ACTIONS
FOR THE CONSERVATION
OF COASTAL DUNES WITH
JUNIPERUS spp. IN CRETE
AND THE SOUTH AEGEAN
(GREECE)

LIFE07NAT/GR/000296

Action A.5
Deliverable A.5.1

VISITOR IMPACT ASSESSMENT

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- JUNICOAST -

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Responsible beneficiary: Mediterranean Agronomic Institute of Chania (MAICh)

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ΠΕΡΙΛΗΨΗ

Ο οικοτουρισμός και η αειφορική διαχείριση των προστατευόμενων περιοχών απαιτούν, μεταξύ άλλων, την σωστή χρήση των φυσικών πόρων από τους επισκέπτες και καθιστούν αναγκαία τη διαχείριση των επισκεπτών ως μέρος της συνολικής διαχείρισης των περιοχών αυτών.

Τις τελευταίες δεκαετίες, οι επισκέψεις σε προστατευόμενες περιοχές έχουν αυξηθεί, με αποτέλεσμα η εκτίμηση των επιπτώσεων των επισκεπτών στους φυσικούς πόρους να αποτελεί σημαντικό πρόβλημα στη διαχείρισή τους.

Προηγούμενες έρευνες, έχουν διαπιστώσει ότι η σχέση χρήσης-επίπτωσης είναι καμπυλόγραμμη. Η πλειοψηφία δηλαδή των επιπτώσεων εμφανίζεται με την έναρξη της χρήσης. Επίσης ο βαθμός των επιπτώσεων, δεν εξαρτάται μόνον από το συνολικό αριθμό των επισκέψεων, αλλά και από το είδος των δραστηριοτήτων, την συμπεριφορά των επισκεπτών και την αντοχή και ελαστικότητα του οικοσυστήματος.

Οι Μεσογειακές παράκτιες περιοχές, γνωστές για τις ιστορικές, αρχαιολογικές, οικολογικές και αισθητικές αξίες τους, συγκεντρώνουν μεγάλο αριθμό οικονομικών και τουριστικών δραστηριοτήτων. Η συγκέντρωση του τουρισμού στις παράκτιες περιοχές δημιουργεί αντιπαλότητες ως προς τη χρήση γης και οδηγεί στην συρρίκνωση και πολλές φορές στην καταστροφή των παράκτιων οικοσυστημάτων. Σήμερα υπάρχει αυξανόμενο ενδιαφέρον για τις επιπτώσεις του τουρισμού στο περιβάλλον. Επίσης ολοένα και περισσότεροι τουρίστες ενδιαφέρονται για “οικοτουρισμό” ή “πράσινο τουρισμό”. Στην Κρήτη τα παράκτια αμμοθινικά οικοσυστήματα έχουν περιορισθεί σημαντικά και συνεχίζουν να κινδυνεύουν με εξαφάνιση από την ανεξέλεγκτη ανάπτυξη του τουρισμού. Ειδικότερα, οι “παράκτιες αμμοθίνες με κέδρα” που στα πλαίσια του δικτύου ΦΥΣΗ 2000, έχουν χαρακτηρισθεί ως οικότοπος προτεραιότητας, μεταξύ άλλων κινδυνεύουν από τον τουρισμό και την έλλειψη ενημέρωσης και ευαισθητοποίησης. Ο ανωτέρω οικότοπος είναι το αντικείμενο του προγράμματος JUNICOAST, στα πλαίσια του οποίου συντάχθηκε η παρούσα μελέτη με σκοπό να καταγράψει: α) το είδος του τουρισμού, β) την ένταση χρήσης του οικοτόπου καθώς και την χωρική και χρονική κατανομή της και γ) τα μονοπάτια, τα σημεία κατασκήνωσης και τα ίχνη των

διαταραχών (συμπίεση του εδάφους, ζημιές στη χλωρίδα και στη βλάστηση, απόθεση απορριμμάτων) σε όλες τις περιοχές μελέτης στην Κρήτη (Κεδρόδασος, Φαλάσαρνα, Ν. Γαύδος και Ν. Χρυσή).

Η μελέτη βασίστηκε σε ερωτηματολόγια που συμπλήρωσαν οι επισκέπτες του οικοτόπου, στην καταγραφή των μονοπατιών, στην χωρική και χρονική κατανομή των σκηνών, στην καταγραφή των ζημιών στα δένδρα των κέδρων (σπασμένα κλαδιά), στην καταγραφή των εκτεθειμένων ριζών των κέδρων, στην καταγραφή της φυτοκάλυψης του εδάφους, του αριθμού των φυτικών ειδών, του αριθμού των αρτίφυτρων κέδρου, της φυτοκάλυψης επί και εκτός μονοπατιού υψηλής χρήσης καθώς και στην χωρική κατανομή των απορριμμάτων.

«Ο οικοτουρισμός ορίζεται ως μια περιβαλλοντικά υπεύθυνη ταξιδιωτική δραστηριότητα, σε σχετικά άθικτες φυσικές περιοχές, με στόχο την απόλαυση και γνωριμία των φυσικών αλλά και ενταγμένων στο φυσικό περιβάλλον, αγαθών». Υπό την έννοια αυτή το είδος τουρισμού που δέχονται όλες οι περιοχές είναι ο οικοτουρισμός. Η διάρκεια παραμονής όμως των επισκεπτών διαφέρει μεταξύ των περιοχών μελέτης. Στο Κεδρόδασος το 25% είναι ημερήσιοι επισκέπτες ενώ το 75% κατασκηνώνουν για μια ή περισσότερες ημέρες. Στη Γαύδο το 55% κατασκηνώνει για περισσότερες από 5 ημέρες ενώ οι ημερήσιοι επισκέπτες είναι μόνο 2%. Στη νήσο Χρυσή αντίθετα οι ημερήσιοι επισκέπτες είναι 67%. Στα Φαλάσαρνα ο κύριος όγκος των τουριστών συγκεντρώνεται στη μεγάλη παραλία ενώ ο οικότοπος, ο οποίος βρίσκεται βόρεια και νότια της μεγάλης παραλίας δεν δέχεται επισκέψεις.

Οι κυριότερες δραστηριότητες των επισκεπτών σε όλες τις περιοχές είναι: κολύμπι, κατασκήνωση, παιχνίδια στην παραλία και πεζοπορία.

Σχετικά με τον συνωστισμό, αν και η σημασία του όρου είναι υποκειμενική, το 1/3 – 1/4 των επισκεπτών θεωρούν ότι είναι μεσαίος ενώ περίπου το 1/4 θεωρούν ότι υπάρχει έντονος συνωστισμός. Επίσης 50% των επισκεπτών θεωρούν ότι ο οικότοπος ήταν κατά μέσο όρο καθαρός ή σχεδόν καθαρός, ενώ ο Σεπτέμβριος ήταν ο πιο “βρώμικος” μήνας.

Οι τρεις κυριότερες απειλές για τον οικότοπο σύμφωνα με τις απαντήσεις των ερωτηματολογίων, θεωρούνται τα απορρίμματα, το κόψιμο των κλαδιών και των ριζών των κέδρων και η έλλειψη ενημέρωσης και ευαισθητοποίησης.

60-75% των επισκεπτών θεωρούν ότι ο οικότοπος χρειάζεται καλύτερη προστασία και διαχείριση ενώ 30-45% θεωρούν ότι η κατασκήνωση δεν προκαλεί βλάβες στα Κέδρα και στις αμμοθίνες. Αξιοσημείωτο όμως είναι το γεγονός ότι μεγάλο ποσοστό των επισκεπτών (90% στο Κεδρόδασος, 67% στη Χρυσή και 82% στη Γαύδο) συμφωνούν ότι θα πρέπει να παίρνουν μαζί τους τα σκουπίδια όταν φεύγουν από τον οικότοπο. Επίσης, περίπου οι μισοί επισκέπτες σε όλες τις περιοχές, δηλώνουν ότι θα ήταν διατεθειμένοι να πληρώσουν ένα μικρό ποσό (1-5€) για την διαχείριση, την καθαριότητα και την καλύτερη προστασία του οικοτόπου. Η πλειονότητα των επισκεπτών (75%) είναι πτυχιούχοι 18-34 ετών. Επίσης η πλειονότητα είναι Έλληνες (Κεδρόδασος 90%, Γαύδος 84% και Χρυσή 57%).

Στο Κεδρόδασος υπάρχει το μονοπάτι Ε4 το οποίο διασχίζει τον οικότοπο από ανατολή προς δύση καθώς και ένα κύριο μονοπάτι που οδηγεί στον οικότοπο από βορρά προς νότο. Σε όλη την έκταση του οικοτόπου, όπου το επιτρέπει η βλάστηση και το ανάγλυφο, υπάρχουν ασαφή, δευτερεύοντα μονοπάτια που χρησιμοποιούνται από τους κατασκηνωτές. Οι σκηνές συγκεντρώνονται στο ανατολικό μέρος και ανά ημέρα καταγράφηκαν τον Ιούνιο 45, τον Ιούλιο 57, τον Αύγουστο 158 και τον Σεπτέμβριο 48.

Στη Χρυσή, στον οικότοπο που βρίσκεται στα ανατολικά, υπάρχουν 4 κύρια μονοπάτια από νότο προς βορρά, ενώ σε όλη την έκτασή του καταγράφηκαν δευτερεύοντα μονοπάτια πρόσβασης μεταξύ των σημείων κατασκήνωσης. Στον οικότοπο δυτικά υπάρχει ένα κύριο μονοπάτι κατά μήκος της βόρειας ακτής. Στον ανατολικό οικότοπο οι σκηνές συγκεντρώνονται κυρίως κατά μήκος της βόρειας και νότιας παραλίας καθώς και στο κέντρο του οικοτόπου. Ανά ημέρα καταγράφηκαν τον Ιούνιο 140, τον Ιούλιο 118, τον Αύγουστο 254 και τον Σεπτέμβριο 77 σκηνές.

Στο Σαρακήνικο της Γαύδου υπάρχει ένα κύριο μονοπάτι με δύο διακλαδώσεις στον Άγιο Ιωάννη υπάρχουν 4 και στον Λαυρακά 3. Σε όλες τις περιοχές υπάρχουν επίσης πολυάριθμα, δευτερεύοντα, ασαφή μονοπάτια που αντιπροσωπεύουν συχνή κίνηση επισκεπτών μεταξύ των θέσεων κατασκήνωσης και της παραλίας. Στο Σαρακήνικο καταγράφηκαν ανά ημέρα 16 σκηνές τον Ιούλιο και 116 τον Αύγουστο, ο κύριος όγκος των οποίων περιορίζεται στο κεντρικό και βόρειο τμήμα του οικοτόπου. Στον Άγιο Ιωάννη ανά ημέρα υπήρχαν τον Ιούλιο 135 σκηνές, τον Αύγουστο 314 και τον Σεπτέμβριο 126. Το μεγαλύτερο ποσοστό των σκηνών στον

Άγιο Ιωάννη συγκεντρώνεται στο βορειοδυτικό τμήμα του οικοτόπου. Στον Λαυρακά καταγράφηκαν 31 σκηνές τον Ιούλιο, 81 τον Αύγουστο και 50 τον Σεπτέμβριο και περιορίζονται στο βόρειο τμήμα του οικοτόπου κοντά στην παραλία ενώ ένα μεγάλο μέρος του οικοτόπου (3/4) παραμένει αδιατάραχτο.

Για την καταγραφή των διαταραχών στη βλάστηση μετρήθηκαν τα σπασμένα κλαδιά ανά δένδρο σε επίπεδο δειγματοληπτικών επιφανειών. Κατά μέσο όρο τα σπασμένα κλαδιά ανά δένδρο ήταν 4.6 στο Κεδρόδασος, 3.2 στο Σαρακήνικο, 3.0 στη Χρυσή ανατολικά και 1.9 στον Άγιο Ιωάννη ενώ στη Χρυσή δυτικά, στα Φαλάσαρνα και στον Λαυρακά ήταν περίπου 0.5. Η σύγκριση του αριθμού των σπασμένων κλαδιών ανά δένδρο μεταξύ χρησιμοποιούμενων και μη επιφανειών, έδειξε στατιστικά σημαντικές διαφορές. Επίσης, υπάρχει στατιστικά σημαντική διαφορά μεταξύ χρησιμοποιούμενων και μη επιφανειών όσον αφορά την κάλυψη του εδάφους από εκτεθειμένες ρίζες κέδρων και την φυτοκάλυψη (πόες, φρύγανα και θάμνοι). Αντίθετα, ο αριθμός των φυτικών ειδών δεν έχει στατιστικά σημαντικές διαφορές μεταξύ χρησιμοποιούμενων και μη επιφανειών. Αυτό μπορεί να εξηγηθεί από το γεγονός ότι τα περισσότερα είδη είναι ετήσια και την περίοδο που υπάρχει πίεση από τους επισκέπτες, αυτά έχουν ολοκληρώσει των κύκλο τους. Επίσης, ο αριθμός των αρτίφυτρων κέδρου αν και ήταν μεγαλύτερος στις μη χρησιμοποιούμενες επιφάνειες, δεν έχει στατιστικά σημαντικές διαφορές μεταξύ χρησιμοποιούμενων και μη επιφανειών. Αυτό μπορεί να εξηγηθεί από το γεγονός ότι η φύτρωση των σπόρων του κέδρου και η επιβίωση των αρτίφυτρων εξαρτάται και από πολλούς άλλους, περιβαλλοντικούς κυρίως, παράγοντες.

Η φυτοκάλυψη (πόες, φρύγανα και θάμνοι) και ο αριθμός των ειδών πάνω σε κύριο μονοπάτι (Ε4 Κεδρόδασος) και αριστερά ή δεξιά από αυτό, διέφεραν στατιστικώς σημαντικά.

Τα απορρίμματα που υπήρχαν στον οικότοπο καταγράφηκαν στο Κεδρόδασος και στη Γαύδο στο τέλος της τουριστικής περιόδου(Οκτώβριος 2009) και στη Χρυσή την άνοιξη του 2010. Ο κύριος όγκος των απορριμμάτων σε όλες τις περιοχές αποτελούνταν από πλαστικά και χαρτιά, τα οποία ήταν διεσπαρμένα σε όλη την έκταση του οικοτόπου. Διεσπαρμένα, αλλά σαφώς λιγότερα, ήταν επίσης κουτιά αλουμινίου και γυάλινα μπουκάλια. Υπολείμματα αντικειμένων κατασκήνωσης εντοπίζονταν κυρίως σε θέσεις υψηλής χρήσης. Στον Λαυρακά δεν έγινε καταγραφή

των απορριμμάτων επειδή ο οικότοπος σε όλες τις επισκέψεις που έγιναν ήταν καθαρός, τόσο λόγω του μικρού αριθμού των επισκεπτών-κατασκηνωτών, όσο και λόγω της ευαισθησίας των μόνιμων κατασκηνωτών, οι οποίοι συστηματικά συγκεντρώνουν και μεταφέρουν τα απορρίμματα. Στα Φαλάσαρνα ο οικότοπος βόρεια της μεγάλης παραλίας ήταν καθαρός λόγω του ότι δεν χρησιμοποιείται για κατασκήνωση. Αντίθετα ο οικότοπος νότια της μεγάλης παραλίας έχει σε μεγάλη έκταση απορρίμματα, που αποτελούνται από υπολείμματα θερμοκηπίων, τα οποία μεταφέρονται εκεί και χρησιμοποιούνται ως ζωοτροφή.

Καθώς ο οικότοπος των παράκτιων αμμοθινών με είδη κέδρων αποτελεί, ως χώρος αναψυχής, ιδιαίτερα δημοφιλή τουριστικό προορισμό, υπάρχει επιτακτική ανάγκη ελαχιστοποίησης των αρνητικών επιπτώσεων που προκαλούν οι επισκέπτες στον οικότοπο.

