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SCUBA DIVER PERCEPTIONS AND EVALUATIONS OF CROWDING UNDERWATER

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This article describes three exploratory investigations of dimensions influencing scuba diver perceptions of crowding in underwater settings. Five focus groups of five to eight divers each suggested that number, proximity, and clustering of divers were important crowding dimensions. A multiple sort procedure with 60 other divers revealed that number and proximity were most important. A survey of 101 additional divers confirmed that number and proximity of divers significantly influenced crowding, but the number of divers was the strongest determinant. Photographs were used to test crowding dimensions underwater. Although additional research is needed to confirm these findings, this study serves as a guide for future research on social aspects of dive site planning and management.

Key words: Scuba; Diving; Crowding; Social carrying capacity; Marine recreation

Introduction

Scuba diving is an outdoor recreation activity that has grown rapidly in popularity. The Professional Association of Dive Instructors (PADI), for example, has certified over 17 million recreational divers since 1966 and millions of individuals regularly participate in this activity at locations around the world. Recent research has focused primarily on economic considerations associated with scuba diving (e.g., Davis & Tisdell, 1996; Dixon, Scura, & Van't Hof, 1993; Oh, Ditton, & Stoll, 2008; van Beukering & Cesar, 2004) and environmental impacts of the activity such as damage to coral reefs (e.g., Meyer & Holland, 2008; Rodgers & Cox, 2003; Rouphael & Inglis, 2001). Comparatively fewer studies have targeted social indicators such as crowding, conflict, and satisfaction among scuba divers (e.g., Dearden, Bennett, & Rollins, 2007; Leujak & Ormond, 2007; Musa, 2002; Uyarra, Watkison, & Cote, 2009). Social carrying capacity related issues, such as crowding, will likely become increasingly important management considerations as the number of visitors increases at many of the world's dive sites (Lück, 2008; Orams, 1999).

Perceived crowding refers to a subjective nega-

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tive evaluation that the number of encounters or people observed in a given area is too many (Manning, 1999; Vaske & Donnelly, 2002). This concept has received considerable attention in the recreation and tourism literature, but most of this research has investigated crowding in terrestrial settings such as along trails and at campsites in parks and wilderness areas (see Manning, 1999, 2007; B. Shelby, Vaske, & Heberlein, 1989; Sumner, 1936; Vaske & Donnelly, 2002; Vaske & Shelby, 2008, for reviews). Although a limited number of studies have investigated crowding in recreational settings such as rivers or lakes (e.g., Tarrant, Cordell, & Kibler, 1997; Lewis, Lime, & Anderson, 1996), comparatively little crowding research has occurred in underwater environments such as marine protected areas or popular dive sites. This paucity of underwater studies may exist because of the relatively recent popularity of scuba diving and the challenges of conducting behavioral research in extreme or unusual environments (Inglis, Johnson, & Ponte, 1999; Suedfeld, 1987). Many of the conceptual approaches and methodological techniques used for examining crowding may not be directly transferrable from terrestrial settings to underwater environments because visibility can be limited by water clarity, and perceptions of size, distance, and sound can be distorted by the surrounding environment (Inglis et al., 1999). The use of scuba equipment can also restrict movement, decrease the field of vision, and limit the tactile ability of divers who tend to focus on their immediate environment to a greater degree than terrestrial recreationists (Suedfeld, 1987). These differences are substantial and suggest that understanding cognitive processes used by humans to evaluate crowding in terrestrial settings may not be entirely transferrable to marine environments. This article, therefore, explores dimensions influencing scuba diver perceptions of crowding underwater.

Crowding in Terrestrial and Marine Environments

Individual interpretations of the surrounding environment are central to any investigation of perceived crowding, so research on this topic has relied on theoretical and methodological foundations developed in the field of environmental psychology (Stokols, 1972). Crowding studies have been expanded and conducted in a range of disciplines such as architecture, environmental design, urban planning, tourism, and recreation and leisure studies. In most cases, a distinction has been drawn between measurement of physical conditions and investigation of experiential states (Desor, 1972). Crowding is a complex phenomenon involving perceptions of physical conditions by individuals who use this information to identify patterns and create meaningful cognitive structures that assist in interpretation of environments (Stokols, 1972).

In the recreation and tourism literature, investigations of crowding typically combine descriptive information such as actual density or use level (i.e., number of individuals recorded per unit area) with evaluative and experiential information such as reported encounters (i.e., number of people an individual remembers observing) and perceived crowding (i.e., negative evaluation that this number of encounters is too many) that reflect a personal subjective appraisal of the conditions experienced (Absher & Lee, 1981). When individuals evaluate a given area as crowded, they have implicitly compared conditions they experienced with their perceptions of what they feel conditions should or should not be in the area (Vaske & Shelby, 2008).

