SUMMARY OF CRAB INJURY ASSESSMENT AND AERIAL EXPOSURE SAMPLE RESULTS FROM SELECTED 1997/1998 BERING SEA/ALEUTIAN ISLANDS KING AND TANNER CRAB FISHERIES AND THE 1998 PRIBILOF ISLANDS HAIR CRAB FISHERY

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INTRODUCTION

Large numbers of female and sublegal-sized male crabs captured in some Bering Sea/Aleutian Islands commercial crab fisheries must be discarded to comply with state regulations stipulating size limits and sex restrictions (ADF&G 1999a). Prior to their return to the sea a percentage of these crabs may be subjected to excessive on-deck aerial exposure and body injuries resulting from on deck handling and subsequent discard. Research studies conducted in both controlled and field settings have examined the types and frequency of injuries and potential resultant handling mortality to bycatch crabs in the commercial fisheries. Zhou and Shirley (1995) studied potentially lethal effects of handling on bycatch female and sublegal male red king crabs by simulating on deck sorting and handling procedures and evaluating injuries and subsequent overall condition of the test subjects. Although body damage increased significantly with increased handling, there were no significant differences among the treatment groups in long term mortality, feeding rates, righting responses or bacterial infections. Study results indicated the effects of handling on red king crab bycatch may be less detrimental than that reported for other commercially caught crab species.

However, numerous other studies examining handling-induced mortality in shellfish have identified lethal and sublethal effects on several crab species due to stress, cold air temperatures and injuries, including limb loss (Kruse et al.1993). Handling experiments conducted on red king crabs and Tanner crabs by Stevens and MacIntosh (1993) examined survival rates of male and female crabs inflicted with various injuries suspected to occur in the Bering Sea commercial fisheries. Variability in mortality rates of new and old-shelled red king crabs subject to different handling methods has also been documented (Watson and Pengilly 1994). In their review of capture and handling effects Kruse et al. (1993) noted that consequences from handling at-sea during the commercial fisheries may result in reduced fishery yields and significant mortality to declining stocks.

To further document the prevalence and nature of injuries and other potentially harmful effects attributable to handling of bycatch crabs, at-sea observers deployed in several Bering Sea/ Aleutian Islands king and Tanner crab fisheries were utilized for a data gathering project initiated in 1997 and continued through conclusion of the 1998 fishing seasons. During this project observers systematically categorized and evaluated injuries to non-retained crabs from fished pots randomly selected on a daily basis over the course of each season. In addition, on deck aerial exposure times of discarded crabs in selected pots were recorded and catch sorting operations were described for each of the observed vessels. The following report summarizes results of the data collected and examines variables that may influence injury rates and handling effects to bycatch crabs. Continuing collection and further analysis of these data may better aid researchers in the design of controlled handling studies as well as correlating results to the commercial fisheries.

METHODS

Observed Fisheries and Vessels

Handling injuries and crab aerial exposure times were recorded in seven fisheries and 10 fishing seasons occurring between November 1, 1997 and December 31, 1998. Observer coverage levels varied by fishery, fishing season and by numbers of participating vessels. Area(s) fished, the target species and seasons for which injury and aerial exposure data were collected in each fishery were as follows:

Bering Sea Snow Crab Jan. 15 – March 20, 1998, April 11 – May 30, 1998
Aleutian Islands Golden King Crab March 23 – August 15, 1998
St. Matthew Island Blue King Crab Sept. 15 – 26, 1998, Sept. 29 – Oct. 12, 1998
Pribilof Islands Hair Crab Oct. 8 – 23, 1998
Bristol Bay Red King Crab Nov. 1 – 5, 1997, Nov. 1 – 5, 1998, Nov. 9 – 23, 1998
Pribilof Islands Red and Blue King Crab Nov. 13 – 26, 1998

In some fisheries data collections were obtained consecutively during open-access (competitive) and Community Development Quota (CDQ) seasons. All CDQ vessels carried observers, as did those fishing Aleutian Islands golden king crabs and Pribilof Islands hair crabs. Observer deployments during two Bristol Bay red king crab open access seasons included all catcher-processors and limited numbers of catcher-only vessels which together comprised just over 7 % of the fishing fleet in each year. Three catcher processors and a single catcher-only vessel observed during the St. Matthew blue king crab open-access season comprised 3 % of the total 1998 effort.

Aerial Exposure Time

On deck aerial exposure times were measured for up to six pot catches randomly selected during each fishing day. Only exposure times for crabs of the target species were recorded, and from this group typically only the exposure times of the non-retained catch, consisting of females and sub-legal or sub-market-sized males. Exposure times for retained crabs were noted in pot catches without bycatch crabs. Exposure times were categorized as follows: *minimum exposure* – the recorded time interval beginning when a retrieved pot was lifted from the water and ending when the first non-retained crab was returned to the sea; and *maximum exposure* – the time interval beginning when a retrieved pot was lifted from the water and ending when the last non-retained crab was returned to the sea. Additionally, in each pot sampled crabs of the target species were enumerated and subdivided into total retained and discarded catch. On some occasions during the snow crab seasons estimates of catch numbers were recorded in place of actual counts, due to large numbers of crabs per pot routinely taken in this fishery.

Complete sample protocols and example forms used to record aerial exposure times are provided in Appendix A.

Injury Assessment Sampling

Pots selected for crab injury assessment sampling were also randomly chosen with at least one pot sampled during each fishing day. Crabs assessed for handling-related injuries consisted wholly of discarded males and females of the target species, which were enumerated and examined after being removed from retrieved pots and sorted from retainable crabs by the vessel crew. Injury sampling procedures included visual inspection of the carapace, sternum, abdomen, coxa and each pereiopod. Injuries noted were categorized by anatomical reference and classified as 'major' or 'minor 'in nature. Minor injuries included punctures, cracks or other shell damage without exposure of integument, muscle or vital organs; internal tissues and viscera were visible through the damaged shells of crabs with major injuries. Leg autotomies, unique from all other types of injuries, were categorized as minor in nature only because of the well documented fact that crabs may voluntarily shed one or more limbs in combat or while fending off predators, and self-cauterize the resultant wound. Sampled crabs were also assessed for vitality and characterized as moribund if not exhibiting appendage movement when prodded, and dead if maxilliped movement was also not apparent. Ancillary data recorded for most crabs inspected included measurement of carapace length (carapace width in snow crabs) and shell age.

Complete sample protocols and example forms used to record injury assessment data are provided in Appendix B.

Documentation of Vessel Catch Sorting Operations

Methods and equipment utilized by vessel crews to sort pot catches examined for injuries were documented through a survey questionnaire completed by the onboard observer. Multiple choice answers provided for survey questions described the design and on deck configuration of sorting equipment and various aspects relating to catch sorting practices, such as the sorting order of retained and non-retained crabs, the means used to release discards, and number of crewmembers participating in sorting operations. Tabulated results of completed surveys for each season were used to create a current profile of catch handling techniques commonly practiced in the commercial fisheries.

An example questionnaire used for describing individual vessel sorting operations is provided in Appendix C.

Data Analysis

To examine the relationship between aerial exposure times and total catches in sample pots, linear regression using the ordinary least-squares (Neter et al. 1983) was used to fit the linear model,

$$Y_{\text{maximum aerial exposure}} = \beta_0 + \beta_1(X_{\text{total crabs per pot}}) + \varepsilon$$

where the error, ε, is assumed normally distributed with a mean 0.

The regression model was applied to exposure times and catch counts recorded for individual vessels and also to those pooled by fishing season. A coefficient of determination (r^2) computed

for each data set identified variation in exposure times attributable to an approximate linear relationship to total catch per pot. Interactive effects between vessel data sets were not considered in evaluating model output for each fishing season. Utility of the linear model was evaluated for each of the data sets by testing the null hypothesis:

$$H_0: \beta_1 = 0$$

at level $\alpha = .05$, and where $t_{\alpha/2,n-2}$ = critical value of the t distribution at .05 and n-2 degrees of freedom.

RESULTS

Bering Sea Snow Crab

Open Access Season

More than 14,000 non-retained snow crabs from 394 sampled pots were assessed for injuries during the 64d open access snow crab season. Injury rates varied greatly among the 11 observed catcher-processors, ranging from just under 7 % to greater than 44 % of crabs sampled (Table 1). Combined samples from all vessels revealed that approximately 24 % of 36.5 non-retained crabs per pot received at least one injury prior to being released. Crabs with two or more injuries comprised slightly less than 7 % of the total. Although just 24 female snow crabs were observed in sampled pots, each suffered injuries during handling.

Injuries considered minor in nature predominated sampled crabs (Figure 1). Autotomized legs were the most prevalent of these and of all injuries in general, comprising 66 % of the minor injury total and 59 % of the grand total (Table 2). Other types of limb damage ranging from mildly bent, cracked and punctured legs to those severely crushed and torn, were the second most prevalent minor injury and the most commonly observed major injury. Excluding broken rostrums (minor in nature and third most common in this category), combined other injuries comprised slightly over 18 % of the grand total. The most rarely recorded injury was minor abdomen damage, observed in just eight sampled crabs.

Injury rates varied between crab shell age groups. Old-shelled and very-old shelled crabs appeared to be more susceptible to injury than those with new shells. While new-shelled crabs accounted for 73 % of samples for which shell age was recorded, they comprised just 32% of shell-aged crabs with injuries. Old and very-old shelled crabs were injured at a rate of 41 and 62 per 100 sampled.

Only 1 % of crabs examined for injuries were characterized as moribund and an additional 1 % were dead.

Aerial exposure times of non-retained crabs were measured from a total of 1,548 pot catches randomly selected daily on each of the observed catcher-processors. Mean maximum exposure of sorted and discarded crabs varied greatly between individual vessels, ranging from just under 2 minutes to more than 6 minutes (Table 3). Overall mean maximum on deck exposure equaled

slightly less than 4.5 minutes. Mean catches of retained and non-retained snow crabs per sampled pot were highly variable and did not correspond well to mean maximum exposure time, even though a positive relationship between maximum aerial exposure and total non-retained crabs per pot was significant for measurements taken on 11 of the 12 observed catcher-processors (r^2 <0.01-0.68; $p<0.05$). Scatter plots of data from each vessel with lines fitted from the regression model are illustrated in Figure 2. Analysis of data pooled from all vessels also revealed a significant relationship between exposure time and total crabs per pot, although a relatively low r^2 value of 0.03 suggested that little variation in exposure times was attributable to the linear model (Figure 3). Results of the model utility *t*-test ($p = 1.16E-12$) indicated that other statistical inferences, such as prediction intervals for exposure times, could be estimated from the data.

CDQ Season

Although fewer pots were sampled during the 49d snow crab CDQ season than during the open access fishery, more than twice the number of non-retained crabs were assessed for injuries. However, at just greater than 16 % of the 29,170 crabs examined, overall injury rates were more than 8 % lower. Individually, injury rates on the 19 observed catcher-only vessels were highly variable, ranging from nearly five to 53 % (Table 4). Crabs with two or more injuries comprised just 4 % of the sample total.

Most injuries were minor in nature, comprising nearly all those noted on some vessels (Figure 4). At 75 % of the sample total, autotomized legs were again the most common type of minor injury. Other minor injuries, relatively uncommon by comparison, consisted principally of damaged rostrums, legs and chelipeds (Table 5). Of all injuries detected, those characterized as major comprised just 5 % of the total. Severe leg injuries were the most commonly observed injury in this category. The most rarely observed injury during the CDQ season was major abdominal damage, with just three instances noted.

Variability in snow crab injury rates was again apparent between shell age groups, although new-shelled and old-shelled crabs incurred injuries at essentially the same rate of 20 crabs per 100 sampled. By contrast, more than 50 of every 100 very-old shelled crabs sampled received injuries during handling.

Results of crab vitality assessments were nearly identical to those from the open access season, with just 1 % of crabs examined moribund and 0.8 % dead.

Crab aerial exposure times were measured for slightly more than 1,000 pots selected daily during the season. Similar to the open access fishery, mean maximum exposures of sorted and discarded crabs were highly variable between some vessels, with the minimum and maximum values differing by up to 7 minutes (Table 6). At 6.1 minutes the overall mean maximum exposure time for CDQ vessels was considerably higher than that for the open access fishery. Although the overall mean catch per pot of retained snow crabs was very comparable between the two fisheries (at 206 and 200 crabs), the mean catch rate of non-retained snow crabs in CDQ sample pots was more than twice that of open access sample pots. Mean catch per pot of retained and non-retained snow crabs was highly variable between individual CDQ vessels and did not appear to correspond to maximum mean aerial exposure. A positive relationship between maximum aerial exposure and total catch per pot for was significant at an alpha of .05 for data

recorded on 12 of 18 vessels (r^2 = 0.10 – 0.67; p =0.01 – 4.5E-16). Scatter plots and fitted regression lines for each data set are provided in Figure 5. Data combined for all vessels showed a slightly significant relationship between exposure time and total crabs per pot at the same r^2 value (0.03) calculated for the open access fishery. Even though results of the regression model utility test were also significant (p = 3.54E-08), a scatter plot of the data, depicted in Figure 6, indicated a high degree of variation in exposure times was not directly attributable to total catch.

Aleutian Islands Golden King Crab

Assessments of crab injuries and observations of aerial exposure were recorded on all participating vessels during 115d of the 350d golden king crab season. From 260 pots sampled a total of 4,697 crabs were examined for signs of major or minor body damage. Injury rates were considerably lower than those observed in the snow crab fishery, ranging between 6 % and just under 21 % by vessel, and at slightly over 13 % overall (Table 7). Crabs with multiple injuries comprised just 2 % of the total sample size.

Minor injuries were most commonly inflicted on sampled crabs with an average of four noted for each major injury observed. Variability in this ratio between individual vessels is illustrated by Figure 7. Most minor injuries consisted of broken rostrums, which afflicted 30 % of crabs in this category, followed in rank by injuries to the mid-section of the carapace (Table 8). Of the 162 crabs with major injuries, more than 50 % had severely damaged legs. Cheliped injuries were the least common injury observed in either of the two categories.

Pooled injury assessment samples were nearly evenly comprised of females and sublegal male crabs, and overall injury rates for each sex were very comparable at 15 % and 16 % of the sample totals. New-shelled golden king crabs made up more than 98 % of those shell aged and accordingly, injury rates for this group were essentially the same as those for male and female crabs. Injury rates for old and very-old shelled crabs, rarely observed in sampled pots, were considerably higher at 30 % and 88 %.

Aerial exposure times for non-retained golden king crabs in an aggregate 790 pots randomly selected during the season were markedly lower than those observed in the snow crab fishery. The overall mean maximum exposure time from data combined for all eight observed vessels equaled just 2 minutes, and mean maximum exposure times between individual vessels varied by less than 3 minutes (Table 9). Overall catches per pot of retained and non-retained crabs were also relatively low at 7.5 and 22.8. Catch rates for individual vessels did not appear to strongly correspond to observed differences in mean maximum exposure times, although data sets from seven vessels revealed a significant relationship between maximum exposure time and total crabs per pot (r^2 = 0.28 – 0.53; p = 0.02 – 1.78E-20). Regression lines fit to each of the data sets are shown in Figure 8. Combined data from all vessels, illustrated by Figure 9, also showed a significant relationship between exposure time and total crabs per pot. Utility of the regression model was confirmed by *t*-test rejection of the null hypothesis $\beta_1 = 0$ (p = 3.54E-08).

St. Matthew Island Blue King Crab

Open Access Season

Just 354 non-retained crabs were examined for injuries from 19 pots selected for sampling on the four vessels observed during the 11d St. Matthew Island blue king crab open access season. Injury rates were relatively low with only 27 crabs (comprising more than 7.5 % of those sampled) showing signs external body damage (Table 10). Minor injuries consisting principally of broken rostrums were the most common, followed by leg autonomies and minor and major leg damage (Table 11). (A comparison of minor and major injuries for crabs sampled on each vessel are provided in Figure 10.) Sampled crabs were in good condition overall as moribund or dead crabs were not observed.

Old-shelled blue king crabs did not appear more susceptible to injuries than new-shelled crabs, even though relatively small numbers were noted in sampled pots (only one very old-shelled crab was observed).

Aerial exposure times were taken for 47 pots randomly selected from three of the four vessels observed during the season. Mean maximum exposure of non-retained crabs, identical for two vessels at 1.8 minutes, was 5.2 minutes on the remaining vessel (Table 12). Overall catches per pot of retained and non-retained blue king crabs were substantially lower than snow crab and golden king crab catch rates, at 4.9 and 12.6 crabs. Exposure times were not significantly correlated ($p = 0.12 - 0.20$) to total crabs per pot for any of the data sets, likely due to high variability in individual exposure times, as shown by scatter plots presented in Figure 11. A regression line fitted to exposure times pooled from all three vessels is provided in Figure 12.

CDQ Season

A total of 166 non-retained crabs were inspected for injuries from a small sample of 17 pots selected on the two vessels participating in the 14d CDQ season. Handling related injuries were noted for just 17 crabs which comprised slightly more than 10 % of the sample total (Table 13). Nine of the 17 injured crabs had autotomized legs, while most of the remainder had broken rostrums (Table 14). Moribund and dead crabs were not observed in sample pots. At just under 9.8 crabs per pot, non-retained catch rates for sample pots were nearly one-half those observed in the open access fishery.

Nearly all blue king crabs assessed for injuries were undersized males. Injury rates by shell age group were somewhat different than those observed during the open access fishery, affecting 8 % of the 136 new- shelled crabs sampled and 13 % of old and very old-shelled crabs.

Mean maximum exposure times of 1.7 and 1.8 minutes for non-retained crabs in 35 pots selected on each of the two vessels were comparable to sample results from the open access season, as were overall retained and non-retained crab catch rates (Table 15). Exposure times in each of the data sets showed a significant correlation to total numbers of crabs ($r^2 = 0.29, .56$; $p = 7.7E\text{-}5, 0.04$), which differed from regression analysis of exposure times for the open access fishery (Figure 13). As expected, combined exposure times from the two vessels also showed a relatively strong correlation to total catch. A pooled data scatter plot and fitted regression line

are provided in Figure 14. Results of the model utility test ($p = 3.7E-05$) also confirmed the significance of the linear relationship.

Pribilof Islands Hair Crab

Injury rates of non-retained crabs in 480 pots selected for sampling during the 17d hair crab fishery were highly variable between observed vessels, ranging between 2 % and 54 % (Table 16). However, injury rates of catches sampled from relatively few pots on several of the 12 vessels participating in the fishery likely resulted in poor estimates of actual injury rates for each. Overall injury rates for non-retained hair crabs were just over 13 %. Catch rates of non-retained hair crabs were extremely low by comparison to other observed fisheries, at just 2.3 crabs per sample pot. Crabs with minor injuries were most prevalent in the non-retained catch, comprising 75 % of the total. A comparison of injury rates by type for individual vessels is provided in Figure 15. Equal numbers of crabs with mid- section carapace damage and leg damage made up the most common types of minor injuries noted (Table 17). Damaged legs also constituted the majority of major hair crab injuries, comprising 60 % of those recorded. Moribund or dead crabs, relatively rare in comparison to the total sample size, were observed on a total of 11 occasions.

A catch ratio of 1.5 undersized males for each female hair crab in sample pots was very comparable to the respective 1.6 ratio of injuries by sex. Injury rates by shell age group (from a total of 477 shell aged crabs), however, were greatly disparate. While just 11 % of new-shelled crabs incurred injuries, essentially one of every two old-shelled crabs and virtually all very old-shelled crabs were damaged during handling.

Mean maximum crab aerial exposure times were brief for non-retained hair crab catches in 304 pots selected during the season, averaging just 1 minute overall and as low as 30 seconds on one of the 12 observed vessels (Table 18). Catch rates in sample pots of non-retained crabs were extremely low by comparison to other observed fisheries at less than two crabs per pot. Correlation of aerial exposure to total catch per pot was significant in just two of the 12 vessels observed ($r^2 = 0.23, 0.37; p = 0.03, <0.01$). In most cases a poor linear relationship was in part likely due to high variability in the sample data (Figure 16). A regression line fitted to exposure times and total catch for pots sampled on all vessels also failed to show dependence between the two variables ($r^2 = <0.01$; $p = 0.84$) (Figure 17). Results of the model utility *t*-test additionally confirmed this finding.

Bristol Bay Red King Crab

Open Access Season (1997)

The short duration of the 5d Bristol Bay season resulted in just 146 pots selected for crab injury assessment sampling from the 19 observed catcher-processor and catcher-only vessels. An average of nearly 11 non-retained male and female red king crabs per pot were examined for injuries and a total of 228 injured crabs observed. As in other fisheries, injury rates between vessels were highly variable ranging from over three 3 to approximately 43 % of the sample total (Table 19). Overall, approximately 15 % of sampled crabs displayed visible evidence of damage

attributable to handling. Crabs with more than a single injury accounted for slightly less than 2 % of the total sample size. Minor injuries, occurring at an overall rate five times greater than that of major injuries, were principally comprised of broken rostrums, although autotomized legs and damaged legs were also noted relatively frequently (Table 20). Damaged legs were also a commonly observed major injury, making up more than one-half of those recorded. Moribund or dead crabs were not observed in the sampled catches. Numbers of crab injuries by type for each observed vessel are provided in Figure 18.

Undersized males, comprising nearly 90 % of the total injury assessment sample, appeared to be more prone to handling injuries than did female crabs. While injuries were noted for only 6 % of 159 females sampled, more than 17 % of 1,410 male crabs examined displayed external signs of body damage. As was evident in other crabs, injuries appeared to vary amongst red king crabs by shell age groups. At 16 %, injury rates of new-shelled crabs were comparable to the 14.5 % overall injury rate. Old-shelled crabs were injured at a substantially higher rate, which equaled 27 % of the total crabs sampled in this group.

Aerial exposure times of bycatch crabs were measured on nine of the observed vessels (all catcher-only) for a total 255 selected pots. Catch rates of non-retained crabs varied between vessels by as much as 20 crabs per pot and averaged slightly over 14 crabs. Mean maximum exposure times varied as well, from slightly more than one to nearly 7 minutes, but as seen in other fisheries, changes in mean exposure times did not seem to correspond to changes in catch rates of retained and non-retained crabs (Table 21). Overall mean maximum exposure time equaled 2.8 minutes. The relationship between maximum aerial exposure and total crabs per pot, depicted by scatter plots provided in Figure 19, was significant for eight of the nine vessels (r^2 = 0.20 – 0.92; p = 5.1E-16 – 0.04). Analysis of pooled data also demonstrated significance between exposure time and total crabs (r^2 = 0.29; p = 2.0E-20) (Figure 20), and rejection of the utility *t*-test null hypothesis (p = 2.01E-20) validated application of the regression model.

Open Access Season (1998)

Collection of handling injury statistics was continued during the 1998 Bristol Bay season, with 118 pot catches sampled and total of 5,305 crab examined on the 18 of the 20 observed vessels during the 5d season. Although injury rates on a number of vessels were greater than 15 %, the overall rate of approximately 12 % was lower than that recorded during the 1997 season (Table 22). Numbers of non-retained crabs sampled per pot increased from the 1997 season to 44.9 crabs. Injuries characterized as minor were most commonly recorded, comprising nearly 84 % of the sample total, and of which more than 58 % were broken rostrums (Table 23). Broken rostrums also constituted the most prevalent injury overall, at slightly less than 49 % of the total crabs sampled. Autotomized legs were the second most common minor injury, followed by damaged legs, which were the most common major injury noted at more than 52 % of the total in this category. Other major injuries frequently observed included damage to the mid-carapace section and cracked, punctured or crushed chelipeds. A total of 14 moribund and seven dead crabs were noted in the catch samples. Comparison of in injury rates by injury type between individual vessels for sampled catches are provided in Figure 21.

Somewhat contrary to sample results from the 1997 season, shell age did not appear to be as significant a factor influencing the probability of injury for non-retained crabs in 1998. From a

total 5,224 shell aged crabs, 13 % of those with new-shells were injured compared to slightly over 19 % of old-shelled crabs.

Crab aerial exposure times were recorded for non-retained catches in 362 pots selected on all 20 of the observed vessels. Mean maximum aerial exposure time was very nearly identical to sample results from the 1997 season, differing by just 12 seconds overall, even though the mean catch of non-retained crabs in sample pots increased more than threefold between the two seasons (Table 24). Mean maximum exposure times for individual vessels varied by as much as 4 minutes. Regression analysis of the data sets showed significant correlation of exposure time to total catch per pot in 14 cases (r^2 =0.24 – 0.87; p = 6.7E-10 – 0.02), as illustrated in Figure 22. Exposure times plotted against total sample catches from all vessels also demonstrated a significant linear relationship between the two variables (r^2 =0.28 p = 4.0E-27). A scatter plot and true regression fitted to the data are shown in Figure 23.

CDQ Season (1998)

Few pots were selected for injury assessment sampling from the seven vessels participating in the 16d CDQ season, and as a result just 837 crabs were examined. Numbers of non-retained crabs per sample pot were one-half those of the open access season and, at just over 5 %, the overall injury rate for CDQ crabs was less than one-half (Table 25). Crabs with more than one injury discernible occurred in sampled catches on just one of the observed vessels. The type and number of injuries noted for crabs sampled on individual vessels are shown in Figure 24. Similar to data results from the open access season, most noted injuries were minor in nature and most minor injuries consisted of broken rostrums (Table 26). Leg autonomies and damaged legs were the second and third most prevalent minor injuries, comprising approximately 18 % and 11 % of the total in this category. Major injuries, which occurred 22 % of all injured crabs, were also predominately damaged legs. Moribund or dead crabs were not observed in any of the sample pot catches.

Female red king crabs in sample pots were injured at twice the rate of undersized males (8 % versus 4 %), although of the crabs sampled 675 were males and just 162 were females. Injury rates between shell age groups were similar with 5 % of 808 new-shelled crabs incurring injuries compared to 7 % of 29 old-shelled crabs.

Individual maximum mean aerial exposure times were recorded for non-retained crabs from 48 pots selected on six of the observed vessels. Although overall catches per sample pot of retained and non-retained crabs were lower than those in pots sampled during the open access season, the overall mean maximum exposure time was virtually identical at approximately 3 minutes (Table 27). Mean maximum exposure for individual vessels ranged from slightly over 2 minutes to 4.5 minutes. Exposure times were significantly correlated to total crabs per pot in data sets from three of the six vessels sampled (r^2 = 0.51 – 0.96; p = 0.002 – 6.0E-3). In each instance where exposure times for which a positive linear relationship to total catch was not apparent, fewer than 10 total pots were sampled. Scatter plots and regression lines fitted to each of the data sets are presented in Figure 25. A regression line fitted to exposure times pooled from all six vessels, shown in Figure 26, was slightly significant (r^2 = 0.12; p = 0.01). Results of model utility *t*-test (p = 0.01) also validated the significance of the linear relationship.

Pribilof Islands Red and Blue King Crab

CDQ Season

A total of 50 non-retained crabs were assessed for injuries from just three pots selected for sampling on the single vessel participating in the 15d CDQ season. Twelve crabs were observed with damage to a single body part or region, and two crabs with multiple body injuries were also noted (Table 28). Nearly all injuries were characterized as minor and similar to the other king crab fisheries, most of these were comprised of broken rostrums. In contrast to other sample results, crabs with autotomized legs and other types of appendage damage were not observed (Table 29). Moribund or dead crabs were also absent from the sample pot catches.

Only six of the 50 red king crabs inspected were males, just one of which was injured during handling. The remaining 44 female crabs sustained injuries at the much higher rate than that of the males, at 29 %. Differences in injury rates by shell age group were also apparent. Even though all seven of the old and very-old shelled crabs examined were injured, just six of the 43 new-shelled crabs were also injured.

Maximum aerial exposure times ranged from one and one-half to 7.5 minutes and averaged 4 minutes for bycatch red king crabs in 13 pots sampled during the CDQ season (Table 30). A significant linear relationship between exposure time and the observed average of nine crabs per pot was not evident from sample data ($r^2 = 0.23$; $p = 0.09$). Individual exposure times and corresponding pot catches plotted around the fitted true regression line depicted in Figure 27.

Catch Sorting

Pot catch sorting equipment and procedure questionnaires were completed for a total of forty different vessels participating in five of the six observed fisheries. While methods and equipment varied for individual vessels and sometimes by fishery, certain items were observed and practices noted more frequently than others. These included tables, rather than totes, for depositing pre-sorted catches from pots; the use of pivot-legged tables moved under the vessel pot launcher for receiving catches and subsequently rotated back to the catch sorting area (as opposed to hinged or one-piece hydraulic tables, which in some cases result in deposited catches being mechanically "thrown" from one side of the table to the other); manually moving bycatch crabs by hand or in totes to the water's edge from the sorting platform (as opposed to employment of ramp structures or conveyor belts for this purpose); and the placement of discarded catches into vessel scuppers manually or via ramps or conveyors (as opposed to dumping crabs over the vessel's freeboard manually by hand or in totes).

