

RANGE CONTRACTION MAY NOT ALWAYS PREDICT CORE AREAS: AN EXAMPLE FROM MARINE FISH

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Abstract. Our goal was to identify the core areas of six severely depleted marine fish species on the Scotian Shelf, Canada, using the theory of ideal free distribution (IFD). We tested for density-dependent distribution on both regional and local scales. At the regional scale, a density-dependent response was observed in the majority of populations. At the local scale, density was expected to remain stable in areas of high density and to change more rapidly in marginal areas, in response to changes in regional abundance. Lower local density responses were associated with areas of higher density, but deviations were evident, in part due to the magnitude of decline and in part due to fishing effects. Former areas of high density can be eroded if the population has severely declined. Fishing directed at an area of high density can cause local depletion when recolonization rates are low relative to the intensity of fishing. Thus, areas occupied during periods of low regional abundance do not of necessity reflect the historical array of core areas. We do not recommend the use of IFD theory to identify core areas of heavily exploited species. Instead, we recommend a precautionary approach that assumes the existence of low-mixing populations that can be differentially affected by fishing. For species at risk, only data derived before significant population declines should be used to identify high-density areas. Such areas would represent those with the potential to support higher densities as well as the historical array of subpopulations. Our study provides insight into the practical aspects of analyzing exploited species using ecological theory.

Key words: core areas; density-dependent habitat selection; fishing effects; ideal free distribution; range contraction; vulnerable species.

INTRODUCTION

Many marine fish species have declined throughout the world due to overfishing (Caddy and Garibaldi 2000, Jackson et al. 2001), and the Scotian Shelf off eastern Canada is no exception (Fu et al. 2001). Fishing mortality has been reduced on a range of overexploited stocks yet many demersal species are not recovering. Habitat degradation, life history constraints, depensation, genetic bottlenecks, and changes as a result of size-selective fishing are among the proposed causes for lack of recovery (Hutchings and Reynolds 2004). While singular or multiple causes remain elusive, habitat protection can only contribute to recovery. That is, a minimal prerequisite for any recovery of a species at risk would be to protect their essential habitat.

It is commonly observed that abundance is positively related to range (Gaston and Blackburn 2000). It is often assumed that as a population contracts, it contracts to its preferred, core area. This notion is conceptually related to the ideal free distribution (IFD) model developed by Fretwell and Lucas (1970) for birds. Over evolutionary time, animals that choose sub-

optimal habitat will be selected against, so a set of adaptive behavioral cues will result in selection of habitats of high suitability, leading to higher reproductive success. But suitability decreases with increasing density, because individual reproductive success is lowered as more animals use the same resource. At some point, in response to density, it is beneficial for some animals to choose suboptimal habitat where they have equal success rates to those in optimal habitat. The resultant spatial distribution thus results from density-dependent habitat selection (DDHS).

Ideal free distribution theory has proved popular because of its efficient logic and has been developed as an evolutionarily stable strategy (reviewed in Morris [2003]). Since Fretwell (1972), empirical support for IFD theory has accrued but, as for many ecological theories, the additional appeal of IFD theory is its use as a reference point to examine the nature of divergence from an evolutionarily stable strategy. Ideal free distribution assumes that resources are limiting, that animals have perfect knowledge of their environment (ideal), and that animals have equal competitive abilities to choose among habitats (free). Deviations from IFD have led to considerable insight on distributions in disequilibrium, trade-offs (e.g., predation risk), species interactions, colonialism, and territorialism. For example, muskrats follow an ideal despotic distribution

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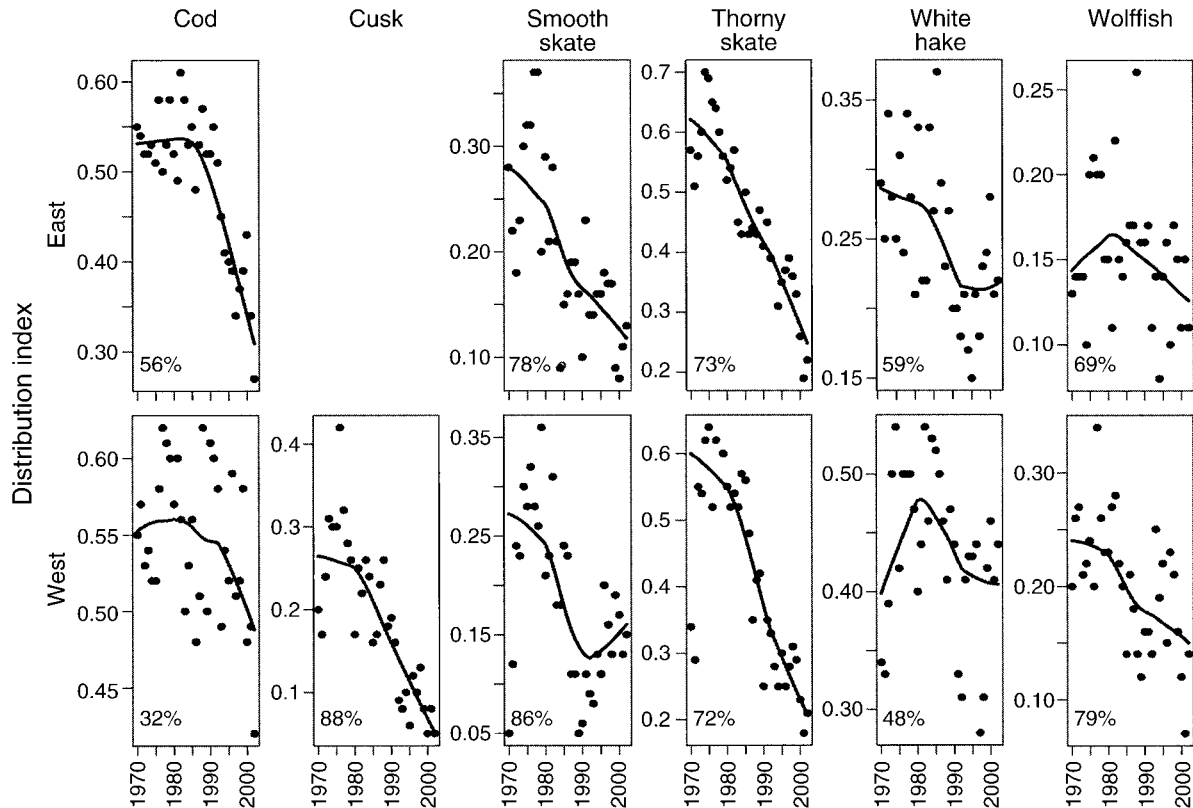