Research has examined dimensions or attributes that influence evaluations of crowding. Several studies, for example, have shown a positive relationship between actual use levels (i.e., number of people) and perceptions of crowding. Across 13 studies, correlations between number of people and perceptions of crowding ranged from 0.01 to 0.61 with an average of 0.21 (Graefe, Vaske, & Kuss, 1984). Similarly, Manning (1999) synthesized results from multiple studies with 26 evaluation contexts and reported that use levels explained an average of 15% of the variance in crowding. In a coastal and marine context, Lankford, Inui, and Whittle (2008) found that use levels significantly influenced perceived crowding, with number of people accounting for 13% of the variance in crowding. These modest relationships suggest that some, but not all, of the variation in perceived crowding is due to the number of people in an area. Other experiential and cognitive dimensions such as proximity, group similarity, location, motivations, experience level, and user behavior also influence crowding (see Manning, 1999; B. Shelby et al., 1989; Vaske & Shelby, 2008, for reviews). Research in mostly terrestrial settings, for example, has shown that people who are more sensitive to crowding tend to be more skilled in their activity (Needham, Rollins, & Vaske, 2005), visit more remote or backcountry areas (Needham, Rollins, & Wood, 2004), and are motivated to seek quietude (Absher & Lee, 1981). Attributes such as proximity or closeness, solitude, and interactions without disruptions also appear to influence perceptions of crowding (Hammitt, 1982; Hammitt & Madden, 1989; Twight, Smith, & Wissinger, 1981).

In contrast to the abundance of research on perceived crowding in terrestrial settings, a limited number of studies have investigated the concept in underwater environments that support activities such as scuba diving and snorkeling. Inglis et al., (1999), for example, asked snorkelers at the Great Barrier Reef to evaluate photographs depicting various crowding conditions below and above water, and found that visibility of 14 snorkelers from above the water and six users in the water were points where crowding became unacceptable. Their results also showed that the number of people (i.e., use level) influenced scuba diver crowding evaluations more than personal attributes such as previous visitation and diving experience. In another analysis of data from the same location, Shafer and Inglis (2000) found that the number of people on boats and snorkeling in the water had the least positive influence on snorkeler enjoyment of the trip.

Similar research has been conducted at a few other sites. In a survey of divers at Sipadan Island in Malaysia, Musa (2002) assessed factors associated with satisfaction such as natural beauty, activities, and facilities. Although divers were extremely satisfied with most factors, they were not as satisfied with the level of crowding, which was considered to be the most alarming social impact at the site. Similar results were found in a study at Hanauma Bay in Hawaii where visitor surveys showed that based on the perceived level of crowding, the bay was exceeding capacity and experiences could be protected by allowing fewer than 2,500 visitors per day at the site (Lankford et al., 2008). Leujak and Ormond (2007) surveyed visitors at sites in Sharm El Sheikh and Ras Mohammed National Park in Egypt, and found that up to 36% felt crowded at these reef sites, concluding that their social capacity seems to be exceeding their ecological capacity. Similarly, Topelko (2007) surveyed snorkelers at Koh Chang Marine National Park in Thailand and found that 92% felt at least slightly crowded at this site with 20% feeling extremely crowded, and crowding levels became unacceptable when 22 or more snorkelers were present. Most recently, Bell, Needham, and Szuster (2011) surveyed snorkelers and divers at Molokini Marine Life Conservation District in Hawaii where 67% felt crowded by the number of boats at the site and considered the number of boats to be more influential on crowding than size of boats.

It is important to examine crowding conditions underwater because participation in activities such as scuba diving and snorkeling is increasing, sites where these activities occur are becoming more popular, and the investigation of crowding underwater is almost completely unexplored (Lück, 2008; Orams, 1999; Szuster, McClure, & Needham, 2009). In Hawaii, for example, more than 80% of the state's 7 million annual visitors engage in marine activities, with the majority participating in scuba diving (e.g., 200,000 people per year from 2001 to 2005) or snorkeling (e.g., 3 million people per year from 2001 to 2005; Friedlander et al., 2005; van Beukering & Cesar, 2004). Understanding the nature of crowding underwater and developing tools to assess these social impacts will allow research data to inform plans and policies for managing capacity-related issues at marine recreation and tourism sites such as marine parks and protected areas. Providing appropriate management recommendations, however, will be difficult until proven techniques are available for measuring and monitoring crowding underwater because it is unclear whether the nature of crowding underwater is comparable to crowding in terrestrial settings.

Research Questions

This article is exploratory and describes three investigations of dimensions influencing scuba diver perceptions of crowding in underwater settings. The goal of these investigations is to provide a foundation for further empirical study of underwater crowding. Three research questions are addressed in this article. First, what dimensions influence scuba diver evaluations of crowding underwater (e.g., number, proximity, clustering of scuba divers)? Second, which of these dimensions most strongly influences scuba diver perceptions of crowding underwater? Third, to what extent can the use of Image Capture Technology (ICT) methods for manipulating and creating visuals representing various crowding conditions be adapted from studies in terrestrial settings and applied to measure crowding in an underwater context?

