and line were 1-3% during 2003-2008 and 3-4% during 2009-2014.

Up to 1,600 fishing events per year have occurred in predicted coral habitat (Figure 2). This higher level usually occurred during 2003-2007, but decreased to a value of about 800 during 2009-2014. Most fishing events in predicted coral habit occurred at depths 200–500 m, except for 2005-2007, when fishing events in predicted coral habitat also were common at depths 500-1,000 m (Figure 3). Pelagic trawl events were most common at depths >200 m prior to 2009, then decreased except for a spike in 2013. Hook and line events in predicted coral habitat were the first or second most numerous among gear types and have generally increased at depths <1,000 m since about 2008. The number of non-pelagic trawl events was consistently below 100 at all depth ranges. Pot events numbered the lowest of all gear types and were highest at depths 500–1000 m.

Fishing effort

Fishing effort for hook-and-line, pots, and jig fishing gears in predicted coral habitat was <1% combined for all years. For pelagic and non-pelagic trawl gears, the percent of predicted coral habitat with fishing effort peaked in 2006 and declined since then except for a secondary spike in 2013 (Table 1, Figure 4). The values for pelagic trawls generally drove this trend and ranged from 14-21% during 2002-2007 and 0-4% during 2009-2014 (except 8% in 2013). The values for non-pelagic trawl ranged from 1-6% during 2003-2014.

Bottom contact

Bottom contact for hook-and-line, pots, and jig fishing gears in predicted coral habitat was <1% combined for all years. For pelagic and non-pelagic trawl gears, the percent of predicted coral habitat with trawl gear bottom contact peaked in 2006 and declined since then except for a secondary spike in 2013 (Table 2, Figure 5). The values for pelagic trawls generally drove this trend and ranged from 11-18% during 2002-2007 and 0-3% during 2009-2014 (except 5% in 2013). The values for non-pelagic trawl ranged from 0-5% during 2003-2014.

We tested the sensitivity of bottom contact estimates to the contact adjustment assigned for each fishing event. In the standard analysis (Table 2, Figure 5), the contact adjustment value is drawn at random from a range unique to each type of gear. In scenario one of the sensitivity analysis, the contact adjustment values were the minimum values for each gear type; in scenario two, the contact adjustment values were the maximum values for each gear type. The choice of contact adjustment value had a small effect on the bottom contact values (Figure 6).

Bottom contact by non-pelagic trawls occurred more frequently in predicted coral habitat near Pribilof Canyon (Figure 7). This occurrence was concentrated in the northwestern part of Pribilof Canyon and northwestward.

Bottom contact by pelagic trawls occurred more frequently in predicted coral habitat near Pribilof Canyon and in some years, along the slope west of Pribilof Canyon (Figure 8). Bottom contact by pelagic trawls in predicted coral habitat was more extensive than bottom contact by non-pelagic trawls (Figure 7). The area of bottom contact by pelagic trawls in predicted coral habitat noticeably decreased after 2008 (Figure 8).

We plotted the percent of bottom contact by trawl gear type for high, medium, and low densities of coral. High, medium, and low were classified based on percentiles, with high areas representing the top 25% of coral densities (> 0.082 corals/ m^2), mediums areas representing 25-75% coral density quantiles (0.011 – 0.082 corals/ m^2), and low areas representing the bottom 25% of coral densities (< 0.011 corals/ m^2). The percent of bottom contact was similar regardless of coral density (Figure 9). For example, bottom contact values by non-pelagic trawl were 0-10% regardless of coral density.

The dominant patterns remain as described before. Pelagic trawl bottom contact in predicted coral habitat was higher during 2003-2007 and lower during 2009-2014 (Figure 9). Non-pelagic trawl bottom contact in predicted coral habitat remained lower during 2003-2014.

References

Rooper, C., Sigler, M., Goddard, P., Malecha, P., Towler, R., Williams, K., Wilborn, R. 2015. Validation of models of the distribution of structure-forming invertebrates in the eastern Bering Sea using an underwater stereo camera. Report to the North Pacific Fisheries Management Council.

Sigler, M.F., Rooper, C.N., Hoff, G.R., Stone, R.P., McConnaughey, R.A., Wilderbuer, T.K. 1158 2015. Faunal features of submarine canyons on the eastern Bering Sea slope. Mar. Ecol. 1159 Prog. Ser. 526:21-40.

Table 1. Fishing effort by year and gear as a percentage of predicted coral habitat in the eastern Bering Sea.

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
NPT	2%	1%	0%	4%	2%	1%	4%	5%	3%	4%	6%	2%
PTR	17%	14%	21%	21%	20%	12%	3%	2%	4%	0%	8%	4%
All Gears	19%	15%	22%	25%	23%	13%	8%	7%	7%	5%	14%	6%

Table 2. Bottom contact by year and gear as a percentage of predicted coral habitat in the eastern Bering Sea.