FIG. 1. Distribution index from the period 1970–2002 on the Scotian Shelf off eastern Canada. Separate populations of five of the six species are assumed to exist within eastern and western regions. The percentage of reduction between the maximal and minimal year of distribution is shown in the inset in the lower left corner of each plot. Solid lines represent the fit of a smoothing function using local regressions (lowess).

(Messier et al. 1990), which occurs when some individuals of greater competitive ability control the best habitat. Shochat et al. (2002) inferred that the distribution of migratory passerines was free but not ideal, because the birds did not have perfect knowledge of the distribution of resources. California towhees may distribute themselves to optimize reproductive success, but then are subject to density-dependent predation (Purcell and Verner 1998). Density-independent geographic distribution might also reflect that habitat-related fitness or habitat selection cues change with population size (Morris 2003), perhaps because of Allee effects (Fretwell 1972). On a practical level, density-dependent habitat selection will not be observed if tested on a region with multiple self-sustaining populations or if core areas are unsaturated or if a species prefers a specific, but limited, habitat.

MacCall (1990) comprehensively applied the theory of density-dependent habitat selection to marine fish. The complete analysis requires detailed knowledge of a species' advection/diffusion patterns during each life history stage, density-dependent and -independent controls on abundance, population structure, and a measure of habitat suitability (MacCall 1990). Such detail is unavailable for most marine species and will likely

remain so, yet many species will still be at risk of local extinction. Still, density-dependent geographic distribution in marine fish has been observed, but not universally, and can vary among and within species (see Swain and Morin [1996]).

In a previous study, we reported that the geographic range of several formerly abundant demersal fish species, resident on the Scotian Shelf, had declined significantly (Shackell and Frank 2003). The species are now considered to be in peril by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and include Atlantic cod (*Gadus morhua*), cusk (*Brosme brosme*), thorny skate (*Amblyraja radiata*), smooth skate (*Malacoraja senta*), white hake (*Urophycis tenuis*), and Atlantic wolffish (*Anarhichas lupus*). All of these species have been exploited to varying degrees, as well as caught incidentally in various fisheries. Cod, for example, experienced annual biomass removal rates in excess of 80% during the early 1990s. From 1970 to 2002, the geographic range of the inferred populations of each of these species declined (Fig. 1). All six of these species are large-bodied predators with medium to low intrinsic rates of increase that render them more vulnerable to extinction than smaller species with high intrinsic rates of increase. The skates (elasm-

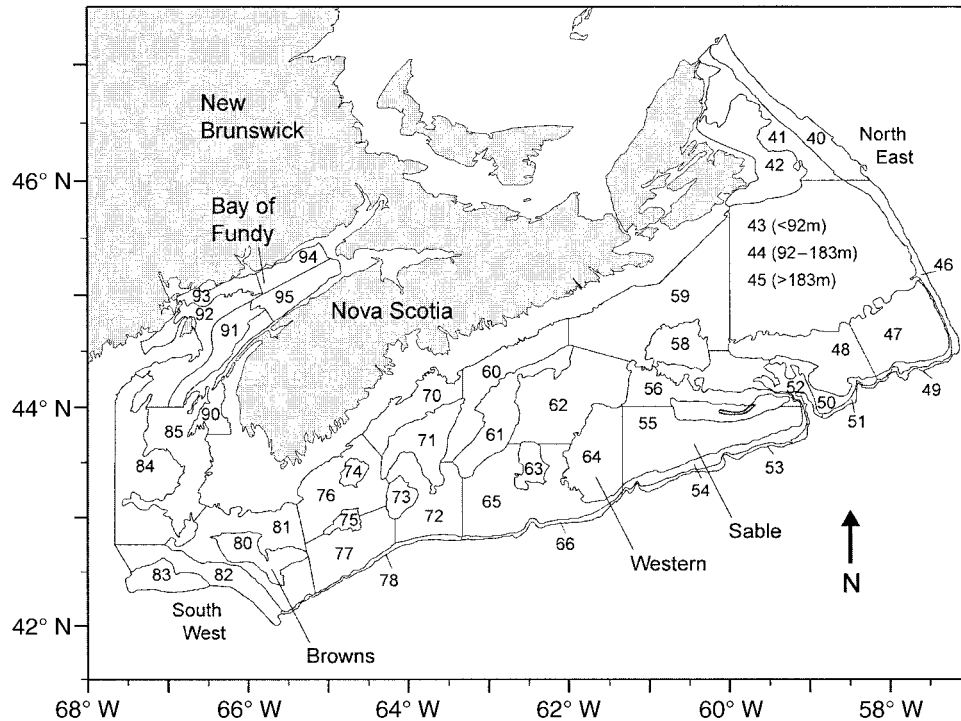


FIG. 2. The Scotian Shelf and the Bay of Fundy. Lines delineate sampling strata used in the Canadian Department of Fisheries and Oceans annual research vessel survey. Numbers refer to the strata codes used in the analyses.

branches) are considered to be even less resilient with slow growth, late maturation, and low fecundity relative to most teleosts. We sought to examine whether empirical spatial distributions were consistent with ecological spatial distribution theory (IFD). Our interest was whether a density-dependent approach in the absence of complete knowledge might provide insights that would contribute to the protection of species at risk of local extinction.