Sorting tables were present on 30 of the 40 observed vessels, and on the majority of vessels in three of the five fisheries (Table 31). While crews of 15 vessels employed ramps or conveyors to move bycatch crabs to the water's edge, the remaining 17 for which questionnaire responses were provided did so by hand carrying or placing them into totes (which were then dragged to the release area). Methods of release of bycatch crabs on nearly all vessels surveyed consisted of placing them in scuppers, although crews on three vessels resorted to hand tossing discards over the side or dumping them from totes.

Survey results of methods for removing crabs from pots, likely a significant potential source of injury in some fisheries, indicated that mechanized equipment was most commonly employed for this part of the process. Retrieved pots were routinely emptied on a majority of vessels by the practice of dumping the contents onto the sorting platform using the hydraulic pot launcher. Crews on nearly all vessels participating in the Pribilof Islands hair crab fishery and on several vessels in the remaining fisheries removed crabs from pots by hand. Crabs dumped from pots fell less than two feet to the sorting platform on 14 vessels and between two and four feet on 12 vessels (drop distances from the remaining vessels were not available).

Aspects of sorting procedures relating to exposure times of bycatch crabs included tallies of crewmembers participating in sorting and the order of priority for separating the retained and non-retained catch. At least two of the crew sorted crabs on 35 of the vessels surveyed, although in all fisheries besides the Bristol Bay red king crab fishery, just a single crew member sorted on at least one vessel. Three crew sorted crabs on 13 of the vessels surveyed. Crews on more than 50 % of vessels retrieved retainable crabs from pot catches before removing and discarding bycatch crabs from the sorting platform. The release of bycatch crabs was prioritized on seven other vessels, while retained or non-retained crabs appeared to be randomly sorted from the catch on the remaining vessels surveyed.

DISCUSSION

Results from the sample data indicate that injury types, rates and aerial exposure times of bycatch crabs can be highly variable between fisheries and individual fishing vessels. Trends apparent in the data suggest that factors influencing the susceptibility of non-retained crabs to injury and excessive time onboard vessels prior to being returned to the sea may at least include directed catch and bycatch rates and timing of fishing seasons. Other prevailing circumstances, such as competition between harvesters, may also be important.

Directed catch and bycatch rates of crabs were expected to correlate strongly to maximum aerial exposure based on the logical assumption that as crabs per pot increase, more time will be required for catch sorting by vessel crews. Indeed, regression analysis by Zhou (1996) of aerial exposure versus catch rates recorded on a single vessel fishing Bristol Bay red king crabs produced results corroborative to this assumption. However, as shown in data results from the observed vessels, combined catch rates of retained and non-retained crabs appear to influence aerial exposure times in some fisheries but not necessarily others. Significant correlation between the two variables was most apparent in the Bering Sea snow crab and Bristol Bay red king crab open access seasons, not withstanding the fact that total snow crab catch rates were substantially higher than those for red king crabs. The relatively strong linear relationship between exposure time and catch rates of blue king crabs in the St. Matthew Island CDQ season was absent in the open access season, although in each case sample sizes were comparatively small. Exposure times were most poorly correlated to catch rates in the Pribilof Islands hair crab fishery, which also had the lowest overall and least variable individual catch rates of retained and non-retained crabs.

Changes in mean catch rates between fisheries appeared to correspond somewhat to changes in mean maximum exposure times. The highest mean maximum exposure times occurred in the

open access and CDQ snow crab seasons, each of which as mentioned previously also produced the highest combined mean catch rates of retained and non-retained crabs. As might be expected, the lowest mean maximum aerial exposure was recorded for the Pribilof Island hair crab fishery. However, it should also be noted that even though mean maximum exposure time in both Bristol Bay open access and CDQ seasons remained relatively constant, the respective mean catch rates of red king crabs varied by as much as 240 %.

In all fisheries and fishing seasons except Bering Sea CDQ snow crab, mean maximum exposure times were less than a 5 minute minimum exposure time threshold used for treatment groups in recent studies of handling mortality, limb loss and righting response of Tanner crabs resulting from aerial exposure and subsequent wind-chill effects (Zhou and Kruse, 1998, Shirley 1998). Study results indicated that for crabs subject to subzero wind-chill temperatures for at least 5 minutes, some mortality, limb loss or reduced vigor could be expected.

Differences in aerial exposure times due to variable sorting practices and equipment used were difficult to detect without further examination of the data. Additionally, association of the two variables would likely be confounded by the observed differences in target species catch rates between fisheries. Other factors also not considered, such as fished gear types, might also influence findings. An illustration of how such factors could complicate sample results can seen in the Pribilof hair crab fishery, where the lowest mean maximum exposure time corresponded to the least mechanized sorting operations. (In contrast to other fisheries, nearly all hair crab vessel crews removed their catches from pots by hand.) However, as noted previously catch rates of hair crabs were also the lowest of all fisheries. In addition, hair crab pots as defined in regulation are smaller and more lightweight than those typically used in other fisheries, and may also be longlined as opposed to being fished singly (ADF&G 1999a). Accordingly, hair crab pots are typically retrieved at relatively rapid rates, an operations detail which by itself may explain the reduction in aerial exposure of bycatch crabs. Without additional consideration of these and other potential variables, inferences relating aerial exposure to sorting practices might be overvalued.

A number of generalized statements can be made based on the results of injury assessment sampling regarding the nature, extent and probable causes of injuries inflicted on crabs during handling in the observed fisheries. In each case the overwhelming percentage of injuries observed were those defined in the study as minor. Major injuries were rare and, when observed, most often consisted of severely damaged walking legs. Bycatch crabs seldom incurred more than a single injury during handling, as those with multiple injuries comprised less than 5 % of sample sizes in all fisheries and fishing seasons except Bering Sea open access snow crab. Autotomized legs were the most prevalent minor injury inflicted on snow crabs and broken rostrums the most commonly recorded for king crabs. However, it should also be noted that autotomized legs were one of the three most common injuries in all fisheries and fishing seasons except the Pribilof Islands CDQ red and blue king crab and the Aleutian Islands golden king crab fisheries. New-shelled crabs typically suffered injuries at rates much lower than that of old and very old-shelled shelled crabs, all of which in some fisheries had damage inflicted prior to being released. Differences in injury rates due to variable sorting practices and equipment used are not easily detectable without further data collection and analysis.

The predominance of damaged rostrums in king crabs corresponds to results of laboratory studies conducted by Zhou (1996) examining injuries and mortality of red king crabs due to the

first of repeated handling treatments (rostrum damage was most prevalent following carapace spine damage, which was not recorded for crabs sampled on the observed vessels). The apparent greater susceptibility of old shelled crabs to injuries due to handling agrees with the aforementioned conclusions of Watson and Pengilly (1994), also pertaining to red king crabs. Study results of Zhou and Kruse (1998) and Shirley (1998) suggest that the prevalence of leg autotomies in both of the snow crab fisheries may be the result of increased cold air exposure due to the winter month timing of the fishing season. Observations of golden king crab handling injuries, also made during the cold winter months, showed lower leg autonomy rates for this species, which coincided with lower aerial exposure times of crabs in pots selected for sampling.

A reduction in overall injury rates between open access and CDQ seasons was evident for two of three fisheries where both harvests occurred. Lower injury rates (and less leg autotomies in particular) during the snow crab CDQ season may be attributable to the later timing of fishing, where bycatch crabs would be exposed to less severe cold air temperatures. However, another possible explanation for this disparity which may warrant future examination is the fundamental difference between the two types of harvests. As the name implies, open access fishing is competitive in nature, while CDQ harvests are based on a pre-determined allocation of the crab resource to qualifying user groups (ADF&G 1999b). A reasonable assumption is that the absence of competition during CDQ seasons may lead to slower-paced harvesting which in turn may result in more careful handling of bycatch crabs. Viewed in conjunction with fewer daily pot pulls than reported by vessels in the open access fishery (ADF&G 1999b), lower injury rates recorded in the CDQ fishery lend some credence to this assumption. The significant reduction in injury rates during the Bristol Bay red king crab CDQ fishery compared to those recorded for each of the open access seasons may also imply a link between injury rates and competitive harvesting. However, the concurrently similar aerial exposure times for each fishery and greater overall catch rates during the CDQ season suggest that conclusions should not be drawn on this basis without further studies.

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Table 1. Observed body injuries of crabs in pot samples taken on 11 catcher-processors during the 1998 Bering Sea snow crab open access season.

Vessel	Pots Sampled	Crabs Sampled		Crabs With Injuries			
		Total	Number per Pot	Total	Number per Pot	Percent of Sample	Percent with >1 Injury
A	28	371	13.3	61	2.2	16.4	1.3
B	54	2,067	38.2	913	16.9	44.2	16.9
C	44	687	15.6	303	6.9	44.1	17.3
D	32	1,250	39.1	96	3.0	7.7	0.9
E	32	1,640	51.3	222	6.9	13.5	1.0
F	58	2,995	51.6	680	11.7	22.7	4.8
G	28	1,885	67.3	472	16.9	25.0	7.4
H	42	908	21.6	163	3.9	18.0	6.3
I	39	825	21.1	55	1.4	6.7	1.6
J	28	1,359	48.5	328	11.7	24.1	9.6
K	9	412	45.8	86	9.6	20.9	3.2
Totals	394	14,399	36.5	3,379	8.6	23.5	6.9

Table 2. Major and minor body injuries of crabs examined in pots sampled on 11 catcher-processors during the 1998 Bering Sea snow crab open access season.

VESSEL	A	B	C	D	E	F	G	H	I	J	K			
% Crabs sampled per pot	100	25	100	23	95	97	100	100	30	100	60	Total Injury By Type	Percent Minor Injuries	Percent Total Injuries
# POTS OBSERVED	28	54	44	32	32	58	28	42	39	28	9			
MINOR INJURIES														
Rostrum	15	91	52	0	0	14	88	18	7	0	20	305	6.8	6.1
Carapace(middle)	0	7	3	0	4	9	3	3	0	0	1	30	0.7	0.6
Carapace (side)	1	3	5	1	5	23	2	0	0	2	1	43	1.0	0.9
Leg injury	1	83	35	0	59	181	130	37	1	50	17	594	13.4	11.9
Leg -Autotomy	27	1036	329	80	139	365	329	101	35	474	39	2954	66.5	59.2
Left chela	4	67	18	0	12	48	46	0	3	16	2	216	4.9	4.3
Right chela	6	73	14	0	12	41	37	1	4	6	2	196	4.4	3.9
Chela-autotomy	0	0	2	0	1	4	3	0	3	1	0	14	0.3	0.3
Abdomen	0	1	1	0	0	4	2	0	0	0	0	8	0.2	0.2
Sternum	0	9	0	0	0	18	0	0	1	1	0	29	0.6	0.6
Coxa	0	8	1	0	0	8	8	1	0	29	0	55	1.2	1.1
Total Minor Injuries	54	1378	460	81	232	715	648	161	54	579	82	4444		89.1
MAJOR INJURIES												Total Injury By Type	Percent Major Injuries	Percent Total Injuries
Carapace(middle)	0	5	1	1	1	19	5	6	0	1	0	39	7.2	0.8
Carapace(side)	2	11	1	1	3	34	4	8	1	1	4	70	12.9	1.4
Leg injury	9	32	32	15	3	12	7	52	12	4	12	190	35.1	3.8
Left Chela	1	0	9	3	0	23	4	13	2	0	2	57	10.5	1.1
Right chela	0	1	3	8	0	7	5	17	2	1	0	44	8.1	0.9
Abdomen	0	0	0	0	1	10	2	0	0	3	0	16	3.0	0.3
Sternum	0	3	0	0	0	23	0	2	2	1	0	31	5.7	0.6
Coxa	0	8	0	0	0	52	19	10	2	4	0	95	17.5	2.0
Total major injuries	12	60	46	28	8	180	46	108	21	15	18	542		10.9

VITALITY												TOTAL
Moribund	0	4	24	0	4	62	16	3	1	19	6	139
Dead	3	4	8	4	10	63	11	7	3	12	3	128

Table 3. Correlation of maximum aerial exposure time with CPUE (crabs per pot) of retained and non-retained crabs combined in pots sampled on 12 catcher-processors during the 1998 Bering Sea snow crab open access season.

Vessel	Pots Sampled	Mean Crabs per Pot		Mean max. Exposure (min.)	r^2 value
		Retained	Non-retained		
A	102	236.5	14.9	6.2	0.19
B	165	168.3	60.6	3.0	0.50
C	149	240.1	24.2	1.9	0.22
D	137	199.6	84.3	3.3	0.65
E	135	114.2	45.5	4.1	0.33
F	157	160.4	68.1	5.8	0.03
G	76	426.4	127.8	3.9	0.24
H	157	254.7	46.1	6.1	0.08
I	108	219.5	100.6	4.8	0.43
J	154	263.2	86.7	3.0	0.03
K	128	145.8	48.4	5.1	0.06
L	80	92.7	47.7	5.8	0.05
Totals	1,548	205.6	61.2	4.4	0.03

Table 4. Observed body injuries of crabs in pot samples taken on 20 catcher-only vessels during the 1998 Bering Sea snow crab CDQ season.

Vessel	Pots Sampled	Crabs Sampled		Crabs with Injuries			
		Total	Number per Pot	Total	Number per Pot	Percent of Sample	Percent with >1 Injury
A	13	1,211	93.2	102	7.8	8.4	.7
B	15	698	46.5	83	5.5	11.9	2.4
C	11	261	23.7	18	1.6	6.9	1.1
D	23	2,073	90.1	98	4.3	4.7	0.9
E	18	3,818	212.1	1,399	77.7	36.6	12.5
F	6	1,065	177.5	55	9.2	5.2	0.8
G	13	1,529	117.6	271	20.8	17.7	3.7
H	18	2,179	121.1	180	10.0	8.3	0.5
I	13	897	69.0	475	36.5	53.0	7.2
J	21	1,751	83.4	202	9.6	11.5	2.1
K	5	664	132.8	47	9.4	7.1	2.0
L	18	1,568	87.1	199	11.1	12.7	2.3
M	16	1,174	73.4	294	18.4	25.0	10.2
N	22	2,022	91.9	216	9.8	10.7	4.2
Q	31	3,034	97.9	665	21.5	21.9	4.9
R	8	1,443	180.4	120	15.0	8.3	2.7
S	19	1,138	59.9	84	4.4	7.4	0.4
W	14	163	11.6	29	2.1	17.8	1.2
X	14	1,099	78.5	135	9.6	12.3	1.2
Y	34	1,383	40.7	91	2.7	6.6	1.7
Totals	332	29,170	87.9	4,763	14.3	16.3	4.1

Table 5. Major and minor body injuries of crabs examined in pots sampled on 20 catcher-only vessels during the 1998 Bering Sea snow crab CDQ season.

VESSEL	A	B	C	D	E	F	G	H	I	J	K	L	M	N	Q	R	S	W	X	Y	Total Injury By Type	Percent Minor Injuries	Percent Total Injuries
% Crabs sampled per pot	71	100	100	53	75	75	50	66	100	66	55	88	44	67	20	97	98	98	17	75			
# POTS OBSERVED	13	15	11	23	18	6	13	18	13	21	5	18	16	22	31	8	19	14	14	34			
MINOR INJURIES																							
Rostrum	1	27	0	0	19	1	59	0	1	17	0	0	5	21	130	0	26	7	30	7	351	5.8	5.5
Carapace (middle)	0	1	0	6	4	0	8	11	3	2	1	4	0	14	8	1	9	3	5	1	81	1.3	1.3
Carapace (side)	1	0	1	5	23	0	5	9	0	5	1	3	5	4	15	2	0	6	2	2	89	1.5	1.4
Leg injury	12	13	0	9	63	13	7	31	135	23	0	6	1	30	146	0	22	3	10	41	565	9.4	9.0
Leg injury-autotomy	76	40	13	96	1877	39	206	112	384	165	58	187	382	169	499	138	12	2	41	38	4534	75.2	71.3
Left chela	1	6	0	1	21	1	1	6	0	11	0	13	0	13	12	6	0	0	10	2	104	1.7	1.6
Right chela	1	6	0	1	31	1	3	16	0	12	0	26	0	16	8	2	3	0	12	4	142	2.4	2.2
Chela-autotomy	2	0	0	0	1	0	9	0	0	0	2	1	51	12	0	0	0	1	0	0	79	1.3	1.2
Abdomen	1	0	0	0	1	0	2	2	0	0	0	0	0	2	0	0	0	2	1	0	11	0.2	0.2
Sternum	0	1	0	0	1	0	5	0	2	0	0	1	0	8	12	0	4	0	1	0	35	0.6	0.6
Coxa	1	0	0	0	2	0	0	0	0	1	0	5	1	0	21	0	0	0	3	0	34	0.6	0.5
Total Minor Injuries	96	94	14	118	2043	55	305	187	525	236	62	246	445	289	851	149	76	24	115	95	6025		94.8
MAJOR INJURIES																					Total Injury By Type	Percent Major Injuries	Percent Total Injuries
Carapace (middle)	2	2	0	0	1	0	2	0	1	1	0	0	0	4	0	3	2	0	2	6	26	7.7	0.4
Carapace (side)	0	2	0	0	1	0	0	1	0	2	1	1	0	4	1	1	0	0	3	7	24	7.1	0.4
Leg injury	12	6	6	7	0	4	19	2	9	0	3	0	5	17	18	18	10	7	21	2	166	49.2	2.6
Left chela	0	0	0	3	7	4	5	0	0	6	4	2	3	9	0	3	1	0	1	4	52	15.4	0.8
Right chela	0	0	1	0	2	1	10	0	0	7	1	0	1	6	1	2	1	0	1	2	36	10.7	0.6
Abdomen	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	3	0.9	<0.1
Sternum	0	0	0	0	0	0	0	0	0	0	0	0	0	5	1	1	0	0	7	1	15	4.5	0.2
Coxa	0	0	0	0	0	0	6	0	0	0	0	1	0	0	5	1	0	0	2	0	15	4.5	0.2
Total Major Injuries	14	10	7	10	11	9	43	3	11	16	9	4	9	45	26	29	14	7	37	23	337		5.2

VITALITY																					Total
Moribund	9	4	0	1	9	0	6	6	14	23	3	2	38	10	6	18	182	21	18	24	394
Dead	4	5	0	0	15	2	6	4	9	7	8	17	20	12	6	6	68	0	7	24	220

Table 6. Correlation of maximum aerial exposure time with CPUE (crabs per pot) of retained and non-retained crabs combined in pots sampled on 19 catcher-only vessels during the 1998 Bering Sea snow crab CDQ season.

Vessel	Pots sampled	Mean crabs per pot		Mean max. exposure (min.)	r^2 value
		Retained	Non-retained		
A	56	349.7	373.3	5.8	0.26
B	55	152.5	49.2	5.7	0.11
C	54	212.9	204.5	4.1	0.12
D	77	173.3	n/a	3.6	-
E	52	277.0	178.7	7.8	<0.01
F	18	320.2	190.3	4.0	0.25
G	47	266.7	219.5	9.6	0.26
H	67	166.0	193.6	7.8	0.19
I	42	133.1	68.0	5.3	0.03
J	66	162.0	143.9	10.0	0.03
K	28	350.3	381.5	7.2	0.20
L	8	195.5	149.1	6.3	0.01
M	55	246.3	90.0	4.1	0.16
N	45	112.9	118.7	5.3	0.56
O	95	119.9	85.9	3.3	0.50
P	34	293.8	352.4	6.4	0.68
Q	117	185.7	287.7	5.8	0.44
R	24	286.5	120.7	3.6	0.04
S	74	133.1	119.8	11.0	0.01
Totals	1,014	199.9	134.2	6.1	.03

Table 7. Observed body injuries of crabs in pot samples taken on seven catcher-only vessels and one catcher-processor during the 1997/98 Aleutian Islands golden king crab fishery.

Vessel	Pots Sampled	Crabs Sampled		Crabs with Injuries			
		Total	Number per Pot	Total	Number per Pot	Percent of Sample	Percent with >1 Iinjury
A	33	618	18.7	78	2.4	12.6	1.3
B	44	220	5.0	38	0.9	17.3	2.7
C	35	644	18.4	77	2.2	12.0	1.7
D	26	997	38.3	114	4.4	11.4	1.8
E	29	340	11.7	20	0.7	5.9	0.3
F	23	1,139	49.5	153	6.7	13.4	2.6
G	41	458	11.2	95	2.3	20.7	2.0
H	29	281	9.7	46	1.6	16.4	2.1
Totals	260	4,697	18.1	621	2.4	13.2	1.9

Table 8. Major and minor body injuries of crabs examined in pots sampled on seven catcher-only vessels and one catcher-processor during the 1997/98 Aleutian Islands golden king crab fishery.

VESSEL	A	B	C	D	E	F	G	I	Total Injury By Type	Percent Minor Injuries	Percent Total Injuries
% Crabs Sampled Per Pot	100	100	99	100	97	100	100	100			
#Pots Observed	33	44	35	26	29	23	41	29			
MINOR INJURIES											
Rostrum	9	3	21	33	5	53	36	16	176	30.7	23.9
Carapace(middle)	8	7	11	18	6	45	6	5	106	18.5	14.4
Carapace (side)	30	7	15	8	0	9	17	9	95	16.6	12.9
Leg Injury	13	0	8	16	0	44	8	4	93	16.2	12.6
Leg-Autotomy	3	3	5	21	4	22	1	4	63	11.0	8.6
Left Chela	0	0	0	1	0	1	0	0	2	0.3	0.3
Right Chela	0	0	0	0	0	0	1	0	1	0.2	0.1
Chela-autotomy	0	0	3	6	0	2	5	0	16	2.8	2.2
Abdomen	0	0	0	2	0	0	0	0	2	0.3	0.3
Sternum	2	1	0	1	0	0	0	0	4	0.7	0.5
Coxa	0	0	0	14	0	1	0	1	16	2.8	2.2
Total Minor Injuries	65	21	63	120	15	177	74	39	574		78.0
MAJOR INJURIES									Total Injury By Type	Percent Major Injuries	Percent Total Injuries
Carapace(middle)	10	0	5	1	2	4	4	1	27	16.7	3.7
Carapace (side)	6	5	3	3	2	1	9	2	31	19.1	4.2
Leg Injury	4	15	18	14	2	7	19	11	90	55.6	12.1
Left Chela	0	0	0	0	0	0	0	0	0	0.0	0.0
Right Chela	1	0	0	0	0	1	0	0	2	1.2	0.3
Abdomen	2	3	0	1	0	0	1	0	7	4.3	1.0
Sternum	1	0	0	0	0	0	1	0	2	1.2	0.3
Coxa	3	0	0	0	0	0	0	0	3	1.9	0.4
Total Major Injuries	27	23	26	19	6	13	34	14	162		22.0

VITALITY									TOTAL
Moribund	8	1	28	17	1	17	0	2	74
Dead	3	0	3	0	0	1	0	0	7

Table 9. Correlation of maximum aerial exposure time with CPUE (crabs per pot) of retained and non-retained crabs combined in pots sampled on seven catcher-only vessels and one catcher processor during the 1997/98 Aleutian Islands golden king crab fishery.

Vessel	Pots Sampled	Mean crabs per pot		Mean max. Exposure (min.)	r^2 value
		Retained	Non-retained		
A	121	4.8	21.2	3.0	0.39
B	130	4.2	2.9	1.0	0.48
C	94	8.0	13.6	1.5	0.38
D	93	6.1	55.0	2.2	0.40
E	89	10.9	16.1	3.6	<0.01
F	110	15.1	38.3	2.3	0.05
G	69	4.7	7.1	1.0	0.28
H	84	6.3	30.2	1.7	0.53
Totals	790	7.5	22.8	2.0	0.16

Table 10. Observed body injuries of crabs in pot samples taken on three catcher-processors and one catcher-only vessel during the 1998 St. Matthew Island blue king crab open access season.

Vessel	Pots Sampled	Crabs Sampled		Crabs with Injuries			
		Total	Number per Pot	Total	Number per Pot	Percent of Sample	Percent with >1 Injury
A	5	110	22.0	18	3.6	16.4	0
B	1	3	3.0	0	0	0	0
C	6	122	20.3	6	1.0	4.9	0.8
D	7	119	17.0	3	0.4	2.5	0
Totals	19	354	18.6	27	1.4	7.6	0.3

Table 11. Major and minor body injuries of crabs examined in pots sampled on three catcher-processors and one catcher-only vessel during the 1998 St. Matthew blue king crab open access season.

VESSEL	A	B	C	D			
% Crabs sampled per pot	100	100	100	100	Total Injury By Type	Percent Minor Injuries	Percent Total Injuries
# POTS OBSERVED	5	1	6	7			
MINOR INJURIES							
Rostrum	6	0	2	1	9	42.9	33.4
Carapace(middle)	1	0	1	0	2	9.5	7.4
Carapace(side)	1	0	0	0	1	4.8	3.7
Leg injury	3	0	0	0	3	14.3	11.1
Leg-autotomy	2	0	0	1	3	14.3	11.1
Left chela	1	0	0	0	1	4.8	3.7
Right chela	0	0	0	0	0	0	0
Chela-autotomy	0	0	0	0	0	0	0
Abdomen	0	0	0	0	0	0	0
Sternum	0	0	0	0	0	0	0
Coxa	1	0	1	0	2	9.5	7.4
Total Minor Injuries	15	0	4	2	21		77.8
MAJOR INJURIES					Total Injury By Type	Percent Major Injuries	Percent Total Injuries
Carapace(middle)	0	0	0	0	0	0	0
Carapace(side)	0	0	0	0	0	0	0
Leg injury	1	0	1	1	3	50.0	11.1
Left chela	0	0	1	0	1	16.7	3.7
Right chela	0	0	0	0	0	0	0
Abdomen	1	0	0	0	1	16.7	3.7
Sternum	0	0	0	0	0	0	0
Coxa	1	0	0	0	1	16.7	3.7
Total Major Injuries	3	0	2	1	6		22.2

Vitality= No dead or moribund crabs seen

Table 12. Correlation of maximum aerial exposure time with CPUE (crabs per pot) of retained and non-retained crabs combined in pots sampled on three catcher-processors and one catcher-only vessel during the 1998 St. Matthew Island blue king crab open access season.

Vessel	Pots Sampled	Mean crabs per pot		Mean max. Exposure (min.)	r^2 value
		Retained	Non-retained		
A	14	7.5	12.3	5.2	<0.01
C	15	5.6	17.3	1.8	0.13
D	20	2.7	9.2	1.8	0.09
Totals	49	4.9	12.6	2.9	0.13

Table 13. Observed body injuries of crabs in pot samples taken on two catcher-only vessels during the 1998 St. Matthew Island blue king crab CDQ season.

Vessel	Pots Sampled	Crabs Sampled		Crabs with Injuries			
		Total	Number per Pot	Total	Number per Pot	Percent of Sample	Percent with >1 Injury
A	7	63	9.0	7	1.0	11.1	0
B	10	103	10.3	10	1.0	9.7	0
Totals	17	166	9.8	17	1.0	10.2	0

Table 14. Major and minor injuries of crabs examined in pots sampled on two catcher-only vessels during the 1998 St. Matthew Island blue king crab CDQ season.

VESSEL	A	B		
%Crabs Sampled per pot	100	100	Total Injury	Percent Minor
#POTS OBSERVED	7	10	By Type	Injuries
MINOR INJURIES				
Rostrum	1	3	4	23.5
Carapace(middle)	0	0	0	0
Carapace(side)	0	0	0	0
Leg injury	1	2	3	17.7
Leg-autotomy	4	5	9	52.9
Left chela	0	0	0	0
Right chela	0	0	0	0
Chela –autotomy	1	0	1	5.9
Abdomen	0	0	0	0
Sternum	0	0	0	0
Coxa	0	0	0	0
Total Minor Injuries	7	10	17	
Total Major Injuries	0	0	0	0

Vitality= No dead or moribund crabs observed

Table 15. Correlation of maximum aerial exposure time with CPUE (crabs per pot) of retained and non-retained crabs combined in pots sampled on two catcher-only vessels during the 1998 St. Matthew Island blue king crab CDQ season.

Vessel	Pots Sampled	Mean crabs per pot		Mean max. Exposure (min.)	r^2 value
		Retained	Non-retained		
A	14	14.3	7.6	1.8	0.23
B	21	9.5	9.6	1.7	0.57
Totals	35	11.4	8.8	1.7	0.41

Table 16. Observed body injuries of crabs in pot samples taken on 12 catcher-only vessels during the 1998 Pribilof Islands hair crab fishery.

Vessel	Pots Sampled	Crabs Sampled		Crabs with Injuries			
		Total	Number per Pot	Total	Number per Pot	Percent of Sample	Percent with >1 Injury
A	14	47	3.4	1	0.1	2.1	0
B	4	5	1.3	0	0	0	0
C	39	52	1.3	17	0.4	32.7	7.7
D	21	55	2.6	0	0	0	0
E	24	89	3.7	16	0.7	18.0	1.1
F	2	4	2.0	0	0	0	0
G	7	8	1.1	0	0	0	0
H	30	43	1.4	23	0.8	53.5	23.3
L	33	69	2.1	2	0.1	2.9	0
J	3	5	1.7	0	0	0	0
K	35	101	2.9	3	0.1	3.0	0
L	1	2	2.0	1	1.0	50.0	0
Totals	213	480	2.3	63	0.3	13.1	3.1

Table 17. Major and minor body injuries of crabs examined in pots sampled on 12 catcher-only vessels during the 1998 Pribilof Islands hair crab fishery.

