Abstract—Pots are a form of trap used to capture fishes, crustaceans, or gastropod mollusks. Occasionally, these traps are lost at sea, where they have the potential to fish for many years because they are constructed of robust man-made materials. The present study quantified the mortality and number of animals caught by a fleet of crustacean pots (12 pots) that were set on the seabed and left to fish continually in a manner designed to simulate ghost-fishing off the coast of Wales, UK. The bait originally placed in the pots was consumed within 28 days of the beginning of the experiment. Spider crabs and brown crabs dominated the catches within the pots throughout the experiment. The CPUE of spider and brown crabs declined as an inverse function of time and reached a minimum between 125 to 270 days after initial deployment in August 1995. After this period, CPUE increased again, although it did not attain the rates associated with the beginning of the experiment. The fleet of twelve pots caught a minimum of 7.08 spider and 6.06 brown crabs per pot per year and killed a minimum of 6.06 brown crabs and 0.44 lobsters per pot per year. Other species caught in the traps included velvet swimming crab, lobster, ballan wrasse, dogfish, and triggerfish. The pots continued to catch animals into the second year of the experiment. These results suggest that pots have the potential to fish for extended periods. The wider use of biodegradable escape panels is recommended because currently there is no national legislation in the UK to enforce such escape measures.

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A study of catches in a fleet of "ghost-fishing" pots

Blaise A. Bullimore
Philip B. Newman
Countryside Council for Wales
Skomer Marine Nature Reserve
Fisherman's Cottage
Martin's Haven
Dyfed, SA62 3BJ, United Kingdom

Michel J. Kaiser
School of Ocean Sciences
University of Wales-Bangor
Menai Bridge
Gwynedd, LL59 5EY, United Kingdom
E-mail address (for M. J. Kaiser, contact author): m.j.kaiser@bangor.ac.uk

Susanne E. Gilbert
Kate M. Lock
Countryside Council for Wales
Skomer Marine Nature Reserve
Fisherman's Cottage
Martin's Haven
Dyfed, SA62 3BJ, United Kingdom

Static fishing gear, such as gill and trammel nets and pots or traps, are considered to be highly selective for target species. In addition, these gears might be considered to be environmentally friendly because they cause relatively little disturbance of seabed communities when compared with towed bottom-fishing gears (Jennings and Kaiser, 1998). However, set nets or pots can be lost as a result of bad weather, ice chafing and cutting mooring ropes, pots being snagged on seabed obstructions, or pots being inadvertently towed away by mobile fishing gears. The lost gear may then continue to fish indiscriminately, which is a phenomenon known as "ghost-fishing." In contrast with the numerous records of bird, reptile, and cetacean entanglement in set gears (see Dayton et al., 1995 and references therein), little is known about the frequency of static gear loss or for how long such gears continue to fish. The paucity of information relating to this phenomenon results from the reluctance of fishermen to report such incidents and the difficulty in undertaking long-term studies in a realistic manner.

Estimates of the proportion of nets lost from commercial fleets appear to be substantial. Approximately 7000 km of drift nets (20–30% of the total nets set each day) were lost per year in a North Pacific fishery (Eisenbud, 1985). Considerable numbers of pots are also lost each year from some fisheries, although estimates vary greatly between different studies. For example, Kruse and Kimker[1] estimated that that in 1990 and 1991, 31,600 pots per year were lost in the North American Bristol Bay king crab (*Paralithodes camtschaticus*) fishery, whereas Paul et al. (1994) and Stevens (1996) estimated that losses from the same fishery were respectively 20,000 and 7000 pots per year. Breen (1987) estimated that 11% of the traps used in the Dungeness crab *Cancer magister* fishery of British Columbia are lost each year. Modern com-

[1] Kruse, G. H., and A. Kimker. 1993. Degradable escape machanisms for pot gear: a summary report to the Alaska Board of Fisheries. Regional Information Report 5J93-01, 23 p. Alaska Department of Fish and Game (ADFG), 211 Mission Rd. Kodiak, AK 99615, Alaska.