MATERIAL AND METHODS

Every July since 1970, the Canadian Department of Fisheries and Oceans (DFO) has conducted a bottom trawl survey of the Scotian Shelf to assess the distribution and abundance of groundfish. The standardized survey uses a depth-stratified random sampling design. The shelf is divided into 48 sampling strata based on uniform depth and location (Fig. 2). Within each stratum, sets are sampled randomly. A "set" is one tow based on deployment of a Western II-A bottom trawl with a 19-mm cod-end liner towed at a constant speed of 1.8 m/s for 30 min. The number of sets is proportional to the stratum size. Stratum abundance is calculated by multiplying the stratum mean density of sets by the total stratum area, and the sum of strata abundance yields the regional abundance. All densities herein are number per tow. We used the software R, version 2.0.0 for analyses (R Development Core Team 2004).

Geographic distribution of abundance

The Scotian Shelf has oceanographically distinct eastern and western areas, and fish "stocks" are managed separately within each area by the DFO. The strata dividing east/west divisions for each species in this analysis were: cod, strata 40–65, 70–95; cusk, strata <50; smooth skate, strata 40–71, 72–95; thorny skate, strata 40–65, 70–95; white hake, strata 40–58, 59–95; and wolffish strata 40–60, 61–95. This resulted in 11 populations of the six species.

We visually assessed whether areas of high density tended to be in the same regions during periods of high and low abundance. For each species, we selected those years from 1970 to 2002 when total abundance was higher (>25th percentile) or lower (\leq 25th percentile) and calculated the mean density (number per tow) of sets in 20-min geographic grids for each period. This represented geographic distributions during periods of higher and lower abundance, respectively. It is often reasonably assumed that optimal areas are occupied during periods of lower regional abundance (e.g., Swain and Morin 1996). Below, we describe a further analysis using a density-dependent approach to examine whether areas of high density were stable.

Regional-scale patterns

For each year (1970–2002), the proportion of the total regional area occupied by 90% of the population

was calculated. This metric provided an index of distribution based only on the spatial spread, which is independent of the estimate of regional abundance (Swain and Sinclair 1994). We then estimated the relationship between the natural logarithm of regional abundance and the arcsine square-root-transformed distribution index to determine whether regional-scale distribution was density dependent.

Local-scale patterns

Our primary goal was to estimate the response of each stratum (local scale) to changes in regional abundance. The ecological model is that, under DDHS, areas of higher density will remain consistently high as the regional population declines to zero, at which point the local density will also be zero. Marginal areas will not be occupied at low regional population sizes, but will increase as the regional population increases. The algebraic expression to describe the range of responses is a simple power model (Myers and Stokes 1989).

Generalized additive models (GAMs), developed ultimately from linear regression models, have been gaining favor in the ecological literature because they allow the analysis of observations that are not normally distributed but may be derived from various exponential distributions (Guisan et al. 2002). Further, GAMs describe the relationship between dependent variables that are not linearly related to the independent variables, without having to transform the dependent variable. The expected value of observations is related to a linear combination of independent variables through a "link" function. We used a semiparametric GAM with a log-link function and assumed a negative binomial distribution (Johnson and Kotz 1969). The response variable (local density) was modeled as an additive sum of the parametric variable (regional abundance) and a nonparameterized (smoothed) covariate (temperature). Fish distribution is influenced by environmental variables, but only local temperature was available and relevant as depth was fairly uniform within strata. While responses to changes in local temperature are interesting, our primary interest was to test for DDHS. We included temperature primarily to remove its effect on the parametric estimate. The following model, in the form realized by Swain and Morin (1996), was fit to data for each stratum for each population:

$$n_{hit} = \alpha_i N_t \beta_i + s_i T_{hit} \quad (1)$$

where n_{hit} is local density in set h in stratum i in year t , N_t is the regional abundance in year t , T_{hit} is the local temperature measured in set h in stratum i in year t ; α_i is a scale factor, β_i represents a shape parameter that measures the response of local density in stratum i as regional abundance changes, and s_i is a smooth function summarizing the relationship between the response and temperature in stratum i . Local densities are count data. We examined separate models assuming either Poisson

or negative binomial error distributions and opted for the latter. Our decision was based primarily on the relationship between the deviance residuals and fitted values. A negative binomial distribution allows for greater dispersion than the Poisson (Johnson and Kotz 1969, McCullagh and Nelder 1989).

As regional abundance (N) changes, local density (n) of a given stratum could remain stable ($\beta < 1$), change linearly ($\beta = 1$), or exponentially ($\beta > 1$). The null hypothesis, to test for density-dependent distribution, is that the variation in local density responses (β) is independent of habitat suitability (Myers and Stokes 1989). A density-dependent response occurs if the array of local density responses (β) varies inversely with habitat suitability. That is, core strata would be expected to have higher habitat suitability and lower responses (β), implying greater stability as regional abundance changes. Marginal areas would be expected to have lower habitat suitability and greater local density responses (β). We examined the relationship between the array of local density responses and suitability in each of the populations.