VESSEL	A	B	C	D	E	F	G	H	I	J	K	L			
% Crabs Sampled per pot	100	100	100	100	100	100	100	100	100	100	100	100	Total Injury By Type	Percent Minor Injuries	Percent Total Injuries
# Pots Observed	14	4	39	21	24	2	7	30	33	3	35	1			
MINOR INJURIES															
Rostrum	0	0	0	0	0	0	0	2	0	0	0	0	2	3.4	2.6
Carapace(middle)	0	0	1	0	1	0	0	15	0	0	1	0	18	31.0	23.1
Carapace (side)	0	0	2	0	1	0	0	0	0	0	1	0	4	6.9	5.1
Leg injury	0	0	5	0	11	0	0	0	1	0	1	0	18	31.0	23.1
Leg-autotomy	0	0	7	0	0	0	0	0	0	0	0	0	7	12.1	9.0
Left chela	0	0	1	0	1	0	0	0	0	0	0	0	2	3.4	2.6
Right chela	0	0	2	0	1	0	0	0	0	0	0	0	3	5.2	3.8
Chela-autotomy	0	0	1	0	0	0	0	0	0	0	0	0	1	1.7	1.3
Abdomen	0	0	2	0	0	0	0	0	0	0	0	0	2	3.4	2.6
Sternum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coxa	0	0	0	0	1	0	0	0	0	0	0	0	1	1.7	1.3
Total Minor Injuries	0	0	21	0	16	0	0	17	1	0	3	0	58		74.4
MAJOR INJURIES													Total Injury By Type	Percent Major Injuries	Percent Total Injuries
Carapace(middle)	0	0	0	0	0	0	0	0	1	0	0	0	1	5	1.3
Carapace (side)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leg injury	0	0	0	0	0	0	0	11	0	0	0	1	12	60	15.4
Left chela	0	0	0	0	0	0	0	1	0	0	0	0	1	5	1.3
Right chela	1	0	0	0	0	0	0	5	0	0	0	0	6	30	7.7
Abdomen	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sternum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coxa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Major Injuries	1	0	0	0	0	0	0	17	1	0	0	1	20		25.6
VITALITY															
Moribund	1	0	1	0	0	0	0	6	0	0	0	0	8		
Dead	1	0	0	0	0	0	0	1	1	0	0	0	3		

Table 18. Correlation of maximum aerial exposure time with CPUE (crabs per pot) of retained and non-retained crabs combined in pots sampled on 11 catcher-only vessels during the 1998 Pribilof Islands hair crab fishery.

Vessel	Pots sampled	Mean crabs per pot		Mean max. exposure (min.)	r^2 value
		Retained	Non-retained		
A	20	3.0	4.0	1.1	<.01
B	15	1.3	.2	.3	<.01
C	47	2.4	.6	1.5	<.01
E	26	2.8	.8	.8	.17
F	34	2.0	6.5	1.1	<.01
G	20	1.5	0	.4	.03
H	40	1.1	.9	.4	.08
I	34	2.0	1.7	.5	.19
J	3	2.7	1.0	.8	.37
K	35	1.5	1.9	.8	.05
Z	30	2.9	.9	3.5	.23
Totals	304	2.0	1.8	1.0	<.01

Table 19. Observed body injuries of crabs in pot samples taken on 11 catcher-only vessels and eight catcher-processors during the 1997 Bristol Bay red king crab open access season.

Vessel	Pots Sampled	Crabs Sampled		Crabs with Injuries			
		Total	Number per Pot	Total	Number per Pot	Percent of Sample	Percent with >1 Injury
A	4	33	8.3	2	0.5	6.1	0
B	6	156	26.0	19	3.2	12.2	0
C	6	34	5.7	2	0.3	5.9	0
D	2	2	1.0	0	0	0	0
E	8	40	5.0	17	2.1	42.5	12.5
F	11	123	11.2	26	2.4	21.1	1.6
G	14	23	1.6	3	0.2	13.0	0
H	13	58	4.5	17	1.3	29.3	1.7
I	10	207	20.7	16	1.6	7.7	0.5
J	8	28	3.5	6	0.8	21.4	3.6
K	8	95	11.9	11	1.4	11.6	2.1
L	10	133	13.3	15	1.5	11.3	0.8
M	10	236	23.6	19	1.9	8.1	1.7
N	3	12	4.0	2	0.7	16.7	8.3
O	9	30	3.3	1	0.1	3.3	3.3
P	6	141	23.5	24	4.0	17.0	2.8
Q	7	25	3.6	2	0.3	8.0	0
R	5	185	37.0	46	9.2	24.9	3.2
S	6	7	1.2	0	0	0	0
Totals	146	1,569	10.7	228	1.6	14.5	1.8

Table 20. Major and minor body injuries of crabs examined in pots sampled on 11 catcher-only vessels and eight catcher-processors during the 1997 Bristol Bay red king crab open access season.

VESSEL	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	Total Injury By Type	Percent Minor Injuries	Percent Total Injuries
% Crabs sampled per pot	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100			
# POTS OBSERVED	4	6	6	2	8	11	14	13	10	8	8	10	10	3	9	6	7	5	6			
MINOR INJURIES																						
Rostrum	0	12	0	0	9	16	1	9	3	5	0	8	11	0	0	16	1	15	0	106	49.5	41.2
Carapace (middle)	0	0	0	0	0	2	0	0	2	1	0	0	2	0	0	0	0	6	0	13	6.1	5.1
Carapace (side)	0	1	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	13	0	17	7.9	6.6
Leg injury	1	0	0	0	2	2	0	5	3	0	0	0	3	1	0	1	0	5	0	23	10.7	8.9
Leg-autotomy	1	1	2	0	2	3	0	0	4	0	2	4	0	0	0	3	0	1	0	23	10.7	8.9
Left chela	0	0	0	0	1	0	1	2	2	0	0	0	1	0	0	1	0	1	0	9	4.2	3.5
Right chela	0	0	0	0	6	0	0	0	0	0	0	0	1	2	0	0	0	4	0	13	6.1	5.1
Chela-autotomy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Abdomen	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0.5	0.4
Sternum	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.5	0.4
Coxa	0	0	0	0	2	0	0	0	1	1	0	0	4	0	0	0	0	0	0	8	3.7	3.1
Total Minor Injuries	2	14	2	0	22	25	3	16	16	7	2	12	23	3	0	21	1	45	0	214		83.3
MAJOR INJURIES																				Total Injury By Type	Percent Major Injuries	Percent Total Injuries
Carapace (middle)	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1	1	2	0	6	14.0	2.3
Carapace (side)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	2.3	0.4
Leg injury	0	4	0	0	0	1	0	0	0	0	8	4	0	0	2	3	0	5	0	27	62.8	10.5
Left chela	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0	4	9.3	1.6
Right chela	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	4.7	0.8
Abdomen	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0
Sternum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0
Coxa	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	3	7.0	1.2
Total Major Injuries	0	5	0	0	0	3	0	2	1	0	11	4	0	0	2	7	1	7	0	43		16.7

VITALITY= No dead or moribund crabs observed

Table 21. Correlation of maximum aerial exposure time with CPUE (crabs per pot) of retained and non-retained crabs combined in pots sampled on nine catcher-only vessels during the 1997 Bristol Bay red king crab open access season.

Vessel	Pots Sampled	Mean crabs per pot		Mean max. Exposure (min.)	r^2 value
		Retained	Non-retained		
B	25	10.8	62.6	3.3	0.20
C	21	9.0	12.3	2.5	0.20
E	28	4.4	11.9	1.1	0.23
G	42	24.7	7.0	2.5	0.01
H	26	8.9	8.0	2.3	0.43
I	29	9.7	10.9	3.2	0.58
J	26	9.6	5.8	1.7	0.56
M	9	16.4	55.6	6.7	0.92
Z	49	22.3	50.8	2.2	0.76
Totals	255	14.2	24.0	2.8	0.29

Table 22. Observed body injuries of crabs in pot samples taken on eight catcher-only vessels and 10 catcher-processors during the 1998 Bristol Bay red king crab open access season.

Vessel	Pots Sampled	Crabs Sampled		Crabs with Injuries			
		Total	Number per Pot	Total	Number per Pot	Percent of Sample	Percent with >1 Injury
A	9	244	27.1	25	2.8	10.2	<0.1
B	7	649	92.7	57	8.1	8.8	1.0
C	3	239	79.7	40	13.3	16.8	2.5
D	4	117	29.3	11	2.8	9.4	0.0
E	8	602	75.3	141	17.6	23.4	4.2
F	10	388	38.8	12	1.2	3.1	0.0
G	10	341	34.1	50	5.0	14.7	0.0
H	7	104	14.9	12	1.7	11.5	0.0
I	7	184	26.2	10	1.4	5.4	0.0
J	5	298	59.6	7	1.4	2.3	0.0
K	2	54	27	24	12.0	44.4	1.1
L	4	144	36	6	1.5	4.2	0.0
M	7	126	18	6	.86	4.8	0.0
N	5	294	58.8	39	7.8	13.3	7.8
O	4	170	42.5	14	3.5	8.2	0.0
P	10	605	60.5	110	11.0	18.2	1.5
Q	10	428	42.8	45	4.5	10.5	1.0
R	6	318	53.0	20	3.3	6.3	<0.1
Totals	118	5,305	44.9	629	5.3	11.9	1.5

Table 23. Major and minor body injuries of crabs examined in pots sampled on eight catcher-only vessels and 10 catcher-processors during the 1998 Bristol Bay red king crab open access season.

VESSEL	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	Total Injury By Type	Percent Minor Injuries	Percent Total Injuries
% Crabs sampled per pot	28	57	100	100	100	100	100	70	100	100	100	100	100	100	85	100	100	64			
# POT OBSERVED	9	7	3	4	8	10	10	7	7	5	2	4	7	5	4	10	10	6			
MINOR INJURIES																					
Rostrum	20	13	27	1	72	4	36	0	1	2	22	2	2	21	11	92	21	0	347	58.3	48.7
Carapace (middle)	1	10	9	1	9	0	1	0	0	0	0	0	0	2	0	7	1	0	41	6.9	5.8
Carapace (side)	0	0	7	1	2	0	1	0	0	0	1	0	0	0	0	3	0	0	15	2.5	2.1
Leg Injury	0	21	1	2	5	1	3	7	1	0	1	3	1	8	0	5	0	4	63	10.6	8.8
Leg-autotomy	4	12	0	4	23	3	5	3	5	1	4	0	2	0	3	5	18	3	95	16.0	13.3
Left chela	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	1	5	0.8	0.7
Right chela	0	4	0	0	1	0	0	1	0	0	0	0	0	3	0	0	1	0	10	1.7	1.4
Chela-autotomy	0	1	0	0	0	3	1	1	1	0	0	0	0	0	0	0	1	1	9	1.5	1.3
Abdomen	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	3	0.5	0.4
Sternum	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0.2	0.1
Coxa	0	0	0	1	1	0	0	0	0	0	0	0	0	2	0	0	0	2	6	1.0	0.8
Total Minor Injuries	25	62	44	10	113	11	47	12	8	3	29	6	5	39	14	112	44	11	595		83.6
MAJOR INJURIES																			Total Injury By Type	Percent Major Injuries	Percent Total Injuries
Carapace (middle)	0	1	0	0	4	0	0	0	0	0	0	0	0	4	0	0	2	1	12	10.3	1.7
Carapace (side)	0	0	0	1	1	0	1	0	0	0	0	0	0	2	0	0	0	0	5	4.3	0.7
Leg injury	1	0	2	0	34	1	0	0	2	3	1	0	1	5	0	4	3	4	61	52.1	8.6
Left chela	0	0	0	0	3	0	1	0	0	0	0	0	0	2	0	1	1	2	10	8.5	1.4
Right chela	0	0	0	0	3	0	1	0	0	0	0	0	0	2	0	0	0	1	7	6.0	1.0
Abdomen	0	1	0	0	2	0	0	0	0	0	0	0	0	3	0	2	0	1	9	7.7	1.3
Sternum	0	0	0	0	1	0	0	0	0	0	0	0	0	3	0	0	0	0	4	3.4	0.6
Coxa	0	0	0	0	5	0	0	0	0	1	0	0	0	2	0	0	0	1	9	7.7	1.3
Total Major Injuries	1	2	2	1	53	1	3	0	2	4	1	0	1	23	0	7	6	10	117		16.4
VITALITY																					
Moribund	0	0	0	0	8	0	0	0	0	1	0	1	0	1	0	0	3	0	14		
Dead	0	0	0	0	5	0	0	0	0	0	0	0	0	2	0	0	0	0	7		

Table 24. Correlation of maximum aerial exposure time with CPUE (crabs per pot) of retained and non-retained crabs combined in pots sampled on 10 catcher-only vessels and 10 catcher-processors during the 1998 Bristol Bay red king crab open access season.

Vessel	Pots Sampled	Mean crabs per pot		Mean max. Exposure (min.)	r^2 value
		Retained	Non-retained		
A	30	24.7	65.8	3.6	0.11
B	11	7.4	235.8	3.0	0.62
C	20	20.0	107.8	4.8	0.27
D	26	17.0	77.8	2.0	0.44
E	15	9.7	41.3	3.8	0.11
F	15	15.0	116.7	3.6	0.47
G	15	18.7	47.7	3.3	0.02
H	15	18.1	29.5	1.2	0.48
I	9	29.0	91.0	1.9	0.17
J	28	27.8	64.1	2.5	0.65
K	20	16.5	57.8	3.0	0.24
L	9	24.3	128.4	3.7	0.80
M	10	4.3	62.4	2.9	0.49
N	24	15.5	179.5	5.4	0.27
O	20	13.3	79.8	3.3	0.01
P	14	20.2	81.0	2.8	0.80
R	15	40.1	35.9	3.1	0.69
W	33	3.4	11.8	2.1	0.71
X	15	18.7	27.6	1.8	0.87
Y	18	22.8	42.2	2.9	0.70
Totals	362	18.1	74.5	3.0	0.28

Table 25. Observed body injuries of crabs in pot samples taken on seven catcher-only vessels during the 1998 Bristol Bay red king crab CDQ season.

Vessel	Pots Sampled	Crabs Sampled		Crabs with Injuries			
		Total	Number per Pot	Total	Number per Pot	Percent of Sample	Percent with >1 Injury
A	4	150	37.5	4	1.0	2.7	0
B	4	68	17.0	13	3.3	19.1	1.5
C	2	89	44.5	2	1.0	2.2	0
D	2	130	65.0	3	1.5	2.3	0
E	6	160	26.7	6	1.0	3.8	0
F	5	87	17.4	8	1.6	9.2	0
X	3	153	51.0	8	2.7	5.2	0
Totals	26	837	32.2	44	1.7	5.3	.1

Table 26. Major and minor injuries of crabs examined in pots sampled on seven catcher-only vessels during the 1998 Bristol Bay red king crab CDQ season.

VESSEL	A	B	C	D	X	E	F			
% Crabs sampled per pot	100	100	100	75	100	100	100	Total Injury By Type	Percent Minor Injuries	Percent Total Injuries
# Pot Observed	4	4	2	2	3	6	5			
MINOR INJURIES										
Rostrum	2	9	0	1	1	1	1	15	42.9	33.3
Carapace (middle)	0	0	0	0	2	0	0	2	5.7	4.4
Carapace (side)	0	0	0	0	0	0	0	0	0.0	0
Leg injury	0	0	0	1	2	2	0	5	14.3	11.1
Leg-autotomy	0	2	0	1	0	1	4	8	22.9	17.8
Left chela	0	0	0	0	0	1	0	1	2.9	2.2
Right chela	0	0	0	0	0	0	0	0	0	0
Chela-autotomy	0	1	1	0	0	0	2	4	11.4	8.9
Abdomen	0	0	0	0	0	0	0	0	0	0
Sternum	0	0	0	0	0	0	0	0	0	0
Coxa	0	0	0	0	0	0	0	0	0	0
Total Minor Injuries	2	12	1	3	5	5	7	35		77.8
MAJOR INJURIES								Total Injury By Type	Percent Major Injuries	Percent Total Injuries
Carapace (middle)	0	0	0	0	0	0	1	1	10.0	2.2
Carapace (side)	1	0	0	0	0	0	0	1	10.0	2.2
Leg injury	1	0	1	0	3	1	0	6	60.0	13.3
Left chela	0	0	0	0	0	0	0	0	0	0
Right chela	0	0	0	0	0	0	0	0	0	0
Abdomen	0	1	0	0	0	0	0	1	10.0	2.2
Sternum	0	1	0	0	0	0	0	1	10.0	2.2
Coxa	0	0	0	0	0	0	0	0	0	0
Total Major Injuries	2	2	1	0	3	1	1	10		22.2

VITALITY= No dead or moribund crabs observed

Table 27. Correlation of maximum aerial exposure time with CPUE (crabs per pot) of retained and non-retained crabs combined in pots sampled on six catcher-only vessels during the 1998 Bristol Bay red king crab CDQ season.

Vessel	Pots Sampled	Mean crabs per pot		Mean max. Exposure (min.)	r^2 value
		Retained	Non-retained		
A	6	18.7	47.2	4.0	0.29
B	7	30.7	15.3	2.1	0.83
C	7	20.9	39.7	4.5	0.02
D	6	12.8	88.8	2.8	0.96
E	12	30.2	29.6	2.3	0.51
F	10	27.0	20.0	2.3	0.36
Totals	48	24.6	36.6	3.0	0.12

Table 28. Observed body injuries of red king crabs in pot samples taken on one catcher-only vessel during the 1998 Pribilof Islands red and blue king crab CDQ season.

Vessel	Pots Sampled	Crabs Sampled		Crabs with Injuries			
		Total	Number per Pot	Total	Number per Pot	Percent of Sample	Percent with >1 Injury
A	3	50	16.7	12	4.0	24	2

Table 29. Major and minor body injuries recorded for red king crabs examined in pots sampled on one catcher-only vessel during the 1998 Pribilof Island red and blue king crab CDQ season.

Vessel	A	Total Injury By Type	Percent Minor Injuries	Percent Total Injuries
% Crabs Sampled per pot	100			
# Pots Observed	3			
MINOR INJURIES				
Rostrum	9	9	75.0	64.4
Carapace (middle)	0	0	0	0
Carapace (side)	2	2	16.7	14.3
Leg Injury	0	0	0	0
Leg-autotomy	0	0	0	0
Left chela	0	0	0	0
Right chela	1	1	8.3	7.1
Chela-autotomy	0	0	0	0
Abdomen	0	0	0	0
Sternum	0	0	0	0
Coxa	0	0	0	0
Total Minor Injuries	12	12		85.8
		Total Injury by Type	Percent Major Injuries	Percent Total Injuries
MAJOR INJURIES				
Carapace (middle)	1	1	50.0	7.1
Carapace (side)	1	1	50.0	7.1
Leg injury	0	0	0	0
Left chela	0	0	0	0
Right Chela	0	0	0	0
Abdomen	0	0	0	0
Sternum	0	0	0	0
Coxa	0	0	0	0
Total Minor Injuries	2	2		14.2

VITALITY=No dead or moribund crabs observed

Table 30. Correlation of maximum aerial exposure time with CPUE (crabs per pot) of retained and non-retained red king crabs combined in pots sampled on one catcher-only vessel during the 1998 Pribilof Islands red and blue king crab CDQ season.

Vessel	Pots sampled	Mean crabs per pot		Mean max. exposure (min.)	r^2 value
		Retained	Non-retained		
A	13	0.6	3.0	4.0	.23

Table 31. Summary of crab sorting survey questionnaire results for observed vessels during the 1997-1998 Bering Sea / Aleutian Islands king and snow crab fisheries and the 1998 Pribilof Islands hair crab fishery.

		Sorting methods								
		Sorting equipment			Removing catch from pots					
Fishing Season	Vessels surveyed	table/totes	table type[a]	catch discard devices[b]	by hand / launcher	shake pot w/ launcher	catch drop distance[c]	catch discarding	# of crew sorting	sorting priority[d]
1998 Pribilof Islands CDQ red king crab	5	table – 2 tote – 3	pivot - 5	ramp – 1 conveyor – 0 none – 1 n/a - 3	by hand - 1 launcher - 4	no – 4	2-4 feet - 4	scupper – 2 over side - 0 both – 1 n/a – 2	'one' – 1 'two' – 3 'three' - 1	retained – 5
1997/98 Aleutian Islands golden king crab	2	table – 1 tote – 1	pivot - 1 n/a - 1	none – 1 n/a – 1	by hand - 1 launcher – 1	no – 1	2-4 feet - 1	scupper – 1 n/a – 1	'one' – 1 'two' - 1	retained – 1 random – 1
1998 Pribilof Islands hair crab	10	table – 10	pivot – 1 hydraulic 'A' - 2 other – 6 n/a - 1	ramp – 5 conveyor – 1 none– 4	by hand – 9 launcher - 1	no - 1	n/a - 1	scupper – 3 over side – 2 both – 1 n/a – 4	'one' – 2 'two' – 7 'three' – 1	retained – 4 bycatch – 4 random – 1 n/a – 1
1998 St. Matthew Island open access blue king crab	3	table – 2 tote – 1	pivot – 1 other – 1 n/a - 1	ramp – 1 conveyor - 0 none – 1 n/a - 1	by hand - 1 launcher – 2	no - 3	2-4 feet –2 n/a - 1	scupper - 3	'one' – 1 'two' – 1 'three' - 1	retained – 2 bycatch – 1
1998 Bristol Bay open access red king crab	20	table – 16 totes - 3 both – 1	pivot – 5 hydraulic 'A' – 3 hydraulic 'B' – 2 other - 5 n/a – 5	ramp – 5 conveyor – 2 none – 10 n/a – 3	by hand – 1 launcher – 19	yes – 5 no – 14 n/a – 1	<2 feet – 13 2-4 feet – 5 n/a – 2	scupper – 13 over side – 1 both – 1 n/a – 5	'two' – 10 'three' – 10	retained – 11 bycatch – 2 random – 7

a Table designs: Pivot leg – sorting table rotates across deck to launcher around secured table leg; Hydraulic 'A' – sorting table top hinged at or near mid-section and hydraulically controlled; Hydraulic 'B' – one piece table top, hydraulically controlled.

b Structural or mechanical device to allow the unassisted release of discarded crabs.

c Estimated distance crabs fall to sorting platform (i.e., table or totes) from pots emptied by use of launcher

d Order in which crabs are selected from the unsorted catch.

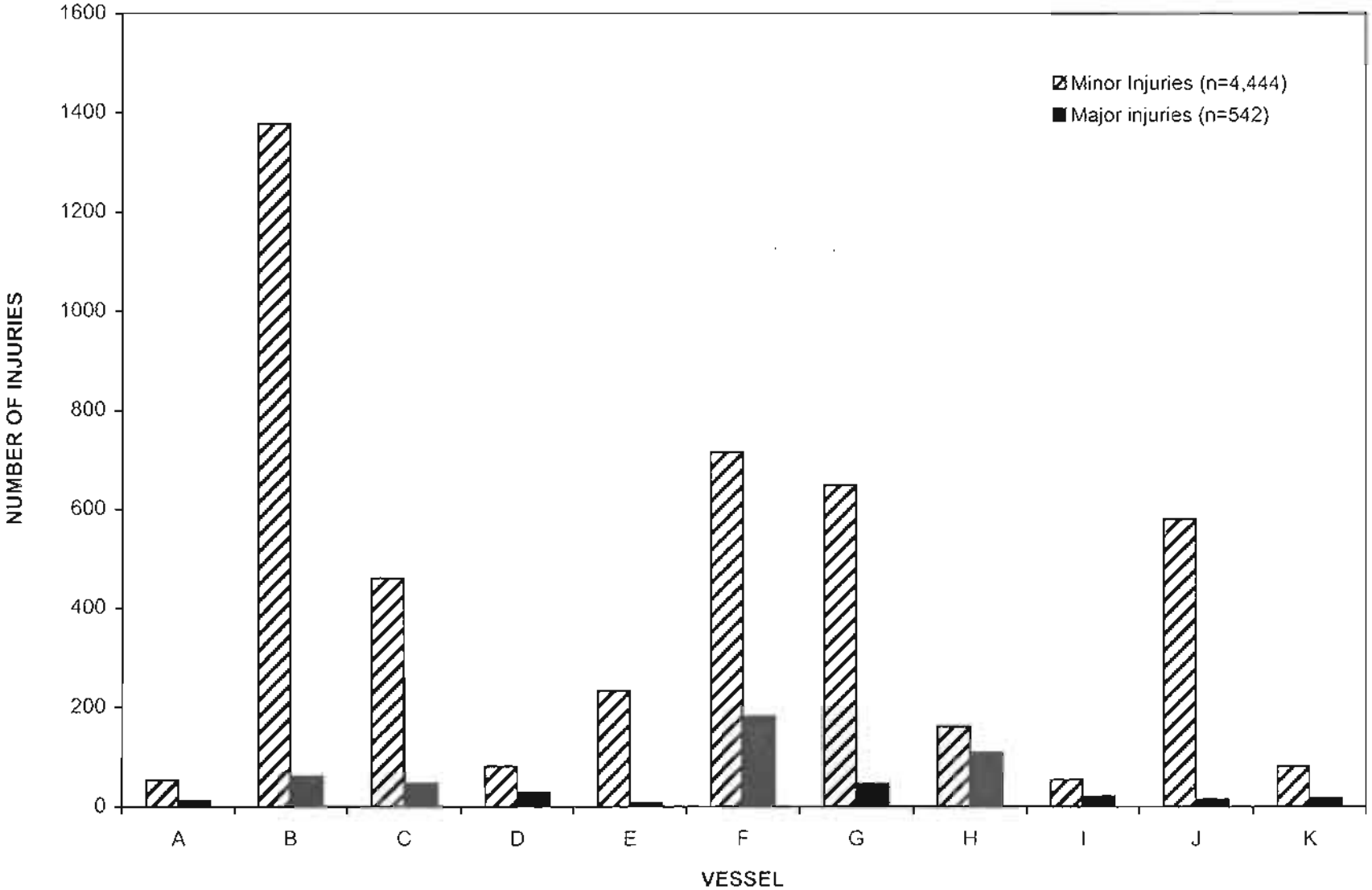

Figure 1. Major and minor body injuries of crabs examined in pots sampled on 12 catcher-processors during the 1998 Bering Sea Bering Sea snow crab open access season.

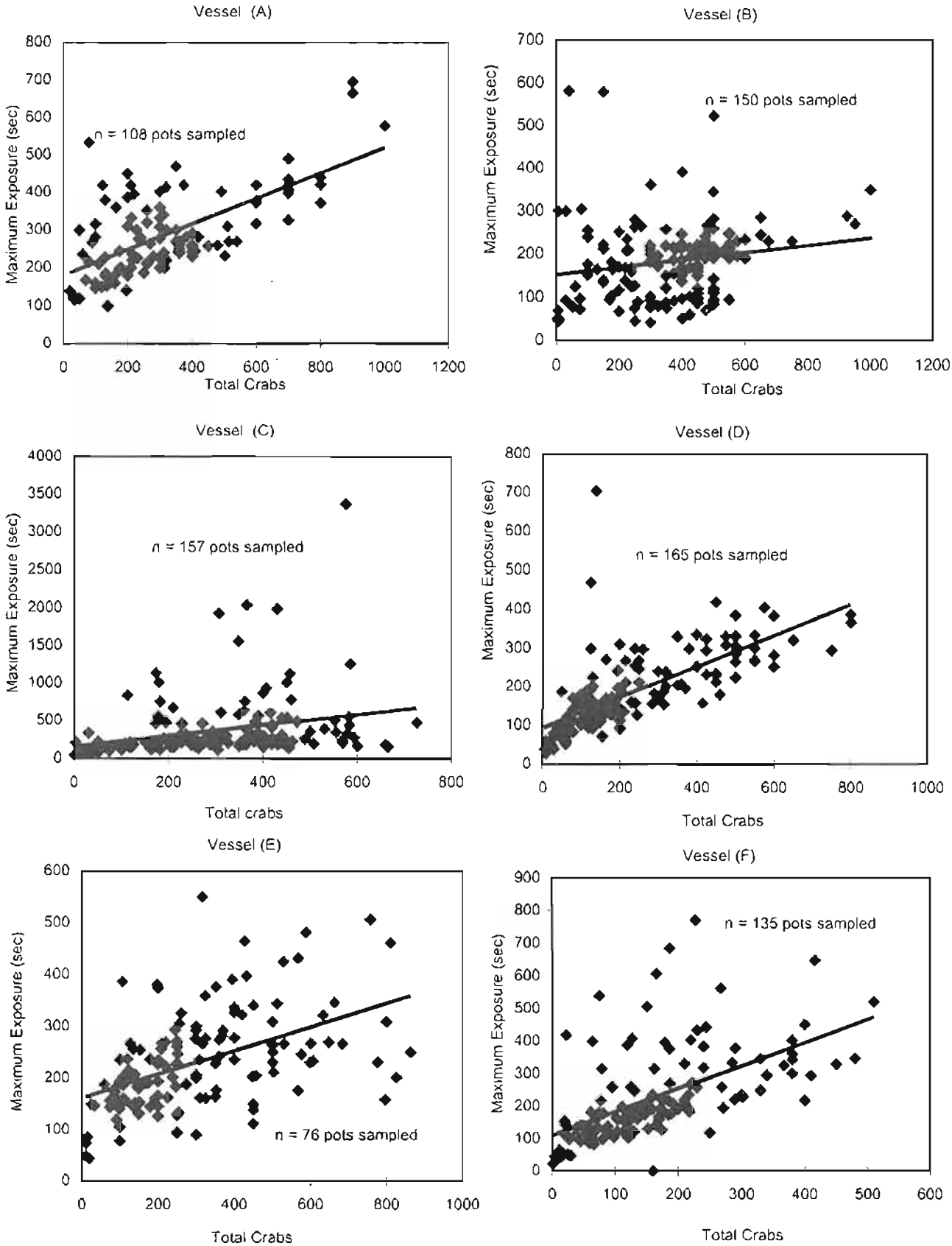

Figure 2. Correlation of maximum aerial exposure times to total crabs per pot from samples taken on 12 catcher-processors (Vessels A-L) during the 1998 Bering Sea snow crab open access season.