mercial set nets and pots are made of nonbiodegradable man-made materials. As a result, lost nets and pots have the potential to persist and continue to fish in the marine environment for several years depending upon the prevailing environmental conditions (Breen, 1987; Carr et al., 1990; Kaiser et al., 1996). Set nets that are lost in areas exposed to large swell and storm activity (e.g. off the North west coast of Spain) are rapidly destroyed (Puente[2]). Nets lost in shallow, clear water are rapidly overgrown with encrusting biota that makes them more visible and reduces their fishing capabilities (Erzini et al., 1997). However, when static gear becomes snagged on rocks that hold it in place, or is lost in deep water in a relatively stable environment, it may continue to fish for more than a year (Carr et al., 1990; Kaiser et al., 1996).

Lost pots are likely to continue fishing for longer than static nets because they are constructed either entirely of metal or of thick netting attached to a rigid frame. Exactly how long lost pots are likely to continue fishing remains unquantified.

The present study was undertaken in grounds where pot gear is typically used—at a site within the Skomer Marine Nature Reserve (MNR), Wales, UK. MNR staff have recorded the occurrence of lost pots over a number of years within the waters of the reserve. Most observations were of single pots in locations sheltered from strong water movement. Such pots were usually heavily overgrown with sessile biota, indicating that they had been submerged for at least 6 months. Lost pots within the MNR have been reported by recreational divers who have described occasional large resident catches of crustacea and fish, such as ballan wrasse (*Labrus bergylta)* and conger eels (*Conger conger)*. The objectives of our study were 1) to quantify the number of organisms removed by a fleet of lost pots; 2) to describe changes in catch rate over time; and 3) to record any deterioration in the integrity of the fishing gear.

Methods

Site selection

The study site was located in the Skomer MNR off the coast of Pembrokeshire, Wales (Fig. 1). This site was representative of those fished by locally based inshore pot fishermen. Maximum tidal streams ranged from 2 to 3 knots on spring tides. The site was sheltered from heavy wave action and the seabed comprised mainly boulders to a depth of 15 m below the lowest recorded astronomical tidal height. Below this depth, the substratum was composed of mixed coarse sediments, cobbles and boulders, and occasional bedrock outcrops.

Gear and deployment

The gear comprised 12 parlor pots of approximate dimensions 750 mm · 500 mm · 500 mm with a top-mounted cylindrical entrance ring made of plastic (Fig. 1). Two sizes of entrance ring were used, either 200 mm (*n*=7) or 240 mm (*n*=5) diameter. In our analysis we made no attempt to differentiate catches based on entrance ring size because size of trap entrance was not a major consideration in our experiment. The pots were attached to a mainline by using 3.5-m lengths of polypropylene rope at intervals of 18 m. This configuration of the gear is the normal fishing practice used in the UK (Fig. 1). The fleet of pots was anchored at each end with a 75-kg weight and marked with surface marker buoys (Fig. 1). Each pot was baited with the corpse of a thornback ray (*Raja clavata*) (its wings having been removed) and attached to the entrance ring with a rubber band. On each sampling occasion the position of the fleet of pots was determined by a differential global positioning system. The pots were deployed on 4 August 1995. During deployment, the mainline was checked to see that it was tight between each of the pots when shot from the boat. Gear deployment was undertaken in consultation with a local professional pot fisherman. Divers surveyed the fleet of pots immediately after it had been shot away to confirm that the gear was deployed on the seabed correctly and to record the depth at which each pot had settled. It was thought important to record pot depth during the study because pots lost in shallow water might be more prone to destruction by wave action, whereas progressive movement of the pots into deeper water might prolong their fishing capabilities. Although it would have been preferable to have deployed replicate fleets of pots in different habitats, the logistics of diver-based observations and the need to minimize the adverse effects of the experiment on local populations of animals meant that this was neither possible nor considered ethically acceptable. Indeed, the ethical considerations of undertaking such an experiment in an MNR meant that 3 pots were removed from the experiment after 88 days and a further 3 pots removed after 270 days of fishing to minimize animal deaths associated with the study.