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
NPT	2%	1%	0%	4%	2%	1%	4%	5%	2%	4%	3%	1%
PTR	14%	11%	17%	18%	18%	10%	3%	1%	3%	0%	5%	3%
All Gears	16%	12%	17%	22%	21%	11%	7%	6%	5%	4%	9%	4%

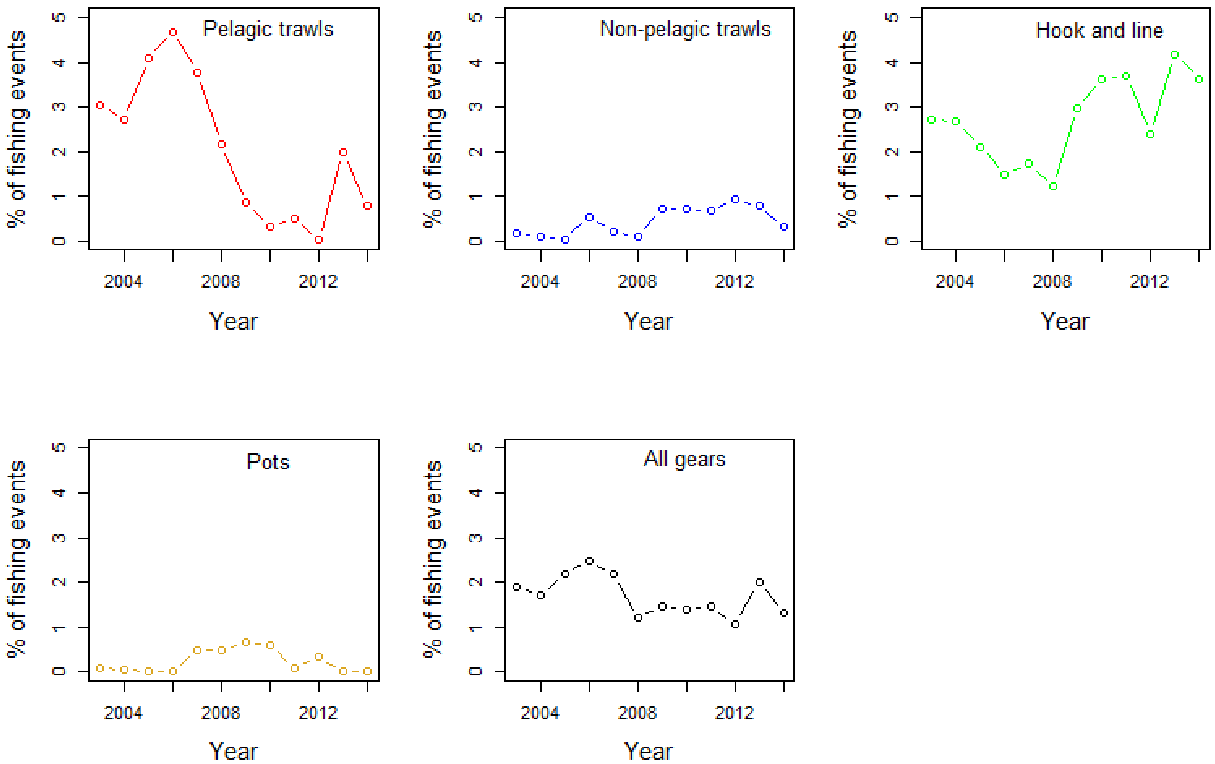

Figure 1. Percent of eastern Bering Sea fishing events in coral habitat by gear type.