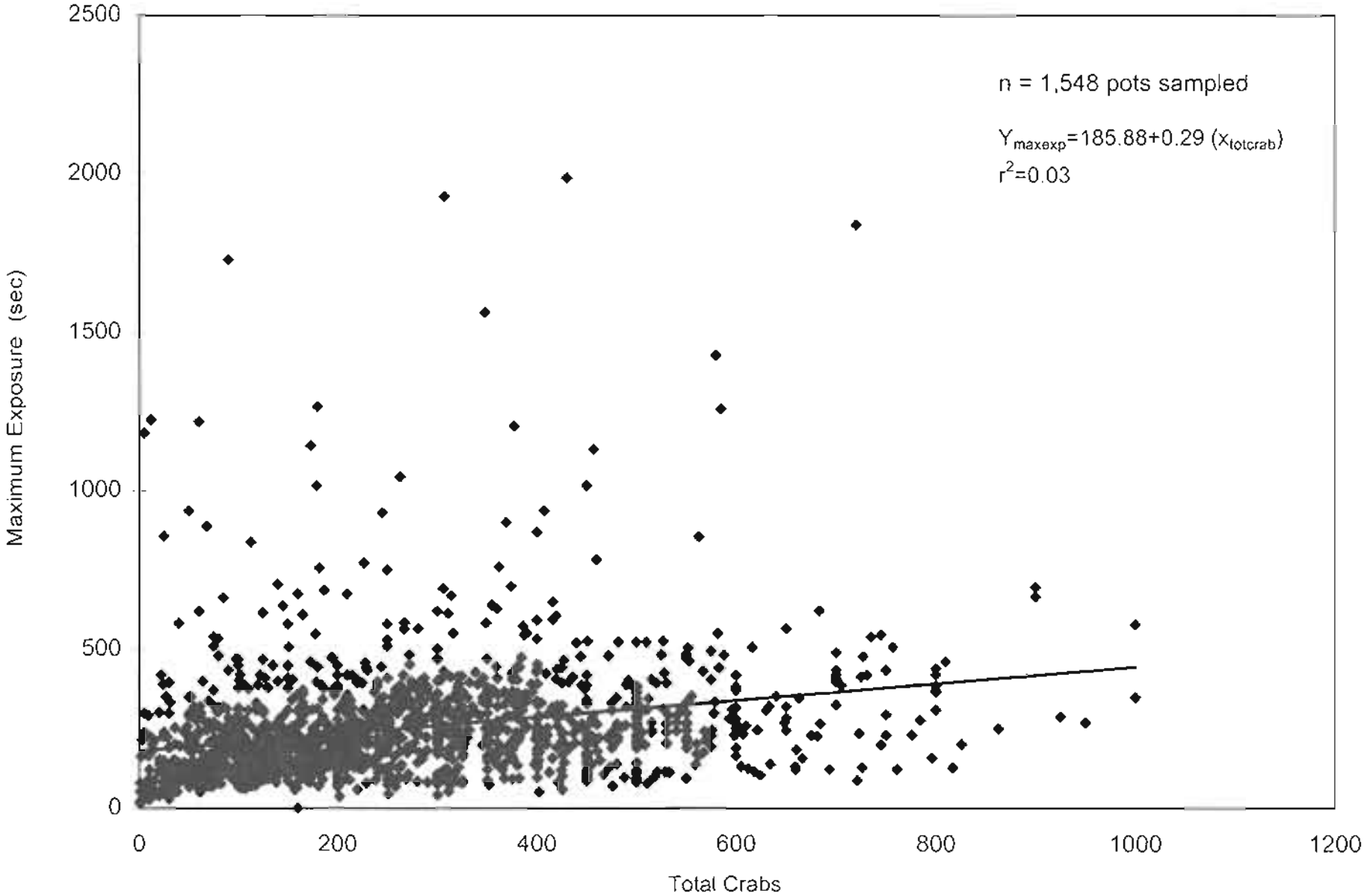

Figure 3. Correlation of maximum aerial exposure times to total crabs from combined pot samples taken on 12 catcher-processors during the 1998 Bering Sea snow crab open access season.

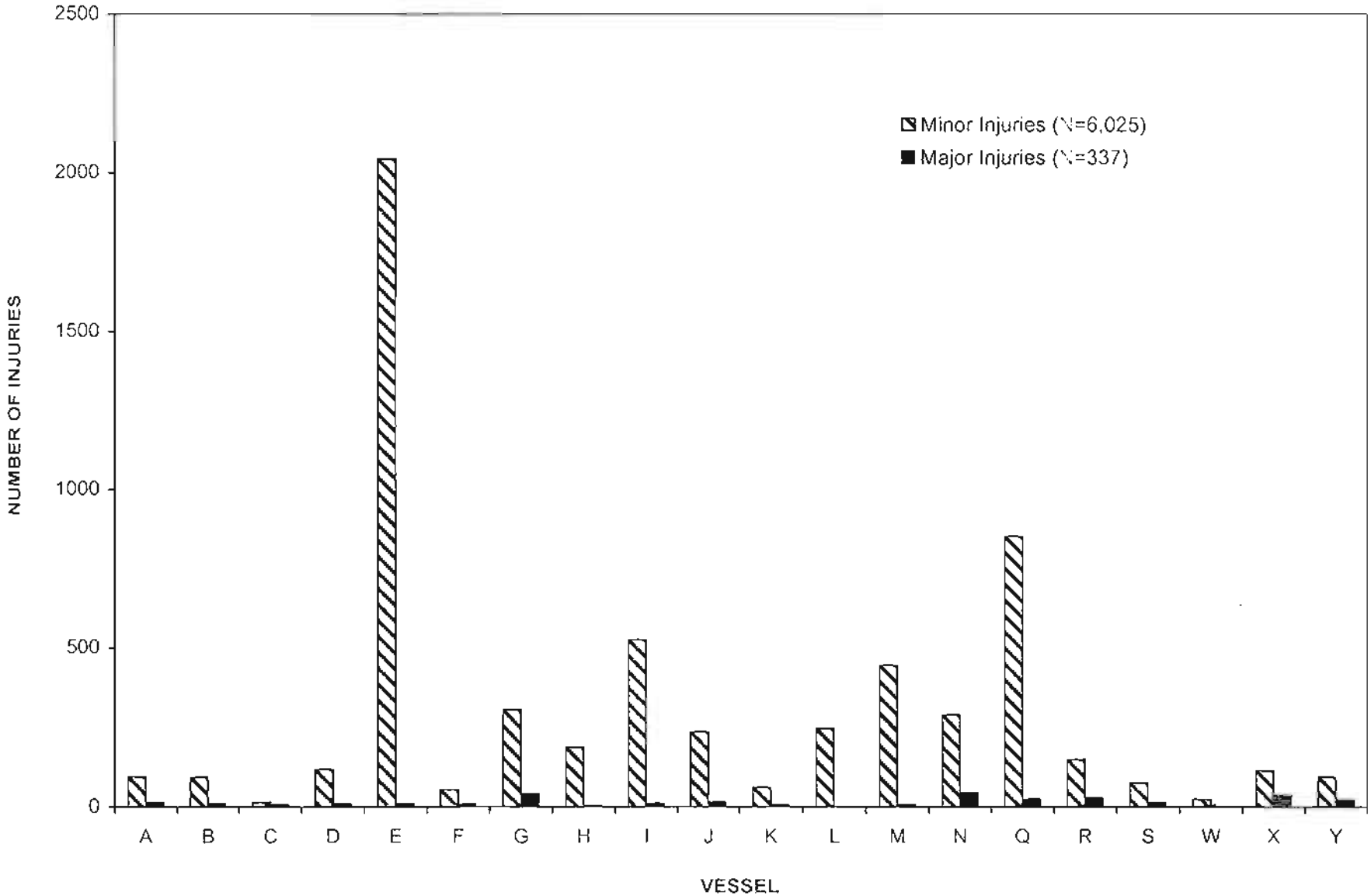

Figure 4. Major and minor body injuries of crabs examined in pots sampled on 20 catcher-only vessels during the 1998 Bering Sea snow crab CDQ season.

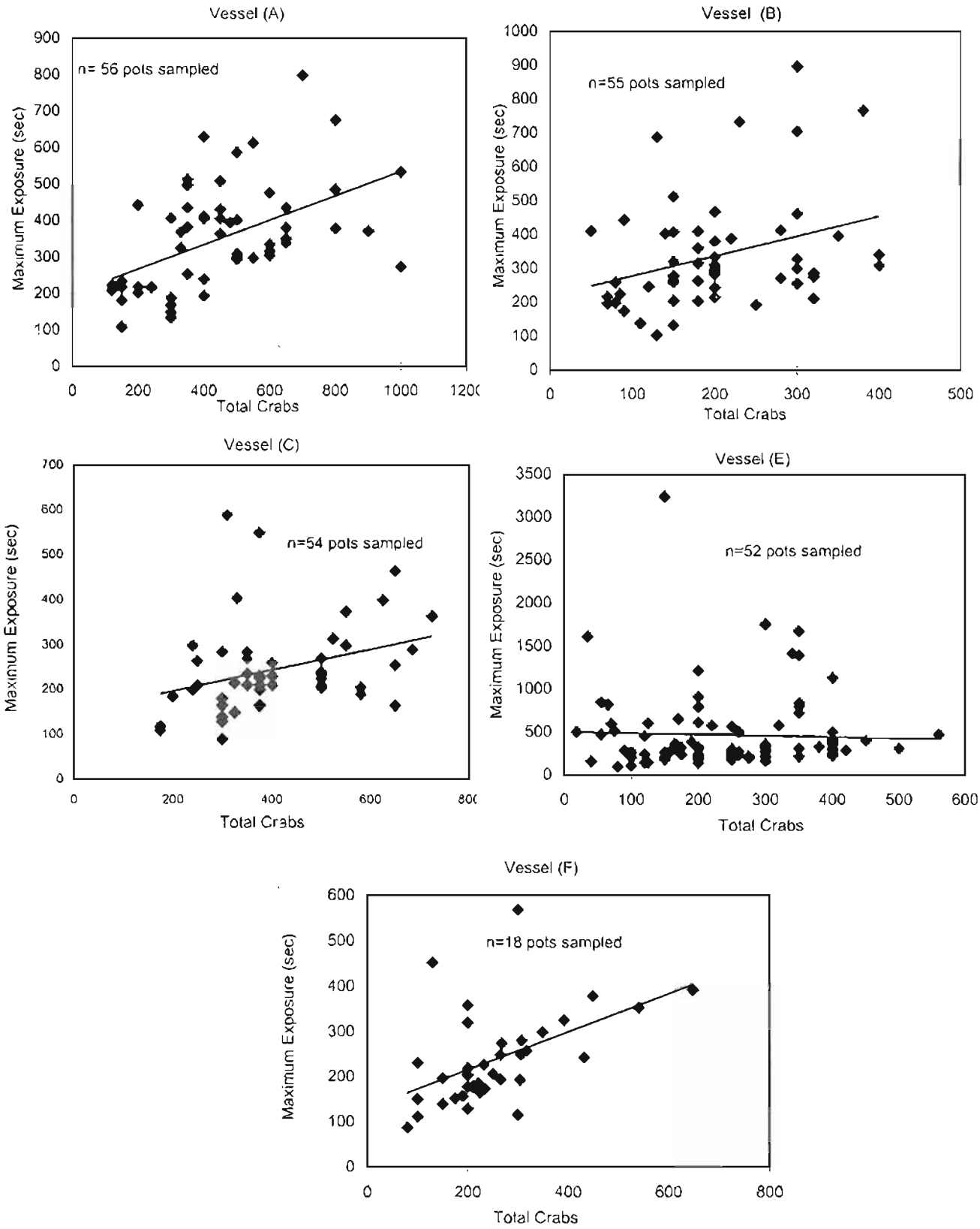

Figure 5. Correlation of maximum aerial exposure times to total crabs per pot from samples taken on 20 catcher-only vessels (A-C,E-S) during the 1998 Bering Sea snow crab CDQ season.

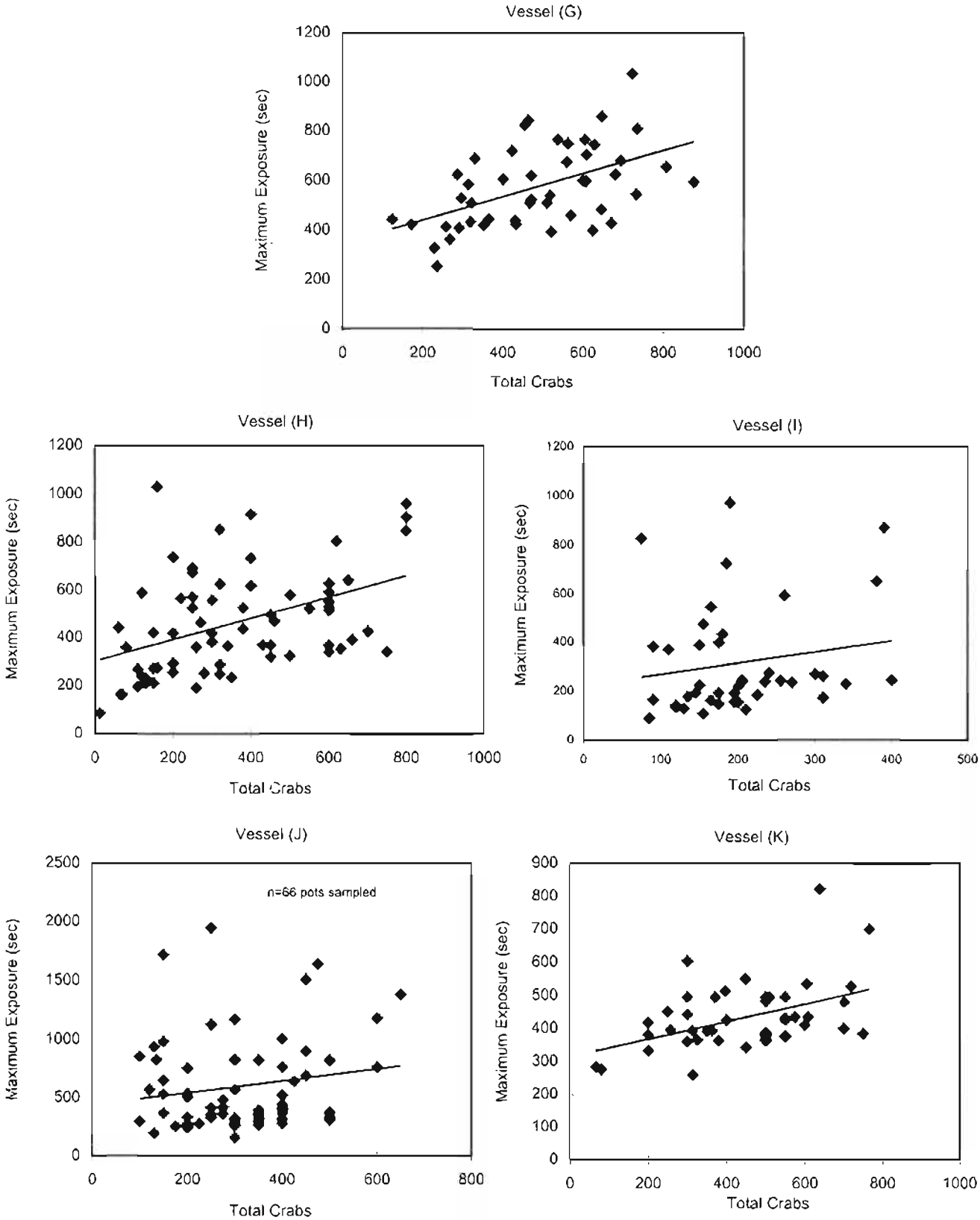

Figure 5. (page 2 of 4)

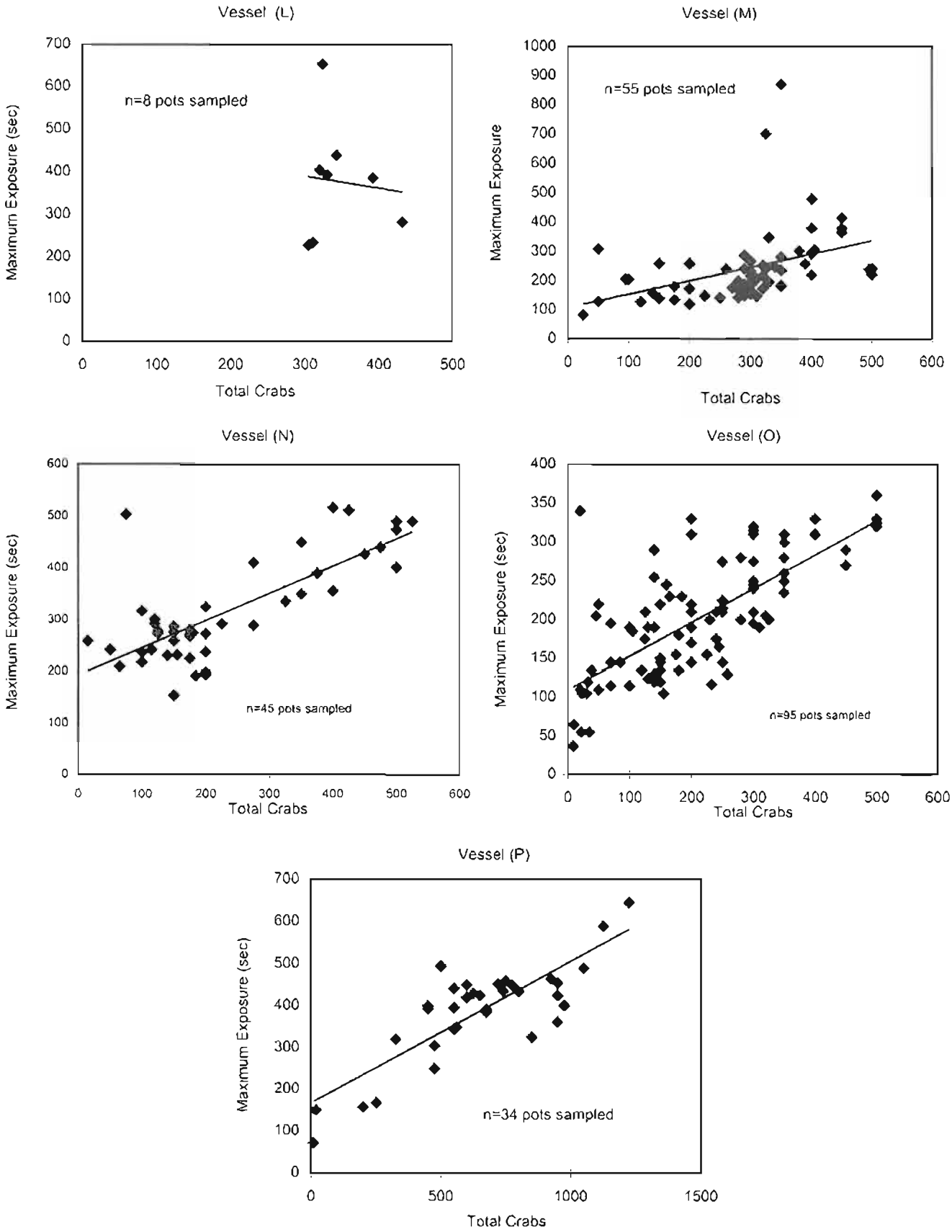

Figure 5. (page 3 of 4)

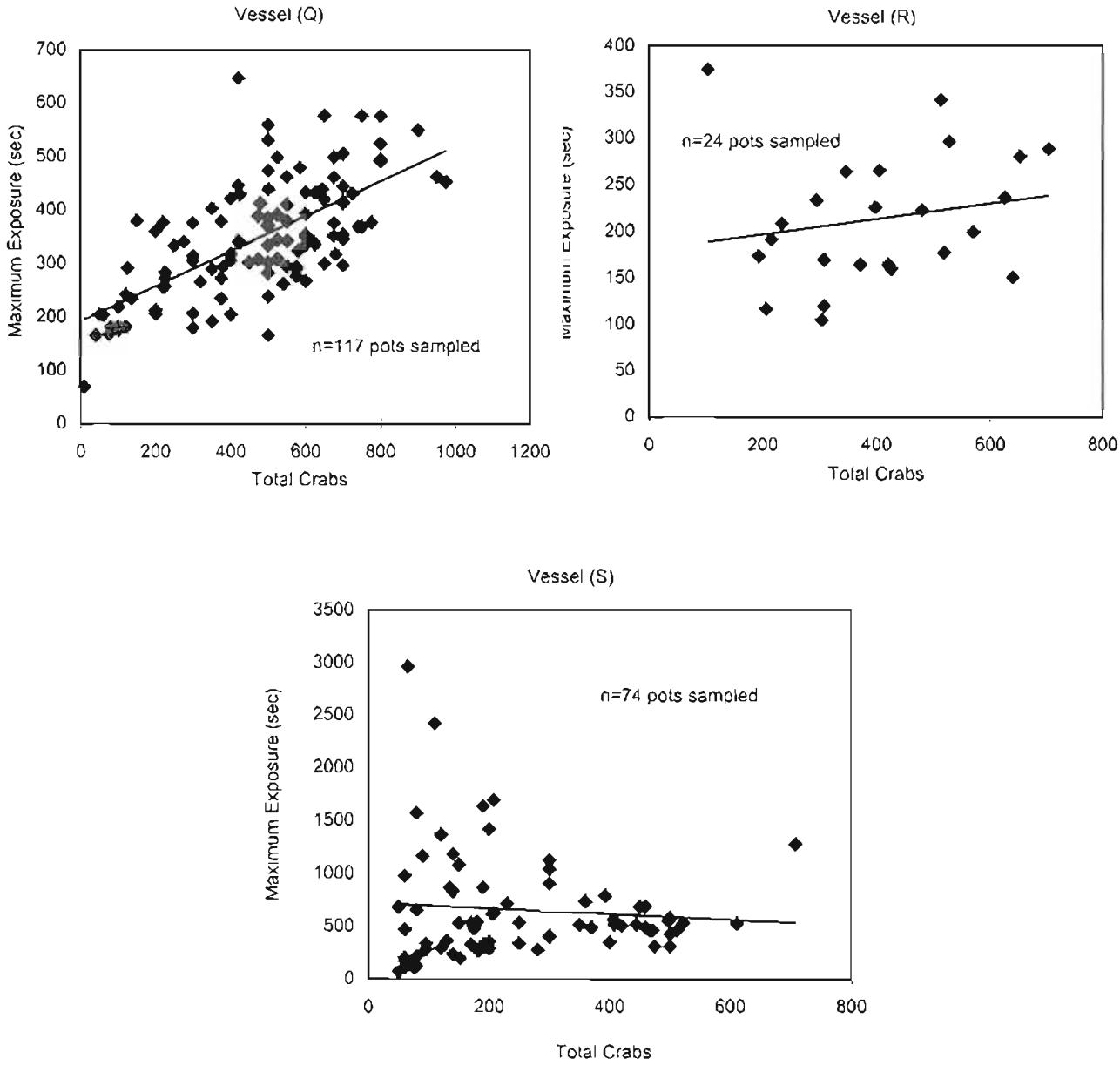

Figure 5. (page 4 of 4)

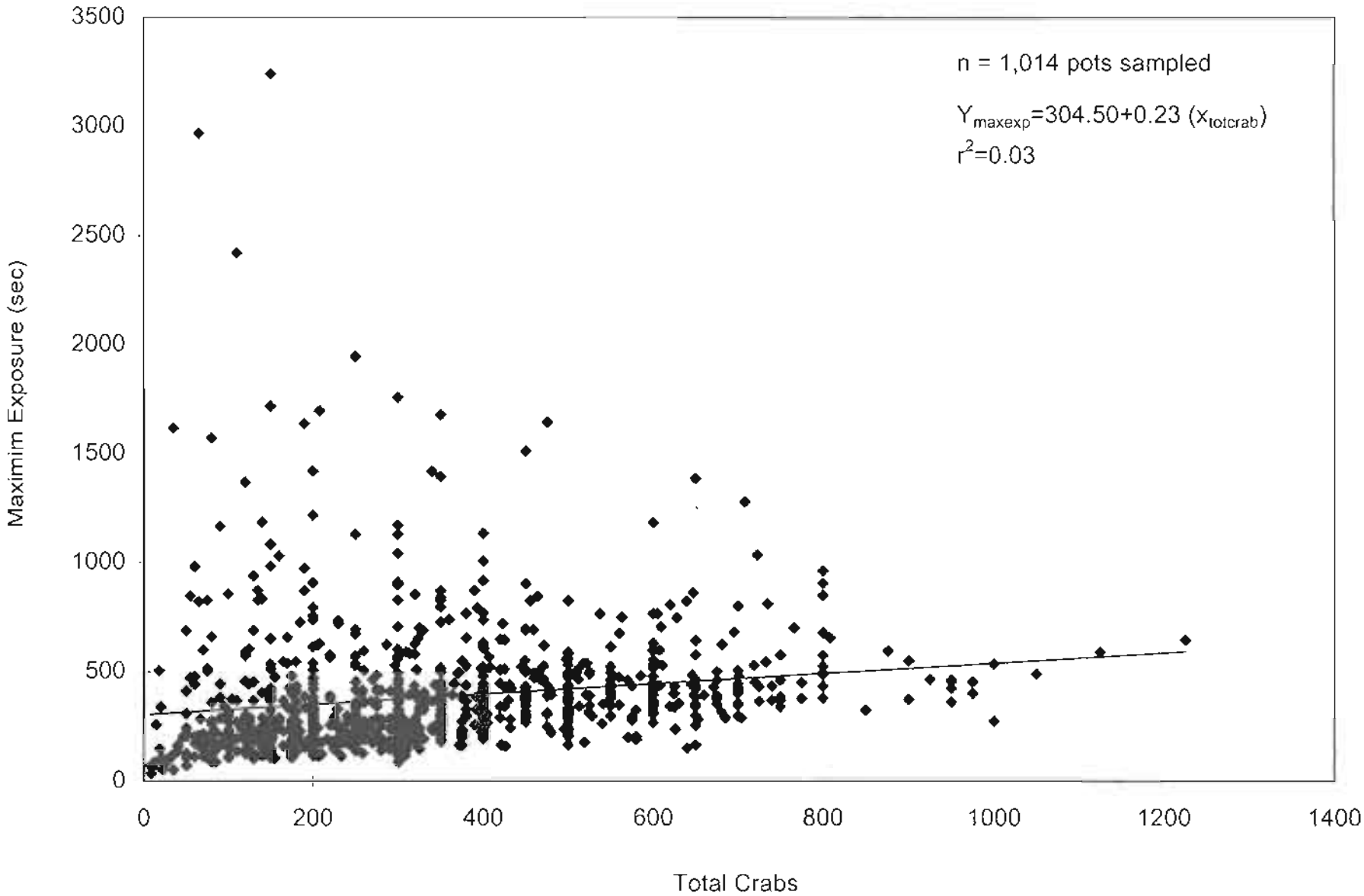

Figure 6. Correlation of maximum aerial exposure times to total crabs from combined pot samples taken on 20 catcher-only vessels during the 1998 Bering Sea snow crab CDQ season.