Methods

The first investigation in this study involved focus groups to identify factors that could influence perceptions of crowding underwater during a dive. Five focus group sessions, each containing between five and eight experienced scuba divers, were conducted in Honolulu, Hawaii during the summer of 2008. Content analysis of participant comments showed that the number of visible scuba divers, physical proximity of divers, and clustering of divers most strongly influence perceptions of crowding underwater. Focus group participants also suggested that no more than approximately 16 scuba divers would be acceptable to see at any one time during a typical dive.

The second investigation built on these focus groups and evaluated these dimensions of number, proximity, and clustering of scuba divers using a series of photographs that were developed using ICT, which involves using software to manipulate photographs and create unique scenarios. This approach has become popular for depicting conditions associated with recreation and tourism use, and is especially useful in high use or unusual areas where it may be difficult or unrealistic for respondents to evaluate conditions from written descriptions (see Manning, 2007; Manning & Freimund, 2004; Manning, Lime, Freimund, & Pitt, 1996, for reviews). Disadvantages, however, include respondent burden from evaluating multiple scenarios and the imposition of static site conditions (Hall & Roggenbuck, 2002; Needham et al., 2004).

An 8 × 6-inch image with a blue background (color selected from an image of Hawaiian waters) was selected as the template. Using Adobe Photoshop software, the number of scuba divers was manipulated with 4 categories showing 2 to 16 divers underwater with the number doubling in each image (i.e., 2, 4, 8, 16 scuba divers). Physical proximity or distance of scuba divers was also manipulated with 4 categories: close (~5 meters), medium (~10 meters), medium-far (~15 meters), and far (~30 meters). A maximum distance of 30 meters was selected because this is a typical maximum visibility that can be reasonably expected under optimal dive conditions. Combining these number and proximity categories resulted in 16 nonrepeating images with divers randomly placed at different distances using a grid of 16 cells on the 8 × 6-inch template. The size of scuba divers at 5 meters was matched to the size of a cell in the 8 × 6-inch image and then reduced in size to 50% at 10 meters, 33% at 15 meters, and 17% at 30 meters compared to the images in the 5-meter scenario. These percentages were used because image size is inversely related to object distance in real space, and all scuba diver images were scaled down to these percentages simultaneously to ensure that reductions were consistent across image categories (Stroebel, 2007). A second set of 16 images using the same numbers and distances of divers was developed to evaluate the clustering dimension. Clusters were developed by shrinking the original image grid by 50% to place scuba divers in closer proximity to each other. Scuba divers were randomly positioned within each image. This combination of photographs showing random and clustered scuba divers created a final total of 32 images that were printed in color (Fig. 1).

A convenience sample of 60 scuba divers at the University of Hawaii was selected for this second investigation. This was deemed acceptable given that this study is an initial exploration of crowding underwater and does not attempt to generalize to a population level. The sample was relatively balanced with 27 females and 33 males with an average age of 31 years old. Participants had an average of 9 years of scuba diving experience, but it ranged from 1 to 48 years, and the sample was also relatively balanced in PADI dive certification level (22 open water divers, 17 advanced divers, and 21 dive masters or above). Participants were presented with the 32 photographs and asked to group these images based on any criteria they chose using a multiple sort approach, which involved sequentially sorting images starting with 2 groups of 16 images, then 4 groups of 8 images, 8 groups of 4 images, and fi-