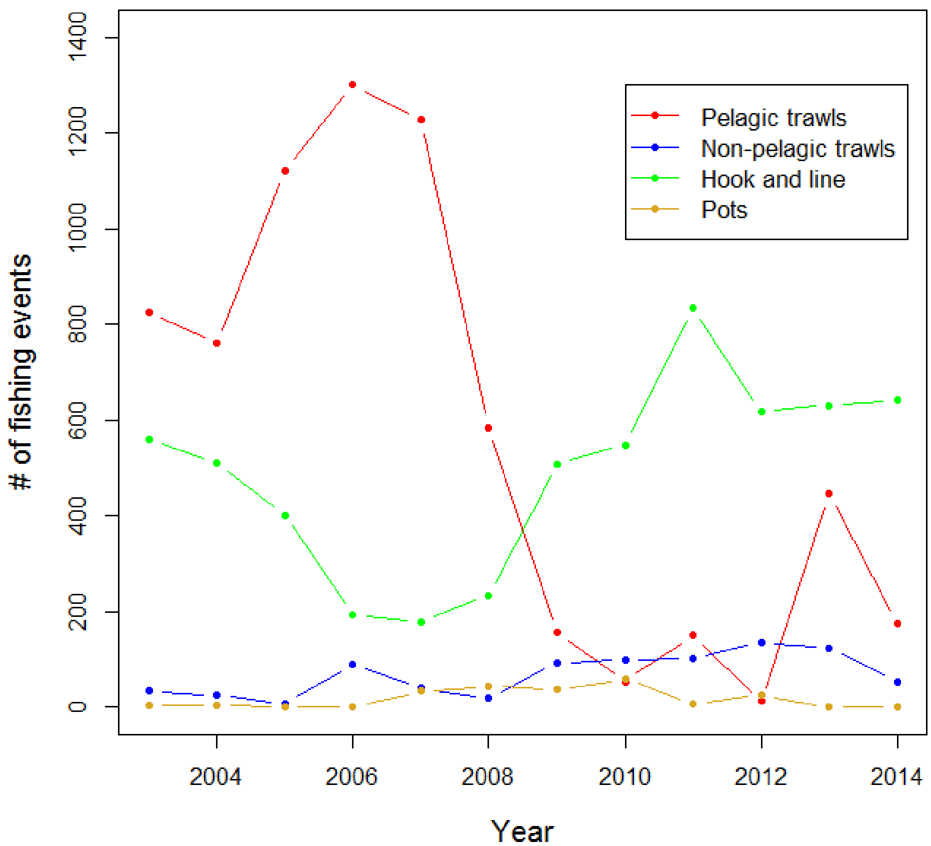

Figure 2. The number of fishing events per year by gear type within predicted coral habitat in the eastern Bering Sea.