Data recording

Observations on each of the pots were recorded by divers 1, 4, 12, 27, 40, 69, 88, 101, 125, 270, 333, 369, and 398 days after initial deployment. Divers undertook the following tasks:

1 recorded the depth (adjusted for tidal height) of pots throughout the experiment.
2 recorded the identity of the catch in each pot.
3 tagged newly captured crustaceans (brown crab [*Cancer pagurus*] spider crab [*Maja squinado*] and the lobster *Homarus gammarus*) on each sampling occasion with coded and colored cable ties on their appendages so that they could be distinguished from newly captured animals (without tags) on subsequent occasions.

The identification of previously caught individual lobsters, brown crabs, and spider crabs caught in the pots was checked by inspection of the species-specific colored and coded tags placed on different body parts of each animal during a previous sampling routine. It was not possible to tag smaller crustaceans such as the velvet swim-

[2] Puente, E. 1997. Personal commun. Isla de Txatxarramendi, s/n 48395 Sukarrieta (Bizkaia), Spain.

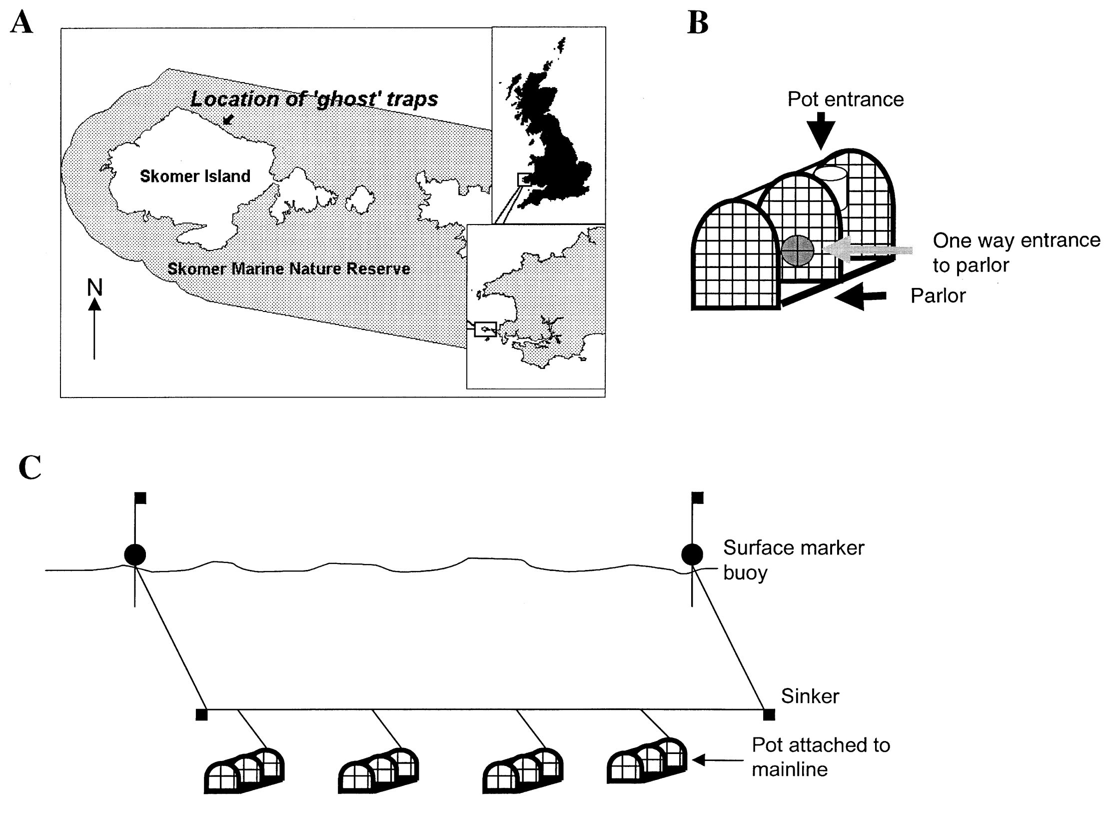

Figure 1

(**A**) Map of Skomer Island MNR, Pembrokeshire, Wales, UK, showing the location of the ghost fishing experiment, (**B**) a schematic diagram of the construction of a parlor pot, and (**C**) the configuration of a deployed fleet of pots.

ming crab (*Liocarcinus puber*) and fish were never tagged. However, fish were readily identifiable on consecutive occasions from the injuries sustained while resident in the pots. These injuries most frequently occurred as wounds on the head region that were sustained as the fish tried to escape through the pot meshes. Records were made of the presence and condition of bait on each occasion. Pot depth was estimated from divers' depth gauges and corrected for the state of tide from appropriate tide-tables.

Statistical analyses

Variation in the total resident catch (all species) within the pots at each time interval was analyzed by using a GLM (general linear modeling) ANOVA with time as the independent variable. Catch rates were calculated as the number of newly captured animals caught per pot and recorded by divers on each consecutive sampling occasion. It was not possible to standardize the sampling time interval because weather conditions and water visibility during the winter period were not conducive to regular sampling. Because the intersample period and number of pots varied throughout the experiment, the catch data were expressed as catch-per-unit-of-effort (CPUE) data with the following formula:

$$CPUE = N_j / \left(E_p(t_j - t_i)\right),$$

where N_j = the number of newly caught animals;
E_p = number of pots fishing; and
$t_j - t_i$ = the time interval since the previous observation (t_i).

The existence of a relationship between the decline in catch rate with time was determined by using nonlinear regression analysis in the SPSS statistical software package (SPSS, 1998). These analyses were performed only for brown and spider crabs because other animals were caught in insufficient numbers for meaningful analyses. Preliminary examination of the data suggested that the capture rate for the crab species differed with season; hence the regression analyses were undertaken by using only the data for the first 125 days of the experiment. Furthermore, there was a long period without direct observations from 125 to 270 days after initial deployment of the gear. Catch rate does not provide an indication of the total actual mortality of individuals associated with the ghost-fishing pots. Mortality was confirmed when divers observed the remains of individuals and their tags either at the bottom of the pot, or on the seabed nearby, because both the tags and dead animal fragments were small

Table 1

Resident catches (all species) in each of the twelve pots in the experimental fleet observed after initial deployment of gear at time intervals from August 1995 to September 1996. Mean resident catch per pot is also shown. "R" indicates those pots that were removed at each time interval

		Pot number												
Month	Day	1	2	3	4	5	6	7	8	9	10	11	12	Mean ± 95% CI
Aug	1	1	2	0	0	1	4	4	1	4	2	2	0	1.75 ±0.87
Aug	4	2	2	1	0	2	4	4	1	4	3	4	1	2.33 ±0.81
Aug	13	3	2	2	2	3	4	4	4	6	0	4	0	2.83 ±0.99
Aug	27	2	2	3	3	4	7	4	6	5	1	3	2	3.50 ±1.01
Sep	40	0	2	3	3	4	5	4	6	5	1	3	1	3.08 ±1.04
Oct	69	0	2	6	3	5	7	5	6	7	1	1	3	3.83 ±1.40
Nov	88	0	2	9	4	5	7	3	5	7	1	1	2	3.83 ±1.60
Nov	101	R	3	8	R	6	6	3	R	7	1	1	2	4.11 ±1.74
Dec	125	R	3	5	R	6	2	5	R	7	2	2	1	3.67 ±1.39
May	270	R	1	0	R	5	2	5	R	2	0	0	0	1.67 ±1.65
Jul	333	R	5	2	R	3	R	4	R	4	0	R	R	3.00 ±1.17
Aug	369	R	7	0	R	2	R	5	R	3	2	R	R	3.17 ±1.62
Sep	398	R	7	0	R	2	R	5	R	3	2	R	R	3.17 ±1.62

enough to pass through the meshes of the pots. Thus we were able to quantify the minimum mortality of animals captured per pot per year for the data up to the first 369 days (approximately 12 months) after initial deployment.