Η διαχείριση των απορριμμάτων, η σήμανση των κύριων μονοπατιών ή η τοποθέτηση ξύλινων διαδρόμων για τον περιορισμό της κίνησης των επισκεπτών, η οριοθέτηση του οικοτόπου, ο περιορισμός της κίνησης των μηχανοκίνητων οχημάτων στη Χρυσή και η τοποθέτηση ενημερωτικών πινακίδων είναι μερικές από τις άμεσες δράσεις που θα ελαχιστοποιήσουν τις αρνητικές επιπτώσεις, διατηρώντας ταυτόχρονα την αισθητική και φυσική αξία των περιοχών.

Επειδή οι επισκέπτες αποδέχονται ευκολότερα περιορισμούς ή κανόνες συμπεριφοράς όταν γνωρίζουν τους λόγους για τους οποίους οι περιορισμοί αυτοί επιβάλλονται, η ενημέρωση και ευαισθητοποίηση του κοινού για την προστασία του οικοτόπου είναι ένας σημαντικός στόχος του προγράμματος. Η τοποθέτηση ενημερωτικών πινακίδων σε διάφορα σημεία του οικοτόπου, η παραγωγή και διανομή φυλλαδίων, αφισών και βίντεο σχετικά με τον οικότοπο, η επικοινωνία-συζήτηση με τους επισκέπτες θα βοηθήσουν στην μακροχρόνια προστασία του μοναδικού αυτού οικότοπου.

Η προστασία της φύσης και ο οικοτουρισμός είναι έννοιες συμβατές και συμπληρωματικές και η ανάπτυξη του οικοτουρισμού εξαρτάται άμεσα από την αειφορική διαχείριση του φυσικού περιβάλλοντος. Συνεπώς η σωστή διαχείριση του οικοτόπου θα συμβάλλει σημαντικά στην προστασία του και στην οικοτουριστική ανάπτυξη των περιοχών.

Introduction

With growing visitor loads in protected areas, managers have become increasingly aware of visitor impacts and the pressures that visitors can place on popular icon sites (Buckley, 1998, 2004; Leung and Marion, 2000; Newsome et al., 2002; Monz and Leung, 2006). In response to these growing threats, the field of recreation ecology emerged in the 1970s with a view to increasing our understanding of ecological responses to visitors and facilitating better management of natural resources (Liddle, 1997; Leung and Marion, 2000). Past research on visitor impacts has found that the use–impact relationship is generally curvilinear with the majority of impact occurring with initial use. The degree of impact depends not only on the overall number of visits, but also on the type of activities, actual behaviour, and the resistance and resilience of the ecosystem (Cole and Marion, 1988; Cole, 1995d; Monz and Leung, 2006).

Mediterranean coastal areas are sites of countless economic and recreational activities and are well known for their historical, archaeological, ecological, and scenic values, which are still to be observed in unspoiled regions. Since the 1970s, man has come to regard the seashore as a prime vacation spot; no other habitat receives a greater number of visitors than the coast as they are among the most attractive of Mediterranean landscapes, and their diverse biotopes sustain an abundance of distinctive and often highly specialized flora and fauna (Gehu 1985; Carter 1991). In fact, about one-third of the world’s tourists come to the Mediterranean shores every year, to generate more than half of the world’s tourism income (Barale and Folving 1996). This concentration of tourism in the Mediterranean Sea does, of course, create a series of conflicts that lead to the deterioration of coastal ecosystems with the consequence of being threatened by misuse and pollution. Sandy beaches and coastal dunes are heavily impacted, since they constitute the preferred landscapes of most summer visitors. During the past 30 years almost 75% of Mediterranean coastal dunes have been damaged or destroyed, mainly due to tourism (Van der Meulen and Salman 1996). Along the Spanish and French Mediterranean coast 75–80% of the sand dunes have been destroyed by tourism, urbanization, and industry. Serious erosion as a result of mass recreation

has been reported for all European countries (Van der Meulen and Salman, 1996). Sand dunes in Portugal, Italy, Greece, Israel, Turkey and Tunisia are under growing tourism pressure as well (Williams, 1998). Stabilized sand dunes that carry climax vegetation have been found to respond more strongly to disruption than shifting and semi-stabilized dunes (Rickard et al., 1994; Kutiel et al., 1999). Examples of impacts produced by human activity in coastal dune systems span the spectrum from “minor” to “highly significant”. A short list includes pedestrian footprints and footpaths; all-terrain vehicle and off-road vehicle tracks and pathways; construction of hard-top roads, ablution facilities and recreational structures; housing development for temporary or permanent occupation; groundwater extraction schemes; stock grazing and farming; waste disposal sites, littering and artificial vegetation (Rust and Illenberger, 1996). Litter left behind on the beach and in the dunes by human visitors has become an escalating problem. Teagle (1966, cited in Ranwell 1972) quantified litter deposited in Studland Dunes, during a two-year period and observed some impact on the fauna. Since this work, non-biodegradable plastic materials have become the chief items of litter, affecting surf-zone animals as well as those higher up the slope. Moore et al. (2001) have recently studied the composition and distribution of beach debris in Orange County, California. In some regions of the world, litter is simply allowed to accumulate, or be washed out to sea. In others, it is collected but then buried above high-water mark or among the dunes, where it tends to resurface. Only in countries with a commitment to environmental conservation the litter is removed to landfill or incinerators. An important negative feature of litter is its detraction from the aesthetic value of the beach.

Of course, natural processes also impact on coastal dune systems, and here, too, the impacts vary in significance. A short list includes storms and floods; sea level changes; climatic changes, including changes in the wind regime; and changes in sand supply. In terms of developing an effective managerial strategy for coastal dune systems the impacts by natural processes should be considered a normal part of the natural environment (Rust and Illenberger, 1996).

In Greece, rapid and uncontrolled tourism growth has contributed to the deterioration of the coastal environment, but there is now a growing recognition that the natural and cultural environment is an important resource worth preserving

(Tzatzanis and Wrbka 2002). Today there is a growing interest in the environmental effects of tourism from governments, non-governmental organizations, the private sector, and the public. A growing number of tourists also became more interested, to varying degrees, in the environmental aspects of tourism. ‘Green tourism’, ‘eco-tourism’ and ‘sustainable tourism’, became favourite phrases in the tourist industry (Holden, 2000). Tourism in Greece however, is still dominated by group tourism, a phenomenon attributed mainly to ineffective public policies (Apostolopoulos and Sonmez 2001) and the strong influence of tour operators who control the tourist market since they are more organized and can offer ‘tourist packages’ at low prices to travellers in the countries of origin (Briassoulis 1993).

In Crete, sandy beaches and sand dunes systems receive ample weight of the tourist industry of the island and represent a perfect example of the development pressure from which coastal landscapes and especially sand dune systems are threatened (Tzatzanis et al., 2003). The region of Crete is rich in natural sand dunes systems, more specifically the priority habitat type 2250* “coastal dunes with *Juniperus* spp.” as in the cases of Kedrodasos-Elafonissi, Falasarna, the island of Gavdos and the island of Chrysi which are selected as Natura 2000 sites due to their ecological importance. Tourism in combination with lack of environmental education and public awareness is considered a serious threat to this priority habitat throughout Greece. Consequently, a visitor impact assessment in order to design and appropriately define the habitat restoration specifications and the various visitor management interventions was deemed necessary. Additionally, information on the visitors’ levels of awareness will enable to target appropriately the content and dissemination of information material.

The specific objectives of this deliverable are to (1) determine the types of tourism, its intensity (spatial distribution) and the extent of visitors’ impacts on coastal dunes with *Juniperus* spp. habitats in all Cretan sites, (2) record pattern of use (e.g. trails, camping locations and hotspots) and impacts (e.g. signs of trampling, vegetation damage, littering), and (3) establish levels of environmental awareness regarding habitat sensitivity, motivation of visit and activities undertaken whilst on site.

For the purpose of this report, “**visitors**” are defined as: “members of the public making recreational visits to the habitat. The term is used in a broad sense and includes, local, national and international visitors, eco-tourists (both individual travellers and people on commercial trips). “**Visitor effects**” are the physical processes associated with the presence of visitors in natural settings, and may or may not be adverse. Any visitor use will have effects on the sites used. Not all of these effects will result in negative impacts. There may also be positive benefits for conservation in general and increased support and awareness in habitat protection in particular (Tzatzanis and Wrbka 2002). For example, Cessford (1995) found that visiting protected sites could stimulate a greater pro-conservation attitude in people. Regardless of this, serious concerns are being expressed about potential negative impacts from visitors on the actual resources and values targeted under protected areas status. “**Visitor impacts**” arise when specific visitor effects present tangible threats to the key conservation values underlying the conservation management of a site. Other natural processes or external human influences may have greater impacts on site conservation values than any direct visitor effects. This working distinction between visitor effects and impacts is essential, and allows significant problems to be more clearly identified. Therefore, “**visitor impacts**” are defined as: “impacts on the natural conservation values of the habitat arising from the presence and activities of visitors”, while “**conservation values**” are the specific elements of natural and historic assets that underlie the high priority assigned to them by conservation management agencies. These are the objects, species or environmental associations attributed with greatest importance for conservation purposes.

We suggest that any impact that leads to long-term effects of change (say, a decade and longer) is a “**highly significant impact**”. An impact that causes medium-term effects of change (say, years) should be considered a “**significant impact**”, whereas an impact likely to produce at the most seasonal effects of change should be viewed as a “**minor impact**”. A minor impact that is taking place continuously, like trampling or grazing, would of course produce an effect for as long as the impact occurs.

Section 1 Visitor effects on the environment

Recreational use can have both direct and indirect effects on the environment. Direct effects can vary from habitat loss through urban development or the provision of tourist facilities, to the direct destruction of vegetation through trampling and vehicles, and the direct disturbance of animals, especially birds (Van der Maarel and Usher 1997). Furthermore, indirect effects include: erosion by trampling, gradual changes in vegetation structure and plant species composition as an adaptation to mechanical pressure, soil compaction and subsequent changes in species composition, and decline of attractive plant species through picking of flowers (Van der Maarel and Usher 1997).

Cessford & Dingwall 1997 demonstrated the complexity of assessing specific impacts of the visitors’ effects on the natural environment but also provided sufficient information to summarize the range of those effects by identifying three overall categories of visitor-related effects: a) physical damage; b) wildlife disturbance and c) hazard introduction (Figure 1).

1.1 Physical damage effects

Physical damage effects comprise those direct structural changes to physical and biological features and environments that occur where visitors walk, ride, drive, rest, and are accommodated. Typical effects relate to direct trampling or wheel action on rocks, soils, vegetation, and micro-fauna. For example, these effects can result in: plant and micro-fauna damage, displacement, or death; soil disruption; damage to natural surfaces or features; and damage to the physical integrity of historical or cultural features. These effects can also contribute to secondary diffusive processes, such as induced soil erosion; disruptions to species balances; and changed habitat viability (Leung and Marion 2000). Visitor behaviour may also go beyond simple unintended effects, to deliberate negative impact behaviours such as vegetation breakage; firewood collection; campsite clearance; specimen collection and removal. Some damage effects relate to the intended and unintended structural changes from management actions. Intended changes are anticipated effects in planned management processes, such as the clearance and disruption of vegetation, soils and wildlife during construction and maintenance of trails, huts, and drainage

channels. Unintended changes are often unanticipated physical effects from management actions, such as shading from buildings; on-flows from water channelling; erosion and damage from wind-channelling. Particular attention is required to the distinction between environmental effects and facility effects, a matter on which there is a common misconception (Cessford, 1997). When people make reference to environmental impacts from visitors', the typical examples described are usually associated with physical trampling damage to trails, campsites, and adjacent vegetation. Consequently, most management and research effort has tended to emphasize this issue, which is relatively simple to observe, understand, and manage. However, it was also noted that in most cases these types of effects were not usually very significant at all in their impact on conservation values. Moreover the impacts generated by them are not primarily environmental ones. They are related more to perceived compromise to the natural character of settings, the quality of facilities and services, and associated quality of visitor experiences. While these are important aspects for management attention, they are essentially part of normal management processes. To achieve the best focus on the significant environmental impacts on conservation values, it is important to distinguish them clearly from those impacts on the facility and service values.

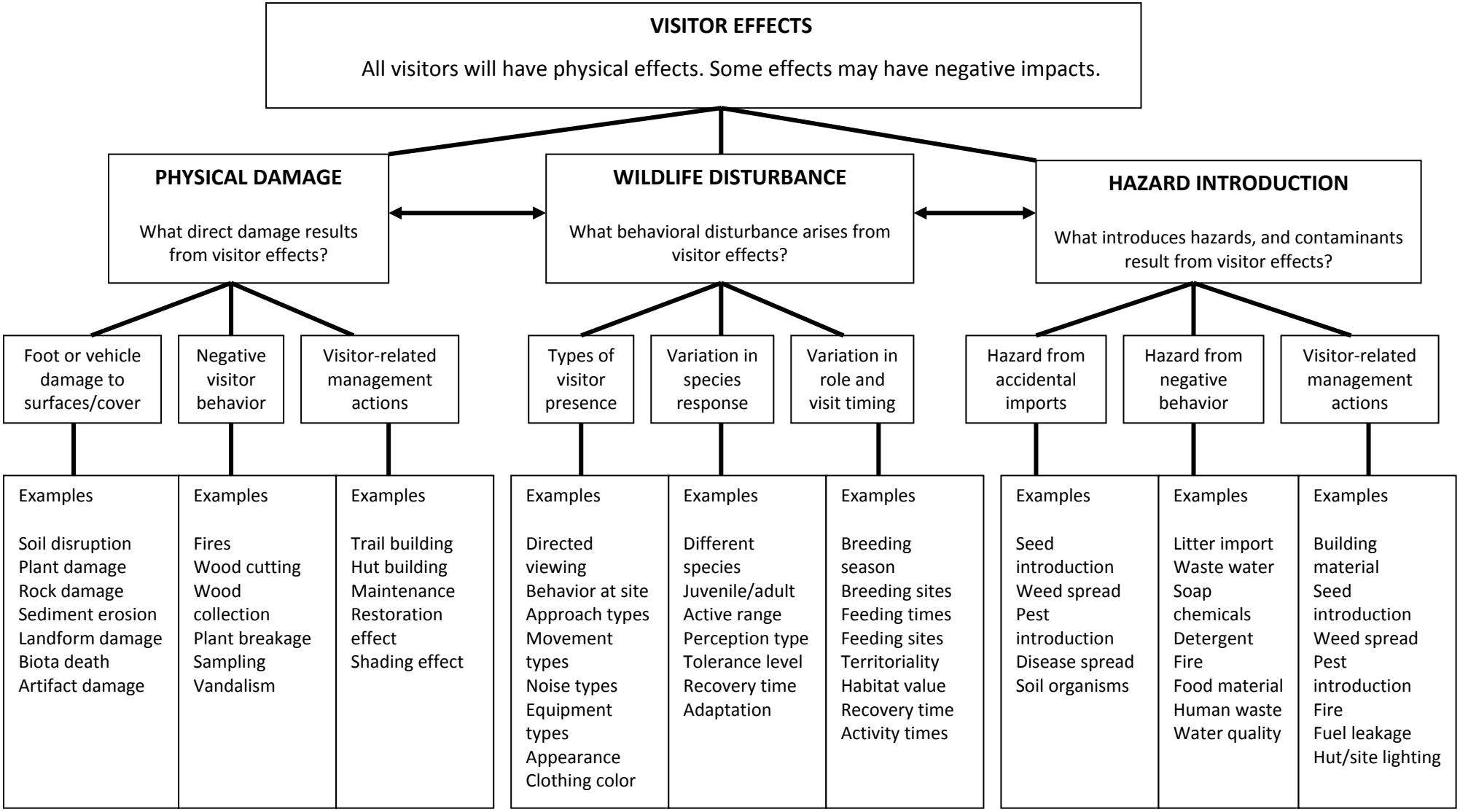

Figure 1 Extent of visitor effects on the environment (Cessford, 1997)

1.2 Wildlife disturbance effects

Visitors can intrude upon wildlife in a variety of ways, from their visual presence to their movement, noise, and behaviour. Different species will perceive the consequent disturbance in different ways and for different reasons. Wildlife tolerance and response, and any impact consequence, will vary among different species, settings and times. Factors contributing to these variations can include different feeding patterns; territoriality; breeding seasons and behaviours; lifecycle maturity; alarm behaviours; and ecological niche competition. Some visitor effects, such as trampers passing by, may be incidental to wildlife, whereas others, such as ecotourism visits or photography, may be specifically directed at wildlife. Additional visitor-related effects can also arise from the ways in which wildlife responds to the presence of staff; any of their associated construction, maintenance and research activities; and the effects related to the presence of facilities and structures (e.g. huts, signs, tracks, lighting, reflections, colour, and noises).