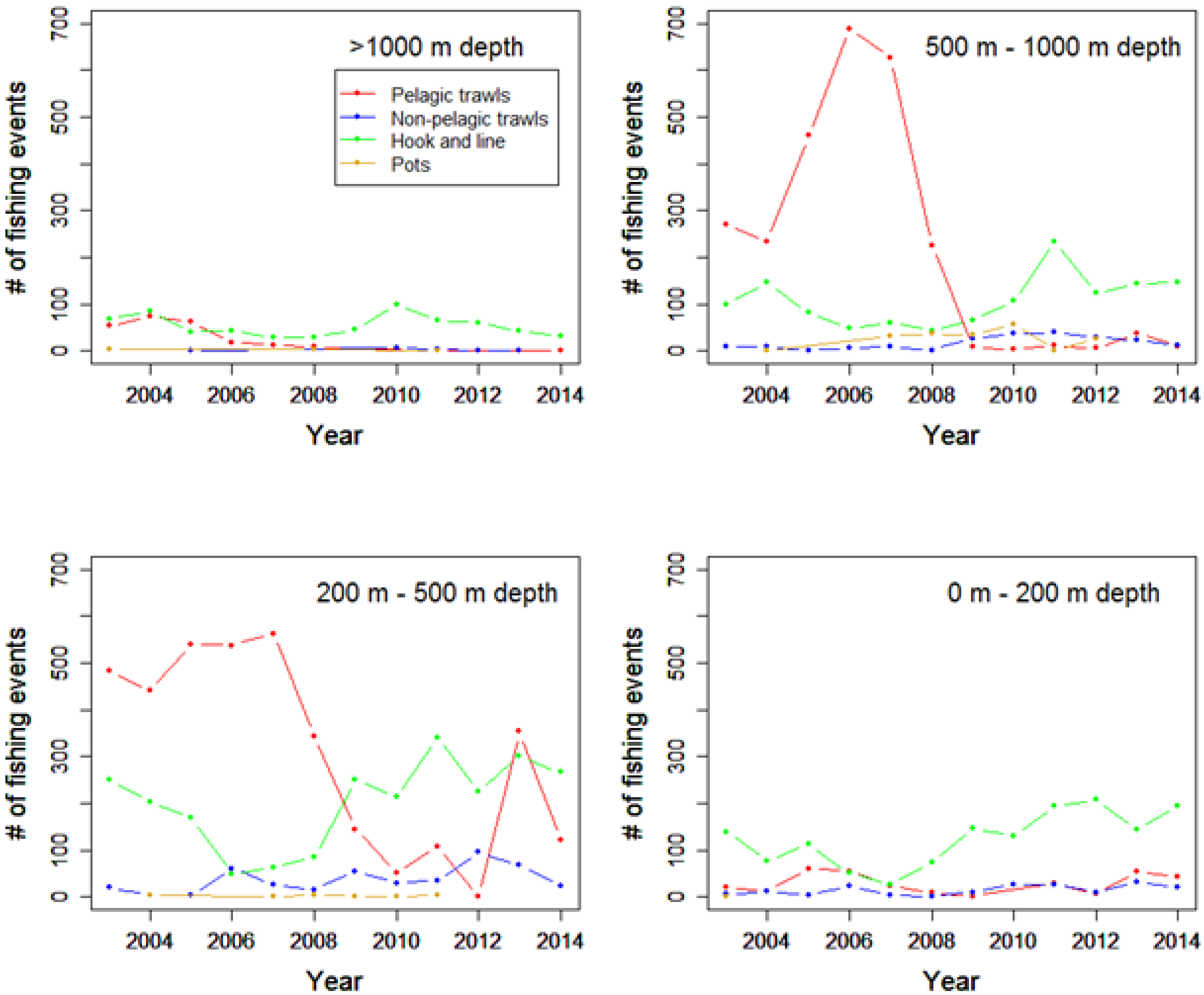

Figure 3. The number of fishing events per year by gear type within predicted coral habitat in the eastern Bering Sea grouped by depth.

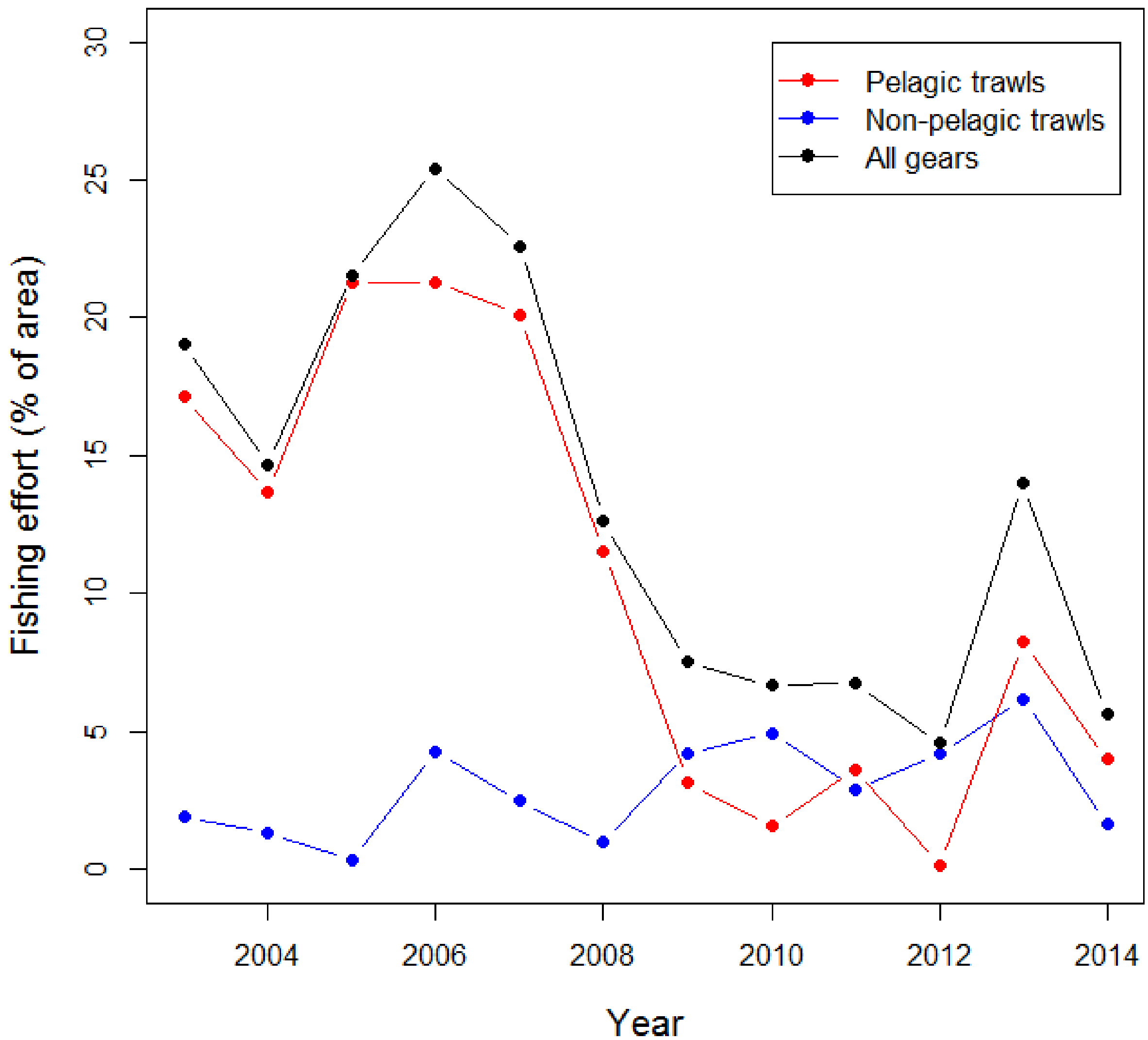

Figure 4. Yearly fishing effort as a percent of area of predicted coral habitat in the eastern Bering Sea by gear type for pelagic trawls and non-pelagic trawls.