The effect of substratum type on the movement of pots on the seabed was analyzed for the first 7 observation periods by using one-way ANOVA. Data from the remaining observation periods were not used because some of the pots were removed after the seventh sampling date. Three different substratum categories were used: rock and large boulders; medium boulders and cobbles; and mixed sediments.

Results

The bait within the pots remained secure during their deployment. The bait was consumed rapidly, and by day 13 only remnants of the bait were observed in 9 of the pots, and by day 27 only 1 pot had any remnants of bait. Throughout the experiment, none of the pots became detached from the mainline between the sinkers. Pot movement was greatest in the first few weeks after deployment and was related to seabed topography. The entire fleet of pots tended to move in a north-westerly direction in line with the prevailing tidal currents as determined from the position of the surface marker buoys. Substratum type did not affect the extent to which the individual pots moved on average during the first 88 days of the experiment (ANOVA, $F_{2,59}$=0.62, P=0.56).

Throughout the experiment seven different species were captured in the pots. Divers observed that some animals were always resident in the pots because previously observed animals were frequently observed on subsequent sampling dates. The number of animals resident in the pots did not differ significantly between different observation periods (Table 1, GLM $F_{12,\,112}$=1.07, P=0.39). This finding suggests that as animals died or escaped, they were replaced by new catches. Only spider and brown crabs were captured in sufficient numbers for more detailed analyses. Analyses of the CPUE up to 125 days after initial deployment of the pots revealed that the CPUE decreased significantly for spider crab and brown crab (Fig. 2). The best relationship between the decline in CPUE with time was given by the following relationships:

CPUE spider crab =
0.0216 + (0.377/day) [r=0.97, $F_{1,7}$=236.7, P<0.0001],

CPUE brown crab =
0.0205 + (0.244/day) [r=0.92, $F_{1,7}$=77.5, P<0.0001].

It is clear from Figure 2 that the CPUE for spider crab and brown crab declined to a minimum rate between 125 and 270 days after initial deployment and then increased rapidly before decreasing again. The regression equation used to calculate the total predicted catch for the first 125 days of the experiment gives a catch of 4.74 spider crabs and 3.88 brown crabs per pot.

Catch rate, however, does not provide an indication of the total mortality of animals associated with the ghost-fishing pots. We were able to confirm annual mortality only per pot for lobster and brown crabs, of which 100% died because divers retrieved all the tags deployed on individual lobsters and brown crabs in the pots (Table 1). A conservative estimate of total mortality indicates that each pot killed on average 6.06 brown crabs and 0.44 lobsters per year (Table 2). This finding takes no account of animals

Table 2

Newly captured animals for the entire fleet of pots at various time intervals after first deployment of gear. For ethical reasons, after day 88, the number of pots was reduced to 9 and after day 270 the number of pots was further reduced to 6. Mean catch per pot per year was calculated from the sum of the total new catch divided by the number of pots fishing at each time interval.