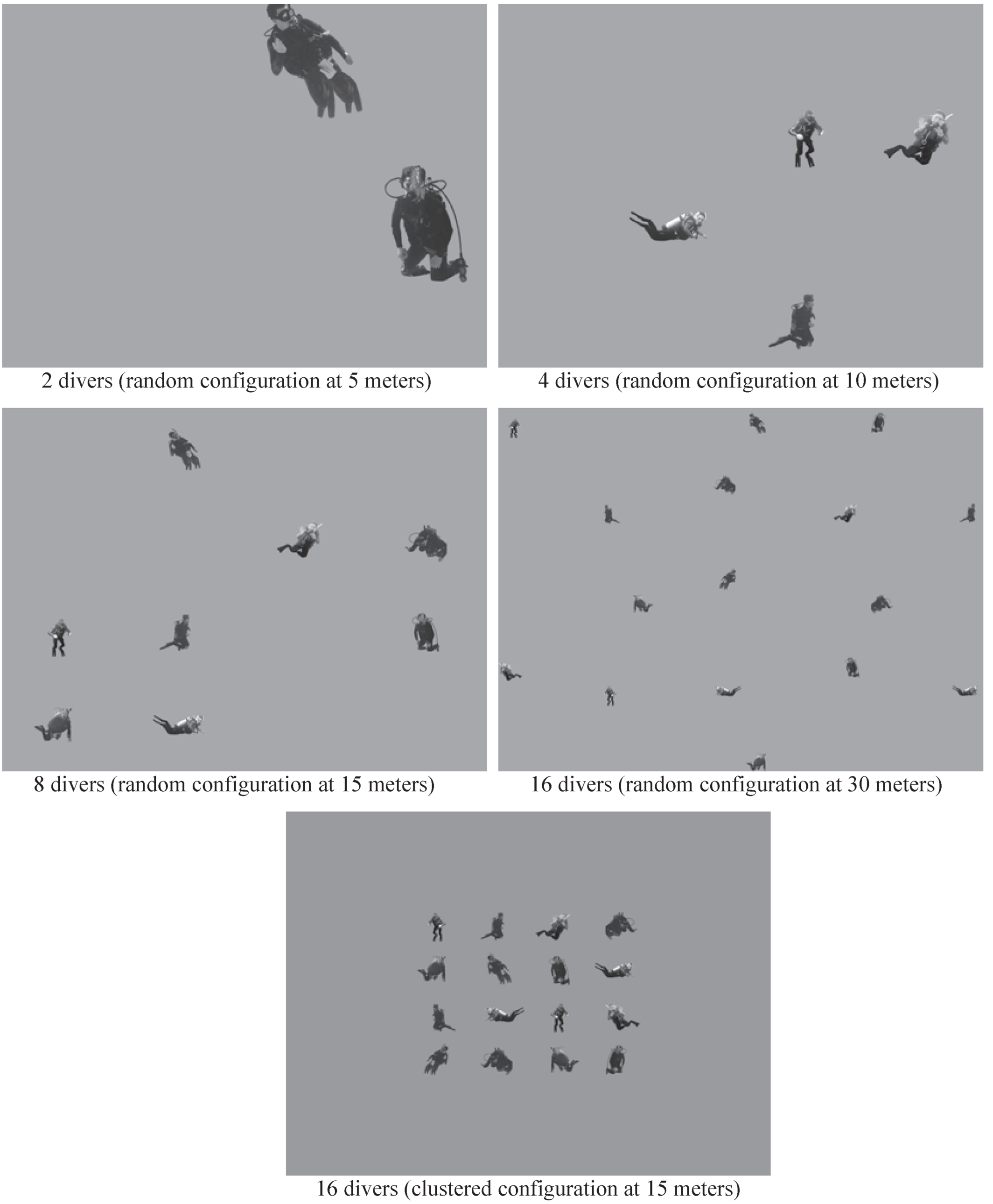


Figure 1. Selection of photographs measuring scuba diver crowding underwater.

nally 16 groups of 2 images (Canter, Brown, & Groat, 1985; Coxon, 1999). Sort criteria were recorded at each stage, and images remaining grouped throughout this process were assumed to possess perceived similarities. This multiple photographic sort procedure is a well established technique that has been used in a diversity of studies to reveal cognitive structures with little bias (Scott & Canter, 1997). The sample of 60 participants is also well above the accepted minimum of 20 to 30 participants required to explore cognitions using a multiple sort approach (Tullis & Wood, 2004).

Findings from this multiple sort procedure were used to inform the third investigation, which involved a survey to quantitatively measure perceived crowding in response to the images that were embedded in the survey instrument. Given that perceived crowding is a psychological construct that exists in the minds of individuals, it is typically measured using self-report methods (Vaske & Shelby, 2008). Heberlein and Vaske (1977) developed a single-item measure of perceived crowding on a 9-point scale where 1 or 2 indicates "not at all crowded," 3 to 4 indicates "slightly crowded," 5 to 7 indicates "moderately crowded," and 8 to 9 indicates "extremely crowded." This measure has been used in hundreds of recreation and tourism studies (see B. Shelby et al., 1989; L. B. Shelby & Vaske, 2007;Vaske & Shelby, 2008, for reviews). Survey data were collected using an onsite intercept sample of other scuba divers on the islands of Oahu and Maui in Hawaii during March and April of 2009. Participants were a convenience sample of customers at two commercial dive shops on Oahu, shore divers at a marine protected area on Oahu, and divers aboard commercial vessels operating out of the three harbors that serve as bases for marine recreation and tourism on Maui. A total of 101 surveys were completed onsite with a response rate of over 90% for the entire survey period. Average age of respondents was 37 (range from 18 to 64) and 63% were male and 37% were female. More than 86% of the sample was American and 46% were residents of Hawaii. A broad range of experience was captured with respondents having completed between 4 and 5000 dives (median = 47 dives). Participants had an average of 9 years of scuba diving experience (range from 3 to 50 years) and 43% were open water PADI certified, 38% were advanced divers, and 20% were divemasters or above.