Stratum suitability index

The summer survey occurs during a rapid growth phase for north temperate marine fish species. Under an ideal free distribution, geographic patterns of density reflect habitat suitability (Fretwell 1972, MacCall 1990). The mean density over a time series has been used as a metric of habitat suitability in DDHS studies (e.g., Myers and Stokes 1989, Marshall and Frank 1994, Swain and Morin 1996). In our case, however, the decline due to fishing will influence that metric. To reduce the effect of overfishing, we defined suitability as the local median density (number per tow) during a period of higher abundance (years when total abundance was >25th percentile). This metric is referred to as the "stratum suitability index," as we recognize that it does not measure the actual habitat, but that some strata have higher densities than others (for whatever underlying reasons).

RESULTS

Geographic distribution of abundance

Distribution of the six species shows strong contraction during a period of lower regional abundance. The degree of contraction varied among species (Fig. 3). The shelf-wide percentage of reduction in areas of high density grids were 60, 88, 60, 49, 70, and 40 for cod, cusk, smooth skate, thorny skate, white hake, and wolffish, respectively. In general, areas of high density during a period of higher regional abundance appeared similar to those during a period of lower regional abundance, but some areas of high density were seemingly more eroded than others, e.g., cod, thorny skate, and smooth skate on or near Banquereau Bank (strata 47 and 48), and cusk at the mouth of the Bay of Fundy

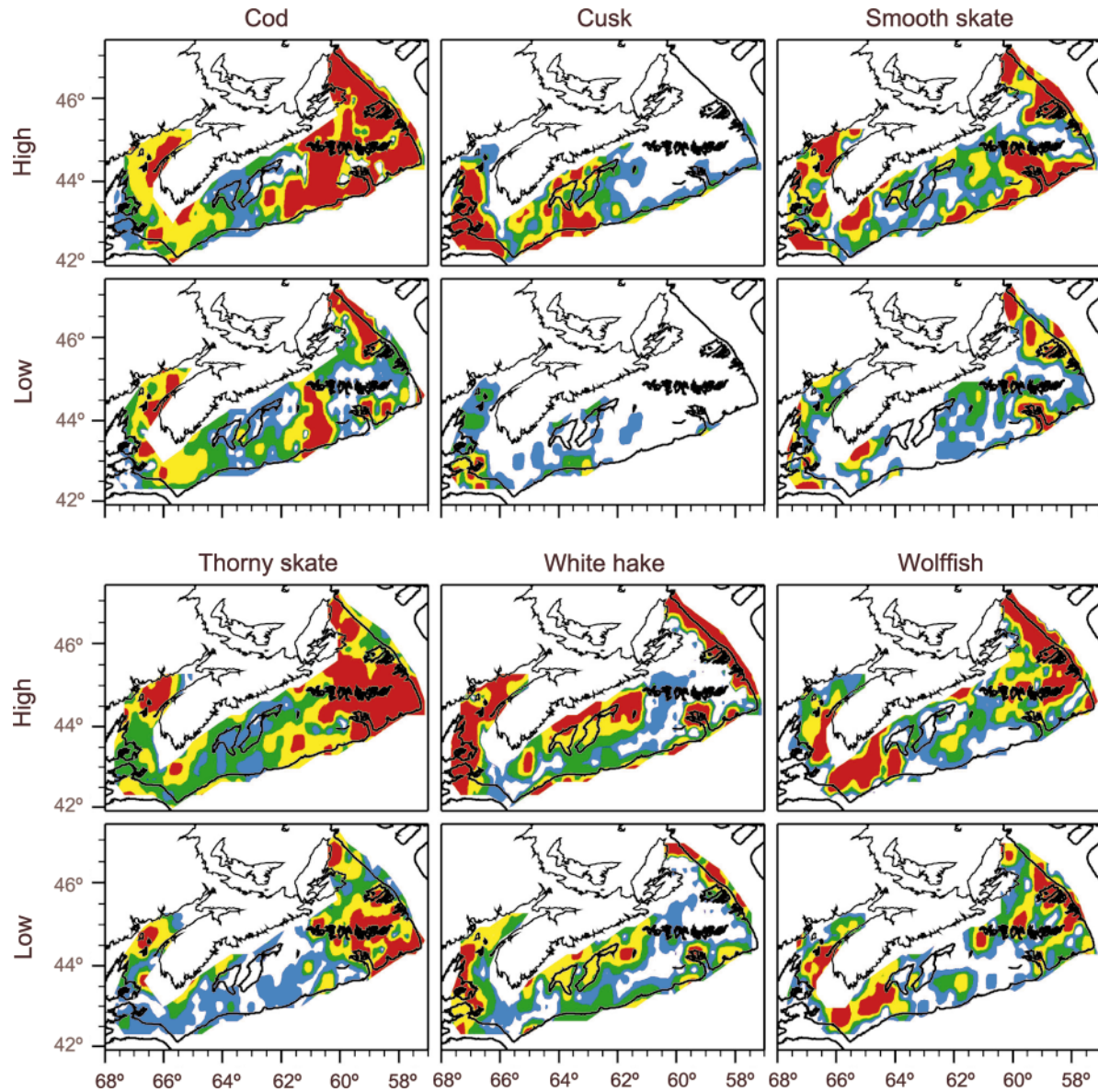


FIG. 3. Distribution during a period of higher regional abundance (High) and lower regional abundance (Low) for each species. Axes are latitude ($^{\circ}$ N) and longitude ($^{\circ}$ W). Contoured colors represent quartiles of density (number per tow) in all nonzero grids for each species: blue (<26%), green (26–50%), yellow (51–75%), and red (>75%).