		Days from original deployment												
		1	4	12	27	40	69	88	101	125	270	333	369	
		Number of pots fishing												
Species	Common name	12	12	12	12	12	12	12	9	9	9	6	6	Mean catch per pot per year
Maja squinado	spider crab	15	3	9	10	6	7	3	2	0	1	8	6	7.08
Cancer pagurus	brown crab	3	5	5	3	3	9	4	0	3	8	7	6	6.06[1]
Necora puber	velvet swimming crab	1	0	1	0	0	0	0	2	2	0	0	0	0.61
Homarus gammarus	lobster	2	1	1	0	0	0	0	0	1	0	0	0	0.44[1]
Labrus bergylta	ballan wrasse	0	0	0	1	0	0	2	0	1	1	4	5	1.97
Ballistes carolinensis	triggerfish	0	0	0	0	0	0	1	0	0	0	0	0	0.08
Scyliorhinus canicula	lesser-spotted dogfish	0	0	0	0	0	0	1	0	0	0	0	0	0.08

[1] indicates those animals for which all observed catches died.

that may have entered the pots and died without being observed by the divers.

Discusssion

The results of this experiment demonstrate that lost pots can continue to fish for many months after the bait within them has been consumed. There was no sign of deterioration in the integrity of the pots throughout the study. Several "ghost-fishing" pots were found in close proximity to the experimental fleet. This discovery emphasized the practicality of our study and confirmed that location of our experiment was representative of sites used by pot fishermen and that pot losses do occur in this area.

Spider and brown crabs dominated the catches, whereas lobster, velvet swimming crab, and fishes were caught less frequently. The rate of decline of the CPUEs for spider and brown crabs both followed similar patterns. We extrapolated the CPUE for only the first 125 days of the experiment because our own observations indicated that spider crabs migrate into shallower waters around Skomer to breed in the late spring and early summer. Consequently, catches of spider crab were high in August and tailed off as the experiment extended into autumn and winter and the spider crabs migrated farther offshore. In contrast, brown crabs are resident throughout the year in the Skomer MNR and although the CPUE was low during the winter period, it is possible that they continued to be caught sporadically between days 125 and 270. A second pulse of spider crab and brown crab catches occurred 333 days after initial deployment of the pots, which may be linked to rising water temperatures that occur in late spring and early summer (Fig. 2).

We were able to confirm mortality only for lobster and brown crabs (0.44 lobster and 6.06 brown crab per pot per

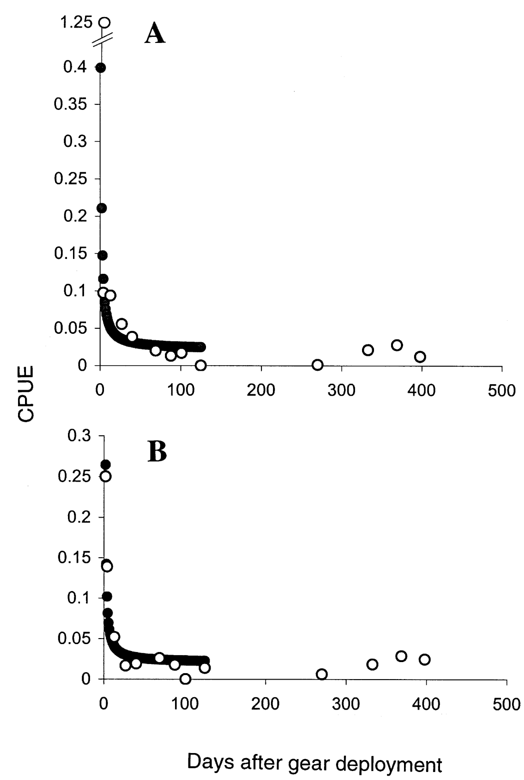

Figure 2

The catch per unit of effort (CPUE) for (**A**) spider crabs and (**B**) brown crabs on each of the sampling dates (open circles). The closed circles represent the predicted values for CPUE as determined from the regression relationships (see text).

Table 3

Bylaws currently in operation in UK waters pertaining to the use of escape gaps and pot design.