Results

Multidimensional scaling was used to investigate crowding dimensions embedded in the multiple sort data (Shepard, 1962). The *INDSCAL-S* (Individual Differences Scaling) component of the *NewMDSX* program (Coxon, Brier, & Hawkins, 2005) was used and implementation of *INDSCAL-S* is based on methods of Carroll and Chang (1970) that provide a three-way analysis of two-mode matrices that are capable of defining both individual and group cognitive space (Coxon, 2001). Similarity values were logged into a 32 × 32 matrix for each participant, with image pairs assigned a value from one to five depending on the number of sorts that images remained grouped. A value of one was assigned to images that were only grouped in the initial assembly of 32 images presented to each participant. A value of two was assigned to image pairs that remained grouped after the first sort, and similarity values continued to increase up to a value of five that was assigned to image pairs that remained grouped through the entire sorting process.

Multiple iterations of *INDSCAL-S* were initially run to allow for a five-dimensional solution, which is the maximum permitted under this implementation of *NewMDSX*. The correlation coefficient of a one-dimensional solution was 0.55, and this increased significantly to 0.73 by adding a second dimension. Relatively little additional model accuracy and explanatory power was achieved by increasing dimensionality to three or more dimensions, suggesting that the two dimensional solution was most appropriate. The "diminishing returns" in terms of model accuracy beyond two dimensions is highlighted by the distinct "elbow" in the scree plot derived for this test (Fig. 2). A split-half test that randomly divided the sample into two equal subgroups was also performed to test stability of the two-dimensional solution. *INDSCAL-S* runs on both subsets provided similar correlation values and scree plots to the full sample, which confirmed stability of the two-dimension solution.

A group cognitive space plot was created to assist in interpretation of the two dimensions identified in the *INDSCAL-S* runs (Fig. 3). The group plot maps the cognitive similarity of all 32 photographs used in the multiple sort procedure for the sample of 60 individuals. Images were labeled based on number, clustering (random, clustered), and proximity of scuba divers. Visual interpretation of the group space plot suggested that the x-axis represented proximity of divers (dimension 1) and the *y*-axis represented number of divers (dimension 2). This interpretation was supported by participants who listed proximity (35%) and number (31%) as their most common initial sort criteria during the multiple sort procedure. There did not appear to be any clear cognitive separation in group space be-

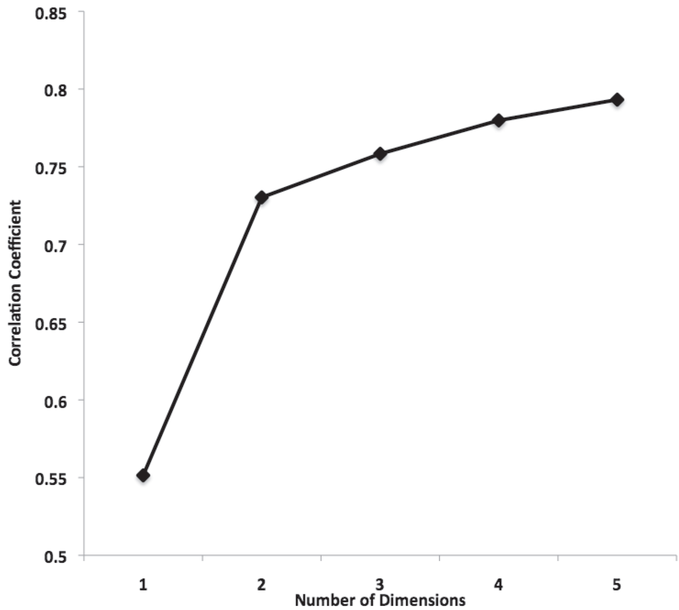
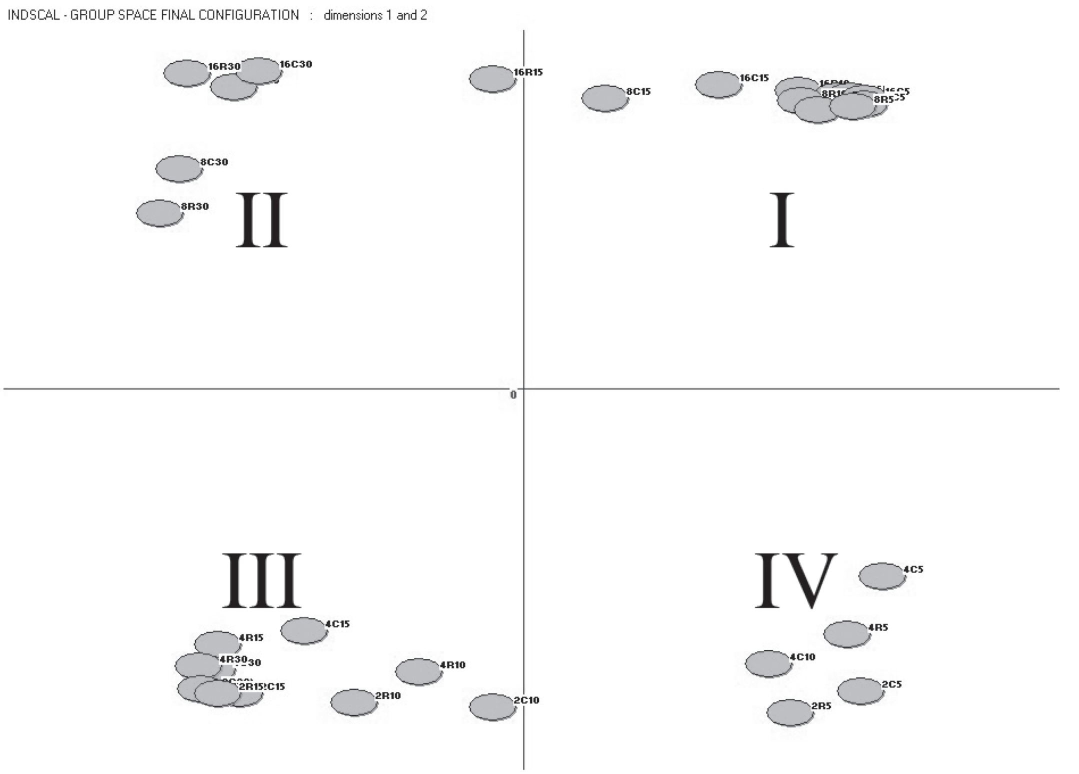