1.3 Hazard introduction effects

When visitors come to a natural environment they can import harmful external material, substances, or biota. Visitors may accidentally introduce hazard sources such as exotic weeds, predators, and diseases. They may also introduce hazards from negative behaviours such as fuel leakage or disposal; soap chemicals from washing; littering; bringing dogs; or inappropriate fire practices. Similar hazards arise from the activities of management staff, both direct and indirect, in facility provision and maintenance. These may be direct introduction effects, such as exotic seeds in track fill or building materials; and chemicals from material degeneration. Or they may be indirect effects, such as providing access routes for predators; fire potential; and providing focal points for visitor congregation.

Wide range of possible visitor effects across a diversity of sites can be summarized in these ways, the critical question still remains – how do we distinguish from among all these effects the situations of significant visitor impacts?

Section 2 Identifying key visitor impacts, a common approach to impact assessment

The most important information required to identify and assess impact problems is better definition and prioritization of the key conservation values in different sites and management situations. This information allows managers to clearly specify their conservation management objectives at different sites. In concluding their major impact visitor impacts review, Kuss et al. (1990: 242) noted that there was strong agreement in the literature that managing visitor impacts must begin with the setting of specific objectives. When reviewing the progress made after 10 years' extensive application of the Limits of Acceptable Change (LAC) impact management process, Cole & McCool (1997: 61) specified that a new step was required at the start of the LAC process - explicitly defining the goals and desired conditions of management. The widespread recognition of this fundamental need leads to the conclusion that greater effort is required to determine which environmental aspects of a site are of most critical conservation importance.

Once the key conservation values are identified, then the key visitor impact issues will become clearer and limited research and management resources can be more effectively and efficiently applied. Significant visitor impacts would be distinguished where the visitor effects, in particular, were compromising the key objectives for conservation management (e.g. sustained or enhanced biodiversity, species viability, representativeness). This approach is more active and directed, based upon identifying the key sites for priority conservation values, and concentrating time and resources on specific situations where visitor use potentially puts these values at direct risk. Thus, instead of continuing attempts to derive generic 'top-down' approaches to defining important visitor impact issues, such definition should be a `bottom up' approach based on an understanding of the key conservation values. A wider research and information framework is required to integrate whatever knowledge of conservation values and visitor effects is currently available, and to direct resources at the most relevant research and information gaps. Figure 2 outlines a framework, and an approach, for more systematically

integrating research and information knowledge to identify key visitor impact issues (Cessford 1997). This is based on a sequence of:

- Improving general ecological baseline research and information;
- Identifying the key conservation values of importance to management;
- Locating where these values occur at specific key sites; and
- Assessing visitor interactions with these values at the key sites.

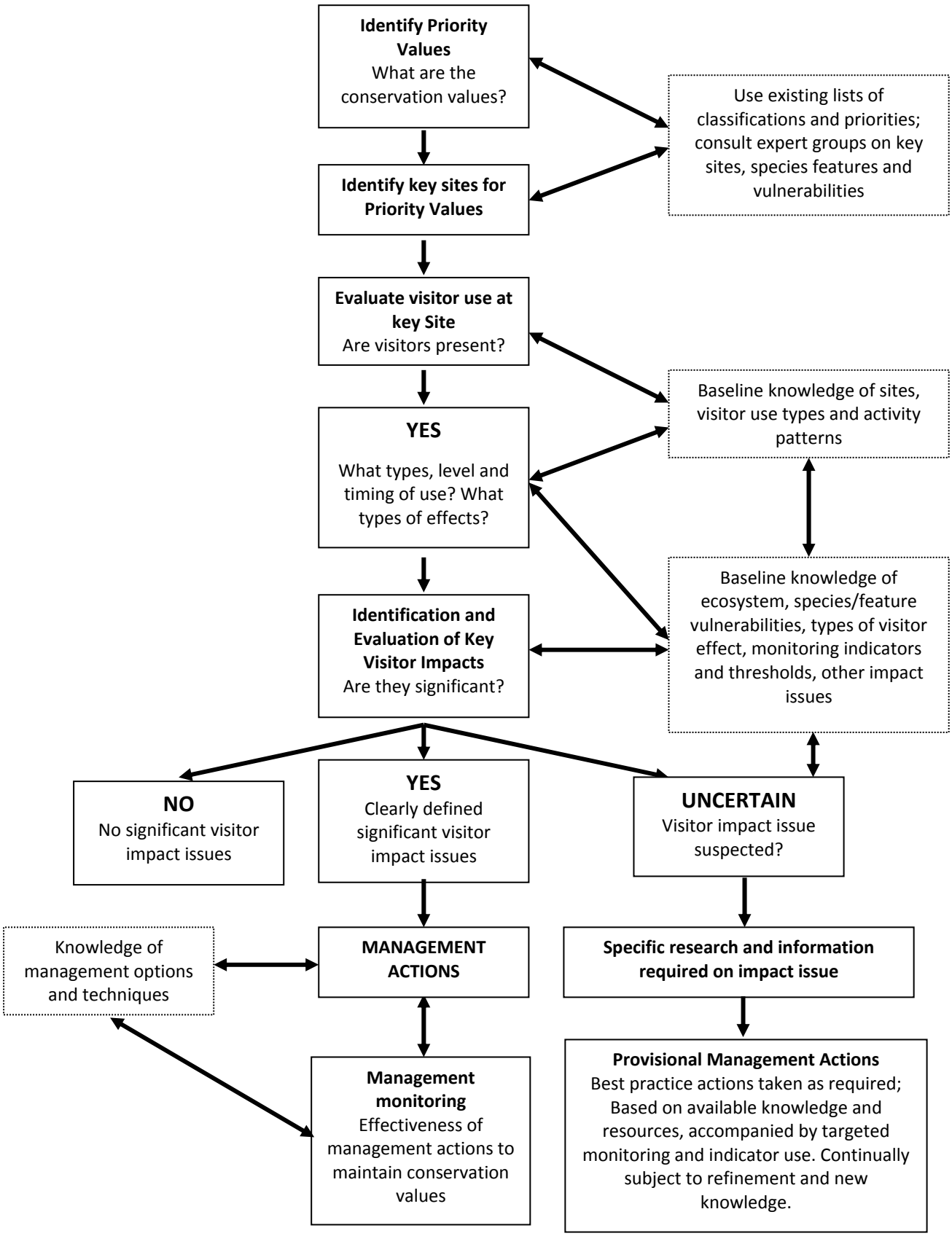

Figure 2 Common approach for identifying key visitor impacts on conservation values (Cessford, 1997)

2.1 Improving use of ecological baseline information

The vital ingredient for assessing visitor impacts on key conservation values is independently derived ecological baseline information. In this context, `baseline' information comprises a general understanding of ecological components and their interactions and associated physical processes. This enables key conservation values and threats to be better defined, prioritized and spatially located.

A common misinterpretation is to loosely view baseline information as defining some ideal “baseline state”, to which subsequent generic monitoring may be related. It is commonly associated with top-down impact assessment approaches. This type of baseline monitoring function can be applied more appropriately and productively later in the impact management process. Once key values and threats are identified and the need is established to address particular impact issues, then case-specific standards, indicators and thresholds can be defined for any specified baseline state that may be required.

Ideally, for any given category of conservation value, the relevant baseline research and information resource of knowledge should already have established the following:

- What values are most important;
- What the main impact vulnerabilities are; and
- What the key sites in their distributions are.

The importance of this type of baseline information for addressing visitor impact issues has not been widely apparent in most research and management considerations to date. In fact, investigations related to visitor impacts in a particular research discipline tend to be considered peripheral or of low priority (Cessford 1997).

Filling the gaps in this baseline knowledge, or overcoming difficulties in collating and integrating what information and knowledge already exists, are together the most prominent current research and information needs in resolving visitor impact problems. General ecological understanding is essential to distinguish among wider ecosystem changes (natural or human-induced), the effects of visitors, and the instances where these visitor effects represent real impacts.

2.2 Identifying key conservation values

Clearly defined conservation values and priorities are the vital baseline information requirements for achieving an optimum balance between management outcomes for visitor and conservation purposes. A summary framework for categorizing the range of conservation values is essential. Where not already available, systematic approaches need to be developed for identifying and prioritizing key conservation values. These would cover the species, ecosystems, associations, or physical features of greatest conservation importance.

Consultations and investigations outside the immediate visitor research and management disciplines are required. Consultation should be encouraged with a variety of specialists and professional associations in different research disciplines. This process should also identify any additional baseline research and information for facilitating development of value classifications or for determining value priorities.

2.3 Locating site-specific conservation values

Once priorities are established in different value categories, the distributions of the higher priority values should be mapped, and the key sites or occurrences located. This requires a spatial inventory of value distributions, preferably making more use of advanced spatial database and analysis systems, such as those represented by Geographical Information Systems (GIS). Such integration is essential for any approach to systematically identify site-specific visitor impact issues. This will be based on identifying the high-priority sites for the high-priority conservation values.

2.4 Identifying visitor impact hot-spots

The process for identifying high-priority sites will also identify their associated site-specific conservation management objectives. Once key sites and objectives are defined, then the most important environmental threats to the priority conservation values can be more directly evaluated. These threats may involve normal environmental processes such as natural environmental fluctuations, catastrophic events, or wildlife predation. However, in some situations, specific visitor effects

may pose the most significant threats. In any case, having a site focus combined with a rationale for specific management objectives will be a major advance.

Where key sites for certain conservation values have been identified, assessment of current visitor use will be required (e.g. presence of visitors, types of use, and levels of use) as part of the general threat assessment. If some characteristics of visitor use pose significant threats to key values, then greater focus will be required on visitor research and management. If visitor effects are not important, then resources can be directed to managing the primary threats. The visitor impact will be more clearly defined by already knowing the key environmental values and the significance of the key site. If the potential impact problems can be resolved by management actions, then visitor use can continue. If not, then a clear basis for management actions or further research is established.

If the zones, areas or sites of key conservation values could be mapped, then overlays of visitor use systems could be applied. The visitor use systems comprise the visitor “nodes” (e.g. huts, campgrounds, viewing points, car-parks, climbing sites, river entry points, etc), and “flows” (e.g. roads, tracks, and rivers). These overlays would enable visitor 'hot-spots' to be defined: i.e. the situations where visitor activity patterns intersect directly with key sites for priority conservation values. They would provide an immediate indication of where impact issues may be occurring. And they would also provide more direct guidance for deciding where assessment, research, monitoring and management action may be appropriate, and what methodologies should be applied.

Section 3 Research and information needs to assessing the environmental impacts of visitors

General investigations of the different types of effects that visitors may have are not a great priority, as they are largely unfocused on the environmentally significant visitor impacts, and have already been extensively dealt with internationally. This also applies to attempts to determine generic environmental impact indicators and carrying capacities. Both represent tools that might be applied by managers once significant visitor impact issues are identified, and their applications are considered necessary for case-specific impact control or monitoring purposes. Research should, therefore, be re-orientated towards more precisely identifying visitor impact 'hot-spots' on the basis of site-specific conservation values.

Apart from the ongoing need for continually improving general baseline information resources, the main requirements for initiating this type of systematic and integrated approach to assessing the environmental impacts of visitors can be summarized as follows:

- Classification processes for determining conservation value categories;
- Prioritization processes for elements in conservation value categories;
- Databases for the visitor use system and priority conservation values.

3.1 Classification and prioritisation processes

Processes for classification and prioritization are already well established in many disciplines, and are subject to ongoing revision as baseline information grows and threatened status changes. For example, Molloy et al. (1994) document the results of a major prioritization process for New Zealand's threatened plants and wildlife. They provide immediate focus on what species conservation values are more immediately important.

3.2 Database developments

A central database that provides an inventory of site-specific locations, site conditions, visitor assets, basic visitor use characteristics, and conservation assets should be established. In this context, assets could refer to the priority conservation values with specified priority site locations. Such a database should be designed to have multiple uses and to be evolutionary and modular, allowing components to be

added as required. Among its other management functions, such an integrated database resource will represent the core of a spatial inventory of visitor use. The spatially defined sites that form its functional basis may also provide the reference points of visitor use relative to key sites for conservation values. Such a conceptual model is based on the idea that specific assets can be related to specific places and processes. This type of core conservation model will allow managers to do the following:

- For any place, list all the assets there, and what processes might be affecting them;
- For any process, list all the assets known to be affected by it, and in what places this occurs; and
- For any asset, list where it occurs, and what processes might be affecting it.

Section 4 Study areas

The study areas included all priority habitat 2250* “coastal dunes with *Juniperus* spp.” in the region of Crete. More specifically, Kedrodasos in the area of Elafonisi, the 2250* habitats in the island of Chrysi, the 2250* habitats in the island of Gavdos and Falasarna. In the area of Falasarna where the habitat 2250* is fragmented, visitors go to the main sandy beach and do not visit the habitat as access to the sea is difficult. Therefore, the social survey was not implemented on the 2250* habitat in Falasarna.

4.1 Kedrodasos

Kedrodasos is located in the south western part of Crete (35°16’09,15’’ N and 23°33’31,56’’ E), 1.5 km east of the Elafonisos area. Administratively it belongs to the municipality of Pelekanou/prefecture of Chania (Figure 5). The main present use of the habitat consists of recreation with an unknown number of visitors using the site for swimming and free camping. Following the implementation of European Habitats directive, the area of Elafonisos has been designated a Natura 2000 site (code GR4340015, name: Paralia Apo Chrysoskalitissa Mechri Akrotirio Krios). The priority habitat of Coastal dunes with Juniperus spp. (Kedrodasos) within the Natura 2000 site of Elafonisos exists in one location and covers an area of 11.3 ha in total (Figure 5). The habitat is only accessible by foot, visitors arrive via a footpath leaving their cars on the top of the hill and walking down to the beach where the habitat is located.

4.2 Chrysi

Chrysi is located southeast of Crete (34°51’40’’ N and 25°42’50’’ E), 15 km south of the municipality of Ierapetra, Prefecture of Lasithi (Figure 5). Chrysi has an area of approximately 5 km2, a maximum altitude of 31 m and geologically consists of cherts, sandstones and breccia. Following the implementation of European Habitats directive, Chrysi has been designated a Natura 2000 site (code GR4320003, name: Nisos Chrysi). Coastal dunes with *Juniperus* spp. on the island of Chrysi exists in two locations and covers an area of 70 Ha in total (Figure 5). Administratively, Chrysi belongs to the municipality of Ierapetra, prefecture of Lasithi. The island is

only accessible by sea, with the main passenger port located on the south east coast. Privately owned boats conduct day trips to the island during the summer months (May to October). The main present use of the island consists of recreation, consisting of daily excursions of a large number of visitors (Figure 3 and figure 4) during the summer months and free camping.