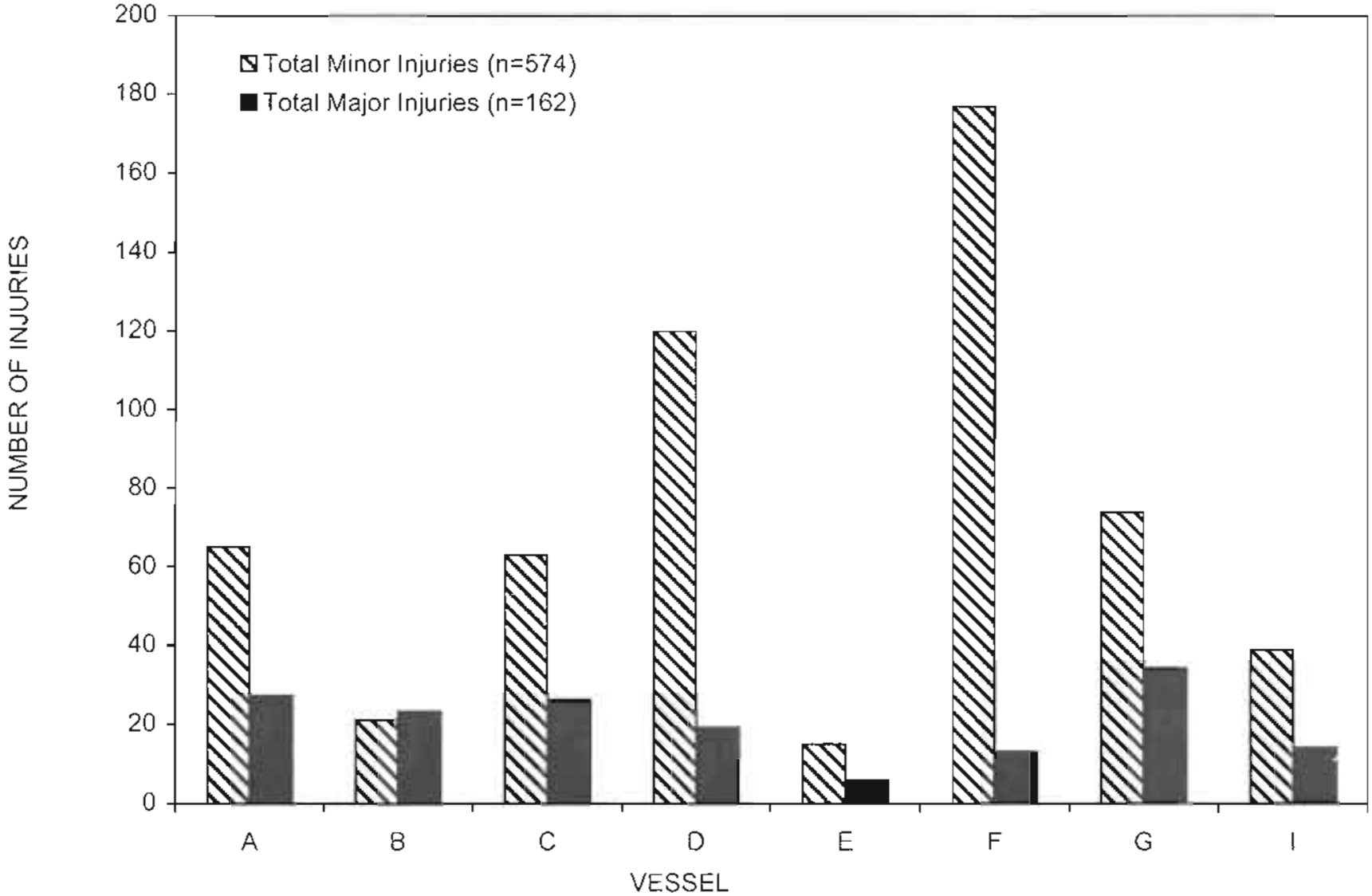

Figure 7. Major and minor body injuries of crabs examined in pots sampled on seven catcher-only vessels and one catcher-processor during the 1997/98 Aleutian Islands golden king crab fishery.

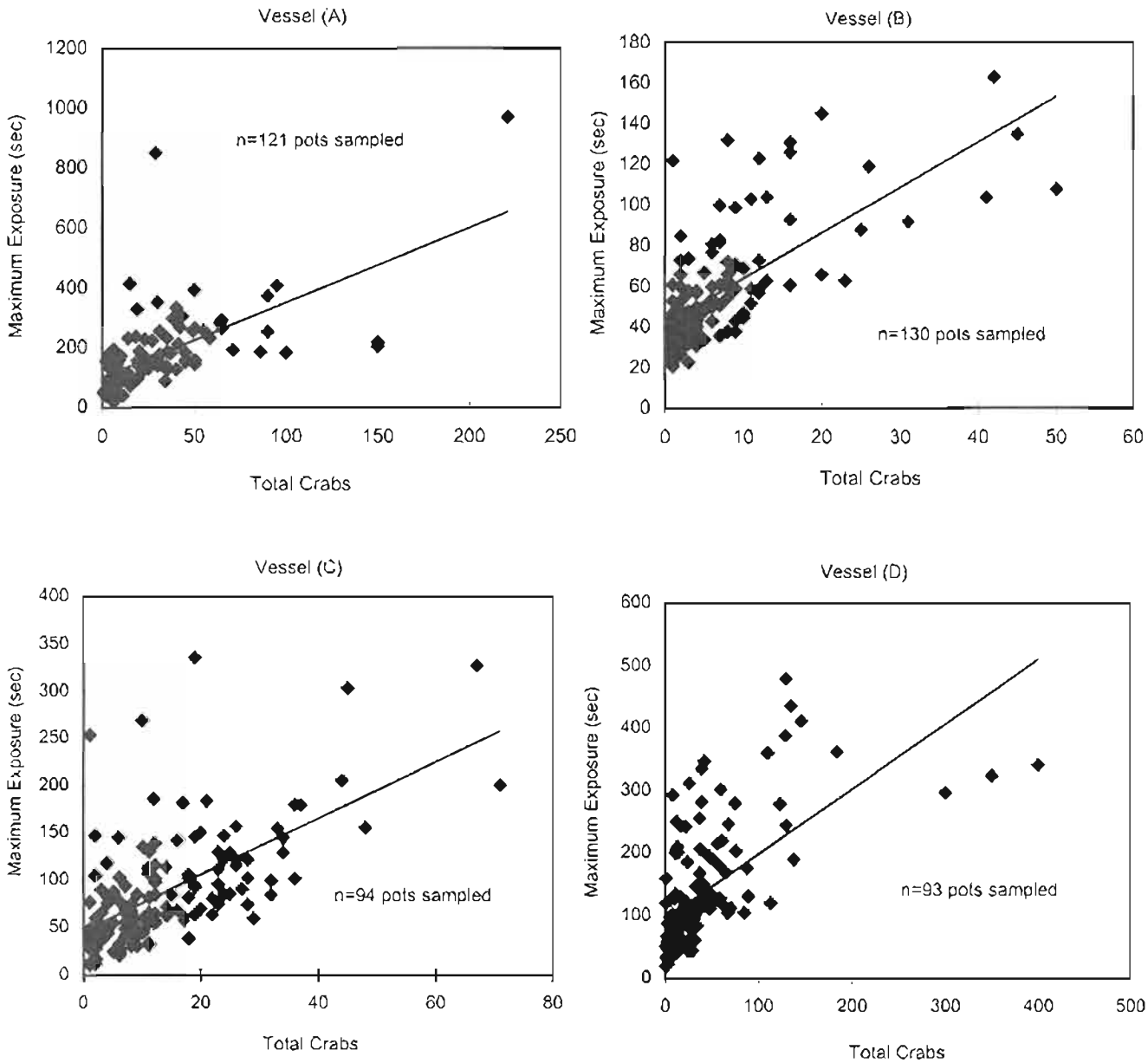

Figure 8. Correlation of maximum aerial exposure times to total crabs per pot from samples taken on seven catcher-only vessels and one catcher-processor (vessels A-H) during the 1997/98 Aleutian Islands golden king crab fishery.

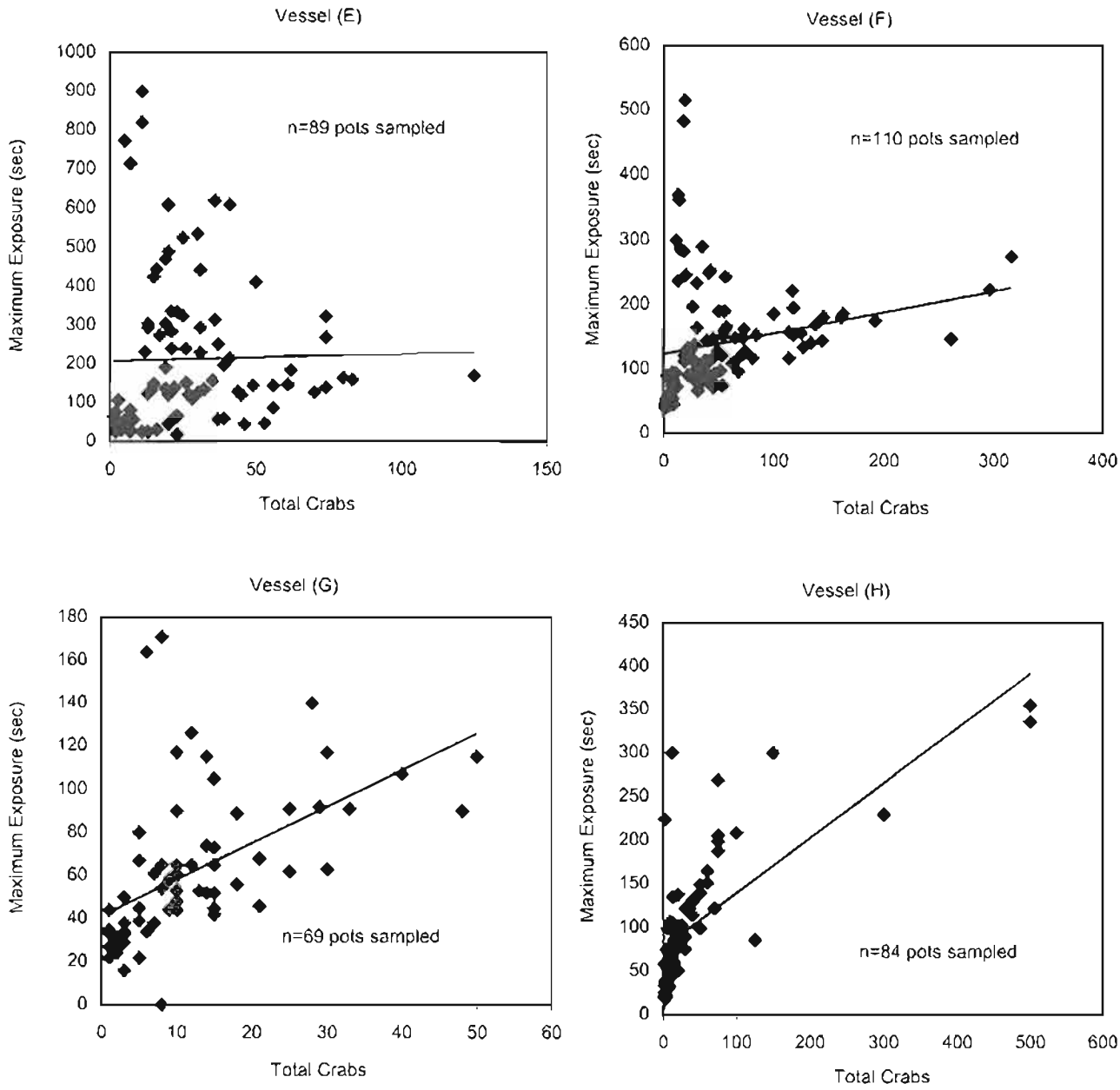

Figure 8. (page 2 of 2)

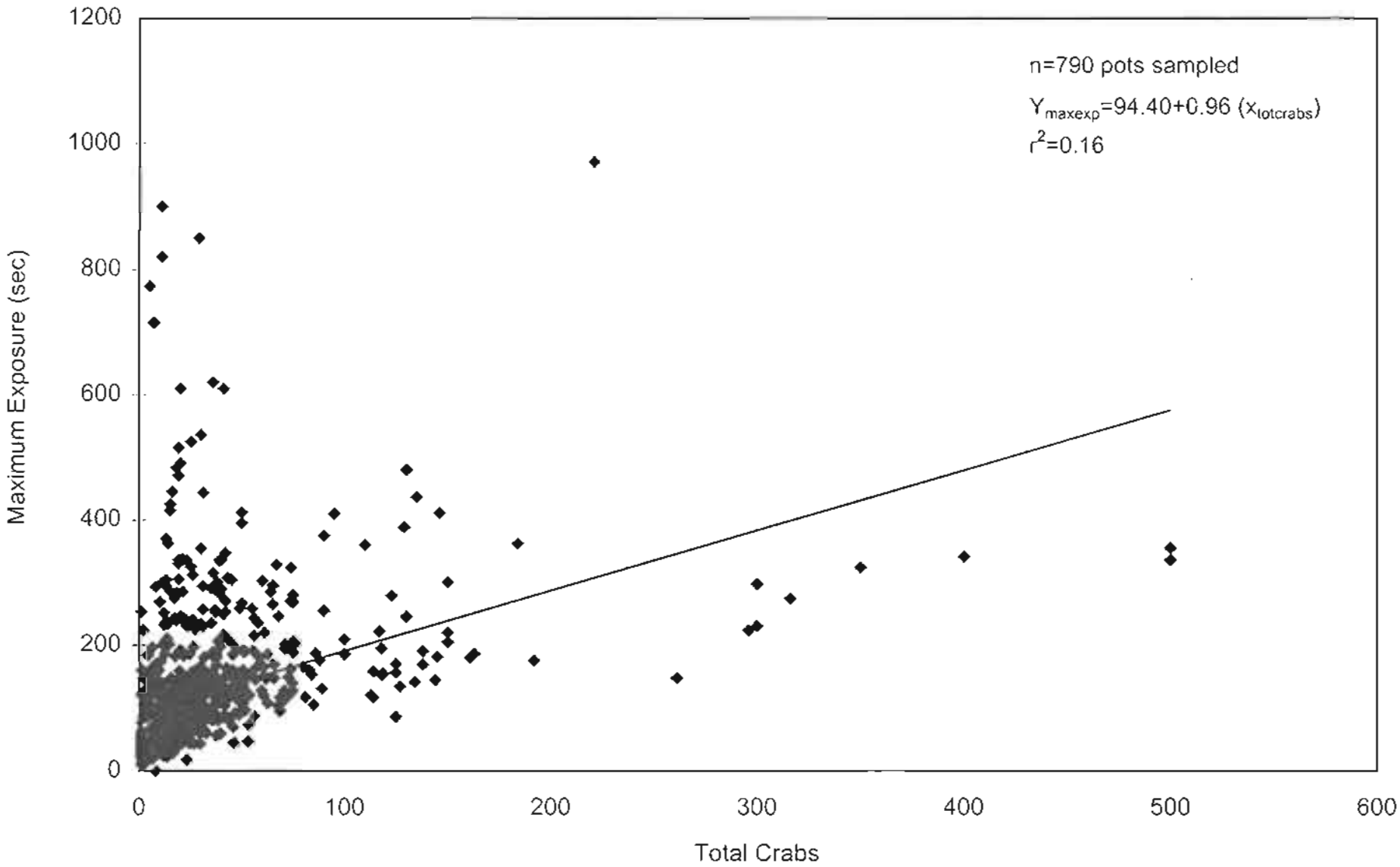

Figure 9. Correlation of maximum aerial exposure times to total crabs from combined pot samples taken on seven catcher-only vessels and one catcher-processor during the 1997/98 Aleutian Islands golden king crab fishery.

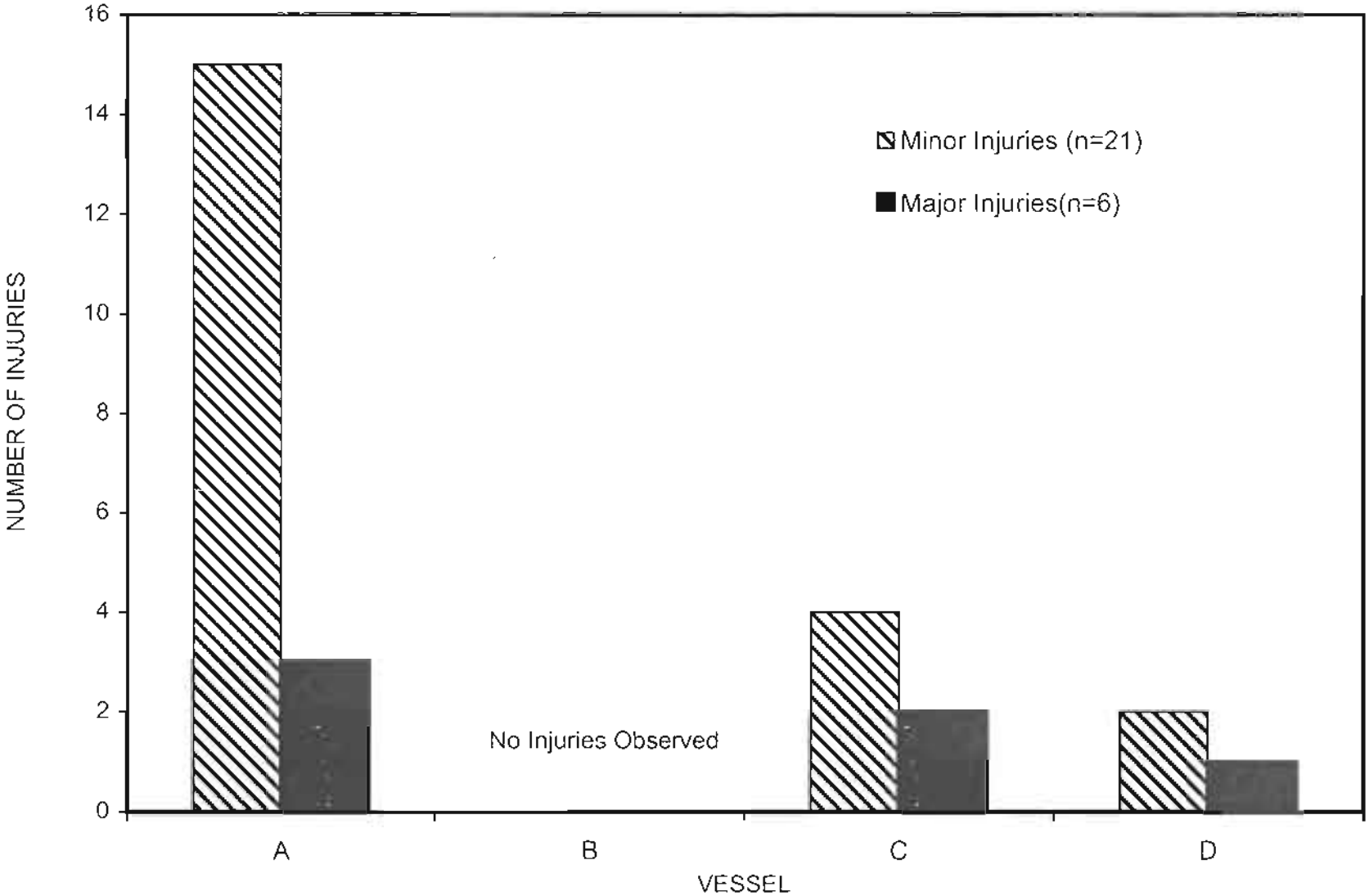

Figure 10. Major and minor body injuries of crabs in pot samples on three catcher-processors one catcher-only vessel during the 1998 St. Matthew blue king crab open access season.

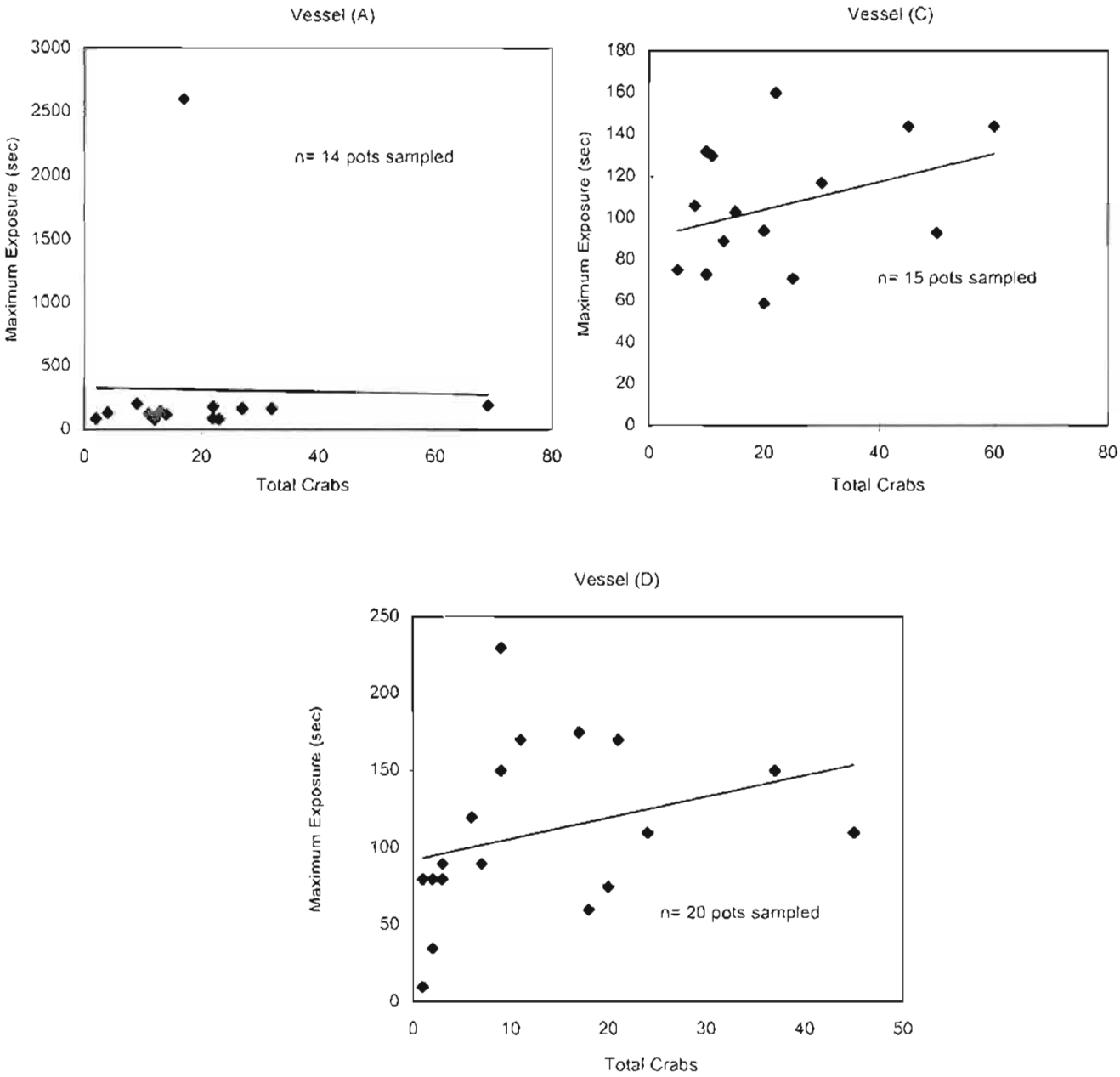

Figure 11. Correlation of maximum aerial exposure times to total crabs per pot from samples taken on three catcher-processors during the 1998 St. Matthew Island blue king crab open access season.

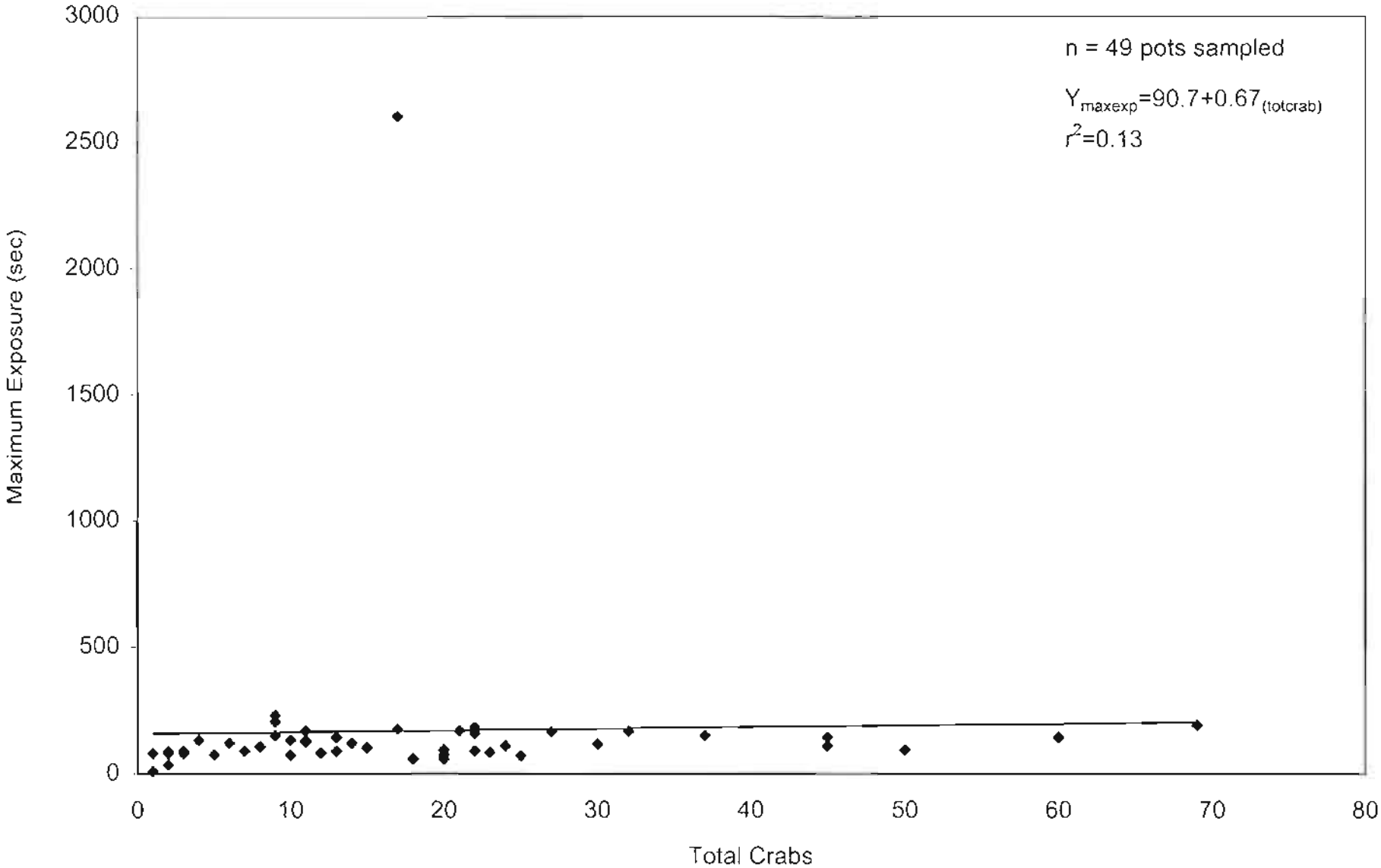

Figure 12. Correlation of maximum aerial exposure times to total crabs from combined pot samples taken on three catcher-processors during the 1998 St. Matthew Island blue king crab open access season.