Figure 2. Multidimensional scaling scree plot of multiple sort data ($n = 60$).

tween random and clustered images, which was supported by the small percentage of participants (8%) who identified clustering as an initial sort criterion. At the conclusion of the multiple sort procedure, participants were also asked an open-ended question about factors influencing their perceptions of crowding underwater. Proximity and number of divers (both 21%) were again the most commonly stated responses, with only 5% of participants identifying clustering as a factor influencing perceptions of crowding when diving.

Given that clustering was not a strong dimension influencing perceptions of crowding underwater during the multiple sort procedure, it was not examined in the survey measuring level of perceived crowding in response to the scenarios depicted in the images. Combining both the number and proximity of scuba divers, therefore, produced the 16 crowding images (number of divers: 2, 4, 8, 16; proximity of divers: close, medium, medium-far, far) for a full factorial design, and each was evaluated by the sample of 101 individuals on the 9-point perceived crowding scale (Table 1). Perceived crowding clearly increased when the number of scuba divers increased and divers were in closer proximity (Table 2). Across all use levels of scuba divers, respondents perceived more crowding when divers were in closer proximity. Likewise, across all proximities or distances, respondents perceived more crowding as the number of scuba divers increased. Respondents, on average, perceived the least amount of crowding with 2 divers at 30 meters ($M = 1.33$, "not at all crowded"), which was the scenario depicting the fewest divers at the farthest distance. The highest crowding was perceived with 16 divers at 5 meters ($M = 8.77$, "extremely crowded"), which was the scenario depicting the most divers at the closest proximity.

A 4 × 4 two-way analysis of variance was used to examine the relative influence of the number and proximity of scuba divers on crowding evaluations. Both the number of divers and proximity of divers significantly influenced perceptions of crowding underwater, $F = 145.13$ to 727.63, $p < 0.001$ (Table 3). The interaction between these two dimensions was also statistically significant, $F = 5.87$, $p < 0.001$. The partial eta squared statistic, however, showed that the number of divers had a much stronger influence on perceptions of crowding (partial $\eta^2 = 0.58$) than the proximity of divers (partial $\eta^2 = 0.22$) or interaction between these dimensions (partial $\eta^2 = 0.03$). This suggests that 58% of the variance



Quadrant	Number of divers	Proximity of divers
I	High	Close
II	High	Far
III	Low	Far
IV	Low	Close

Figure 3. Full sample group space from multidimensional scaling of multiple sort data (n = 60). Data point key: number of divers/clustering/proximity (e.g., 4R10 = 4 divers/random/10 meters).

in perceived crowding defined by the model can be attributed to the number of scuba divers present in each scenario. Proximity or distance of divers was the second most important dimension explaining 22% of the variance in crowding, and the interaction between the dimensions explained only 3%, implying that this interaction was not substantially important. The adjusted R^2 of 0.625 for the model suggested that the number of scuba divers, proximity of divers, and the interaction between these dimensions collectively explained 63% of the variance in perceptions of underwater crowding in this model.