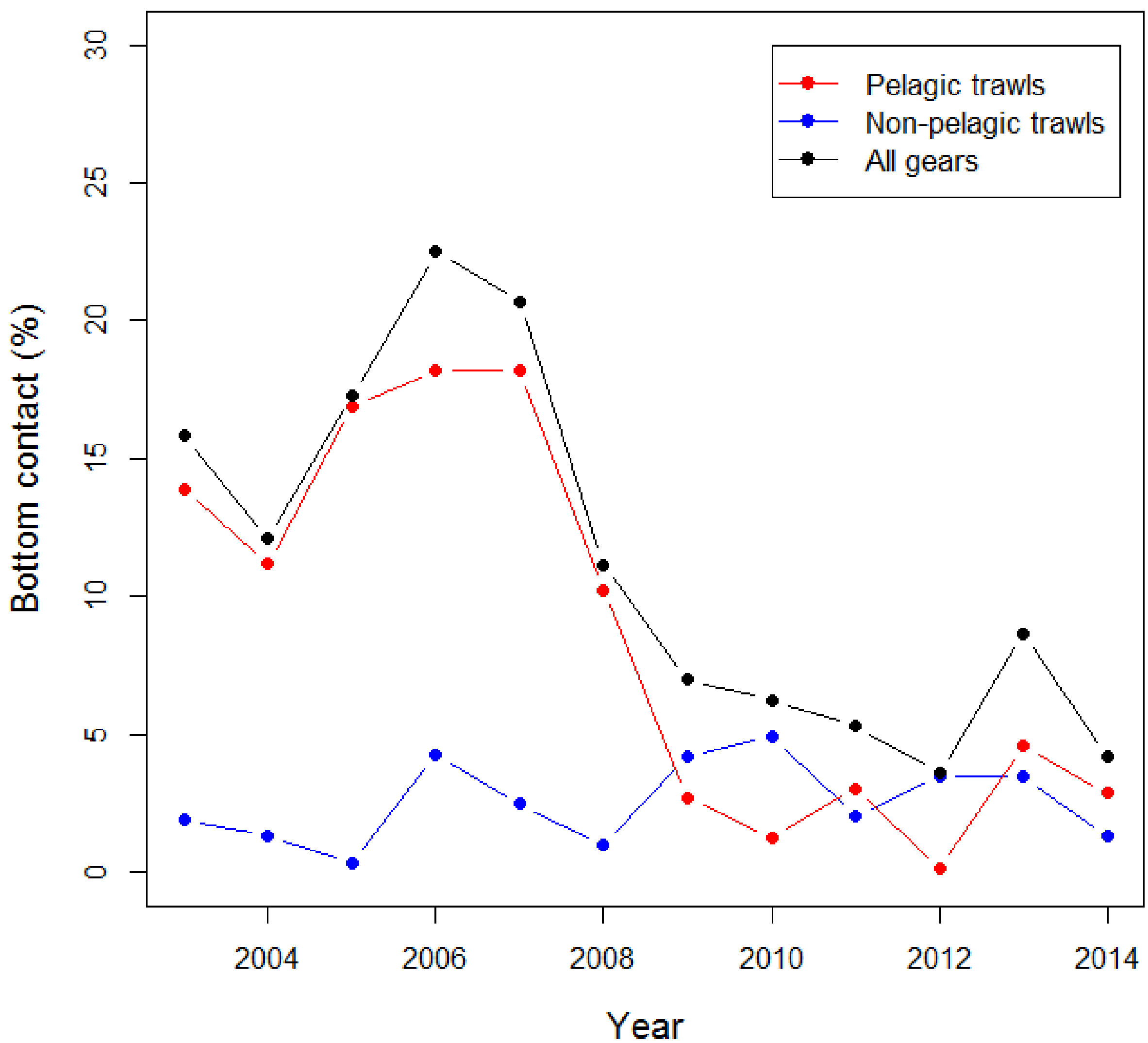

Figure 5. Yearly bottom contact as a percent of area of coral habitat in the eastern Bering Sea by gear type for pelagic trawls and non-pelagic trawls.