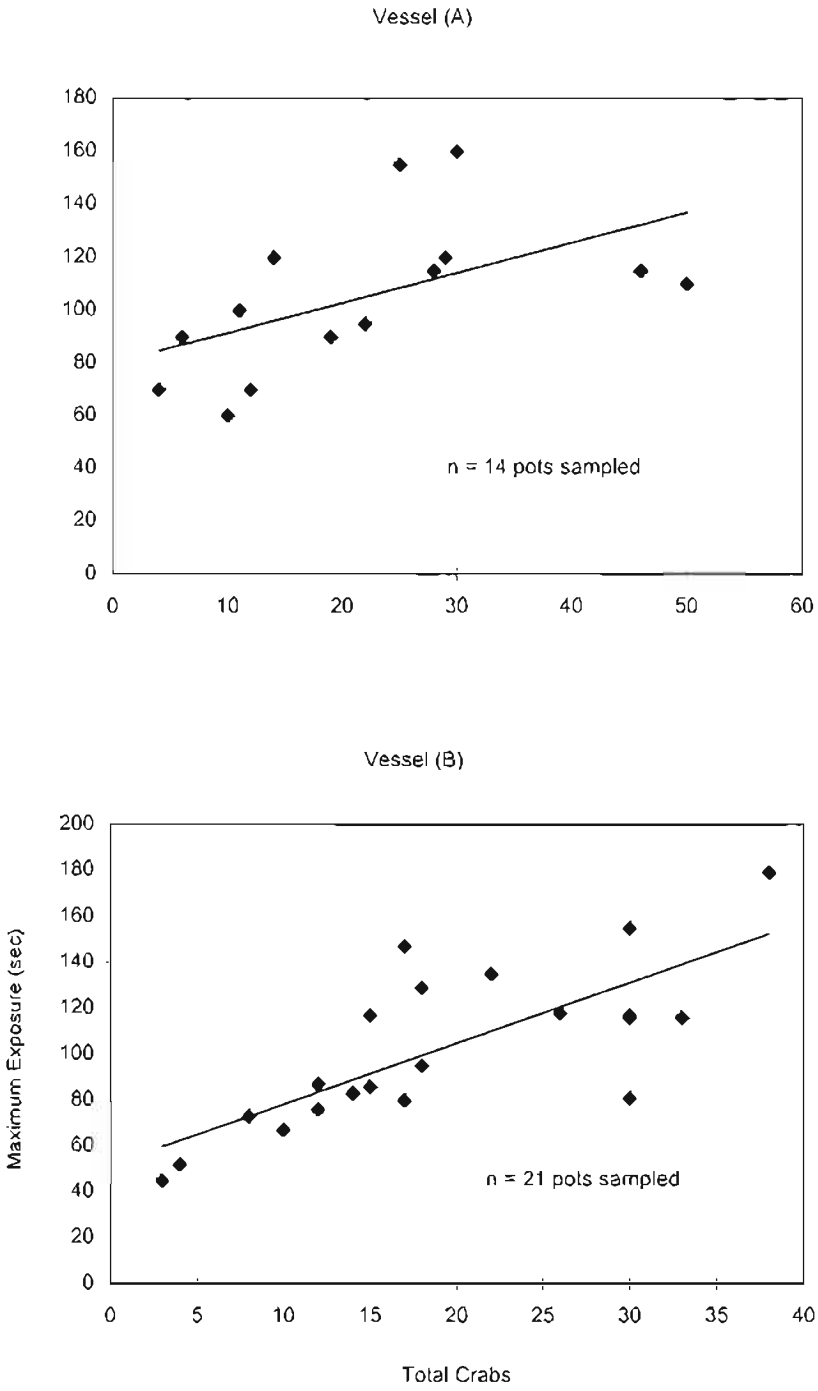

Figure 13. Correlation of maximum aerial exposure times to total crabs per pot from samples taken on two catcher-only vessels during the 1998 St. Matthew Island blue king crab CDQ season.

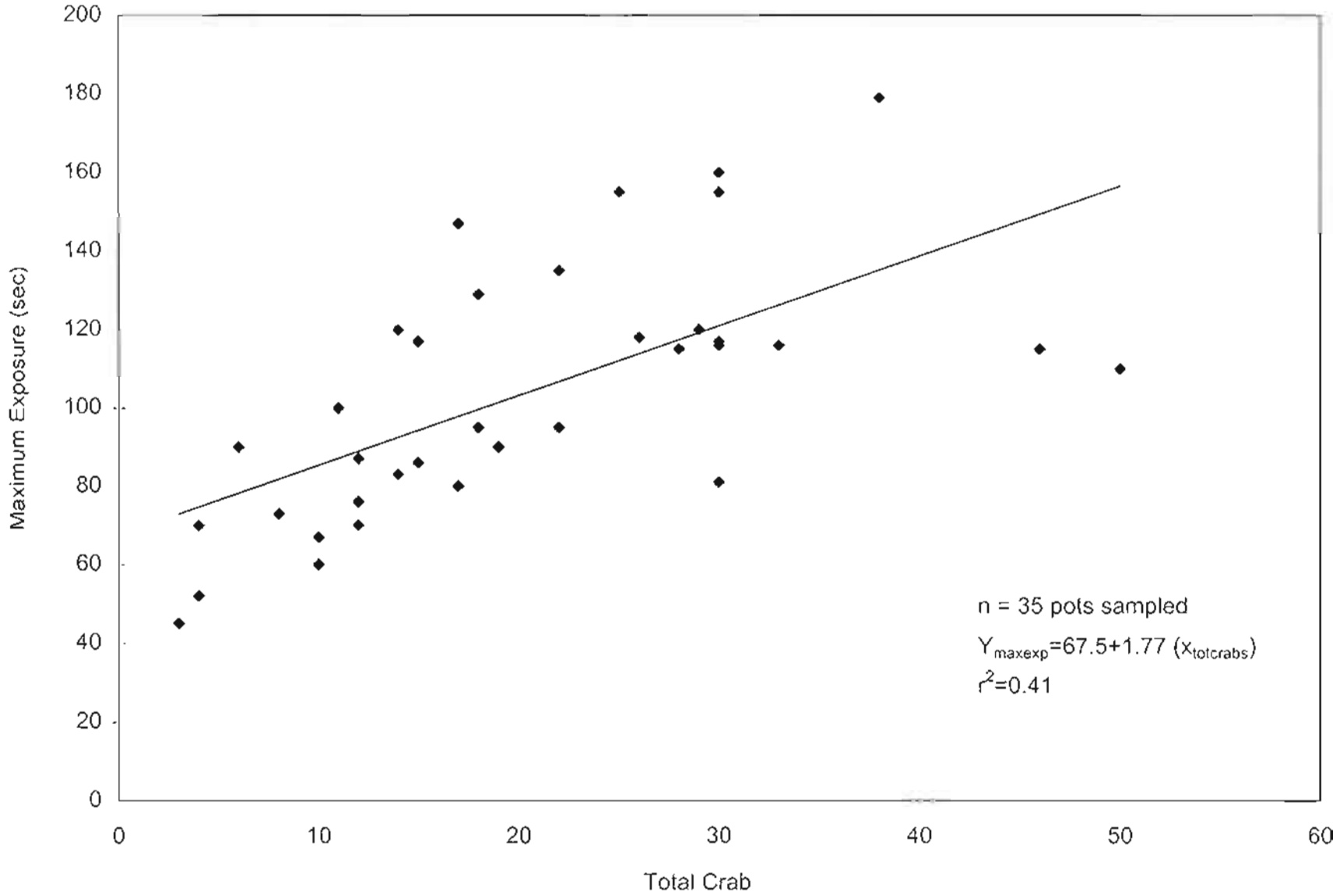

Figure 14. Correlation of maximum aerial exposure times to total crabs from combined pot samples taken on two catcher-only vessels during the 1998 St. Matthew Island blue king crab CDQ season.

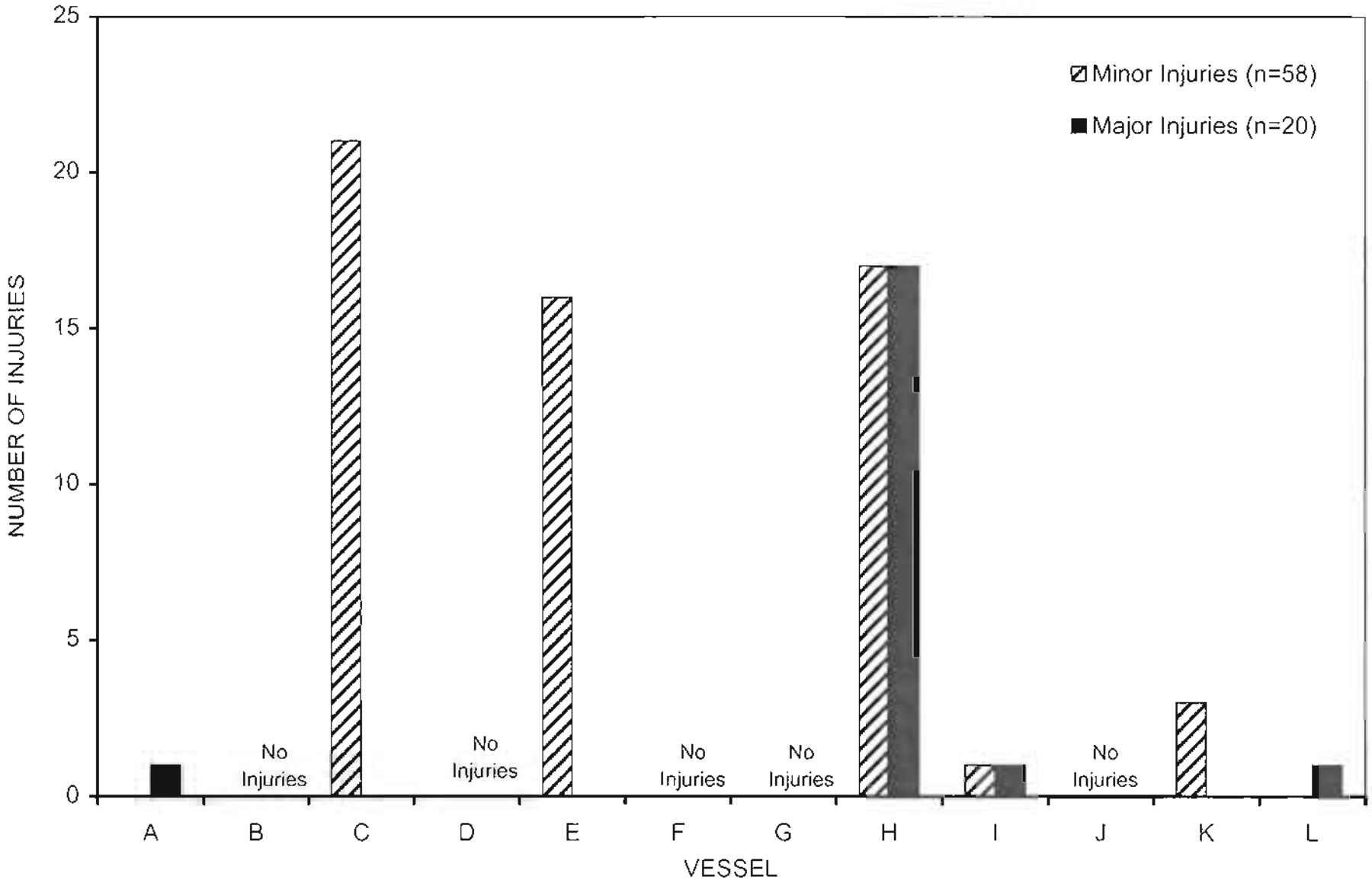

Figure 15. Major and minor body injuries of crabs examined in pots sampled on 12 catcher-only vessels during the 1998 Pribilof Islands hair crab fishery.

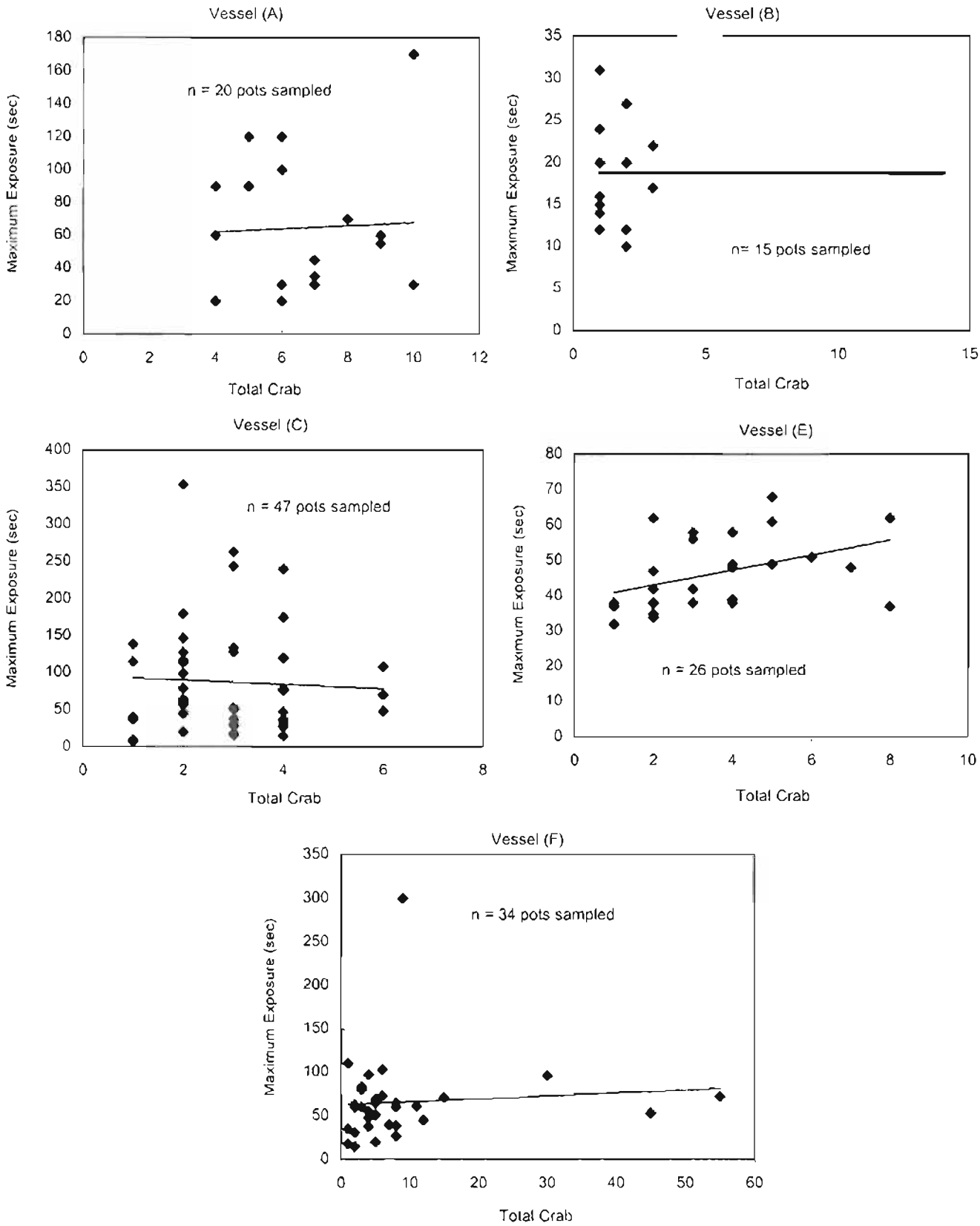

Figure 16. Correlation of maximum aerial exposure times to total crabs per pot from samples taken on nine catcher-only (vessels A-I, K) during the 1998 Pribilof Islands hair crab fishery.

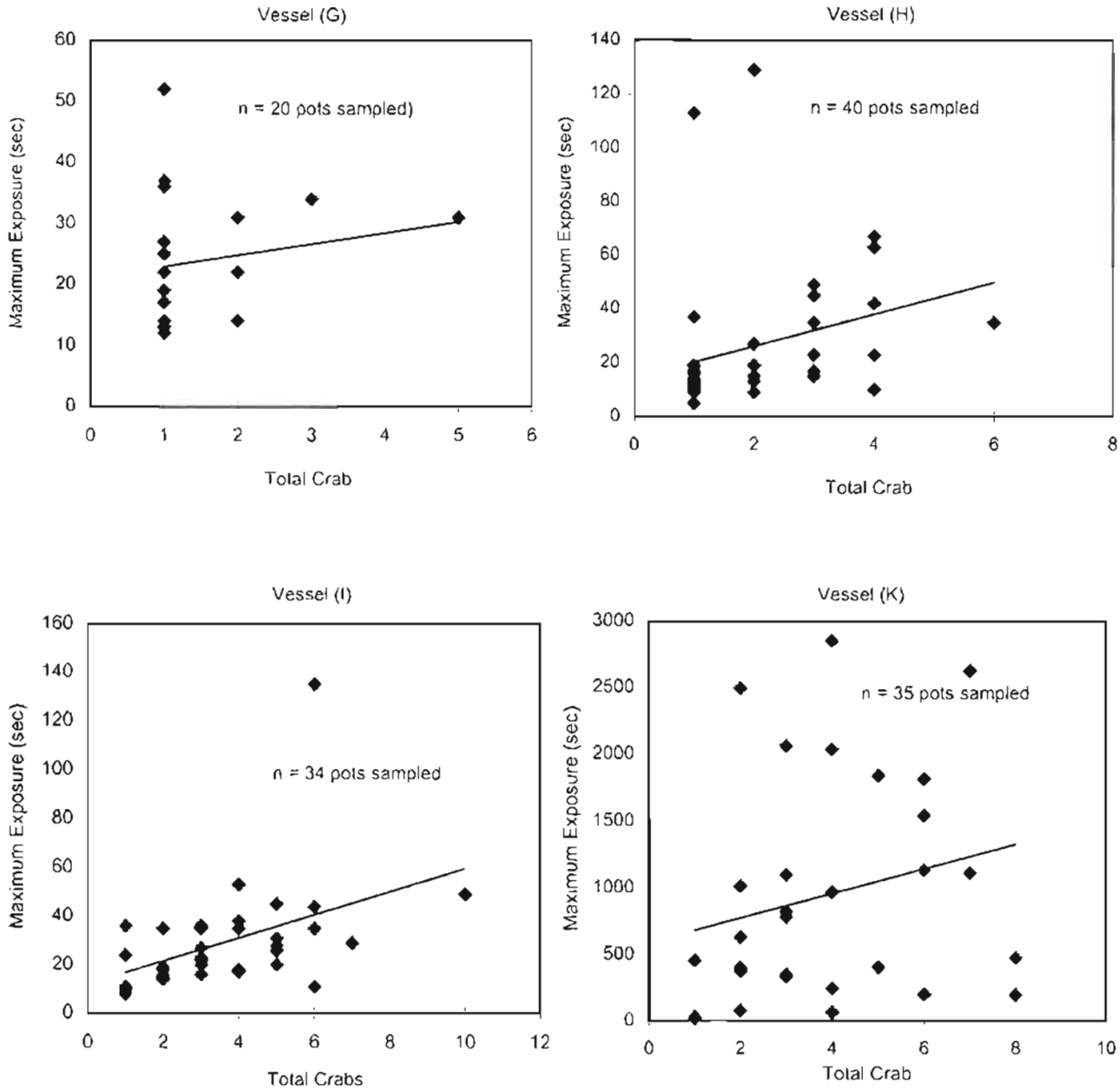

Figure 16. (page 2 of 2)

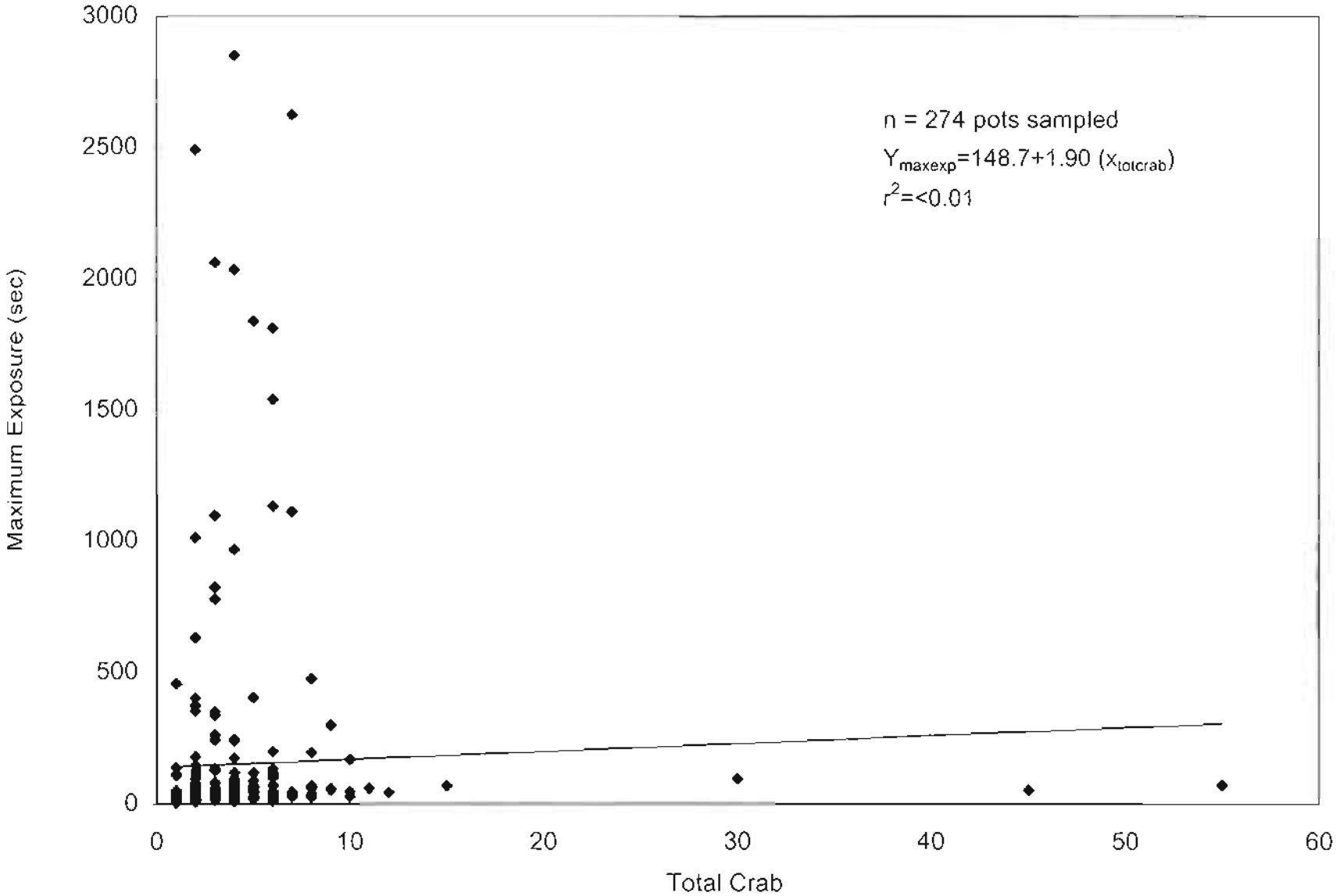

Figure 17. Correlation of maximum aerial exposure times to total crabs from combined pot samples on nine catcher-only vessels during the 1998 Pribilof Islands Korean hair crab fishery.

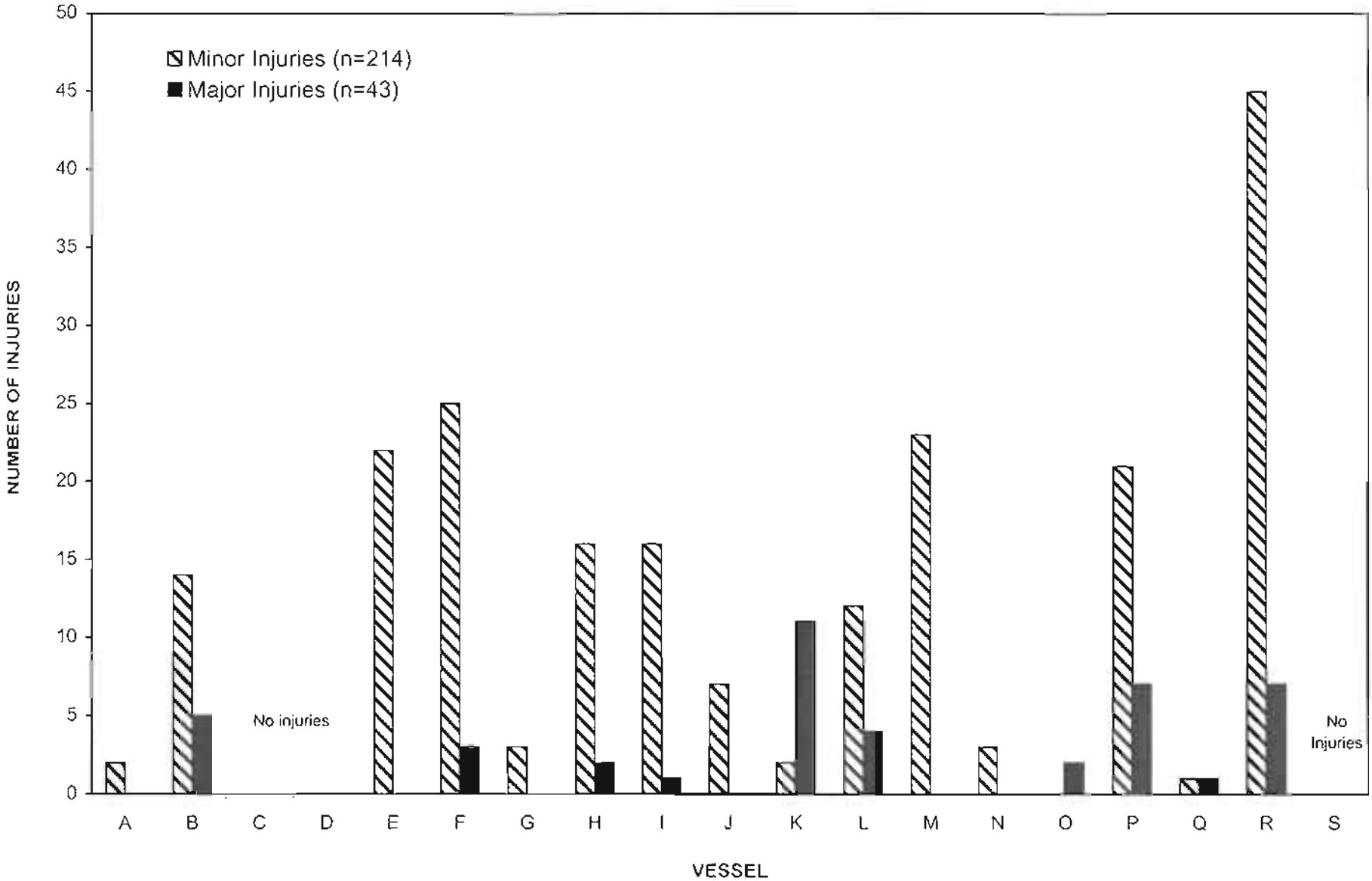

Figure 18. Major and minor injuries of crabs examined in pots sampled on 11 catcher-only vessels and eight catcher-processors during the 1997 Bristol Bay red king crab open access season.

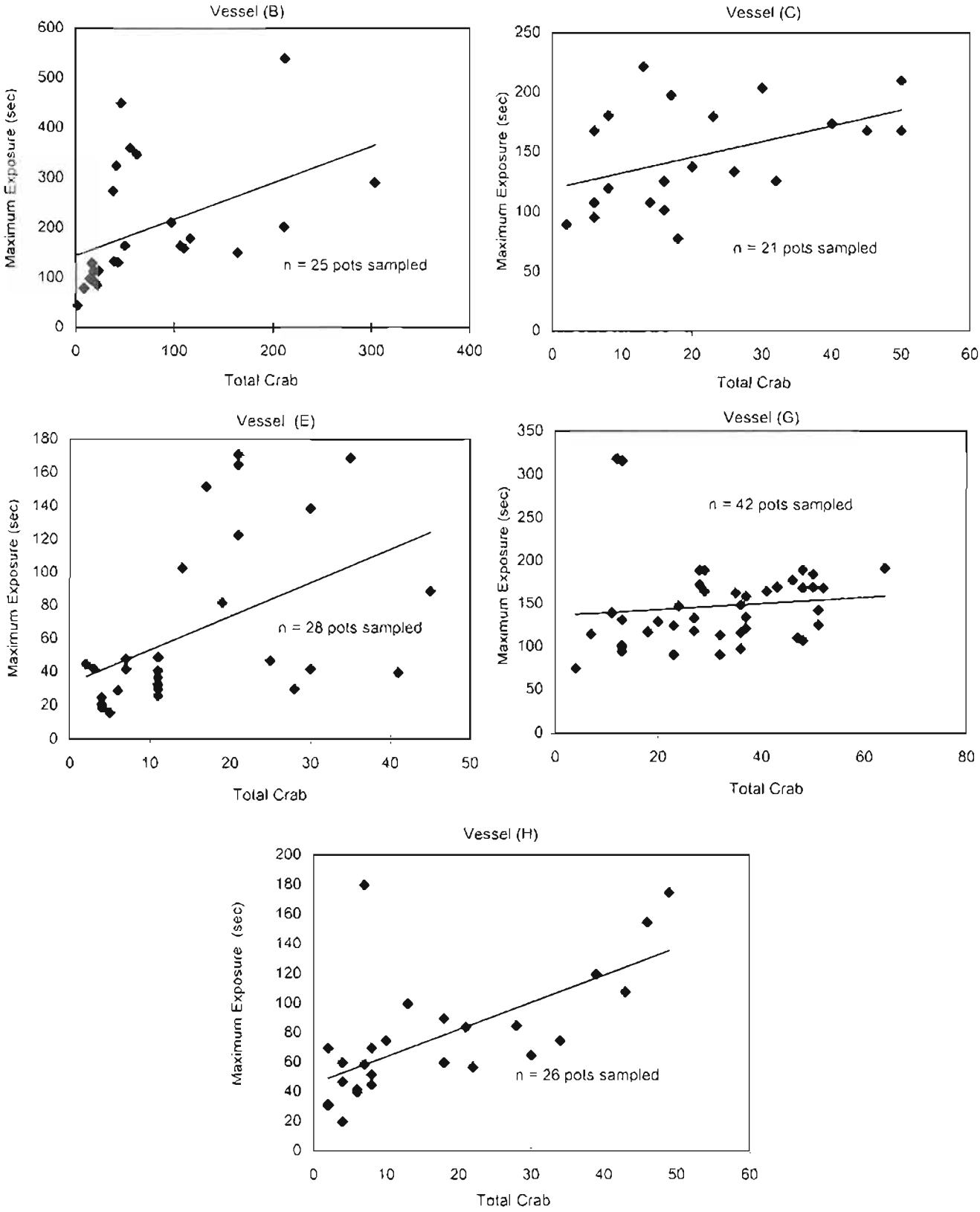

Figure 19. Correlation of maximum aerial exposure times to total crabs per pot from samples taken on seven catcher-only vessels and two catcher-processors (Vessels B-Z) during the 1997 Bristol Bay red king crab open access season.