Conclusion

This article described a series of three exploratory investigations of possible dimensions influencing scuba diver perceptions of crowding in underwater settings. Initial focus groups suggested that number, proximity, and clustering of scuba divers were important dimensions of crowding. A multiple sort procedure then revealed that number and proximity were more important dimensions, and a larger survey confirmed that although both the number and proximity of scuba divers significantly influenced crowding, the number of divers was the strongest determinant. These findings have implications for management and future empirical research.

From a research perspective, many early recreation and tourism studies assumed that crowding was a function of actual use levels and reported encounters (see Manning, 1999, for a review). More recent studies, however, have demonstrated that the

Table 1
Full Factorial Design for Scuba Diver Crowding Photographs (n = 101)

Photograph	No. of Divers	Proximity of Divers (m)
1	4	30
2	2	30
3	4	5
4	4	10
5	4	15
6	8	15
7	2	5
8	16	10
9	16	15
10	8	5
11	8	10
12	8	30
13	16	5
14	2	10
15	16	30
16	2	15

number of people present or encountered only partially influences perceived crowding, and other social psychological (e.g., motivations, preferences) and experiential factors (e.g., behavior and activity of other users) also influence this phenomenon (see Manning, 2007; B. Shelby et al., 1989; Vaske & Shelby, 2008, for reviews). Although findings from this study suggested that the number of scuba divers was the most significant dimension of diver crowding underwater, the proximity of these divers is also important in this context. Clustering of divers, however, did not substantially influence crowding evaluations. Although these three situational dimensions are not likely a complete set of factors that influence crowding, manipulating additional explanatory variables would have exponentially increased the complexity of data collection instruments and intensified respondent burden. Given the exploratory nature of this research and that the study of crowding underwater has been almost completely unexplored, researchers are encouraged to build on the results by considering additional dimensions that may influence perceptions of crowding in underwater settings.

One cognitive dimension that should be considered is the influence of past experience, skill level, or specialization on evaluations of crowding underwater. Snorkeling and scuba diving are unique activities that occur in unique environments, and many newcomers or novices possess little or no experience with activities underwater. Cognitions used for interpreting crowding underwater, therefore, may be largely undeveloped in novices and likely develop as individuals gain experience in marine settings. Past research in terrestrial settings has shown that skill level can influence crowding related evaluations (e.g., Needham et al., 2005) and it is conceivable that underwater crowding conditions that are acceptable to inexperienced users may be intolerable for more experienced individuals. Investigating how perceptions of underwater crowding evolve as individuals gain experience and progress from novice to intermediate and expert levels of proficiency represents a line of behavioral research that is largely unexplored. Longitudinal and panel design studies could provide insight into this issue.

Research is also needed to understand how sociocultural and behavioral dimensions influence evaluations of crowding underwater. Inappropriate behavior and noncompliance with rules and regula-

Table 2
Mean Perceptions of Crowding (n = 101)[a]

	Proximity of Divers				
No. of Divers	5 Meters	10 Meters	15 Meters	30 Meters	Estimated Total Mean
2 divers	2.67	1.73	1.58	1.33	1.83
4 divers	4.87	3.86	3.41	1.90	3.51
8 divers	7.42	6.33	5.77	3.81	5.83
16 divers	8.77	7.95	7.17	5.99	7.47
Estimated total mean	5.93	4.97	4.48	3.26	

[a]Cell entries are means on 9-point perceived crowding scale of 1 “not at all crowded” to 9 “extremely crowded.”

Table 3
Two-Way Analysis of Variance for Diver Perceptions of Crowding (n = 101)[a]

	df	SS	MS	*F*-Value	*p*-Value	Partial Eta Squared (η^2)
Number of divers	3	7384.99	2461.67	727.63	<0.001	0.58
Proximity (distance) of divers	3	1472.96	490.99	145.13	<0.001	0.22
Number × proximity interaction	9	178.62	19.85	5.87	<0.001	0.03

[a]Model adjusted R^2 = 0.625.

tions by other users have been known to contribute to perceptions of crowding (Driver & Bassett, 1975; West, 1982). Group interactions such as the "perceived alikeness" of social groups also influence crowding (Buchanan, Christensen, & Burdge, 1981; Hammitt, 1982; Lee, 1977; Twight et al., 1981). Strong feelings of crowding may be influenced by encounters with individuals who adopt different behavioral standards or participate in dissimilar activities or groups (Manning, 1999). Conversely, perceived group alikeness may reduce perceptions of crowding (Burch, 1981). Studies in fields such as architecture, environmental management, and urban planning have shown that these sociocultural differences are significant in how crowding is experienced (e.g., Evans, Lepore, & Allen, 2000; Fleishman, Fleitelson, & Salomon, 2004; Kaya & Weber, 2003). These differences could be relevant in underwater situations and may play a particularly important role in activities such as scuba diving that are characterized by strong interpersonal relationships among individuals within similar social groups (Dearden et al., 2007). Research is needed to examine the influence of sociocultural and behavioral dimensions on evaluations of crowding in marine and underwater contexts at popular destinations where scuba divers and snorkelers from many different cultures congregate.