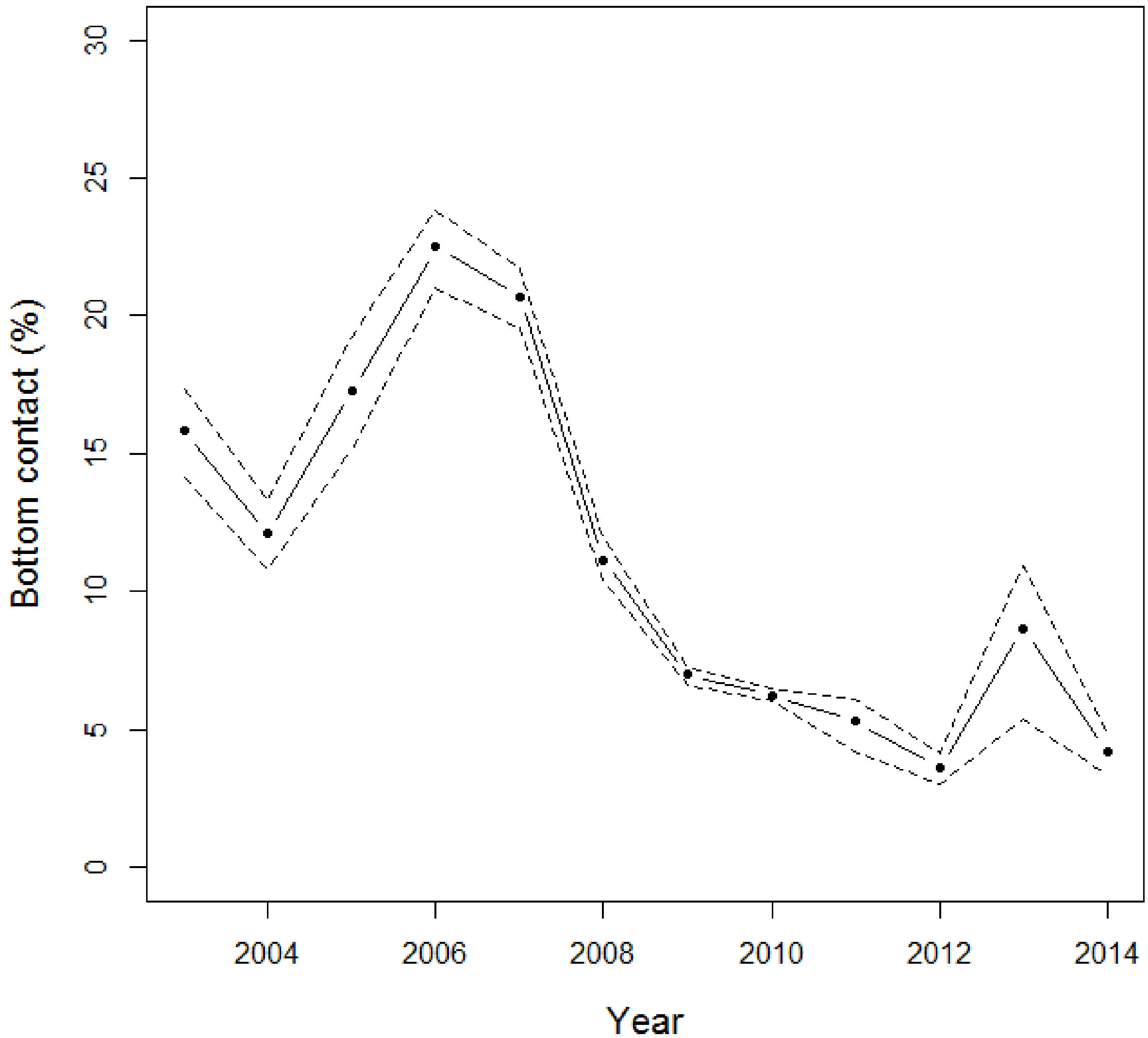

Figure 6. Sensitivity of bottom contact values to the bottom contact adjustment chosen. In the standard analysis (solid line), the contact adjustment value is drawn at random from a range unique to each type of gear. In scenario one of the sensitivity analysis, the contact adjustment values were the minimum values for each gear type (lower dashed line); in scenario two, the contact adjustment values were the maximum values for each gear type (upper dashed line).