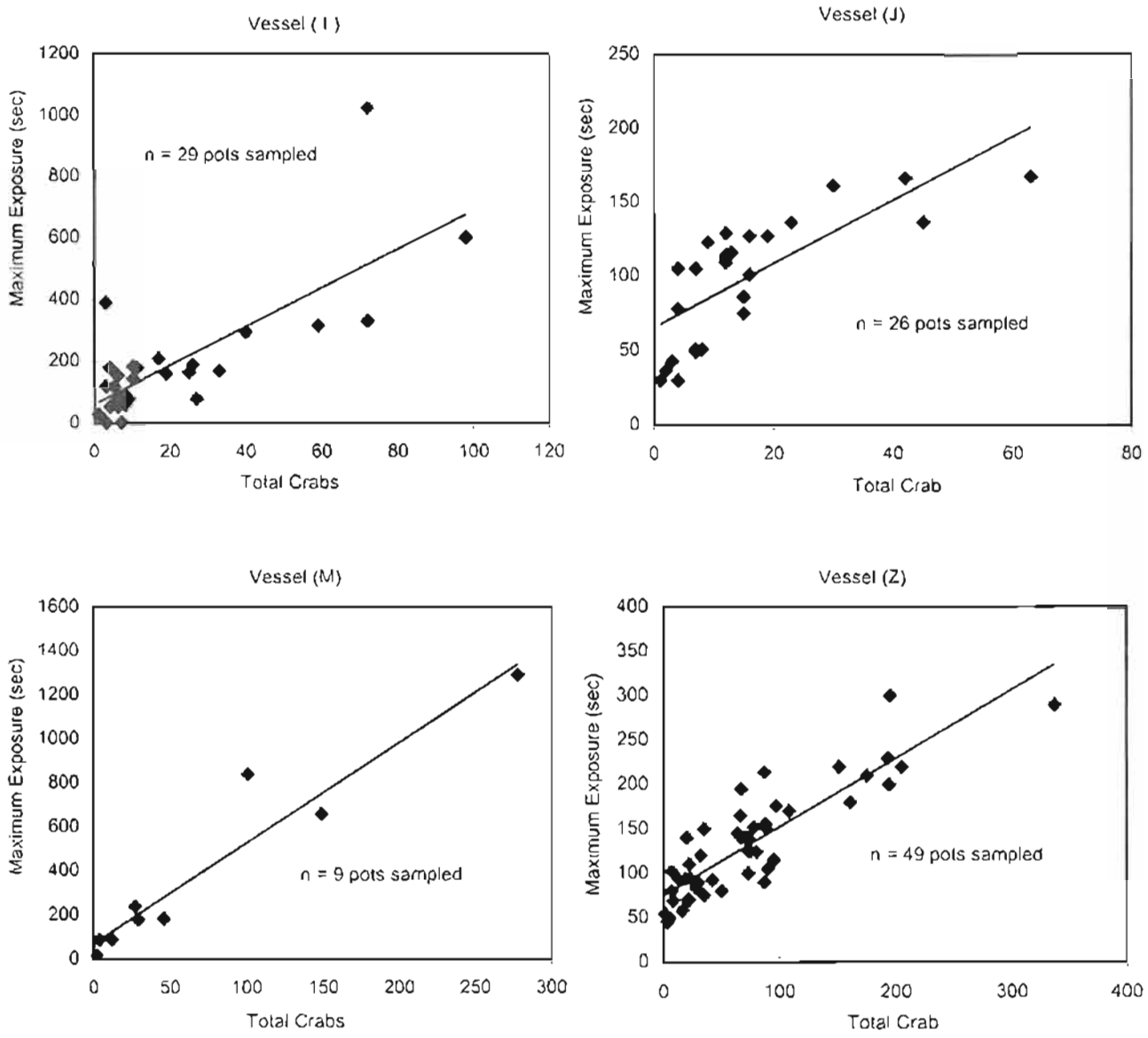

Figure 19. (page 2 of 2)

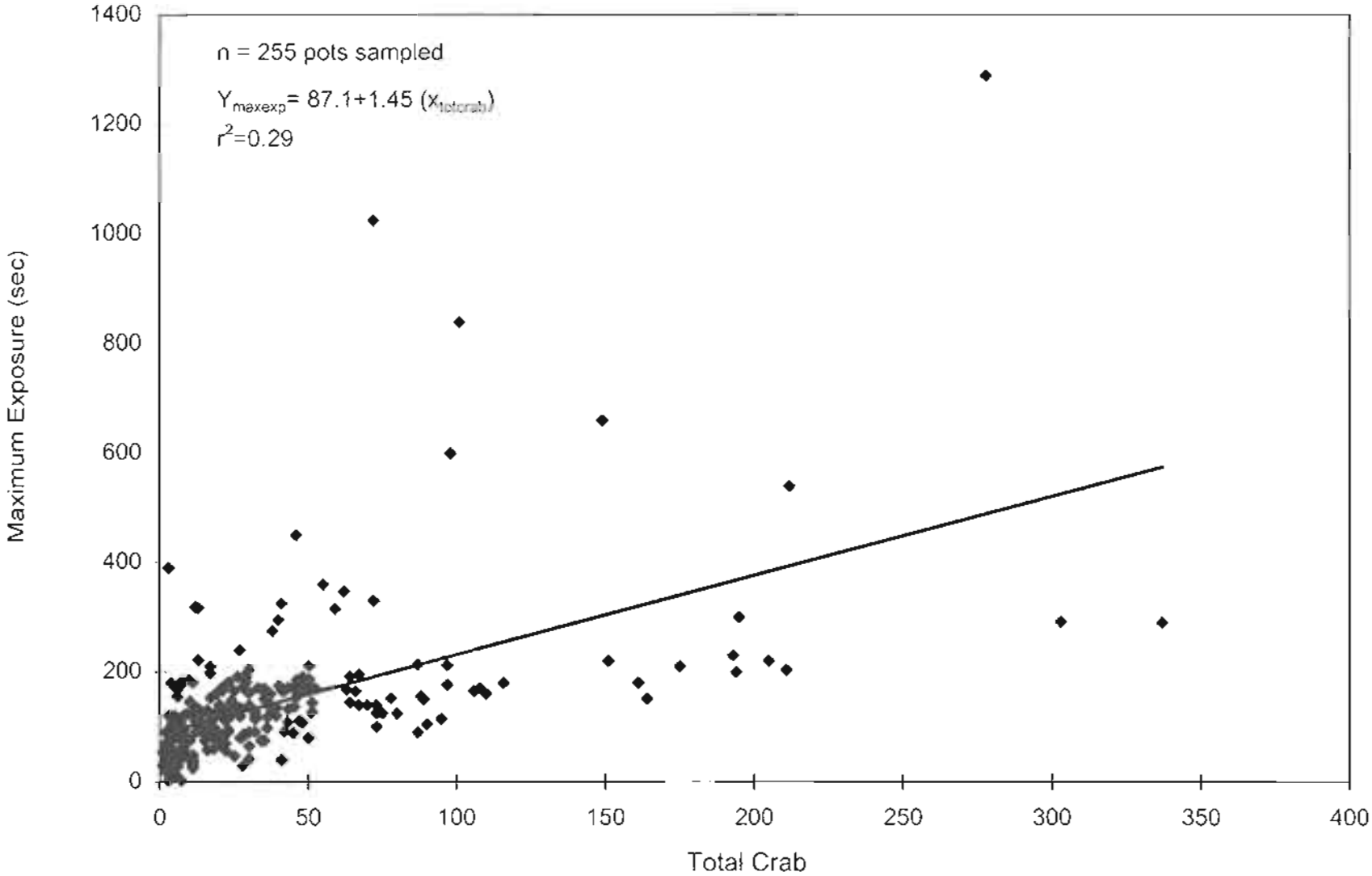

Figure 20 . Correlation of maximum aerial exposure times to total crabs from combined pot samples taken on seven catcher-only vessels and two catcher-processors during the 1998 Bristol Bay red king crab open access season.

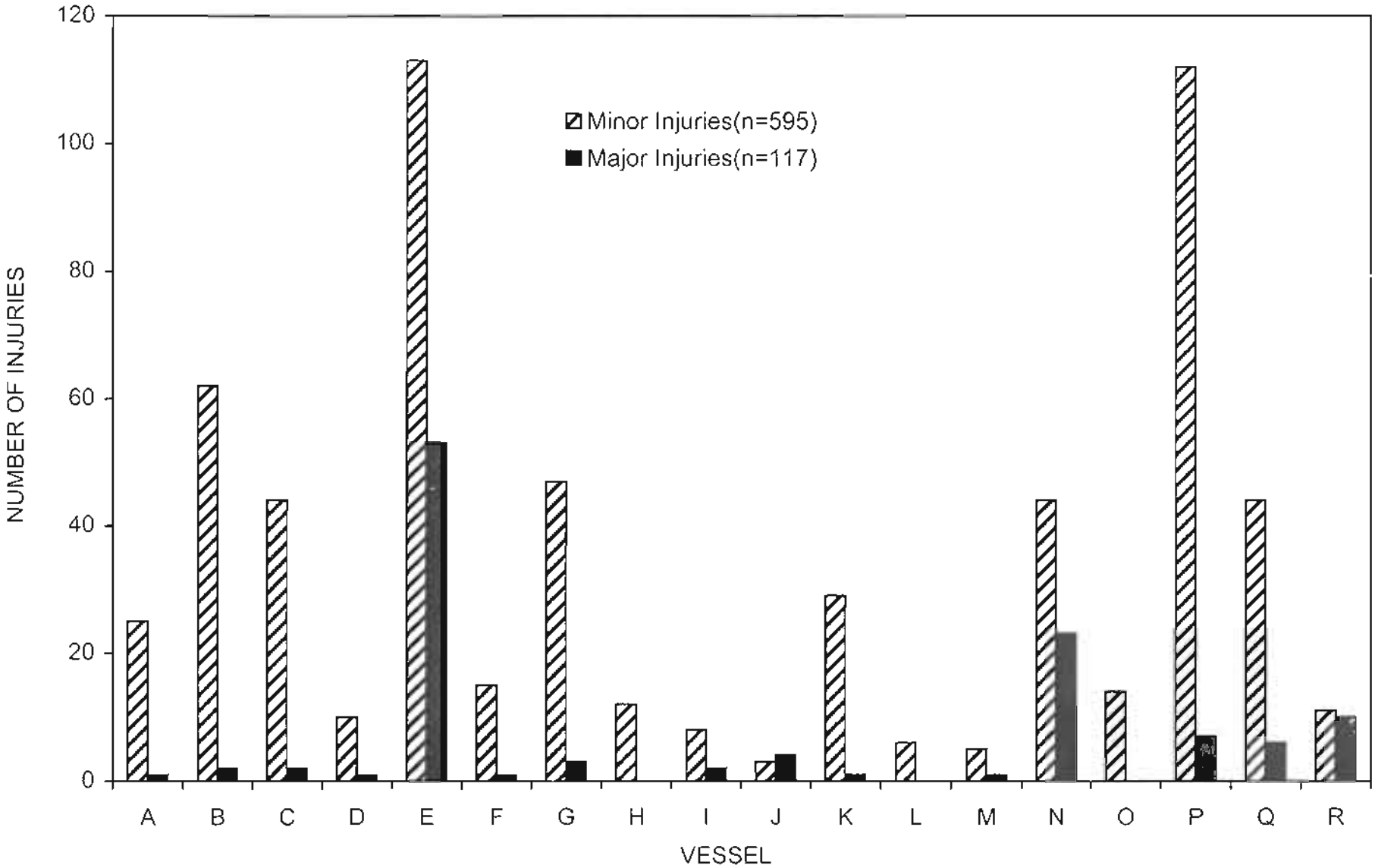

Figure 21. Major and minor body injuries of crabs examined in pots sampled on 10 catcher-only vessels and 10 catcher-processors during the 1998 Bristol Bay red king crab open access season.

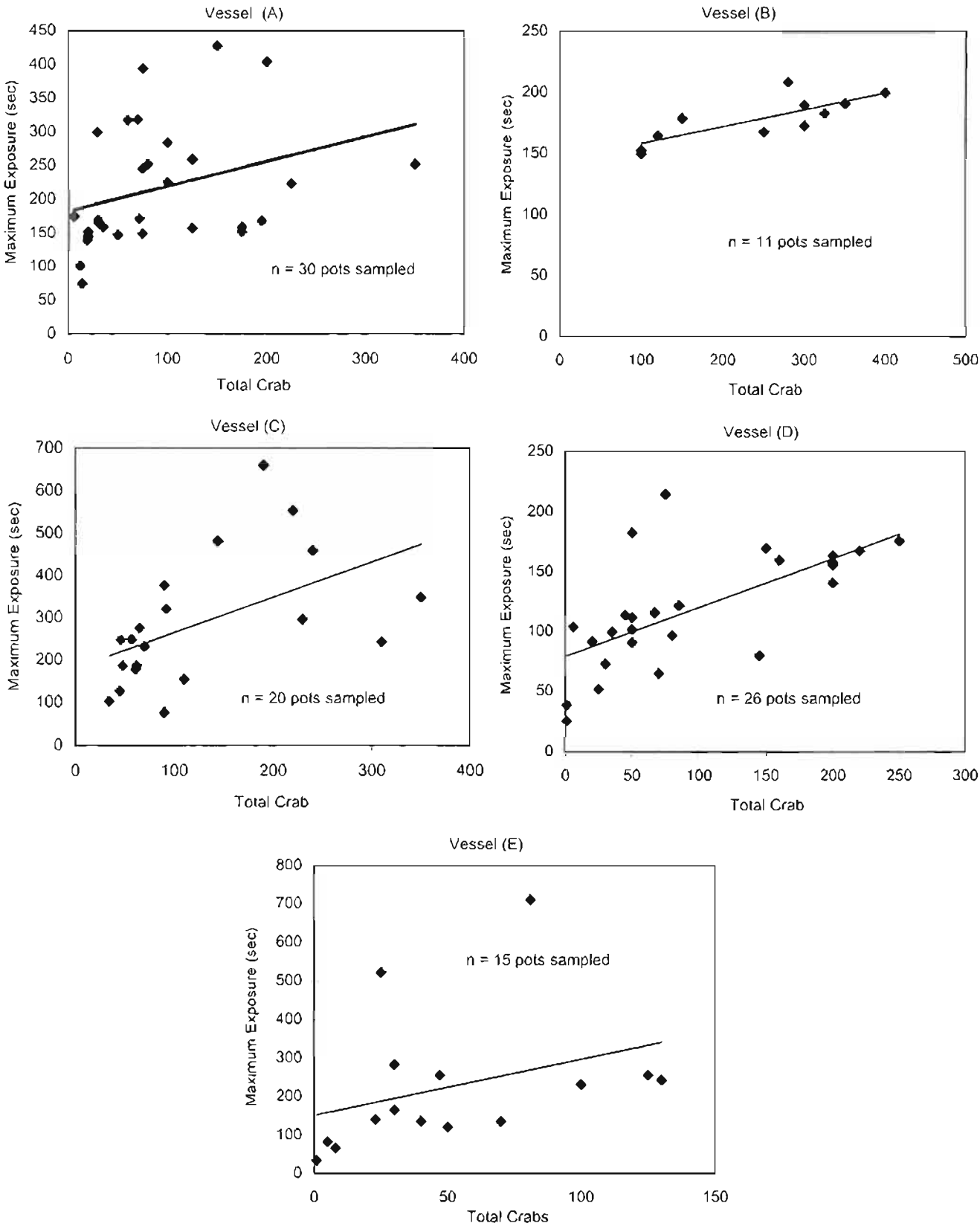

Figure 22. Correlation of maximum aerial exposure times to total crabs per pot from samples taken on 10 catcher-only vessels and 10 catcher-processors (vessels A-P,R, W-Y) during the 1998 Bristol Bay red king crab open access season.

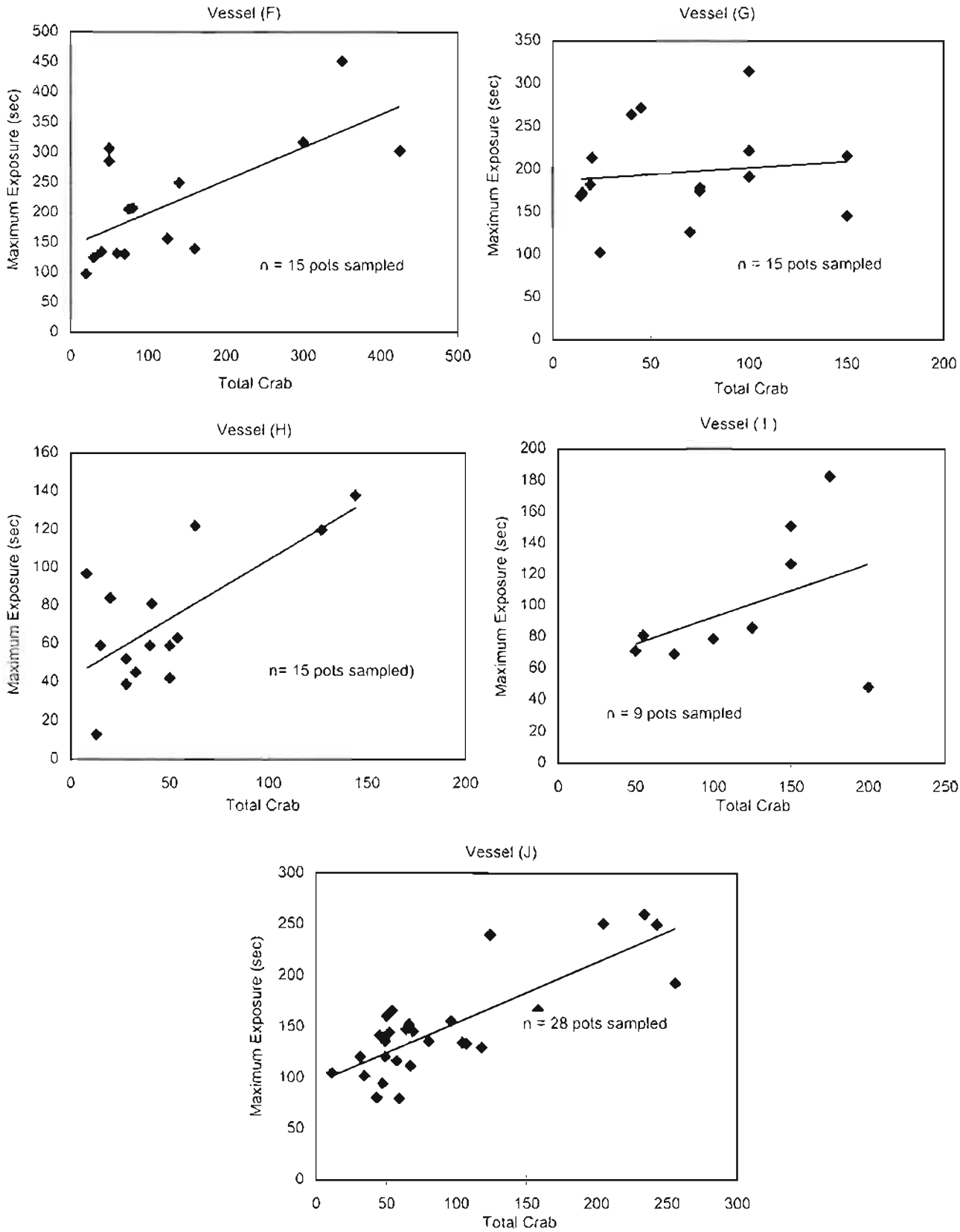

Figure 22. (page 2 of 4)

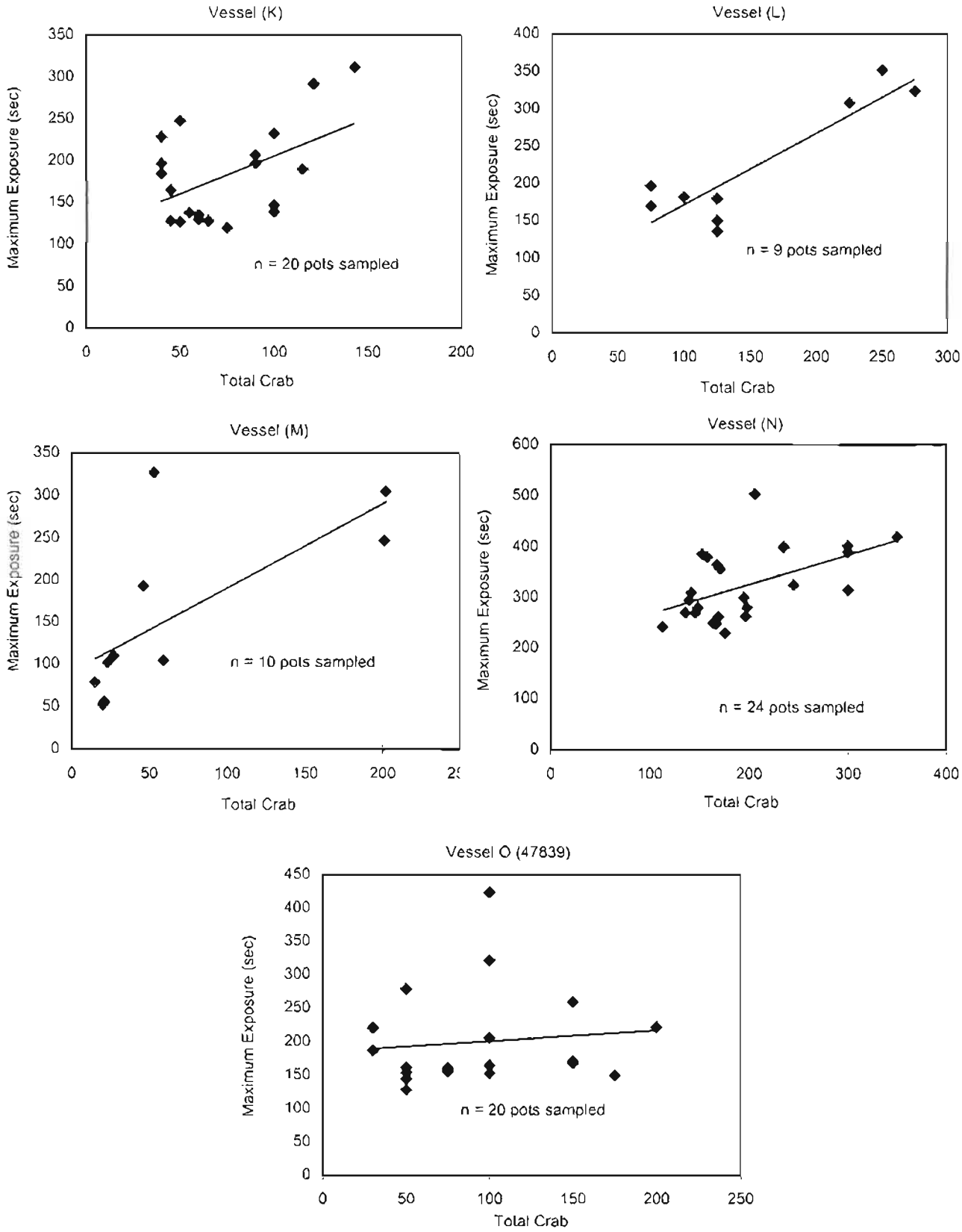

Figure 22. (page 3 of 4)

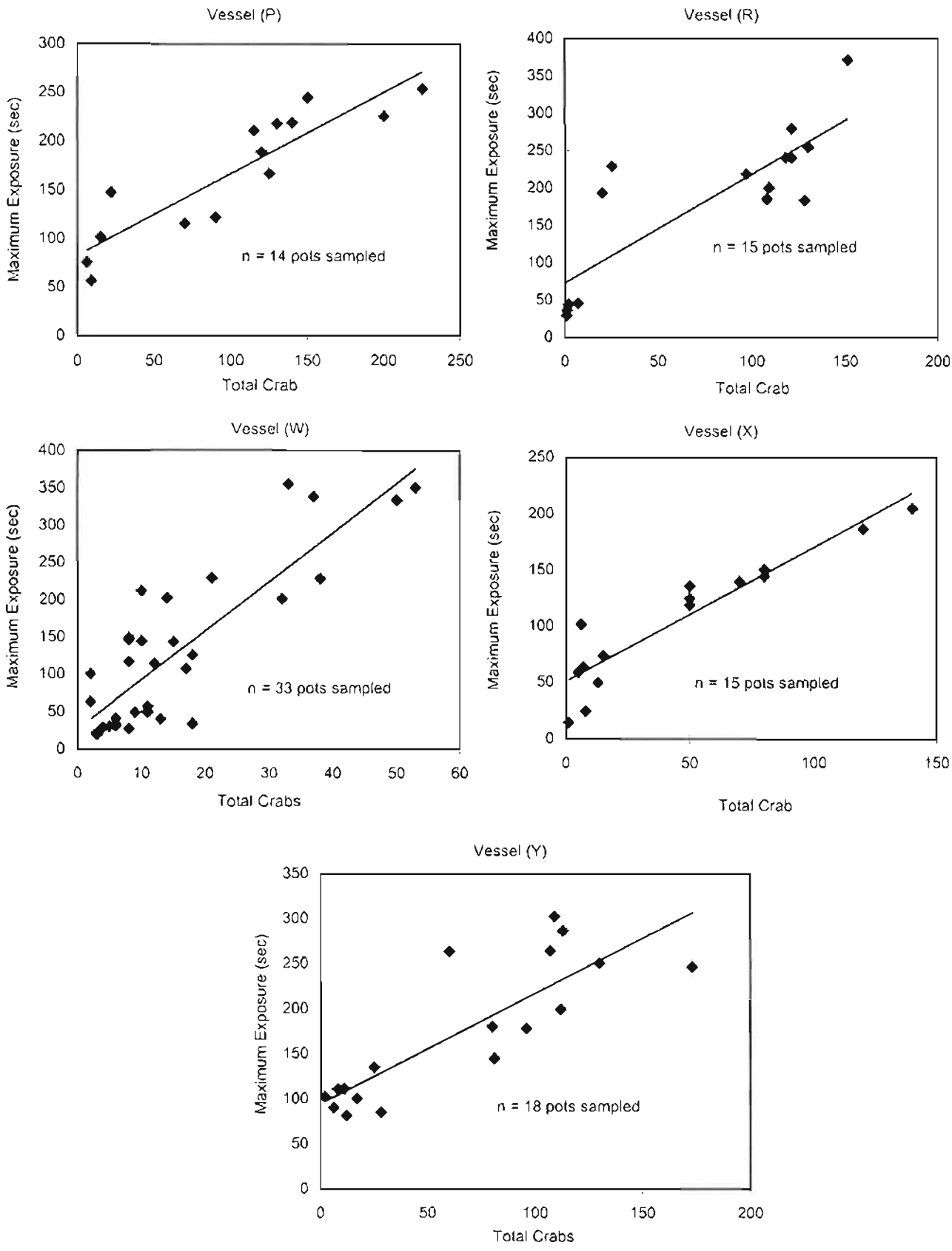

Figure 22. (page 4 of 4)

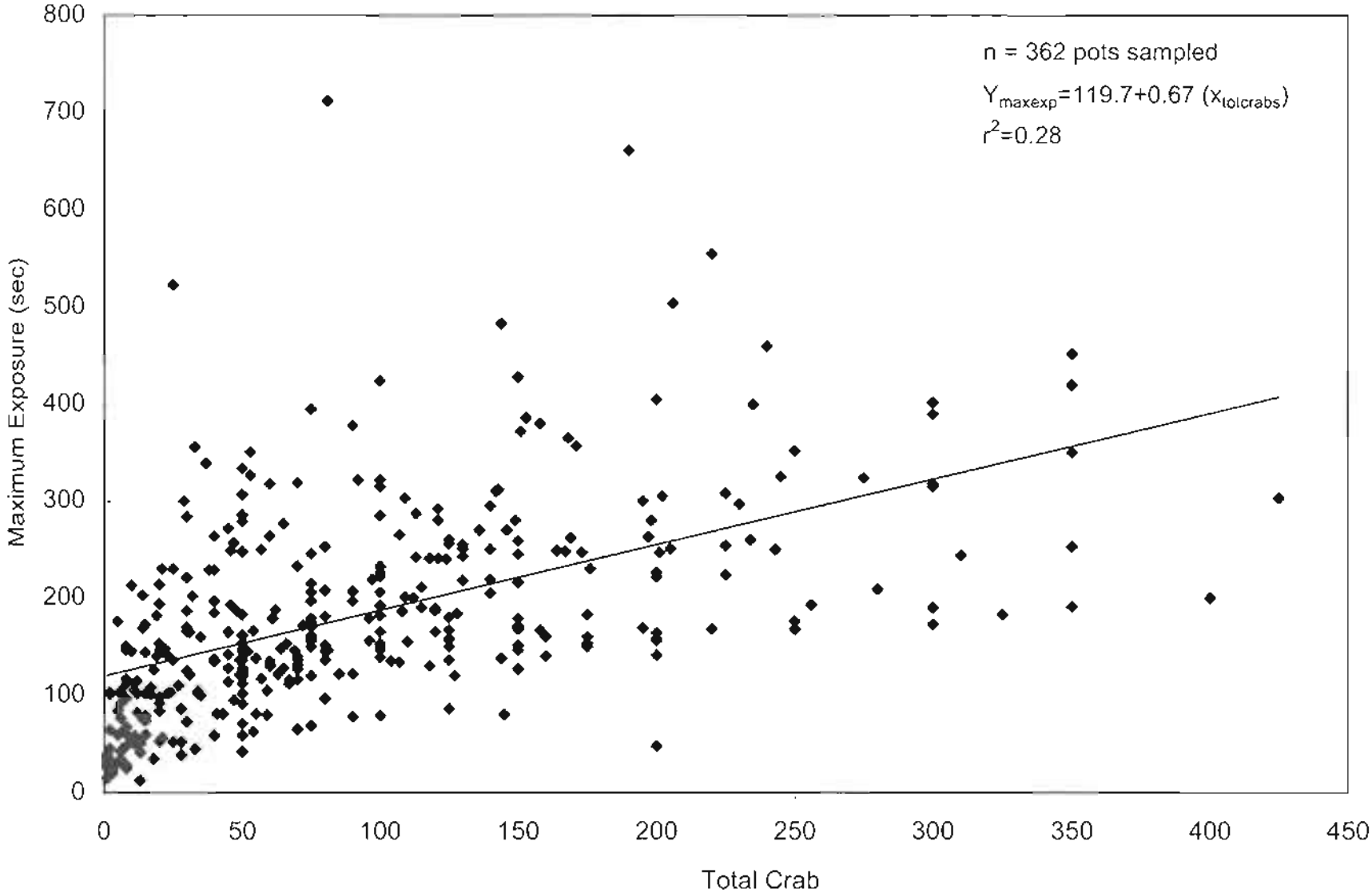

Figure 23. Correlation of maximum aerial exposure times to total crabs from combined pot samples taken on 10 catcher-only vessels and 10 catcher-processors during the 1998 Bristol Bay red king crab open access season.