There have been a few studies to identify dimensions influencing crowding in a marine context. Needham, Szuster, and Bell (2011), for example, examined the influence of number of boats and size of these boats on snorkeler and scuba diver perceptions of crowding. Inglis et al. (1999) evaluated snorkeler crowding above water and underwater. Findings described here add to this small but growing body of research, and suggest that situations and cognitions used by humans to evaluate crowding in marine and underwater contexts may be somewhat different than those used in terrestrial settings. Although some results of this study were consistent with those in terrestrial settings where use levels have also influenced perceptions of crowding (see Graefe et al., 1984; Manning, 1999, for reviews), observing people underwater is different than encountering them on land because water clarity can limit visibility underwater and perceptions of size, distance, and sound can be distorted. In addition, equipment such as masks and breathing apparatus can decrease the field of vision and restrict movement of snorkelers and divers who tend to focus on their immediate environment to a greater degree than terrestrial recreationists. Future research is needed to examine the extent that these issues influence evaluations of crowding underwater.

This study showed that ICT methods for manipulating and creating visuals representing various crowding conditions can be adapted from studies in terrestrial settings and applied in an underwater context. Photographs and ICT have been useful for evaluating recreation and tourism conditions, and this study contributes to this growing body of research (see Manning, 2007; Manning & Freimund, 2004; Manning et al., 1996, for reviews). The research presented here, however, was exploratory and not specific to any particular site since it utilized generic images on a blue background selected to simulate typical tropical waters. Operationalizing techniques that simulate actual site conditions represents an obvious next step in assessing crowding in underwater environments, but incorporating more realistic physical elements that simulate actual site conditions adds substantial complexity to the creation of test instruments. More research is needed to develop valid, reliable, and replicable site-specific techniques for measuring social conditions underwater, and it is unclear if additional realism provided by site characteristics will produce significantly different evaluations of crowding than the generic backgrounds used in this study. More dynamic techniques such as underwater video and other multimedia approaches, rather than still photography, may be more effective for incorporating site conditions into test scenarios and instruments (Freimund, Vaske, Donnelly, & Miller, 2002; Kim & Shelby, 2009).

From a management perspective, results showed that respondents considered scenarios of 2 or 4 scuba divers at any proximity and 8 divers at 30 meters away to be not at all crowded or only slightly crowded. Conversely, scenarios of 8 divers at 5 to 15 meters and 16 divers at any proximity were evaluated as moderately or extremely crowded. These metrics could potentially be used with additional evaluative data to inform management actions designed to improve user experiences and minimize crowding at dive sites. Management actions could include strategies such as spatial and temporal zoning that seek to minimize crowding by providing guidelines for spacing between groups or spreads use over a specific period of time. These approaches may allow managers to achieve the seemingly contradictory goal of simultaneously reducing crowding, while maintaining overall visitation and participation rates (Manning, 1999). Any use of findings from this study to inform management, however, should be considered preliminary because results may not generalize to all coastal and marine environments where scuba diving occurs. Determining management standards and actions that maintain recreation and tourism experiences at any specific sites is beyond the scope of this exploratory study, but this represents fertile ground for additional research and the ultimate goal of this line of inquiry.

Ubuntu in Action

An earlier version of this article was presented in 2009 at the *6th International Congress on Coastal and Marine Tourism*. This Congress was held in South Africa and the guiding theme was the "Spirit of *Ubuntu*—Connecting Continents, Places, and People" that emphasizes allegiances, relations, and shared engagement and learning, which is required if progress is to be made with respect to management of activities in marine environments around the world. Scuba diving, for example, has enabled humans to venture into the undersea world and is growing rapidly in popularity. This activity provides substantial economic benefits to communities worldwide, but can impose adverse environmental and social impacts unless it is systematically planned and managed with multiple stakeholders using the best practices identified through research and management integrating both the physical and social sciences. A wide array of tools has been developed to assess biophysical impacts of scuba diving, but much less research exists on social aspects such as crowding underwater.

This study attempted to help address this knowledge gap by investigating the nature of scuba diver perceptions of crowding, and determined that the number of divers and proximity of these divers influenced crowding underwater. Although managers of recreation and tourism are responsible for ensuring that biophysical and social conditions meet legal and jurisdictional objectives and standards, understanding how different groups such as scuba divers perceive conditions is crucial if managers are to make informed, comprehensive, and transparent decisions. This involves sharing, utilizing, and learning from input inclusive of individuals, organizations, agencies, and scientists with economic, recreational, governmental, and environmental interests. It is hoped that results from this study stimulate further research and application in this area, and that the methodological techniques used can be refined and applied toward the overall goal of improving marine protected areas and other coastal environments.

Biographical Notes

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