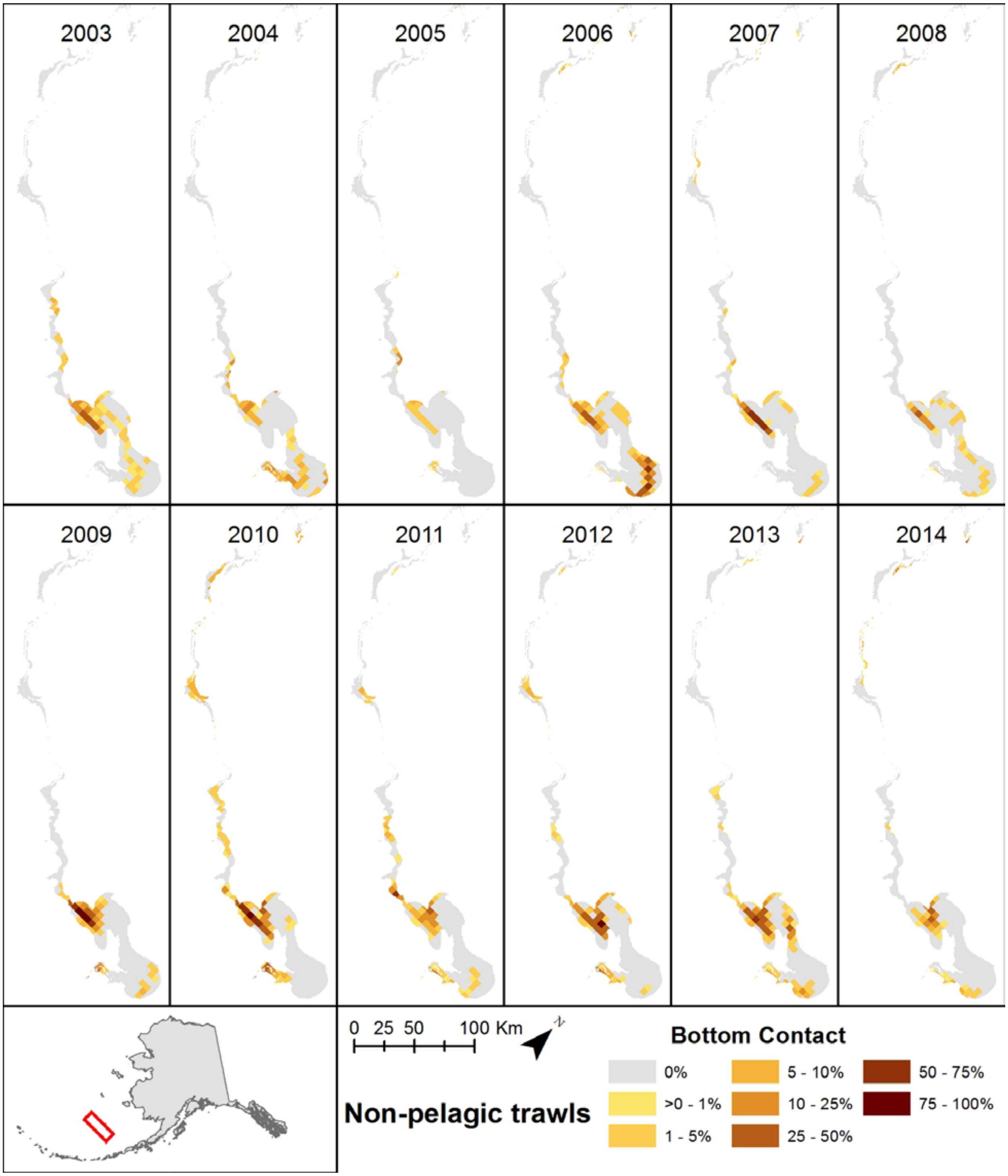

Figure 7. Spatial distribution of bottom contact within eastern Bering Sea canyon coral habitat by non-pelagic trawls. Bottom contact is expressed as a percent of area of coral habitat in the eastern Bering Sea.