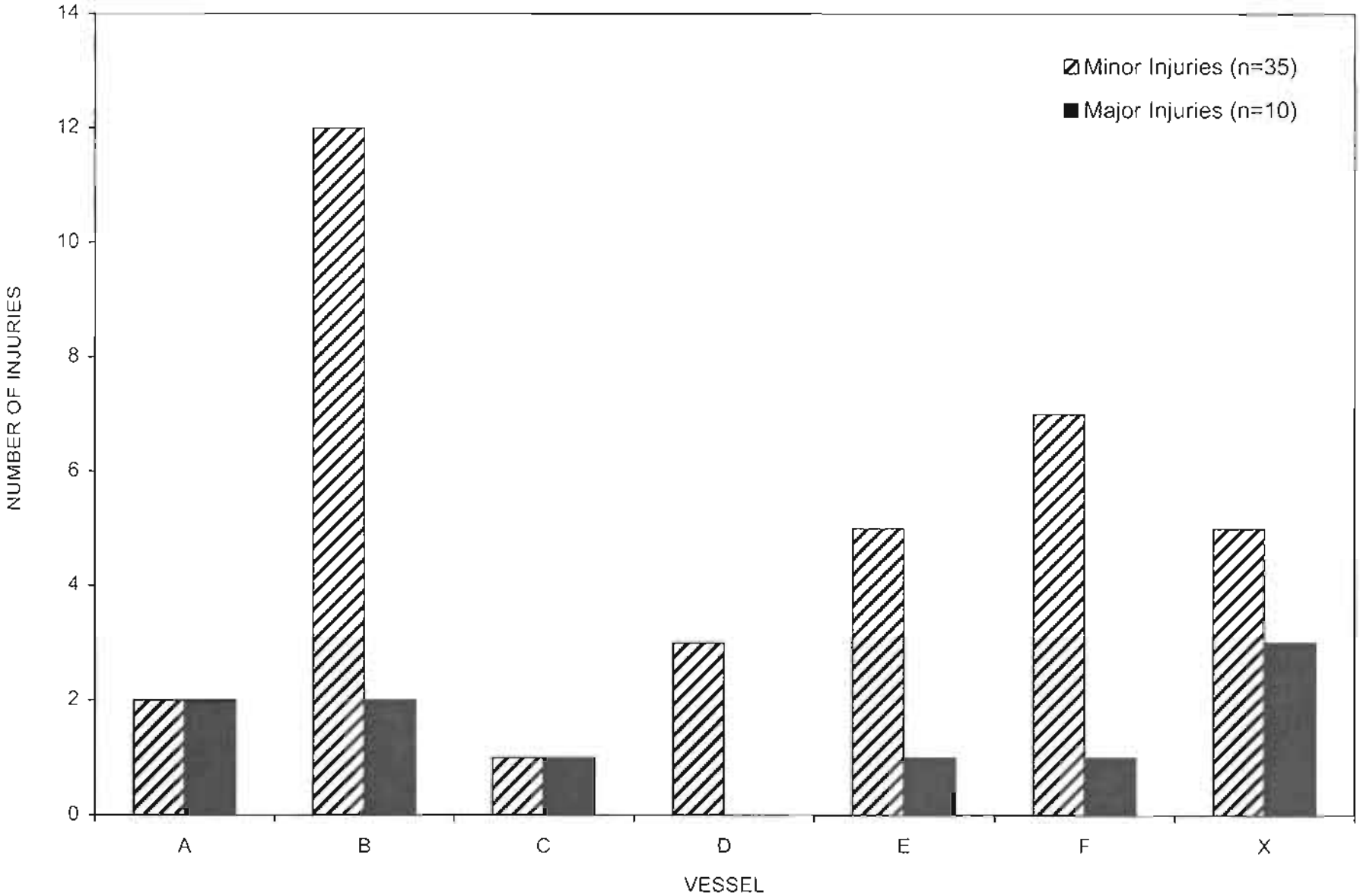

Figure 24. Comparison between vessels of major and minor body injuries recorded for crabs examined in pots sampled on seven catcher-only vessels during the 1998 Bristol Bay red king crab CDQ season.

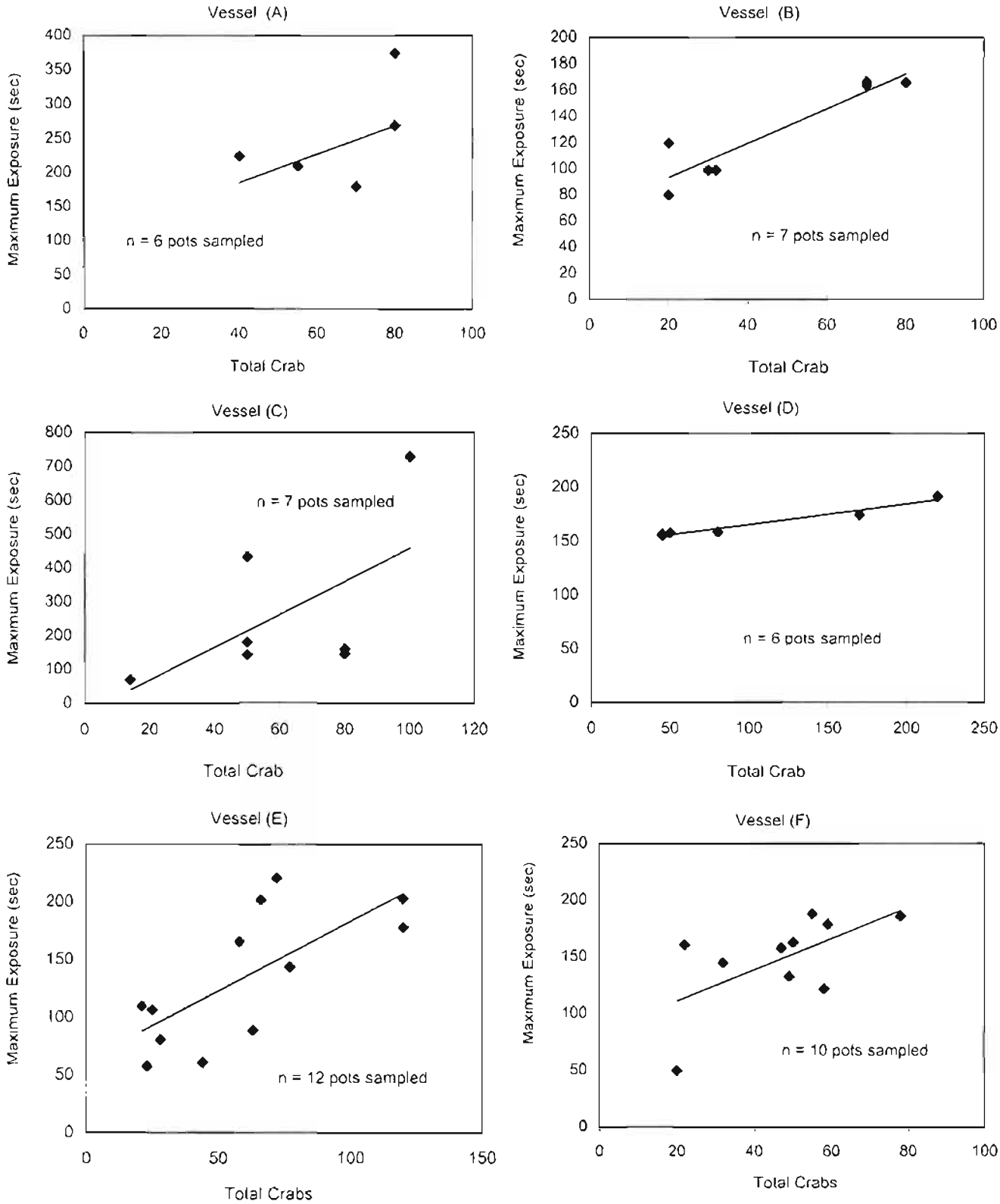

Figure 25. Correlation of maximum aerial exposure times to total crabs per pot from samples taken on six catcher-only vessels (A-F) during the 1998 Bristol Bay red king crab CDQ season.

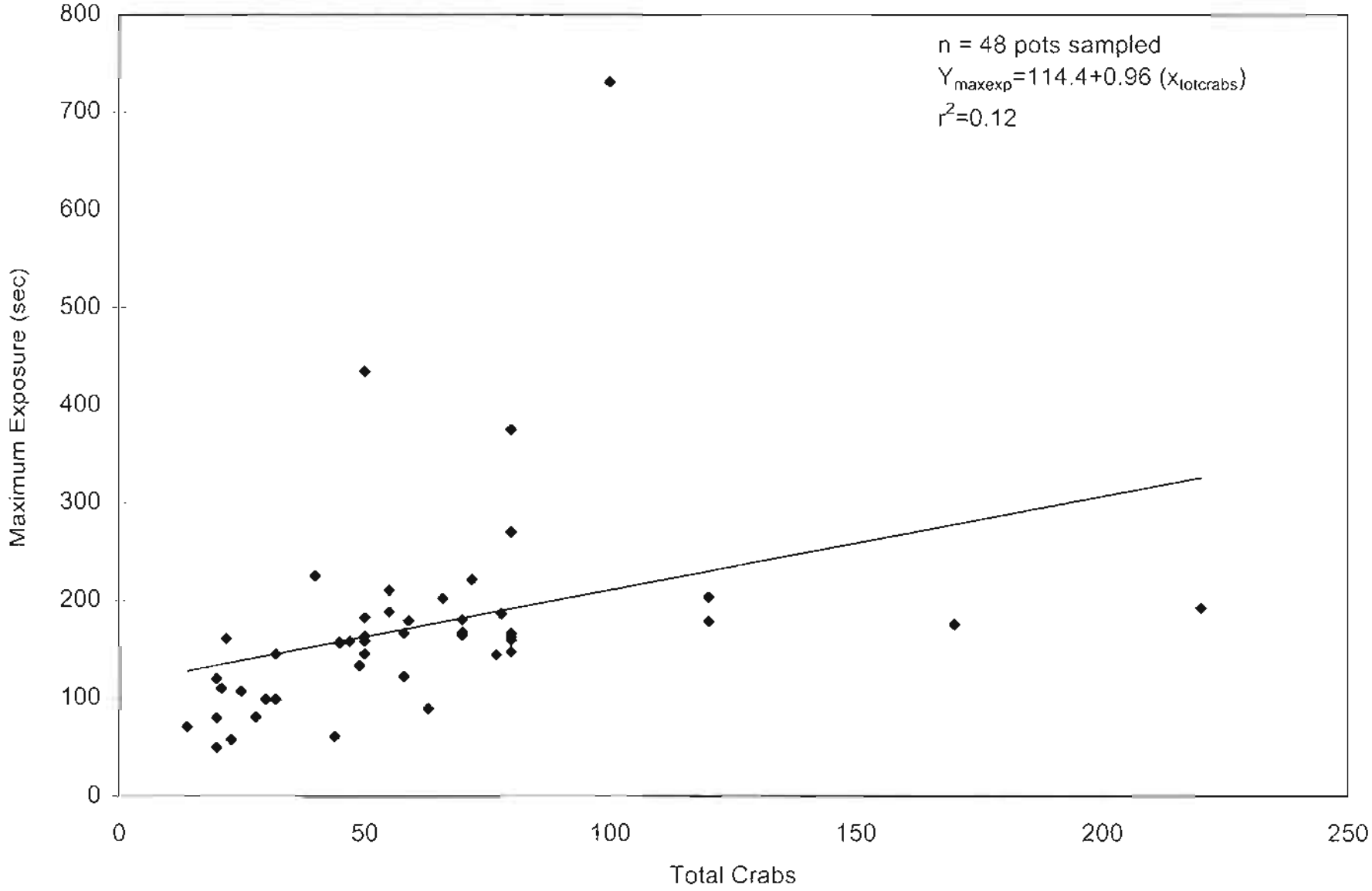

Figure 26. Correlation of maximum aerial exposure times to total crabs from combined pot samples taken on six catcher-only vessels during the 1998 Bristol Bay red king crab CDQ season.

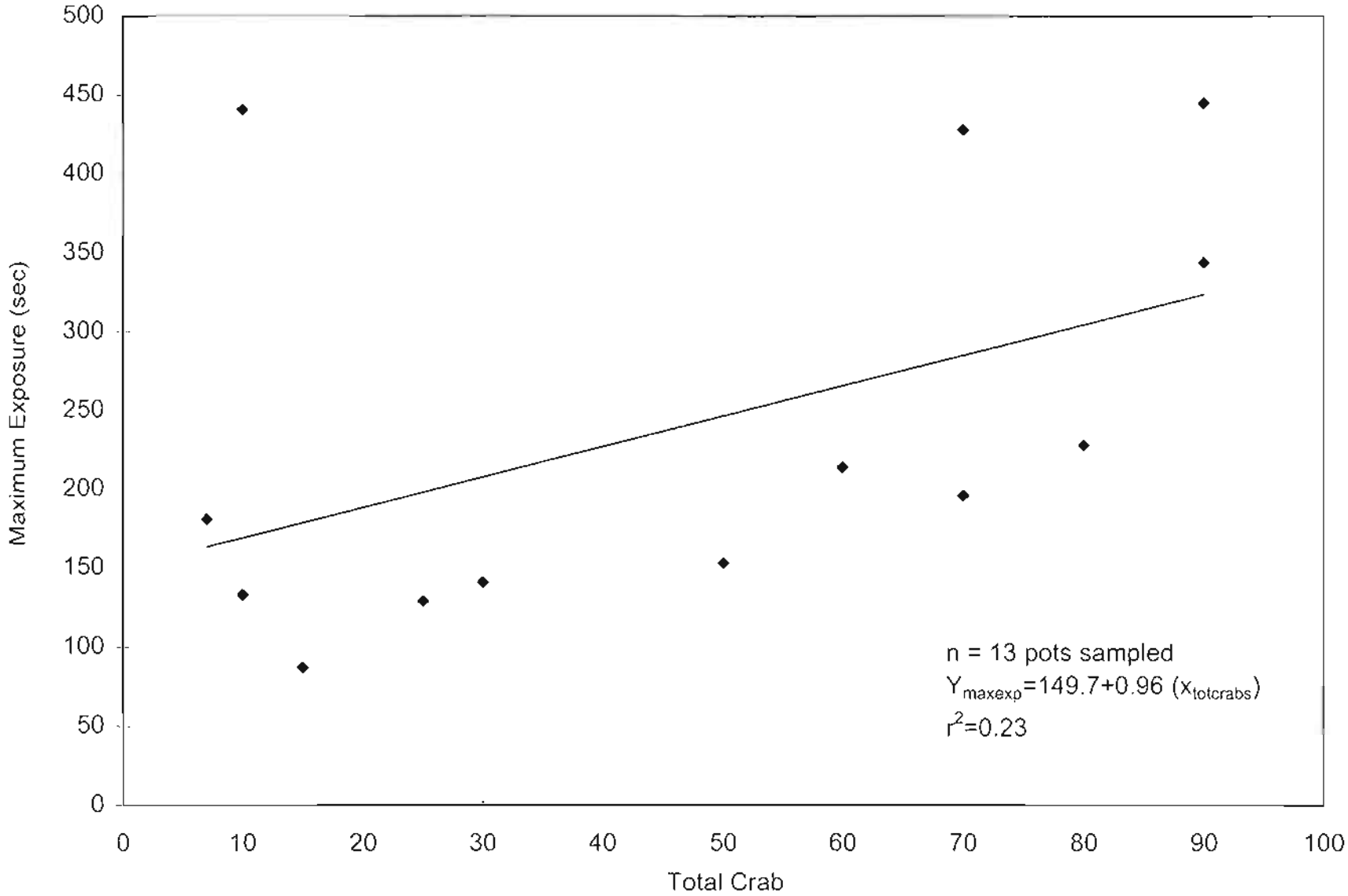

Figure 27. Correlation of maximum aerial exposure times to total red king crabs per pot from samples taken on a single catcher-only vessel during the 1998 Pribilof Islands red and blue king crab CDQ season.

APPENDIX

Appendix A. Alaska Department of Fish and Game aerial exposure sampling instructions.

Daily or cumulative sampling goals for measuring the aerial exposure times of sample pot catches will be provided during briefings or in shipboard instruction manuals. Pots will be randomly selected for this purpose. **Aerial exposures will only be measured for non-retained crabs of the target species - unless retained (legal-sized) crabs comprise the entire pot contents.** Non-retained crabs are sublegal male and female crabs of the target species; do not include fish, non- target crabs or other invertebrates in the measured exposure time interval. **Sampling will comprise objective observations; under no circumstances will accurately measured exposure times be discounted - especially due to situations which result in a perceived extension in the time "normally" spent on deck by non-retained crabs (e.g. accelerated fishing activity, pot stacking, etc.).** In order to maintain an objective sampling environment, exposure times should be recorded without the knowledge of the vessel crew whenever possible. Record data for each category as specified below.

Species code: The target species being sampled; refer to the list of species codes provided in the "ADF&G Shellfish Observer Field Manual".

Fishery code: The 4-character alpha/numeric code provided during briefing for the fishery being sampled.

Observer code: Leave this column blank, unless instructed otherwise during briefing.

Vessel ADF&G #: Refer to the vessel registration or the list of vessel numbers provided in the "ADF&G Shellfish Observer Field Manual".

Sequential Pot Number: Unique and distinct from bycatch sample pot numbers and injury assessment sample pot numbers. Begin with the number one (1); the last sequential pot number reflects the total number of observations made for the purpose of measuring aerial exposures.

Exposure times: All exposure times will recorded in whole seconds only (do not record minutes and seconds).

Minimum: The time interval beginning when a retrieved pot comes out of the water and ending when the **first non-retained crab** is returned to the sea **OR**, if the entire catch contents are retained crabs, when the **first retained crab** is placed in the holding tank.

Maximum: The time interval beginning when a retrieved pot comes out of the water and ending when the **last non-retained crab** is returned to the sea **OR**, if the entire catch contents are retained crabs, when the **last retained crab** is placed in the holding tank.

Number of Retained Crabs: The total number of **retained crabs** of the target species in the pot. **Estimates are acceptable, but only when accurate counts are unobtainable,** and must be noted on the data form.

Estimated (Est.): Check the box in this column if the number of retained crabs is estimated. **Leave this box blank if actual counts of retained crabs in the pot are obtained.**

Total Crabs: The total number of crabs - **retained and non-retained** - of the target species in the pot. **Estimates are acceptable, but only when accurate counts are unobtainable,** and must be noted on the data form.

Estimated (Est.): Check the box in this column if the total number of crabs is estimated. **Leave this box blank if actual counts of total crabs in the pot are obtained.**

Appendix B. Alaska Department of Fish and Game aerial exposure sampling instructions.

Species code: The 3-digit code provided in the "ADF&G Shellfish Observer Field Manual" for the target crab species being sampled.

Fishery code: The 4-character alpha-numeric code provided during briefing for the fishery being sampled.

Observer code: Leave blank.

Sequential pot #: Unique and distinct from bycatch sample pot number. Begin with the number one (1); the last sequential pot number recorded reflects the total number of pots sampled for injury assessment during the vessel deployment.

No. of crabs sampled/sample total: The number of crabs measured and assessed for injuries vs. the total number of crabs in the pot. **Leave blank if sub-sampling does not occur.**

Carapace length/width (CL/CW): The biological measurement (CL = mid-posterior to right eye orbit; CW = greatest width not including peripheral spines).

Shell age: 0 = soft 9 = new-pliable 1 = new 2 = old 3 = very old

Vitality: Assess all sampled crabs for vitality and record the appropriate code as follows:

blank - Leave field blank if crab is alive and exhibiting movement of appendages either spontaneously or when prodded.

1 - Moribund (alive but inactive, i.e. not exhibiting appendage movement even when prodded, but mouth parts are moving either spontaneously or when flicked at 5-10 second intervals.

2 - Dead (i.e. no movement of appendages even when prodded; no movement of mouth parts, even when prodded. Presence or severity of injuries is not a criterion of whether or not a crab is dead.

Injuries:

Examination of each crab measured will include a visual assessment of the carapace, sternum, abdomen, coxa (or "shoulders"), and each leg (refer to the generic anatomy diagram provided). Record all injuries observed on each sampled crab using the following codes. (Note: there can be multiple injuries per individual crab.)

blank - No injuries observed.

minor injuries:

1 - **Rostrum** - this prominent carapace feature breaks off frequently during handling.

2 - **Carapace (middle)** - punctures, cracks, or other damage to the middle section of the carapace over vital organs where integument (new skin) or other tissue isn't visible as a result of the injury.

-Continued-

3 - **Carapace (side)** - punctures, cracks, or other damage to the periphery of the carapace over the gill region where integument or other tissue isn't visible as the result of the injury.

4 - **Leg injury** - punctures cracks or damage to any of the walking legs where integument or other tissue isn't visible as the result of the injury.

5 - **Leg autotomy** - an autotomy is a clean break at a walking leg joint where no blood is lost and no ragged flesh is exposed (a smooth concave surface is seen at the autotomized joint).

6 - **Left chela** - punctures, cracks or any damage to the left chela (claw) where integument or other tissue isn't visible as the result of the injury.

7 - **Right chela** - punctures, cracks, or any damage to the right chela where integument or other tissue isn't visible as the result of the injury.

8 - **Chela autotomy** - an autotomy is a clean break at the chela leg joint where no blood is lost and no ragged flesh is exposed (a smooth concave surface is seen at the autotomized joint).

9 - **Abdomen** - any punctures, cracks or damage to the ventral abdominal flap where integument or other tissue isn't visible as the result of the injury.

10 - **Sternum** - any punctures, cracks or damage to the ventral surface around the abdomen(not including the any part of the legs) where integument or other tissue isn't visible as the result of the injury.

11 - **Coxa** ("shoulder") - punctures, cracks or any damage to the first leg segment closest to the body where integument or other tissue isn't visible as the result of the injury.

major injuries:

12 - **Carapace (middle)** - punctures, cracks, or other damage to the middle section of the carapace over vital organs where integument or other tissue is clearly showing through or protruding from the injury site (i.e., you can see tissue).

13 - **Carapace (side)** - punctures, cracks, or other damage to the periphery of the carapace over the gill region organs where integument or other tissue is clearly showing through or protruding from the injury site (i.e., you can see tissue).

14 - **Leg injury** - punctures cracks or damage to any of the walking legs organs where integument or other tissue is clearly showing through or protruding from the injury site (i.e., you can see tissue).

15 - **Left chela** - punctures, cracks or any damage to the left chela (claw) where integument or other tissue is clearly showing through or protruding from the injury site (i.e., you can see tissue).

-Continued-

16 - **Right chela** - punctures, cracks, or any damage to the right chela where integument or other tissue is clearly showing through or protruding from the injury site (i.e., you can see tissue).

17 - **Abdomen** - any punctures, cracks or damage to the ventral abdominal flap where integument or other tissue is clearly showing through or protruding from the injury site (i.e., you can see tissue).

18 - **Sternum** - any punctures, cracks or damage to the ventral surface around the abdomen(not including the any part of the legs) where integument or other tissue is clearly showing through or protruding from the injury site (i.e., you can see tissue).

19 - **Coxa** ("shoulder") - punctures, cracks or any damage to the first leg segment closest to the body where integument or other tissue is clearly showing through or protruding from the injury site (i.e., you can see tissue).

Appendix C. Alaska Department of Fish and Game vessel catch sorting equipment and procedures questionairre.

Observer name _____ Vessel name _____

Fishery Code	Observer Code	Vessel ADF&G No.	Deployment Dates from Mo.	Day	Yr.	to Mo.	Day	Yr.

Catch sorting equipment and configuration:

1. Are the contents of fished pots typically placed into totes or onto a sorting table?

   a. sorting table b. totes*

   *Skip to Question 5.

2. What is the design of the sorting table?

   a. pivot leg b. hydraulic - one piece c. hydraulic – hinged/split d. other*

   *Describe in the 'comments' section.

3. Are there slide ramps or conveyers used in conjunction with the sorting table for the purpose of placing sorted crabs overboard and/or in the holding tanks?

   a. yes b. no

4. If the answer to Question 3 is 'yes', indicate which of the above devices are used on your vessel.

   a. slide ramp b. conveyer c. other*

   *Describe in the 'comments' section.

Catch sorting and handling methods:

5. Before placing retrieved pots in the hydraulic launcher (or otherwise bringing each one aboard), does the crew routinely swing them against the outside of the vessel hull in order to knock the catch contents to one end?

   a. yes b. no

-Continued-

6. Is the catch typically "shaken out" of each pot by use of the hydraulic launcher, or does the crew remove the pot contents by hand?

   a. catch removed with launcher b. catch removed by hand

7. If the pot contents are emptied by use of the launcher or other platform, what is the estimated distance crabs fall from the pot onto the sorting table or into totes?

   a. less than 2 feet b. 2 to 4 feet c. greater than 4 feet

8. If your vessel does not use a sorting table, or does not use slide ramps or conveyors to transport the catch contents off the sorting table, are non-retained crabs typically returned to the sea by being thrown or dropped over the side of the vessel, or does the crew normally place bycatch in the discard chutes (scuppers)?

   a. catch over the side b. catch in discard chutes

9. How many crewmembers usually participate in sorting the catch?

   a. one b. two c. greater than two

10. Which of the following are usually sorted and removed from the pot contents by the crew first?

    a. retained crabs b. bycatch crabs

Comments:

-Continued-

Fishery code: The 4-character alphanumeric code provided during briefing for the fishery being observed.

Observer code: Leave blank.

Vessel ADF&G #: Refer to the vessel registration or the list of vessel numbers provided in the "ADF&G Shellfish Observer Field Manual".

Deployment dates: The date of briefing and the date of debriefing for the fishery being observed.

Questions:

Preliminary results from crab injury assessment sampling conducted by observers in 1997 indicate that a great deal of variance in injury rates exists between individual vessels. In order to gain further insight as to the reasons for this variability, the ADF&G research staff is requesting that the equipment and methods used to sort crabs are documented on all observed vessels.

Please circle the most accurate answer for each question to describe the sorting operation on your vessel. If necessary, also include other information or comments in the space provided that may better characterize the method(s) used for handling catches. Reference question numbers where appropriate when providing information supplemental to the choice(s) of answers given.