(strata 85) and on the central Scotian Shelf (strata 70–73; Fig. 3). The common areas of high density between periods of higher and lower regional abundance could be conditionally considered core areas. We used the results from the density-dependent analyses below to further examine whether areas occupied during periods of lower abundance represent core areas.

Regional-scale patterns

A positive relationship was observed between distribution and abundance in seven out of 11 populations (Fig. 4). Lack of a density-dependent response can occur if the variation in abundance or distribution is low.

The change in geographic range of the four density-independent populations was lower (32–69%) than the seven populations showing a regional-scale density response (56–88%; Fig. 1). Given sufficient variation in regional abundance, a lack of a regional-scale density-dependent response might indicate that multiple, self-contained populations exist within the region tested or that a species prefers a specific but limited type of habitat or that areas of high density are highly unsaturated. Lack of a density-dependent response might also indicate that the type or cues for habitat selection change over time, in response to some unmeasured variable, or change with populations size (Morris 2003).

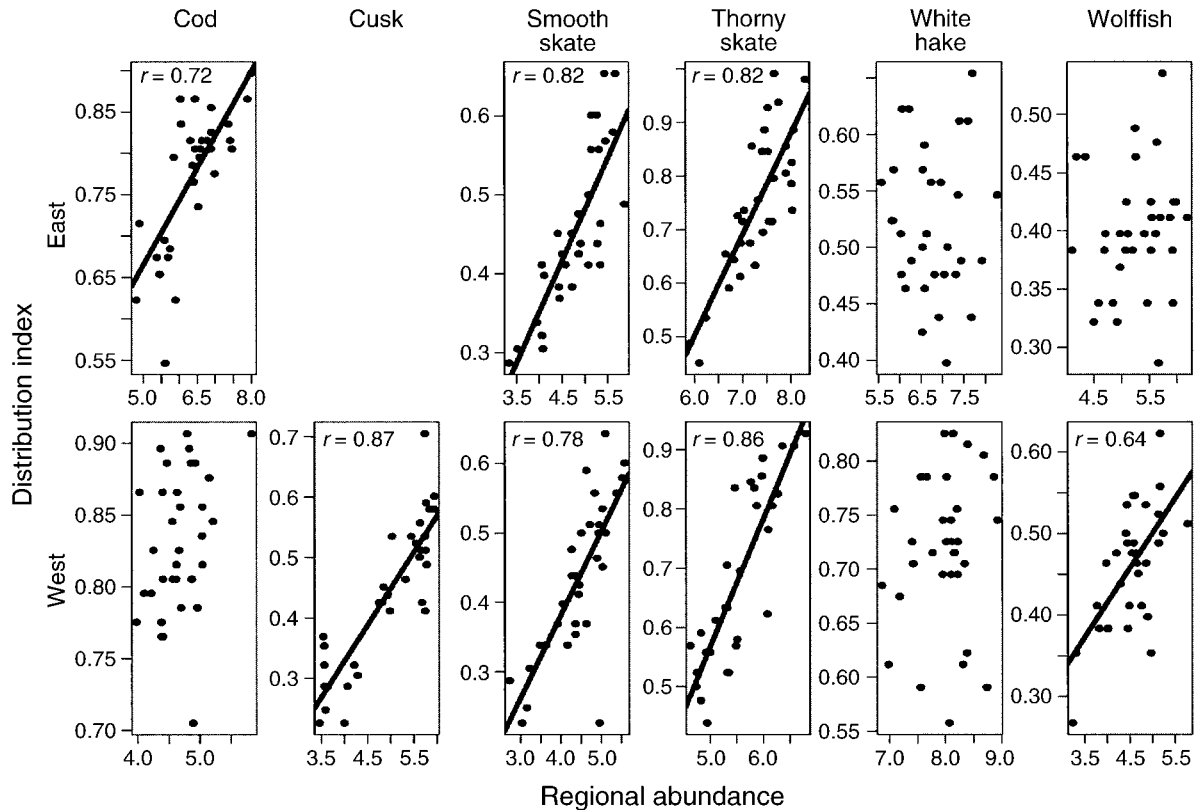


FIG. 4. Transformed indices of distribution and regional abundance for each population. Pearson correlation coefficients (r) and slopes (solid lines) of significant relationships of probability <0.001 are shown.

These are issues that deserve further study as to how they pertain to the identification of core areas. For this paper, however, we pursued the investigation of the seven populations showing a regional-scale density-dependent response.

Local-scale patterns

A local-scale (stratum level) density-dependent response occurs if the array of local density responses (β) is related to stratum suitability (median density during a period of higher abundance). For the seven populations showing regional-scale density dependence, three local density responses (β) were significantly related to stratum suitability (Fig. 5). We generally observed lower local density responses with higher stratum suitability with the exception of western wolffish and eastern thorny skate (Fig. 5). Similar results were obtained when temperature was not included as a covariate.

In our study, the local density response reflects the local response to a general population decline due to fishing. Assuming that abundance is inversely proportional to fishing pressure, the stratum suitability metric includes all possible areas of high density. If fishing has no local effect, and there is a regional-scale density-dependent response, we should observe a negative relationship between the local density-dependent re-

sponse and stratum suitability. Since none was observed for western wolffish and eastern thorny skate, we propose that fishing may have affected their local density responses.