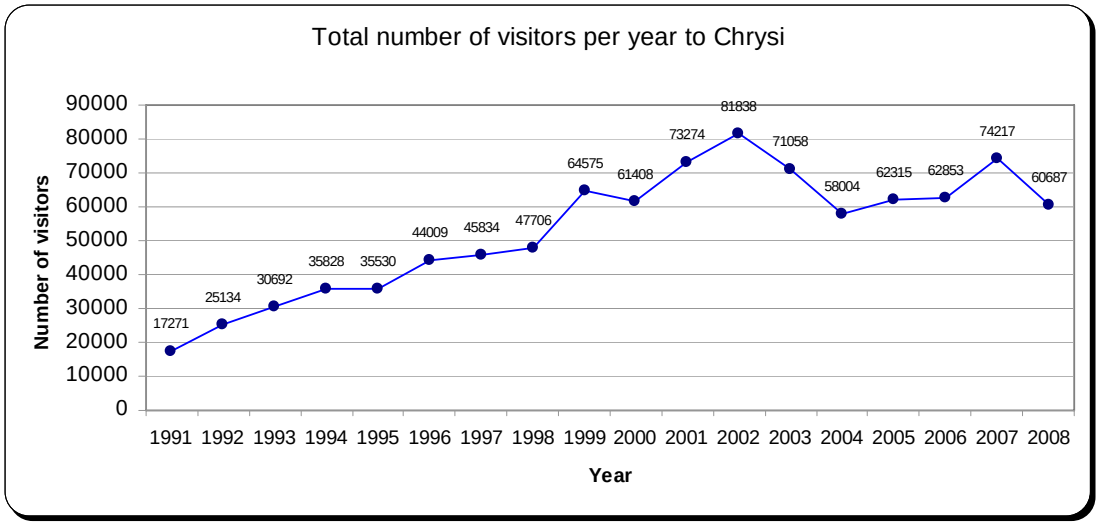

Figure 3 Total number of visitors per year (Source: Port Authority of Ierapetra)

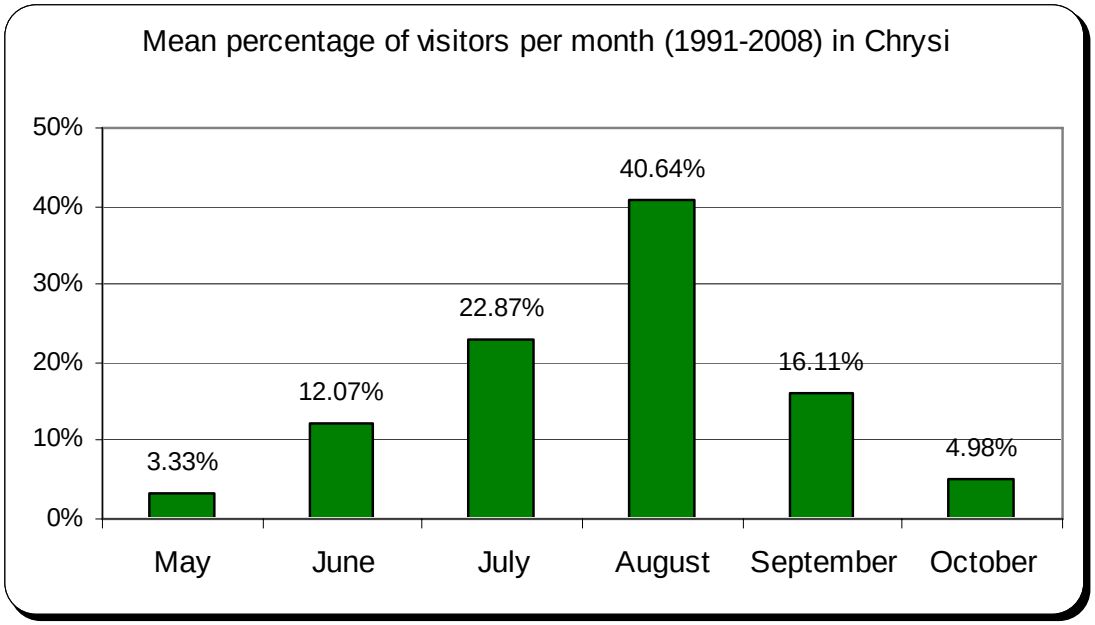

Figure 4 Mean percentage of visitors' arrivals per month (Source: Port Authority of Ierapetra)

4.3 Gavdos

Gavdos lies 28 miles off the island of Crete and 150 miles off the shores of northern Africa (34°52’36’’ N and 24°05’25’’ E) (Figure 5). It has an area of 30 km2, a maximum altitude of 362 m and geologically consists of upper Cretaceous limestones. Following the implementation of European Habitats directive, Gavdos has been designated a Natura 2000 site (code GR4340013, name: Nisoi Gavdos kai Gavdopoula). Coastal dunes with Juniperus spp. on the island of Gavdos exists in three locations (Agios Ioannis, Lavrakas, and Sarakiniko) on the northern coasts and covers an area of 102 Ha in total (Figure 5). Although small and sparsely populated, Gavdos is administratively independent with its own community, and belongs to the prefecture of Chania. Based on National Census 2001, Gavdos has a population of 80 residents 50 of which live permanently on the island, consisting of 24 households (Oikos, 2008). The main income generators of the island are tourism and agriculture. Access to the island is via a ferry, which is receiving a growing number of visitors. Tourism in 2007 was 8000 people during the summer months (Oikos, 2008) whereas in 2008 it rose to 14000 (ANENDYK personal communication). It should be noted that each priority habitat site has its particularities and threats. Both Agios Ioannis and Lavrakas are not accessible by car, can be considered remote and used for tourism (free camping). Sarakiniko on the other hand, is accessible by car, is located next to a popular beach and the area is undergoing tourism development.

4.4 Falasarna

Falasarana is located in western Crete on the neck of Cape Gramboυsa (Figure 5). Administratively it belongs to the municipality of Kissamos, Prefecture of Chania. Following the implementation of European Habitats directive, the area of Falasarna has been designated a Natura 2000 site (code: GR4340001, name: Imeri kai Agria Gramvousa - Tigani kai Falasarna - Pontikonisi, Ormos Livadia-viglia). The habitat of costal dunes with *Juniperus* spp is located in the western part of the basin close to the coastline (Figure 5). The mapped 2250* priority habitat included in the JUNICOAST proposal is fragmented and traversed by a tarmac road. Another location of the 2250* habitat with sparse *Juniperus* populations, which has not been mapped as such in the NATURA2000 network, has been located in the vicinity. Visitors go to

the main sandy beach and do not visit the habitat, as access to the sea is difficult. The new site (Figure 5) is used for recreational purposes, and no evident land ownership issues are known to exist. The surrounding area is characterized by intensive and expanding agricultural activities, mainly greenhouses, as well as tourism.

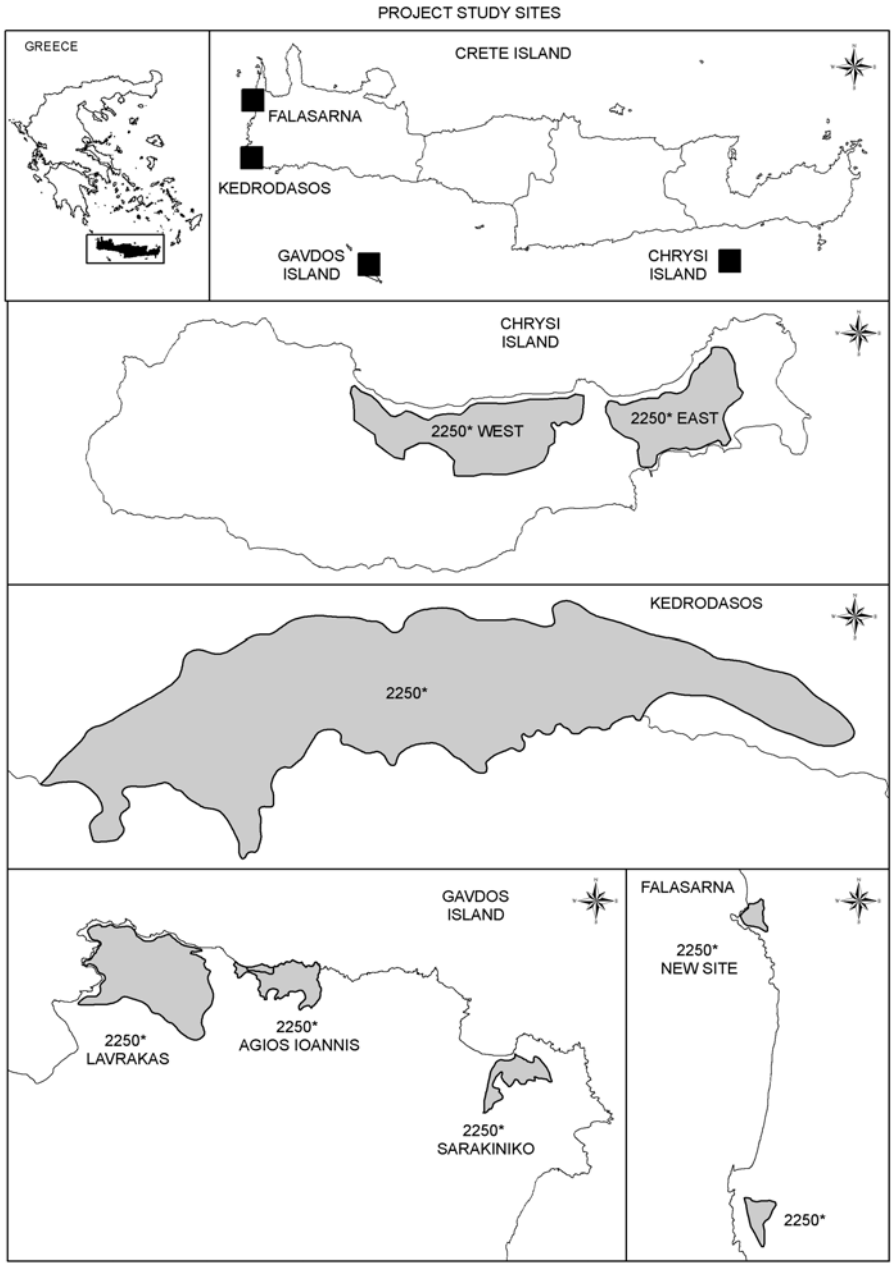

Figure 5 Location of the 2250* priority habitats in Chrysi, Kedrodasos, Gavdos and Falasarna

Section 5 Methods

The conservation values of each habitat, the habitat perceived status and trends and the level of public awareness have been identified during the first stakeholders workshop (consultation meeting) that took place at the premises of the Mediterranean Agronomic Institute of Chania on the 25th of February 2009 (see deliverables A.6.1.1, A.6.1.2, A.6.1.3 and A.6.1.4, for Chrysi island, Gavdos, Kedrodasos, and Falasarna respectively). Moreover, a social survey, i.e. interviews with visitors at all sites was conducted using semi-structured questionnaires in order to establish the type of tourism, the visitor use (activities by the visitors when visiting the site), and their level of environmental awareness regarding habitat sensitivity. Once the main conservation values and the range of activities by the visitors have been identified by the various stakeholders and visitors, a spatial distribution of the visitors use (presence of visitors, types of use and levels of use) was conducted. The patterns of use (trails, camping locations and hotspots) were mapped using GIS. Additionally, camping site condition assessments (damage on Juniper trees, cover of root exposure, ground cover vegetation and a litter survey) were conducted at all sites.

5.1 Social survey (visitors’ interviews)

Interviews took place during the period of May to September 2009. They were conducted in English or Greek, depending on the native language of the interview subject (visitors). Visitors received a verbal introduction of the aims of the survey and a copy of the questionnaire to help them choose their answers. In total 2.350 interviews were conducted (504 in Kedrodasos, 1462 in Chrysi, and 384 in Gavdos). Visitors’ perceptions of the current health status/condition of the sand dunes, including juniper trees, were recorded by asking visitors to rank the health status of the sand dunes and juniper trees (very good, good, average, poor, don’t know). Furthermore, the activities that visitors undertake, the use of habitats and the length of their stay were recorded. This allows estimating the intensity and the spatial distribution of use that the habitat receives. Additionally, the level of “environmental awareness” was estimated with the help of environmental and conservation oriented questions. Finally, background information on the interviewees was

recorded, including age, level of education, and country of origin. Interviews were transcribed and content analysis was performed for qualitative responses (Sarantakos 1993) whereas descriptive statistics using Excel were performed for quantitative data (De Vaus 2007).

5.2 Documenting trail and camping site conditions

We selected and recorded the most heavily visited trails and/or camping sites based on (1) descriptive surveys of each habitat, (2) comparisons of used and unused camping sites and (3) an experimental approach to examine the effect of visitor traffic on vegetation along trails subjected to high visitors use. According to Leung & Marion (2000), these study designs are the most commonly used for trail and campsite condition assessments. Measurements of recreational impacts (number of broken branches, ground vegetation cover, cover of root exposure, number of species, and number of *Juniperus oxycedrus* spp. *macrocarpa* seedlings) were taken on “used” (camping sites) and on “unused” (undisturbed, control) sites. When choosing the unused sites, special attention was given to the fact that the environmental conditions were similar in both unused and used sites. The intent was to locate control sites that would closely resemble to the used sites had the used site never been used. First, a rapid assessment approach was employed in order to identify used and unused sites based on significant evidence of use (broken branches, camping remaining, litter, and sign of fire). The distribution of the main trails, camping sites and the number of tents in Chrysi and Kedrodasos were recorded with a GPS and imported into GIS. In Gavdos, the distribution of tents was not recorded with a GPS because at some point, visitors were bothered and started complaining. Therefore, each habitat in Gavdos was separated into different zones and the number of tents in each zone was counted. The distribution of the main trails in all the habitats in Gavdos was recorded with a GPS and imported into a GIS. Moreover, the effect of visitor traffic on vegetation was examined along the main trail (E4) in Kedrodasos which is subjected to high visitors use. The level of use was defined on the basis of familiarity with the habitat, observation of visitors and the properties of the trail (width and depth in relation to the surrounding area).

5.2.1 Damage on Juniper trees – Number of broken branches

At each site a number of 10x10m permanent plots (6 in Kedrodasos, 4 in Sarakiniko-Gavdos, 6 in Agios Ioannis-Gavdos, 8 in Lavrakas-Gavdos, 10 in Chrysi and 2 in Falasarna) were established (Figures 6, 7, 8, 9, 10 and 11). All 10x10m plots included trees (Juniperus) and their locations were geo-referenced using global positioning system. 10x10m plots were divided into 2 groups: “used” and “unused” plots depending on whether the plot was considered a recreation plot (camping site) or not. At each 10x10 m plot the number of broken branches of each Juniper tree was measured. The ratio of broken branches per tree was calculated. The square root transformation of this ratio was used as independent variable for the statistical analysis (t-Test independent samples, confidence interval =95%).