Cumbria Sea Fisheries Committee Bylaw No. 25: No person shall use or cause to be used for the purpose of fishing for seafish or crustacea any pot, creel or trap constructed of whatever material unless:

- it has at least one unobstructed escape gap located in the lowest part of the pot, creel or trap or in the case of a parlour pot the parlour area; and
- is so designed and constructed that each escape gap is of sufficient size that there may be easily passed through the escape gap and completely passed in to the pot, creel or trap a rigid boxed shaped gauge which shall be a gauge 74 mm wide, 44 mm high and 100 mm long.

States of Jersey Requirements of escape gaps in parlour pots: No person shall use or cause to be used for the purpose of fishing for seafish any parlour pot, of whatever material constructed, unless:

- it has a least one unobstructed escape gap which shall be located in the lowest part of the parlour areas on a side or sides of the parlour or the bottom of the parlour pot; and
- is so designed and constructed that each escape gap is of sufficient size that there may be easily passed through the escape gap and completely inserted into the parlour pot, whether the parlour pot is wet or dry, a rigid boxed shaped gauge which –
  - in the case of an escape gap located on a side of the parlour pot, shall be a gauge 79 mm wide, 44 mm high and 100 mm long; and
  - in the case of an escape gap located on the bottom of the parlour pot, shall be a gauge 199 mm wide, 44 mm high and 100 mm long.

year). Currently, there is no information on the frequency of pot loss in the UK; hence it is presently not possible to speculate about the annual death rate of crabs and lobsters from ghost-fishing in the UK. Financial losses to the industry are potentially high because lobsters command high prices (up to U.S. $12 per kg) whereas brown crab market prices have fluctuated between $0.60 and $1.60 per kg in recent years. However, there is no market for spider crab in the UK and only a sporadic overseas market for this species in countries such as Portugal and Spain.

All of the initial bait was exhausted after day 27. Presumably, as pot residents die, they act as bait luring more animals into the traps. We suspect that the fish that died would provide a ready source of food for trapped Crustacea, an observation that concurs with those in related studies (Kaiser et al., 1996). Recent studies have shown that a similar pattern of capture is observed in lost set nets. Over the first few days, catches decline almost exponentially. Then, for the next few weeks, the decaying bodies of fishes and Crustacea attract large number of scavenging crustaceans that also become trapped in the gear. Thereafter, there appears to be a continuous cycle of capture, decay, and attraction for as long as the gear remains intact (Carr et al., 1990; Kaiser et al., 1996).

It is interesting to note that ballan wrasse were caught in greater numbers in the traps during the last 65 days of the experiment, perhaps when there were fewer Crustacea in the pots compared with the beginning of the experiment. Wrasse seemed to develop wounds on their heads that resulted from their attempts to push through the mesh of the pot. These became severely infected and we believe contributed to their eventual death. Wrasse may become trapped within pots when they seek shelter.

Our estimates of capture rate are probably conservative because some animals may escape the traps. Divers found several spider crabs that had been tagged in one pot, but on the subsequent sampling occasion, they were recorded in a different pot. These animals had escaped one trap only to be captured in another. Similarly, Guillory (1993) found that up to 42% of blue crabs (*Callinectes sapidus*) escaped traps. The "ghost-fishing" potential of pots also varies for different fisheries and pot designs. For example, Parrish and Kazama (1992) found that the majority of Hawaiian spiny lobster (*Palinurus marginatus*) and slipper lobster (*Scyllarides squammosus*) were able to escape traps, whereas parlor-type traps lead to mortalities of 12–25% for American lobster (*Homarus americanus*) (Smolowitz, 1978). Catches in pots are also affected by the identity of the initial occupants. For example, Miller and Addison (1995) found that the presence of American lobsters within a pot deters entry of smaller crab species. Similarly, the presence of recently molted brown crabs within pots deterred entry of conspecifics (Addison, 1995).