Fishing effects

Fishing would have an equivalent effect on geographic distribution on all areas if fish migrated freely. High-density areas would be continually replenished when depleted. However, fishing has the potential to disproportionately deplete core areas in sedentary species (MacCall 1990). Depletion of core areas is more likely when fishing intensity is very high, or directed, and is associated with a slow rate of recolonization. Unfortunately, we have no adequate information to describe the general spatial distribution of fishing at the height of the fishery (1970–1992) that would allow us to assess how fishing affected patterns of contraction. However, recent, fine-scale geo-referenced fishing data exist for eastern thorny skate, and we use them as an example of the manner in which the geographic pattern of fishing might affect contraction.

Banquearea Bank (strata 47–48, Fig. 2) had the highest densities of thorny skate during periods of higher regional abundance, yet those areas were eroded during a period of lower regional abundance (Fig. 3) and had correspondingly high local density responses (cir-

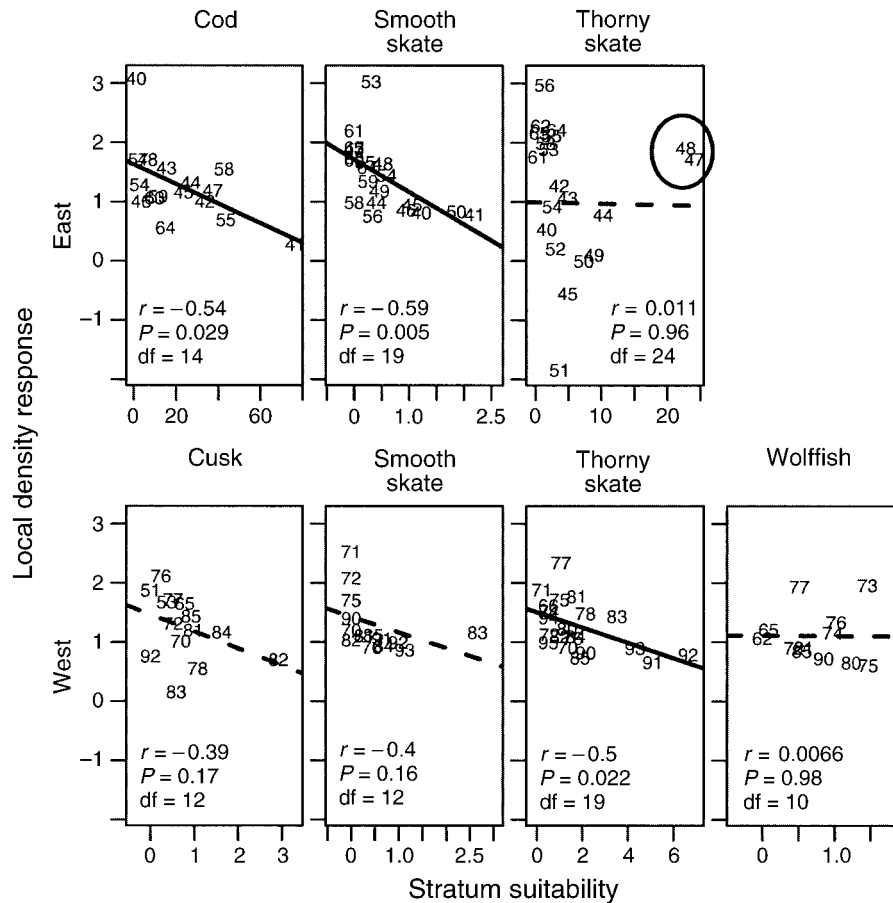


FIG. 5. Local density response (β) from Eq. 1 as related to an index of stratum suitability. Solid and dashed lines denote significant and nonsignificant relationships, respectively. Pearson correlation coefficients (r), probabilities (P), and degrees of freedom (df) are inset. Plot symbols refer to strata codes from Fig. 2.

cled in Fig. 5). From the standardized fishery-independent surveys, the mean occurrence of thorny skates in sets containing cod on Banquereau Bank was 0.96 from 1978 to 1993. That same metric in the predominant large-trawler commercial fishery averaged 0.71, as estimated from a DFO-managed fisheries observer program (FOP) from 1978 to 1993. The most active boats in the cod fishery encountered, on average, 0.74 of the thorny skate that co-occurred with cod. In effect, skates were caught often as bycatch in the Banquereau Bank cod fishery.

Invertebrate fisheries on the Scotian Shelf are growing, in response to a decline in the groundfisheries, and may play a role in habitat alteration. Starting in 1987 to the present day, hydraulic dredges were used to capture Arctic surf clam (*Mactromeris polynma*) on Banquereau Bank. Hydraulic dredges are more invasive than trawlers and greatly disturb the seabed. Experimental hydraulic dredge tracks on Banquereau Bank were still visible after three years, and there was little or no recovery of clam burrow structures. The effect of dredges on the seabed was greater than any observed local natural variation (Gilkinson et al. 2003). Com-

mercial dredging is directed on Banquereau Bank and may have altered the seabed in a way that strongly impacted thorny skate, whose diet is largely benthic invertebrates (Fig. 6a).