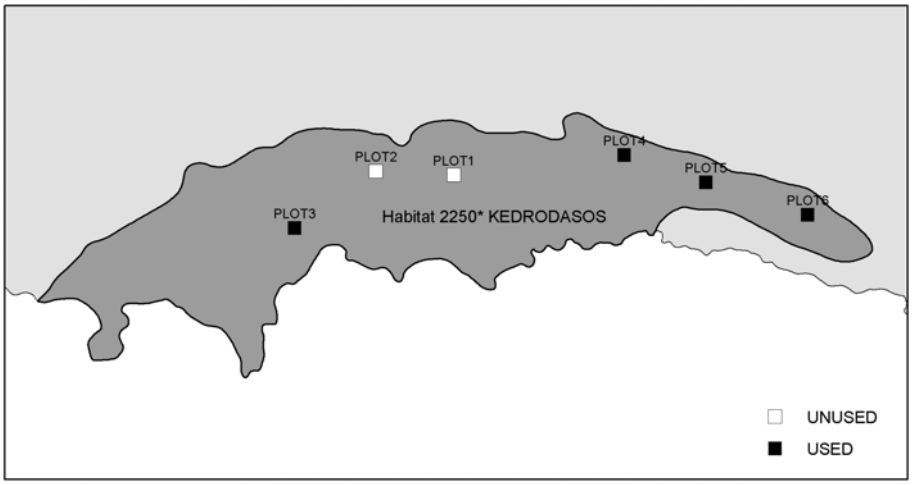

Figure 6 Distribution of the “used” and “unused” 10x10m plots in Kedrodasos

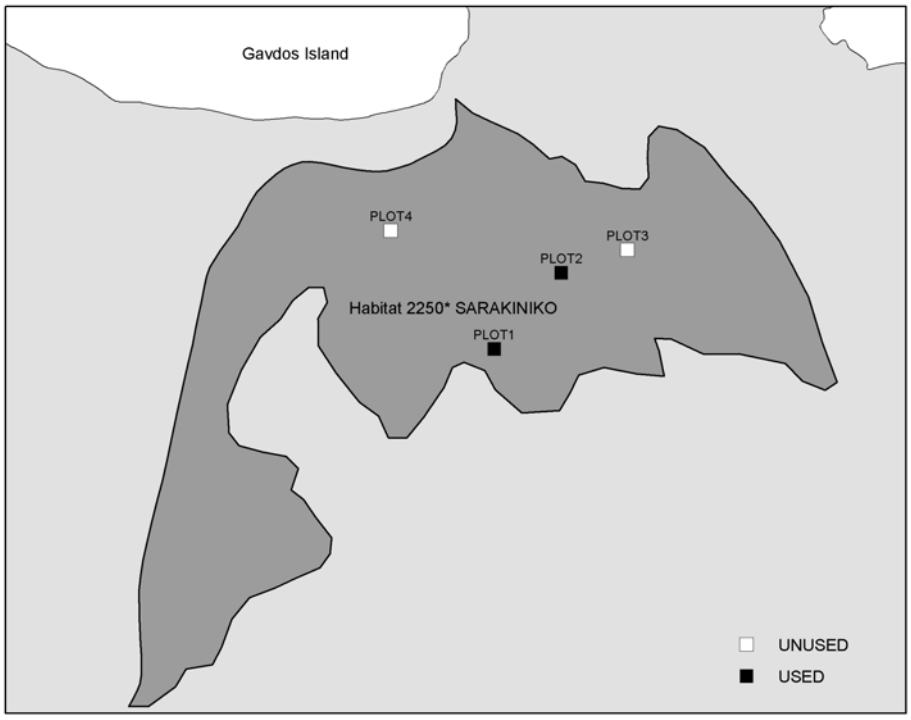

Figure 7 Distribution of the “used” and “unused” 10x10m plots in Sarakiniko-Gavdos

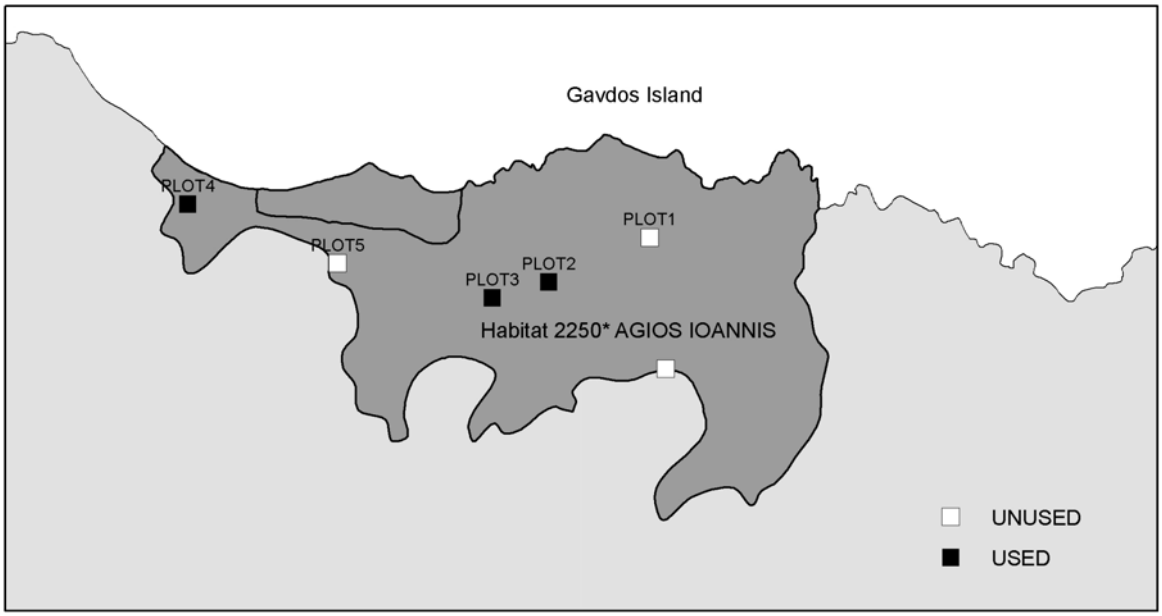

Figure 8 Distribution of the “used” and “unused” 10x10m plots in Agios Ioannis-Gavdos

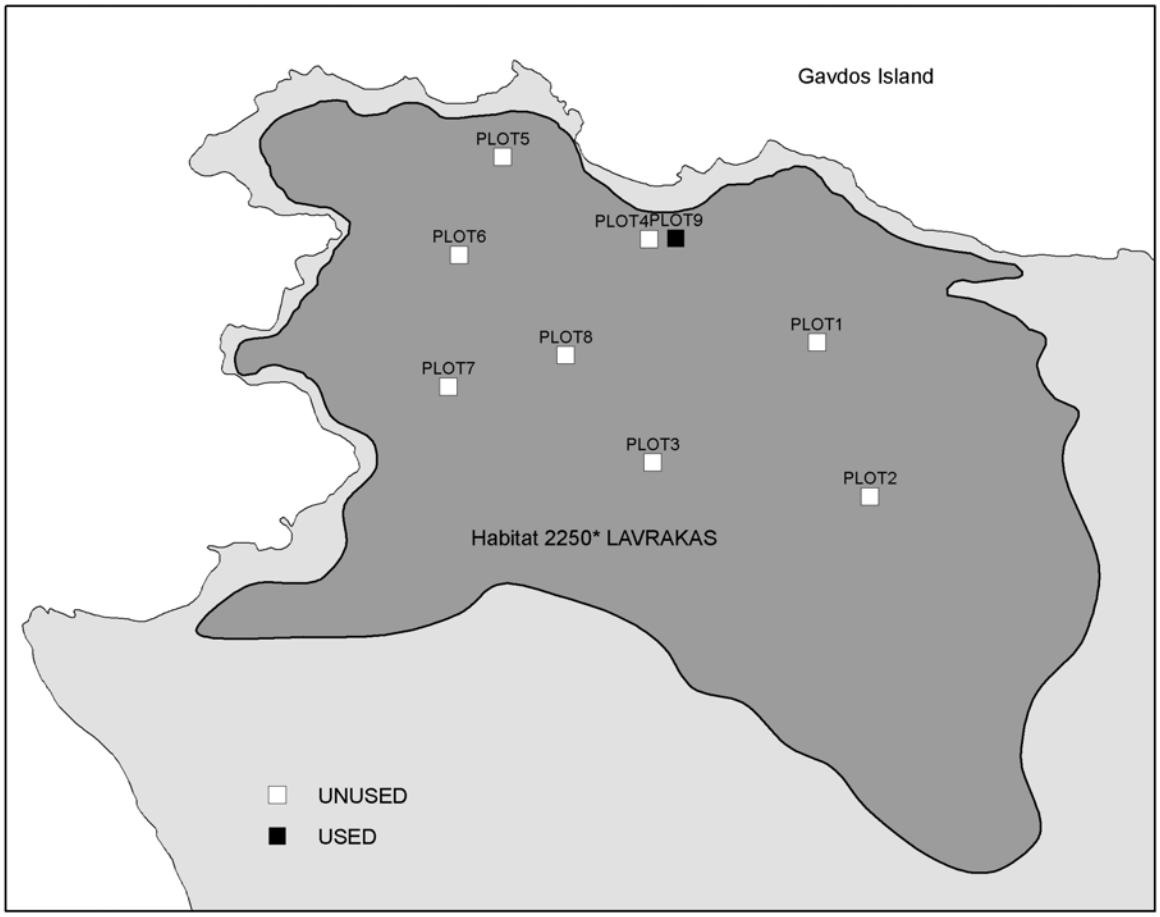

Figure 9 Distribution of the “used” and “unused” 10x10m plots in Lavrakas-Gavdos

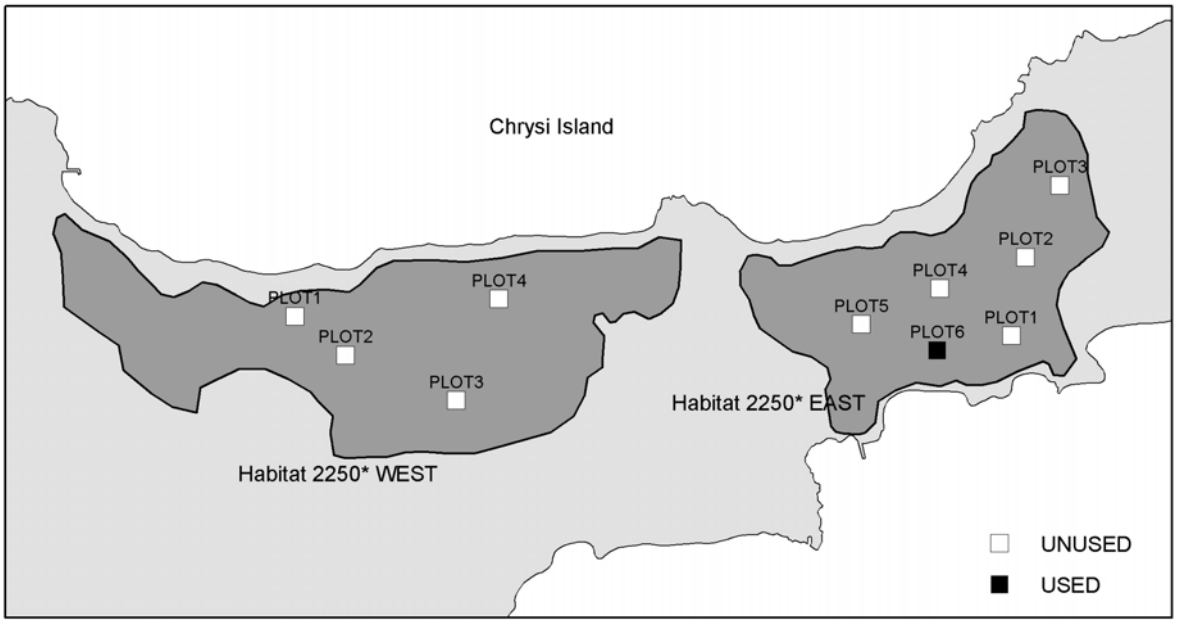

Figure 10 Distribution of the “used” and “unused” 10x10m plots in Chrysi

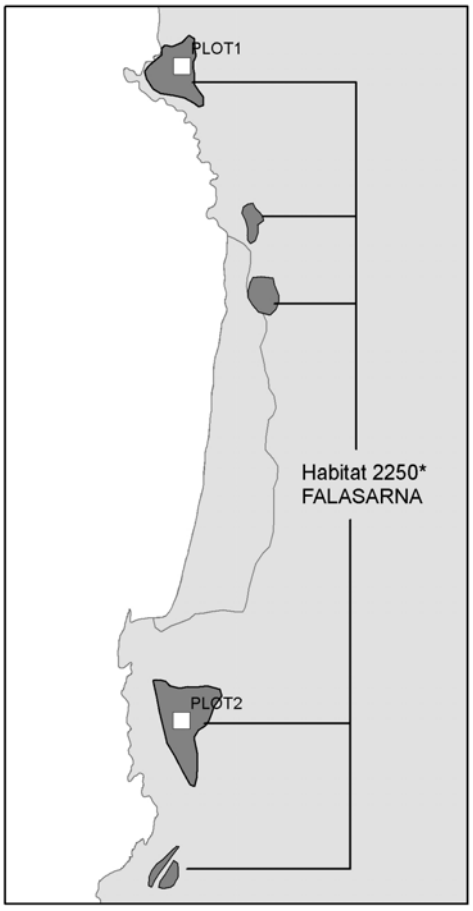

Figure 11 Distribution of the “used” and “unused” 10x10m plots in Falasarna

5.2.2 Cover of root exposure

The percentage cover of root exposure was measured in all 10x10m permanent plots. The arcsine square root transformation of the percentage cover was used as independent variable for the statistical analysis (t-Test independent samples, confidence interval =95%).

5.2.3 Ground vegetation cover

The total ground vegetation cover of shrubs, phrygana and forbs was estimated in all used and unused 10x10m plots. The comparison of the ground vegetation cover between used and unused plots allowed the hypothesis testing that variation (reduction) in vegetation cover in “used” sites was a human induced impact. The arcsine square root transformation of the ground vegetation cover was used as independent variable for the statistical analysis (t-Test independent samples, confidence interval =95%).

5.2.4 Number of species

The total number of species was measured in all used and unused 10x10m plots. A t-Test (independent samples, confidence interval =95%) was used to compare used and unused plots.

5.2.5 Number of *Juniperus oxycedrus* spp. *macrocarpa* seedlings

The number of juniper seedlings was also measured in all used and unused 10x10m plots and t-Test (independent samples, confidence interval =95%) was used to compare used and unused plots.

5.2.6 Damage on ground vegetation along trails subjected to high visitors use

The E4 trail in Kedrodasos was used as a baseline on which 1x1m contiguous sampling quadrats were located at 25m intervals in the middle and the edges of the trail (outside the trail, left and right). In total, 105 sampling points were measured along the trail, on its left and right. For each 1x1m quadrat, the overall percentage of the ground vegetation cover (shrubs, phrygana and forbs) and the presence/absence of each plant species were recorded. A t-Test (independent samples, confidence

interval =95%) was used to compare the ground vegetation cover and the total number of plant species in the middle, left and right of the trail.

5.2.7 Litter survey

Litter surveys were conducted in Gavdos (Sarakiniko, Agios Ioannis), Chrysi (East site, West site), and Kedrodasos. The objective of the surveys was to quantify the distribution and the composition (type) of debris in the habitats. Debris is one of the most highly visible expressions of human impacts on coastal environments (Moore et al. 2001), which is one of the factors that has led to the popularity of public clean-up efforts along the shorelines.

Litter surveys were conducted at regular sampling points (point spacing 30-50 m) generated by the ArcGIS software. The relocation between the sampling points was done with the help of a GPS. The amount and the composition of debris were recorded in 10m radius area around each sampling point.

Section 6 Results

6.1 Social survey (visitors' interviews)

6.1.1 Kedrodasos

The duration of stay of visitors in Kedrodasos varied significantly with the majority of the visitors staying in Kedrodasos for one to two days (25% two days, 24% one day and 22% a one day trip). Only 12% of the visitors stayed for more then 5 days (Figure 12).

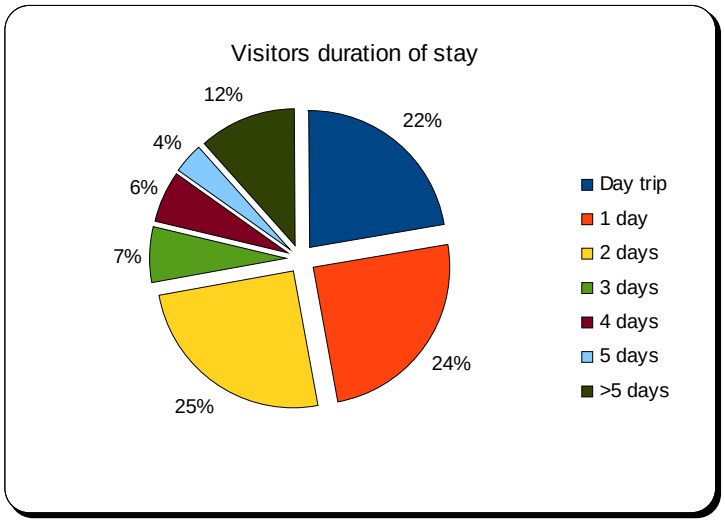

Figure 12 Visitors' duration of stay in Kedrodasos

50% of the visitors have never visited Kedrodasos before their actual trip to the site while 16% have already visited the site once, 8% twice and 26% more than twice (Figure 13).