Potential losses from the brown crab fishery due to ghost-fishing gear could be large. These losses are undesirable both from a conservation and economic point of view. Pot fisheries target species with high individual value, hence each loss is expensive. Fishermen in set-net fisheries have taken their own steps to reduce this phenomenon leading to a grapnel survey of the seabed on Georges Bank and retrieval of 341 actively fishing ghost nets from 286 tows (Brothers[3]). In some fisheries in North America, fishermen must fit their pots with escape gaps or escape panels that either biodegrade and fall out of the pot after a certain length of time, or that have degradable escape panel clips. In contrast, there is no UK legislation to force

[3] Brothers, G. 1992. Lost or abandoned fishing gear in the Newfoundland aquatic environment. Report of the Symposium on Marine Stewardship in the Northwest Atlantic, Department of Fisheries and Oceans, St. Johns, Newfoundland, Canada.

fishermen to use these conservation measures in conjunction with the traps, with the exception of bylaws in two areas (Table 3). Conservation measures such as these are relatively inexpensive to introduce and would greatly reduce losses from the fishery of commercially important species, such as lobster and brown crab, as well as species of conservation interest such as ballan wrasse.

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Literature cited

Addison, J. T.
1995. Influence of behavioural interactions on lobster distribution and abundance as inferred from pot-caught samples. ICES Mar. Sci. Symp. 199:294–300.

Breen, P. A.
1987. Mortality of Dungeness crabs caught by lost traps in the Fraser River Estuary, British Columbia. N. Am. J. Fish. Manage. 7:429–435.

Carr, H. A., E. H. Amaral, A.W. Hulbert, and R. Cooper.
1990. Underwater survey of simulated lost demersal and lost commercial gill nets off New England. *In* Marine debris: sources, impacts and solutions (J. M. Coe and D. B. Rogers, eds.), p. 171–186. Springer, New York, NY.

Dayton, P. K., S. F. Thrush, M. T. Agardy, and R. J. Hofman.
1995. Environmental effects of marine fishing. Aquat. Cons. Mar. Freshwater Ecosyt. 5:205–232.

Eisenbud, R.
1985. The pelagic driftnet. Salt Water Sportsman. May:65–72.

Erzini, K., C. Monteiro, J. Ribeiro, M. Santos, M. Gaspar, P. Monteiro, and T. Borges.
1997. An experimental study of gill net and trammel net 'ghost-fishing' off the Algarve (southern Portugal). Mar. Ecol. Prog. Ser. 158:257–265.

Guillory, V.
1993. Ghost fishing by blue crab traps. N. Am. J. Fish. Manage. 13:459–466.

Jennings, S., and M. J. Kaiser.
1998. The effects of fishing on marine ecosystems. Adv. Mar. Biol. 34:201–352.

Kaiser, M. J., B. A. Bullimore, P. B. Newman, K. M. Lock, and S. E. Gilbert.
1996. Catches in 'ghost-fishing' set nets. Mar. Ecol. Prog. Ser. 145:11–16.

Miller, R. J., and J. T. Addison.
1995. Trapping interactions of crabs and American lobster in laboratory tanks. Can. J. Fish. Aquat. Sci. 52:315–324.

Parrish, F. A., and T. K. Kazama.
1992. Evaluation of ghost fishing in the Hawaiian lobster fishery. Fish. Bull. 90:720–725

Paul, J. M., A. J. Paul, and A. Kimker.
1994. Compensatory feeding capacity of two Brachyuran crabs, Tanner and Dungeness, after starvation periods like those encountered in pots. Alaska Fish. Res. Bull. 1:184–187.

Smolowitz, R. J.
1978. Trap design and ghost fishing: an overview. Mar. Fish. Rev. 40:2–8.

SPSS, Inc.
1998. SPSS user's quide, version 9.0.0. SPSS, Inc, Chicago, IL.

Stevens, B. G.
1996. Crab bycatch in pot fisheries. *In* Solving bycatch: considerations for today and tomorrow, p. 151–158. Alaska Sea Grant Program Report 96-03. Univ. Alaska Fairbanks, Juneau, AK.