Fishing distribution data for a regulated skate fishery (all skates) have been reported since 1994. The skate fishery often prefers the winter skate (*Leucoraja ocellata*) but also catches the far more abundant thorny skate. The distribution of both effort (Fig. 6b) and landings were concentrated (and therefore disproportionately higher) on Banquereau Bank. Fig. 6c shows the difference in thorny skate density between periods of higher and lower abundance. Areas of greatest decline include Banquereau Bank. It is notable that densities of both thorny skate and winter skate have decreased on Banquereau Bank since the start of the skate and surf clam fisheries, but have increased slightly in adjacent areas. Shima et al. (2002) proposed that fish might redistribute themselves in less fished areas in response to intense fishing pressure. Unfortunately, there is no information (such as recapture data from tagging experiments) on skates in this area. In any event, thorny skate appear to have been depleted on

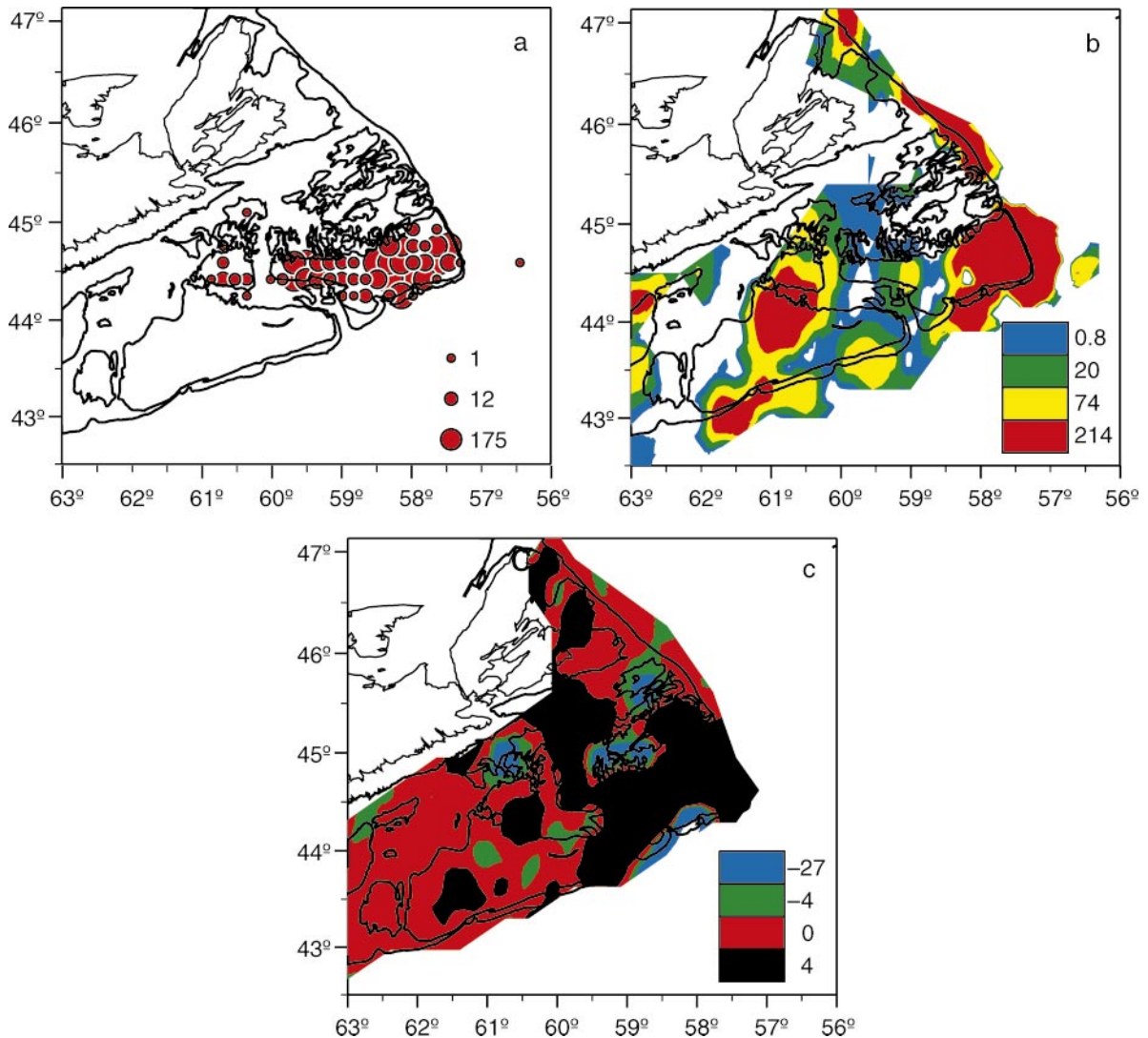


FIG. 6. (a) Arctic surf clam fishing sets as derived from the Maritime Observer Program (Department of Fisheries and Oceans, Canada). Axes are latitude ($^{\circ}$ N) and longitude ($^{\circ}$ W). Red circles are scaled to the number of tows aggregated in 10-min grids. The key represents quartiles of tows of nonzero grids (range 1–859). (b) Sum of fishing effort (in hours), from 1994 (the start of a regulated skate fishery) to 2000, in 20-min grids. The key represents quartiles of hours fished of nonzero grids (range 0.8–6850.4). (c) Difference between density during periods of higher and lower regional abundance of thorny skate: Blue and green depict areas where density increased; red and black depict areas where density declined. Areas of high decline on Banquereau Bank are spatially coincident with directed fishing effort.

Banquereau Bank due to the directed fishing effort and lack of immigration.