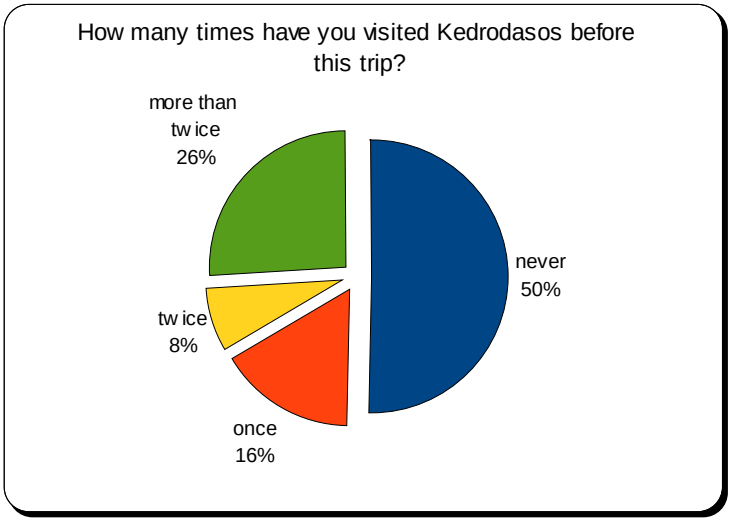

Figure 13 Number of visits to Kedrodasos before the actual trip

42% of the visitors mentioned that they visit the site every two or three years, 39% visit the site once a year and 19% many times per year (Figure 14).

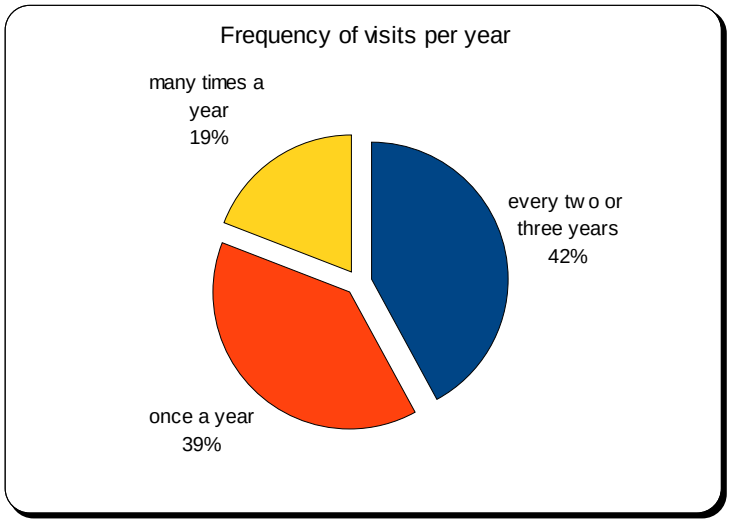

Figure 14 Frequency of visits to Kedrodasos per year

When asked to name the most important reasons for visiting Kedrodasos, the majority (90%) of the visitors stated “the site natural beauty” and “appealing conditions”, 7% because of the low cost of stay and 3% for entertainment (Figure 15).

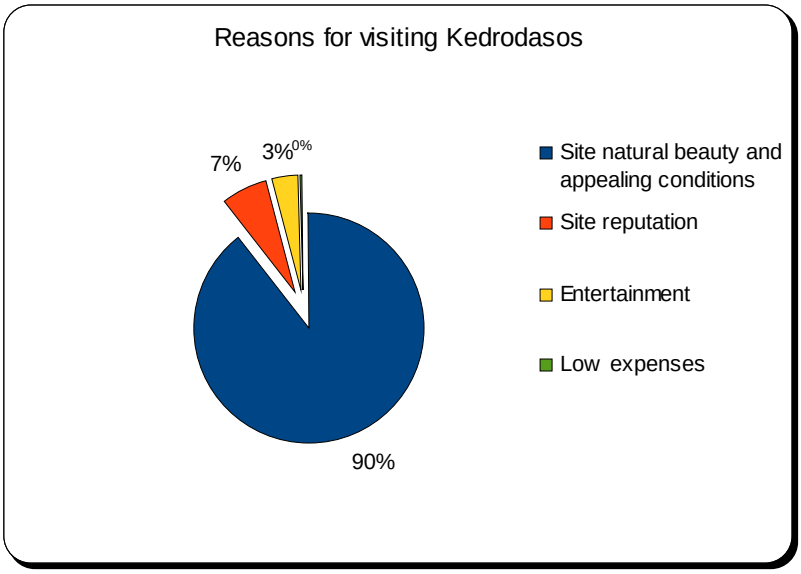

Figure 15 Reasons for visiting Kedrodasos

Activities performed by visitors when on site were mainly beach-based activities. A majority of visitors identified swimming (94%), camping (79%), sun tanning (68%), picnic (41%) as their primary activity, while trekking (35%), wild-life

watching (23%) and fishing (14%) were to a lesser extent performed by visitors (Figure 16).

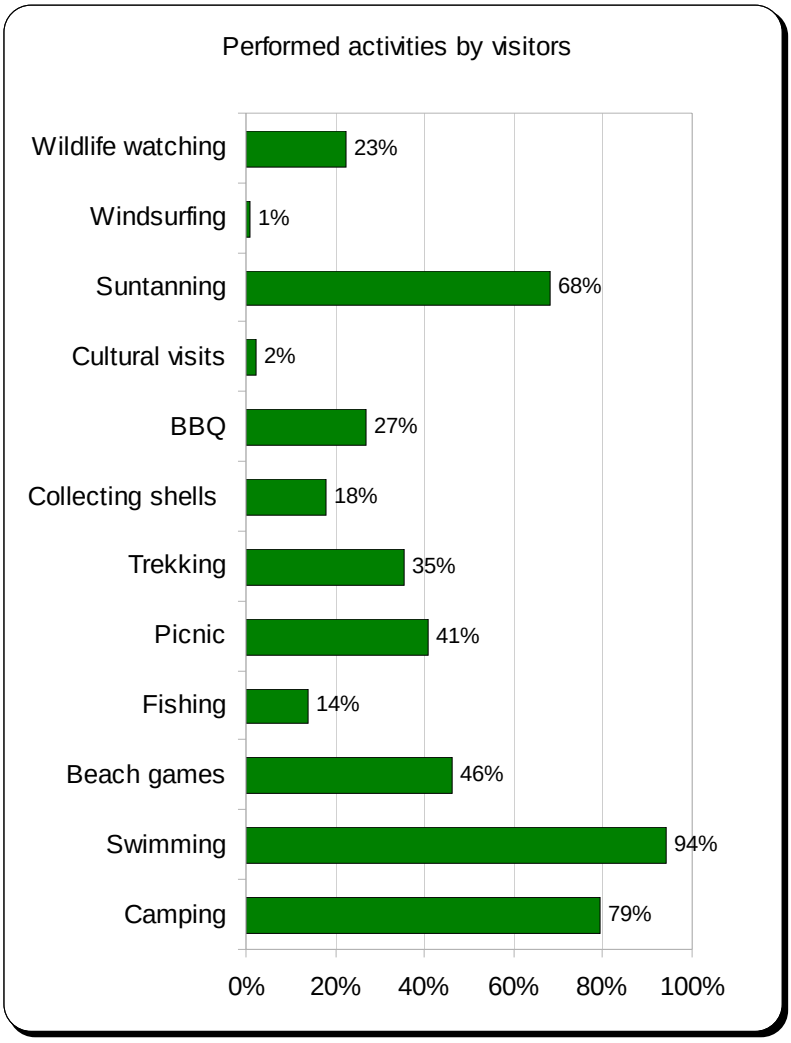

Figure 16 Performed activities by visitors in Kedrodasos

The visitors' perception about the crowdedness of Kedrodasos is shown in figure 17. 30 to 35% of the visitors reported that Kedrodasos was medium crowded (average of the period from June to September 2009) while, for the same period, around 22% considered that the site is overcrowded.

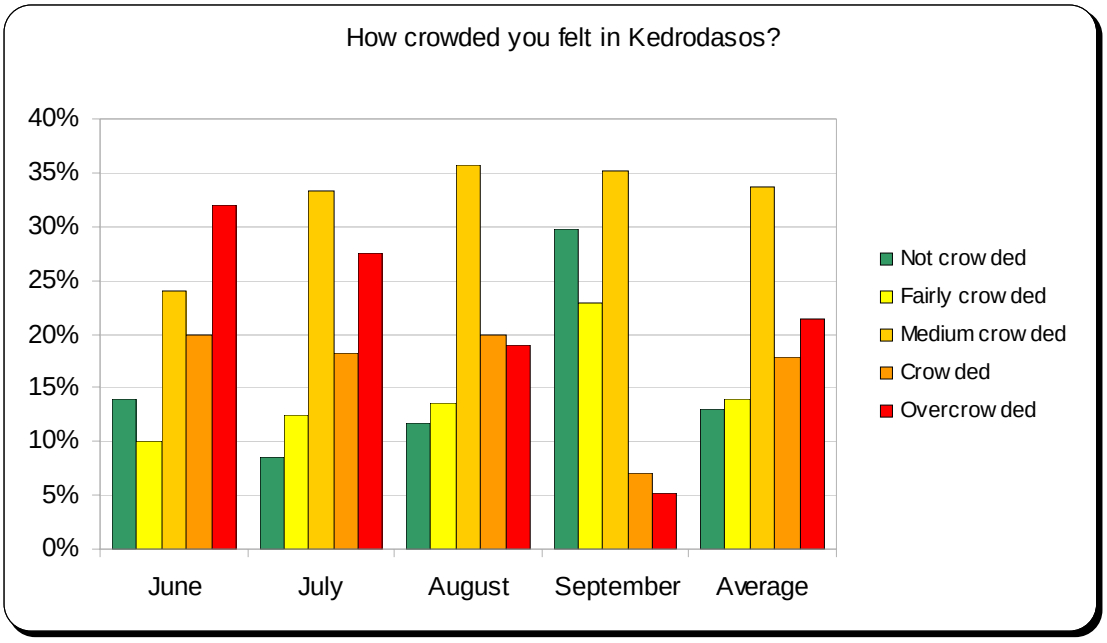

Figure 17 Visitors' perception about the crowdedness of Kedrodasos

When asked about their opinion on the level of cleanliness of Kedrodasos, around 44% of the visitors reported that the site is clean (average of the period from June to September 2009) while, for the same period, around 36% considered that the site is dirty. Around 20% considered that the site is fairly clean. June was reported to be the cleanest month while September was reported to be the dirtiest (period from June to September 2009) (Figure 18).

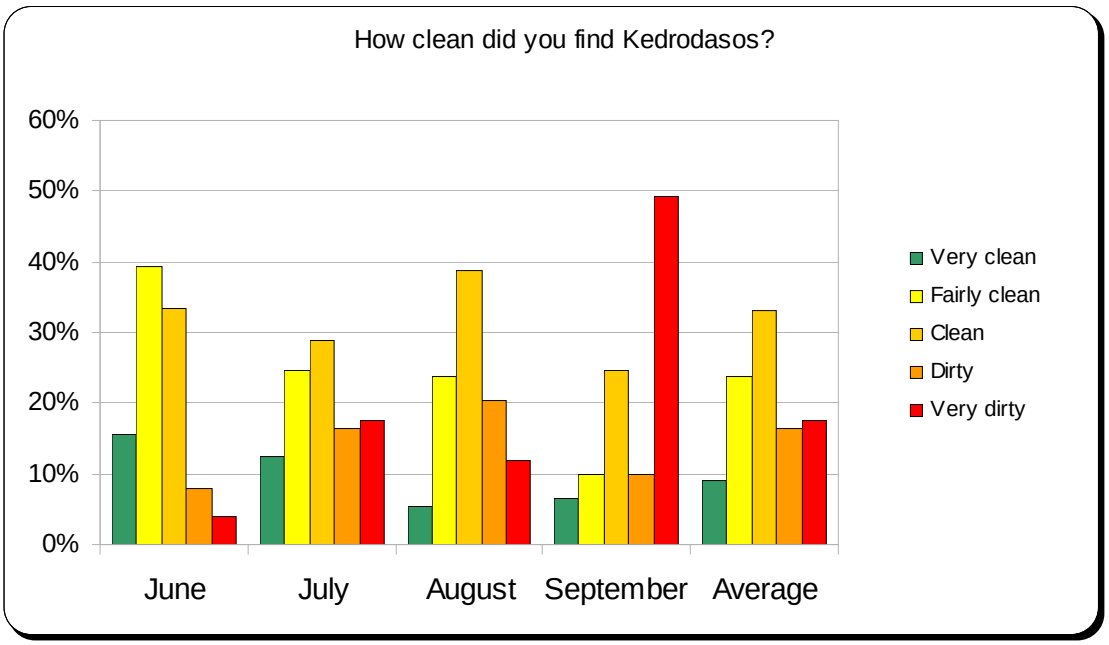

Figure 18 Visitors' opinion about the level of cleanliness of Kedrodasos

When asked to name the most important things that they did not like during their visit to Kedrodasos, 46% of the visitors mentioned the rubbish and human waste, 25% mentioned the excessive visitors pressure and inappropriate visitor conduct, 15% did not appreciate the site rough natural conditions and 7% did not like the lack of visitors' infrastructure and the lack of public awareness (Figure 19).

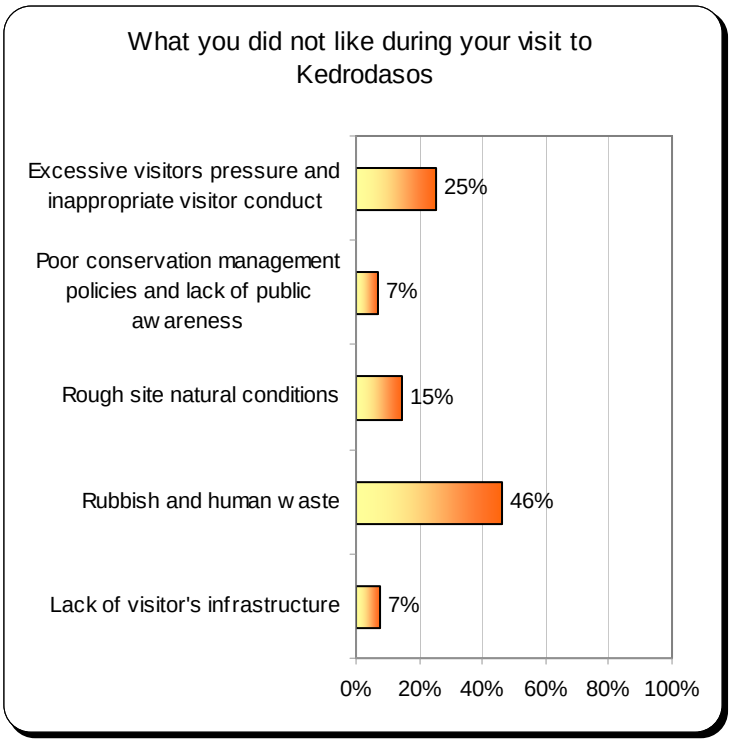

Figure 19 What visitors did not like during their visit to Kedrodasos

The visitors' perception about the main threats affecting Kedrodasos natural environment is shown in figure 20. Rubbish and litter were seen as threat by 84% of the visitors. 60 to 65% of the visitors considered that lack of public awareness and cutting juniper branches and/or roots is also a threat, while 40 to 50% of the respondents regarded fire and human wastes as another threat.

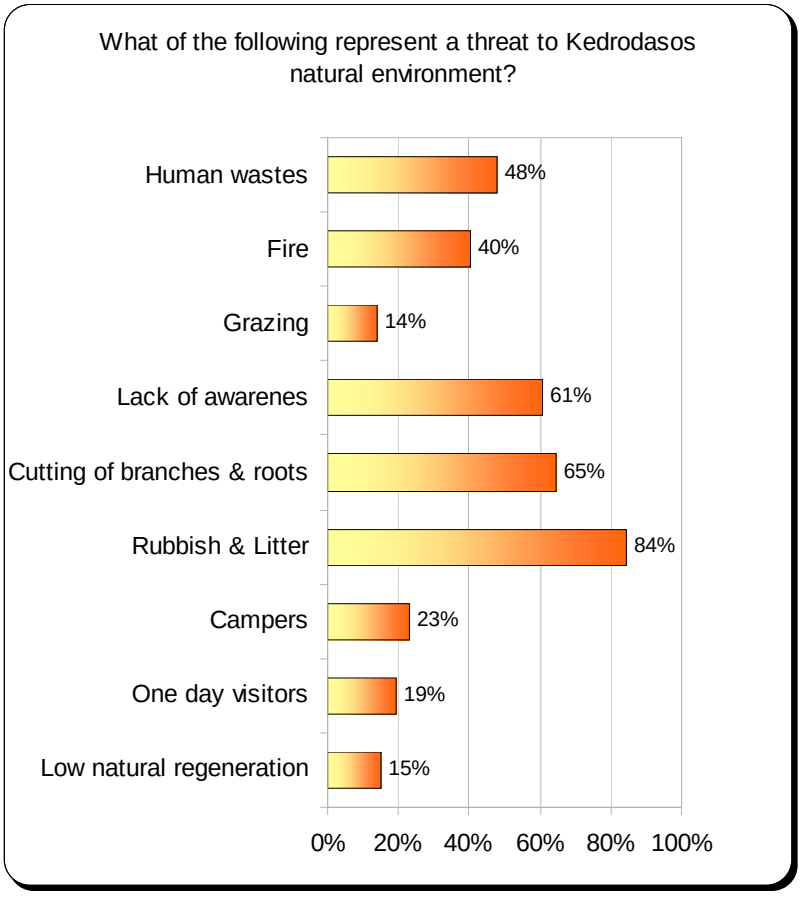

Figure 20 Visitors' perception about the main threats affecting Kedrodasos natural environment

More then half of the visitors (57%) did not know about the site before coming to Crete while only 43% knew about the site before visiting Crete (Figure 21).