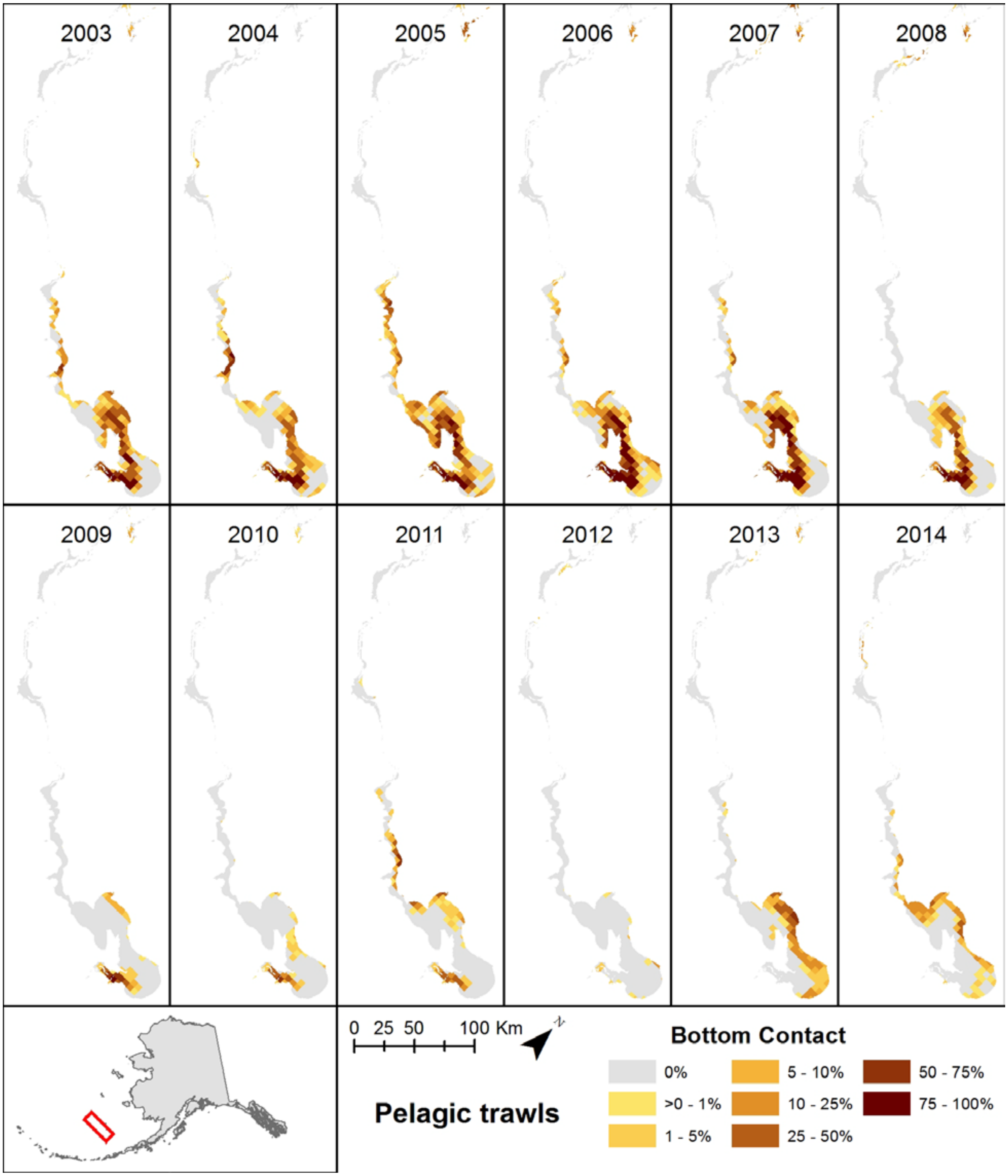

Figure 8. Spatial distribution of bottom contact within eastern Bering Sea canyon coral habitat by pelagic trawls. Bottom contact is expressed as a percent of area of coral habitat in the eastern Bering Sea.

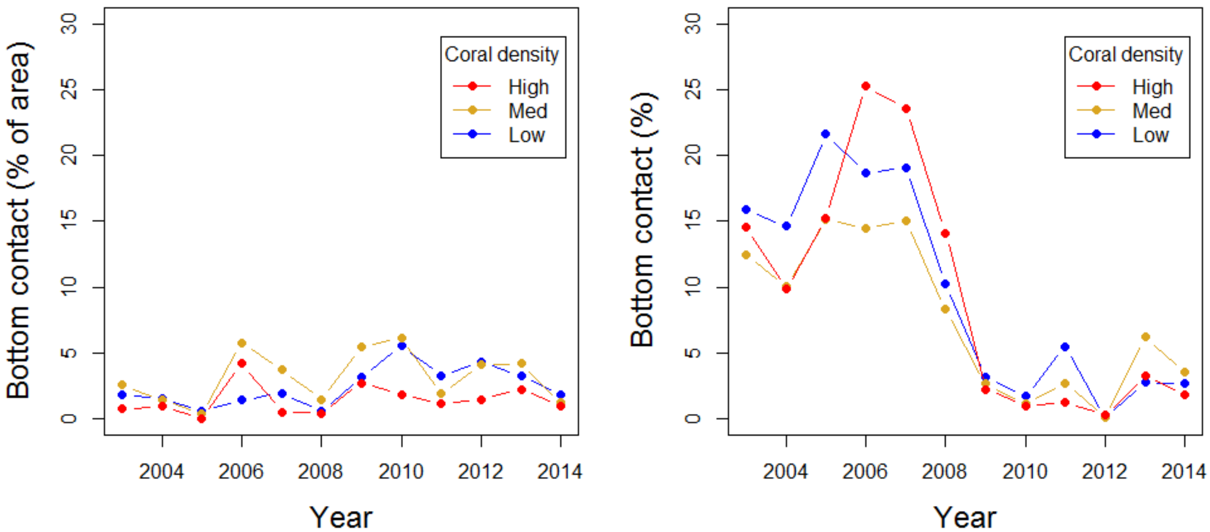

Figure 9. Bottom contact within areas of high, medium, and low coral densities in the eastern Bering Sea. Bottom contact is expressed as a percent of area of coral habitat in the eastern Bering Sea. High, medium, and low were classified based on percentiles, with high areas representing the top 25% of coral densities (> 0.082 corals/ m^2), mediums areas representing 25-75% coral density quantiles (0.011 – 0.082 corals/ m^2), and low areas representing the bottom 25% of coral densities (< 0.011 corals/ m^2).