DISCUSSION

Regional-scale density-dependent geographic distribution was observed in seven out of 11 populations. Of those seven, we observed general trends suggesting a local-scale (stratum level) density-dependent response, but deviations were evident. The local-scale model and the stratum suitability metric may be weak because they do not include all variables relevant to habitat selection. Nonetheless, the approach revealed regional and local effects of fishing. The regional effect

of fishing is manifested in the magnitude of a species' decline. If a population has declined severely, even areas of high density will begin to erode and that will affect the estimate of the local density response. The local effect of fishing occurs when there is directed effort, and we provided evidence that this affected the local density response of the eastern thorny skate population. Below we hypothesize that movement rates of fish were slow relative to the fishing intensity, and thus local density responses are actually a response to both a decline in regional abundance and to local fishing pressure. We then argue that areas occupied during periods of minimal geographic distribution may not al-

ways represent the historical array of subpopulations. We conclude with a practical approach to identifying core areas of heavily exploited species.

Ideal free distribution assumes that animals are free to move among patches. In our study, subpopulations may exist within each region but conform to a regional-scale density-dependent response because the subpopulations mix and represent a type of metapopulation (Gaston and Blackburn 2000). We do not have a strong knowledge base of movement rates of most species in this area. Cusk, cod, and white hake have pelagic eggs that have the potential to disperse because of oceanographic currents. Skates and wolffish have eggs that rest on the bottom and so have less potential for dispersal. Certainly, the adults of all six species are of sufficiently large size to move over a broad geographic area. The only evidence of population structure and movement rates for the species examined is for cod. Genetic analyses of cod on the Scotian Shelf have shown a correlation between gene flow and geographic distance (Pogson et al. 2001). While we cannot translate genetic distances to levels of mixing among components of a metapopulation, tagging studies support low movement rates on the eastern Scotian Shelf (McKenzie 1956, Shackell et al. 1997). Fecundity, a trait related to fitness, differed on small geographic scales on the Scotian Shelf, suggesting some isolation among populations (McIntyre and Hutchings 2003). If the formerly widespread cod shows evidence of low-mixing subpopulations, similar dynamics are possible in the other, less-studied, more narrowly distributed, demersal species.

We will never be able to reconstruct a meaningful fine-scale spatial distribution of the fishery, but we have an indirect measure of its local effect through the temporal trends in abundance. Consider that the decline in abundance is due to fishing. Annual abundance at time t is the sum of abundance at $t-1$ plus recruitment, less natural and fishing mortality. If there is no fishing, abundance should fluctuate, but remain more or less stable. A declining trend of an exploited species usually reflects that fishing mortality has had much more influence on annual abundance than natural processes. If the primary cause of a species' decline is fishing, and movement rates are low, then the local density response includes a response to both regional and local fishing pressures.

Fretwell (1972) noted that if populations exhibited Allee effects at low population size, distributions may shift. But again, these animals have been heavily exploited. A common fishing pattern on a species in decline is that catch-per-unit effort stays high, as fishermen concentrate on high-density areas (e.g., Harley et al. 2001). Densities of cod on eastern Banquereau Bank (strata 47) and Sable Island Bank (strata 55) were comparable during a period of higher abundance. The local density response was higher on Banquereau Bank, reflecting a higher rate of depletion (Fig. 5), so that

Banquereau Bank is almost devoid of cod during a period of lower abundance (Fig. 3). Ruzzante et al. (1996) observed genetic differences between Sable Island Bank and Banquereau Bank cod, suggesting isolation between neighboring banks. Areas occupied during periods of minimal geographic distribution may not always represent the historical array of subpopulations, because subpopulations may have varying degrees of resilience or experience differential fishing pressure.

In summary, animals distributed over a broad landscape may conform to ideal free distribution over a much longer time scale because knowledge of neighboring patches diffuses more slowly as distance between patches increases and movement rates decrease. If fishing is overly intense, areas of high density can be depleted because there is little opportunity for recolonization from slowly moving animals from neighboring areas.

A practical approach to identifying core areas in exploited ecosystems

The use of IFD/DDHS theory to identify core areas has proved to be an informative approach. When results did not conform to theory, it allowed us to generate hypotheses as to the nature of divergence. We do not recommend the use of a density-dependent approach to identify core areas of heavily exploited species primarily because of the potential effects of heavy and/or directed fishing on animals with low movement rates.

In the absence of detailed information, which is the case for most marine fish, the safest approach to identifying core areas would assume demersal marine fish species are generally comprised of low-mixing subpopulations. With few a priori ecological assumptions, generalized additive models can be used to explore and summarize relationships between abundance, habitat variables, and location, if the breadth of the species range has been surveyed (see Guisan et al. 2002). For species at risk, only data derived before significant population declines should be used in any modeling exercise to identify high-density areas. Such areas represent those with the potential to support higher densities and multiple populations, regardless of distribution at minimal population sizes, density-dependent geographic shifts, and possible effects of fishing on declining populations. If we assume a metapopulation structure exists when none does, then the resultant suite of core areas would be an overestimate of the area required to sustain the species. The converse is that fewer core areas are identified, and unprotected populations are at risk of extinction. This argument not only applies to exploited fish, but to any species that is at risk as a result of human activities, e.g., urban development, land-use practices, deforestation. Rodriguez (2002) observed that protection of areas of historically high bird abundance represents a strategy that

emphasizes prevention of decline as opposed to the conservation of remnant populations in marginal areas.

Despite our ignorance of the structure of marine fish populations, protection of their historical areas of high density is essential not only for vulnerable species, but also for those currently exploited. Government fisheries agencies usually support fish habitat protection yet management plans do not automatically protect areas of high density, since these are often the most preferred fishing grounds. Yield could be optimized and stocks sustained over time by controlling the geographic distribution of the fishing fleet, particularly when movement rates are low (MacCall 1990). Core areas are rarely, but should be, automatically protected from fishing at the start of any regulated fishery.

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