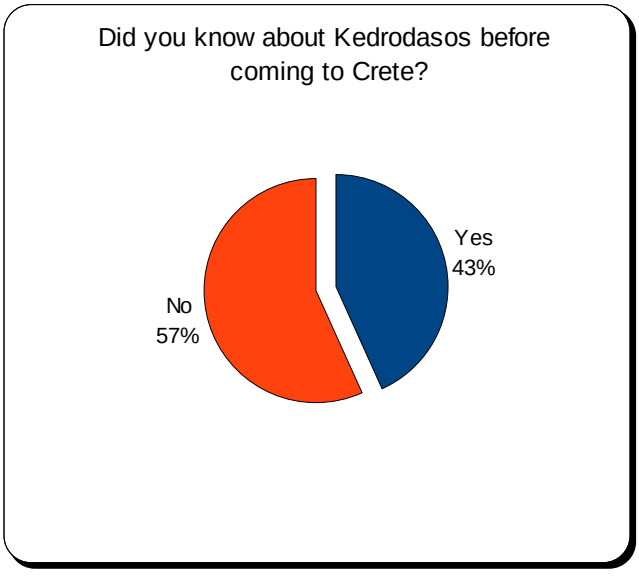

Figure 21 Visitors acquaintance with Kedrodasos

Furthermore, the level of “environmental awareness” was estimated with the help of environmental and conservation oriented questions. 70 to 80% of the visitors believed that Kedrodasos is protected because of the presence of sand dunes and juniper trees while 10 to 20% assumed that the site is protected because of the presence of *Carretta carretta*, archaeological monuments or sea shells (Figure 22).

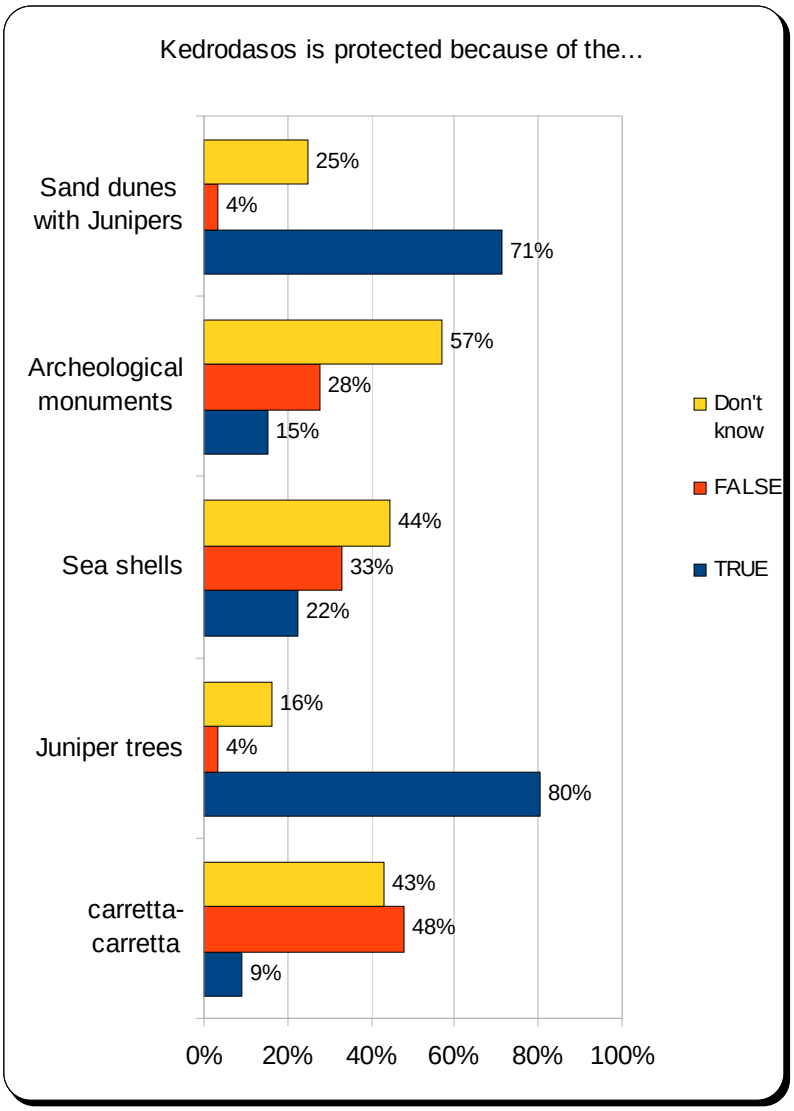

Figure 22 Visitors’ opinion about the reasons for the protection of Kedrodasos

Moreover, only 27% of the visitors knew that the site is included in the Natura 2000 network and 19% that it is a Site of Community Interest. 18% thought that the site is a National Park, 14% thought that the site is a Special Protection Area for birds (Figure 23).

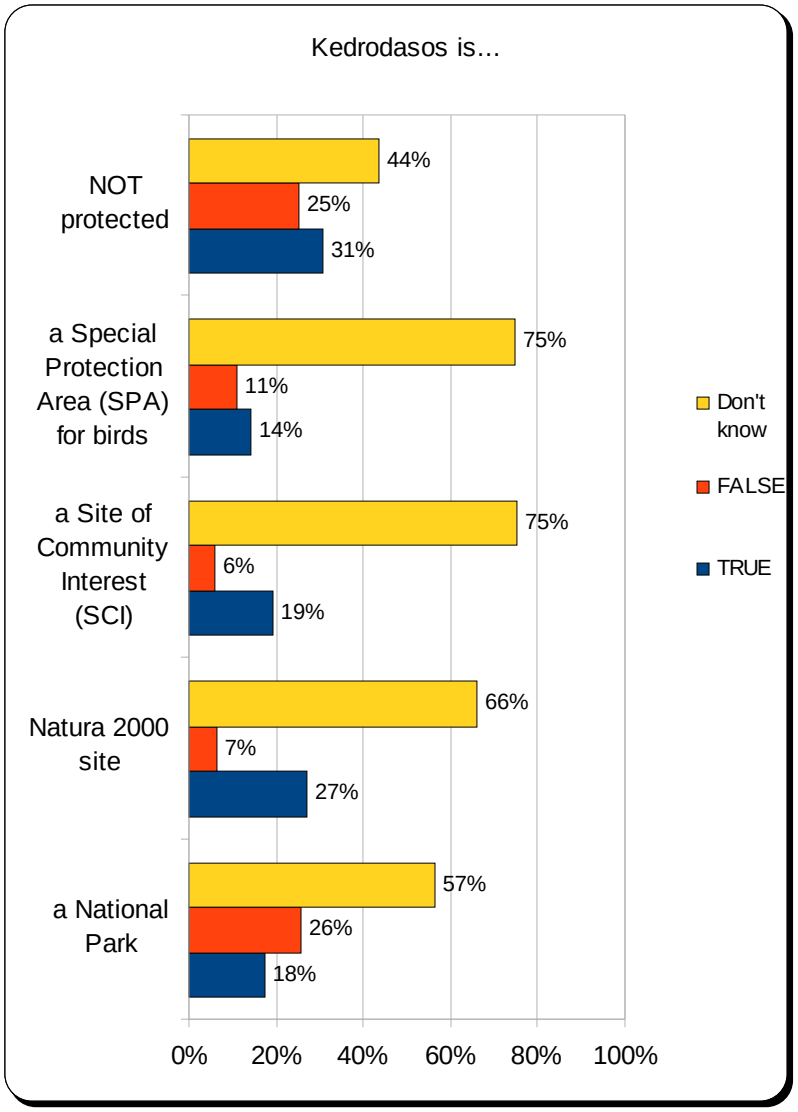

Figure 23 Visitors’ opinion about Kedrodasos protection status

90% of the visitors agree to carry out their rubbish when leaving the site, 37% agree that visitors’ movement should be restricted only to certain part of the site while only 19% consider that camping damages the sand dunes and the juniper trees. 75% of the visitors believe that Kedrodasos require further protection and 53% consider that the site is not well managed (Figure 24).

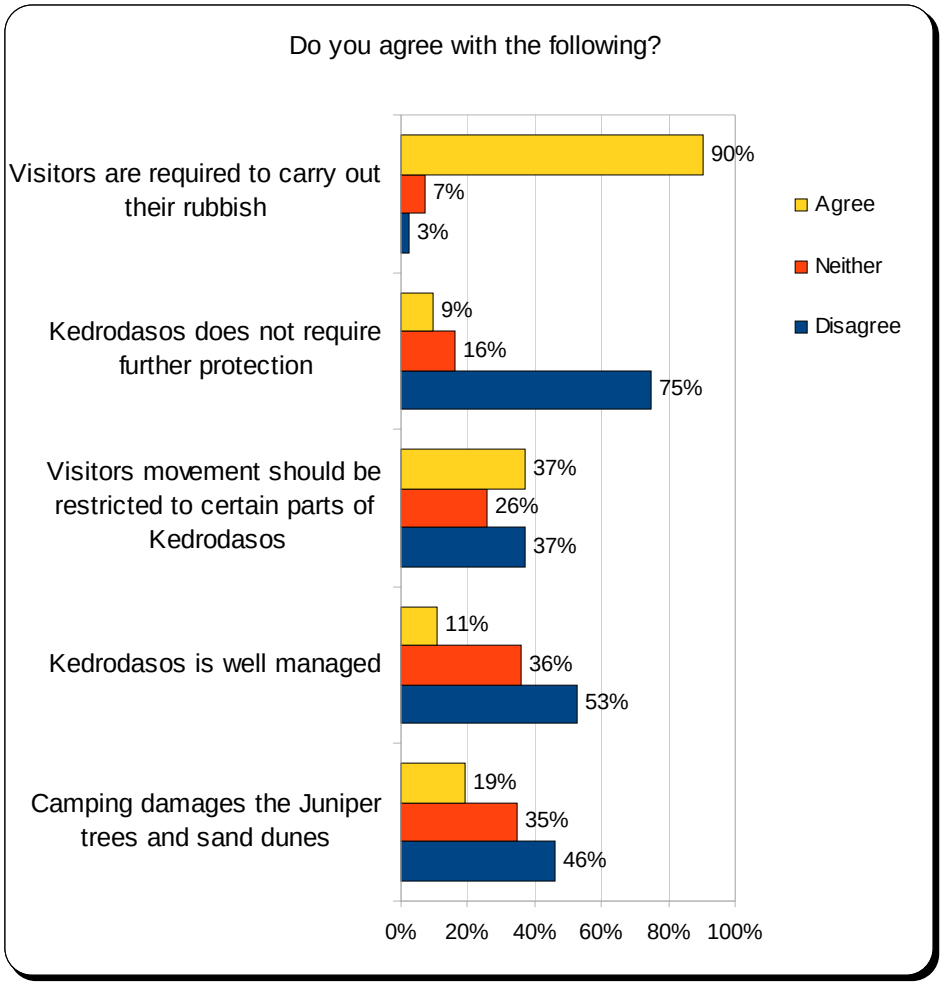

Figure 24 Visitors’ perception about the management of Kedrodasos

The current condition of the sand dunes and juniper trees was estimated by asking the visitors to rank the health status of the sand dunes and juniper trees (very good, good, average, poor, don’t know). The majority of the respondents have positively ranked the health status of the sand dunes and juniper trees. 8% ranked it as very good, 10% as good, 29% as average and only 11% as poor (Figure 25).

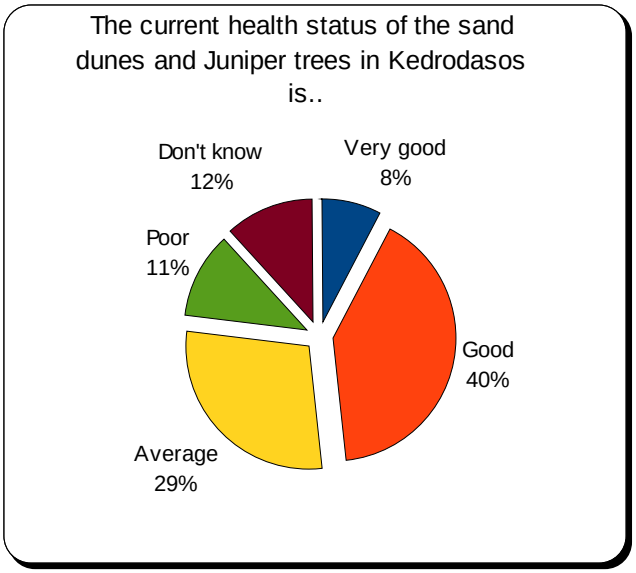

Figure 25 Visitors' perception about the current health status of the sand dunes and Juniper trees in Kedrodasos

When asked if they would be willing to pay an entry fee for the management of the site, half of the respondents did not agree to pay any entry fee while the other half agreed to be charged an entry fee in the range of one to three euros (Figure 26).

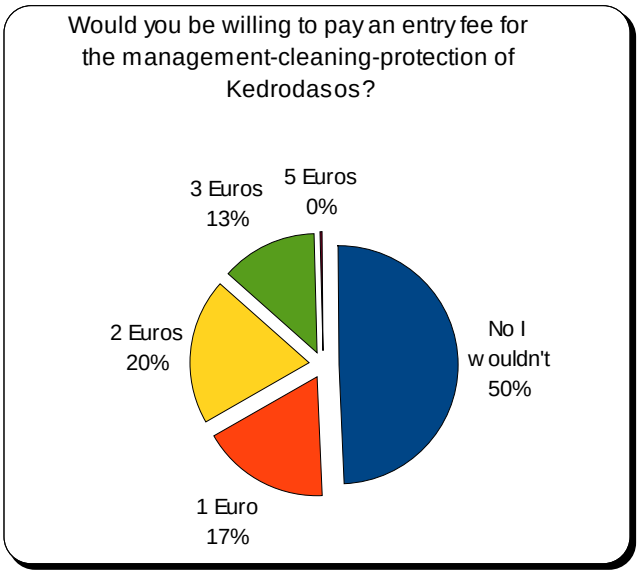

Figure 26 Visitors' opinion about paying an entry fee for the management of Kedrodasos

85% of the visitors declared that they would recommend their friends to visit the site while only 6% confirmed that they would not (Figure 27).

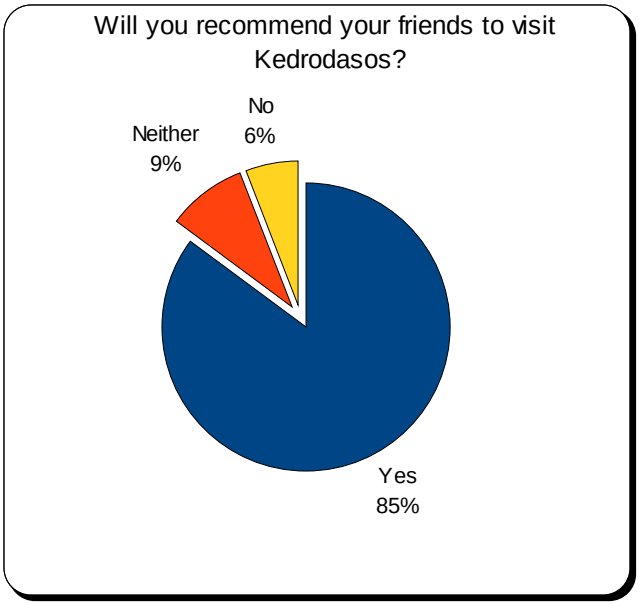

Figure 27 Visitors’ opinion about advising their friends to visit Kedrodasos

When asked what kind of measures should be taken in order to improve the protection and the management of Kedrodasos, 38% of the respondents mentioned the improvement of visitors’ infrastructure, around 25% mentioned raising the public awareness, better law enforcement and improvement of the in-situ conservation measures (Figure 28).

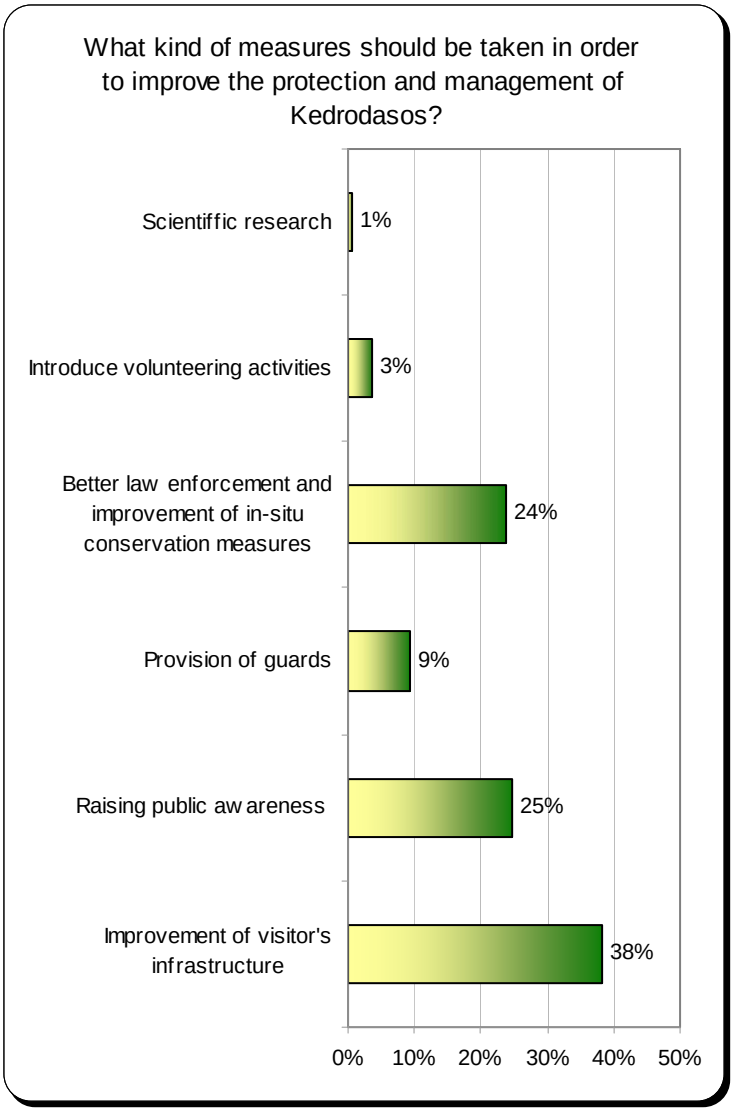

Figure 28 Visitors' opinion on the kind of measures that should be taken in order to improve the protection and the management of Kedrodasos

49% of the visitors were males and 51% were females (Figure 29). The age of the visitors ranged between 18 and 65 years (Figure 30). Age distribution of the respondents was as follows: 18–24 years constituted 32%, 25-34 years were 53%, 35-44 years were 13% while 45-65 years constituted 2%.

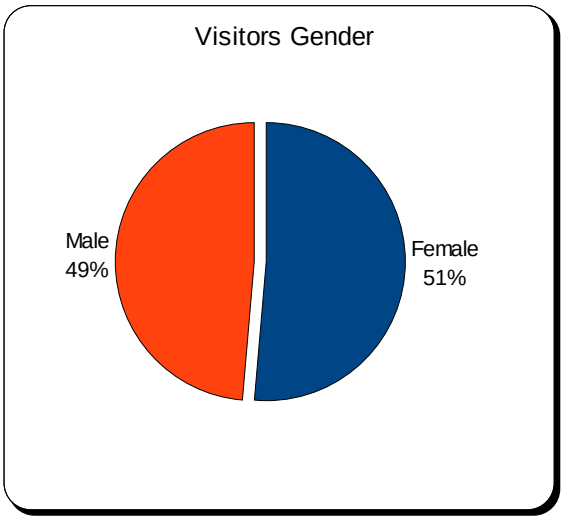

Figure 29 Visitors' gender

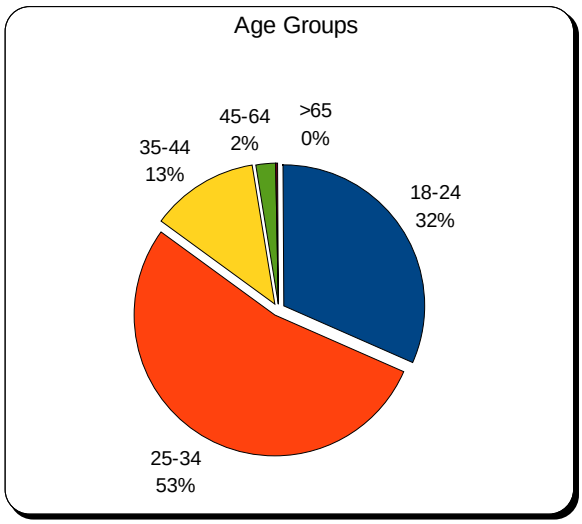

Figure 30 Age groups of the visitors to Kedrodasos

In relation to the education level of the visitors, 76% hold a university degree, 14% have acquired a secondary education while only 10% had a basic education (Figure 31).

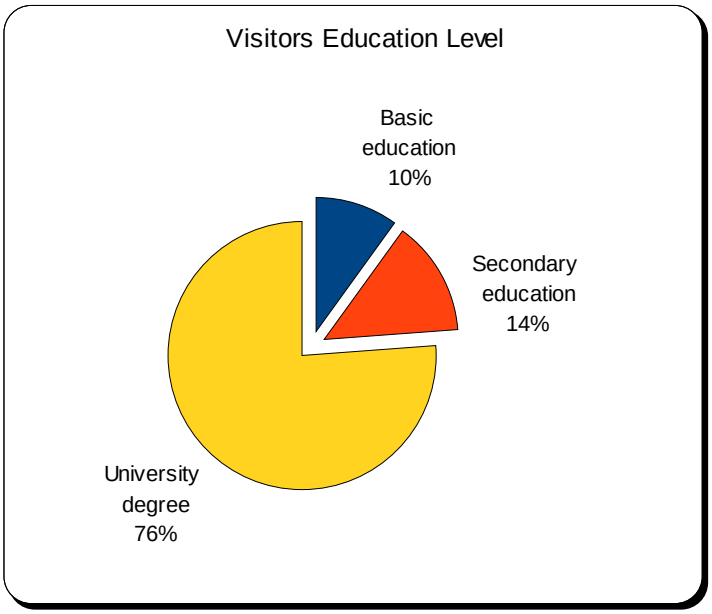

Figure 31 Visitors' education level

Tourists visiting Kedrodasos were mainly Greeks representing 90% of the total number of visitors to the site. Only 10% were foreign tourists (Figure 32).

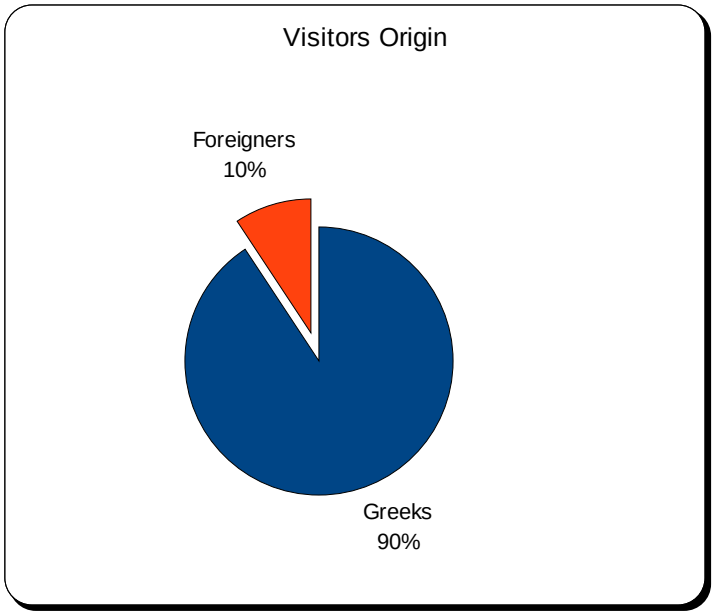

Figure 32 Visitors’ origin

The largest group of Greek visitors to Kedrodasos came from Crete (69%) followed by Athens (21%) and only 10% from the rest of Greece (Figure 33).

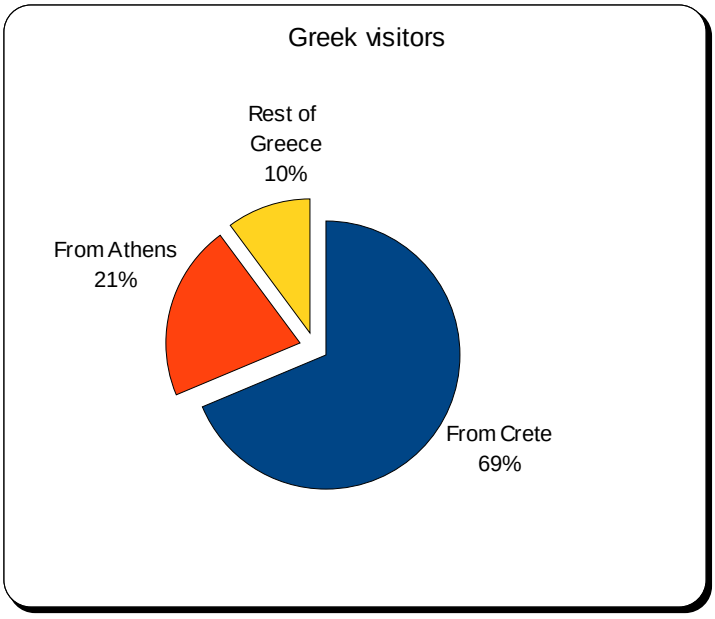

Figure 33 Origin of Greek visitors

The largest group of foreign visitors to Kedrodasos is from Europe (76%) and only 24% from other countries (Figure 34).

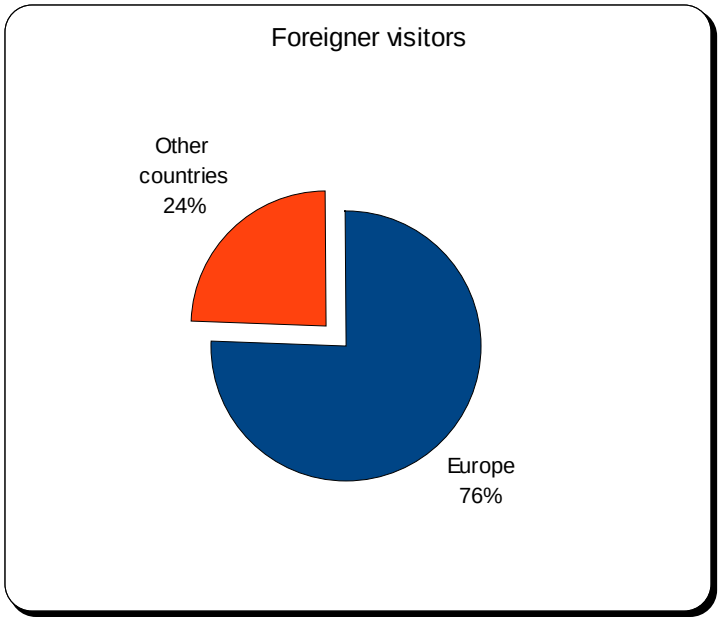

Figure 34 Origin of foreign visitors

6.1.2 Chrysi

The majority (67%) of the visitors to Chrysi are mainly visiting the island on a daily trip and returning to Ierapetra in the afternoon. The duration of stay of visitors in Chrysi varied slightly with 14% of the visitors staying for one day and 5% for two days. Only 8% of the visitors stayed for more then 5 days (Figure 35).

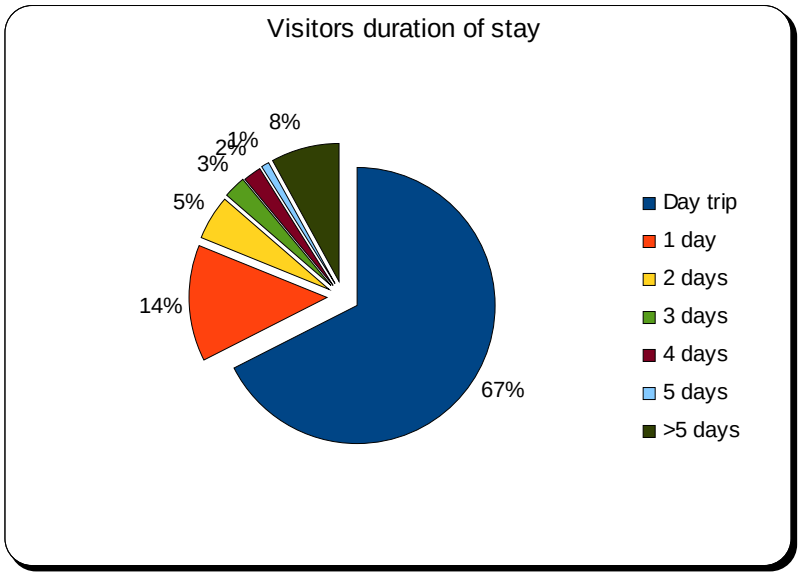

Figure 35 Visitors’ duration of stay in Chrysi

75% of the visitors have never visited Chrysi before their actual trip to the island while 11% have already visited the site once, 3% twice and 11% more than twice (Figure 36).

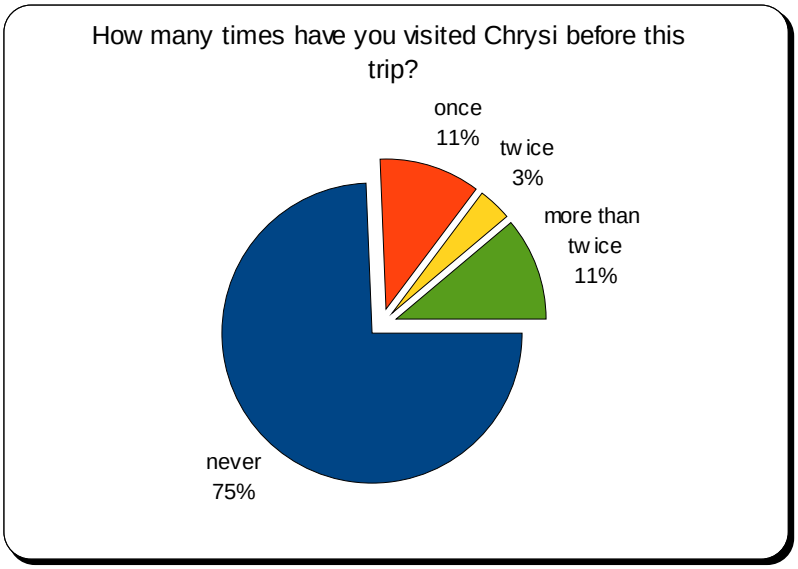

Figure 36 Number of visits to Chrysi before the actual trip

72% of the visitors mentioned that the frequency of their visit to Chrysi is once every two to three years, 20% is once a year and 8% many times per year (Figure 37).

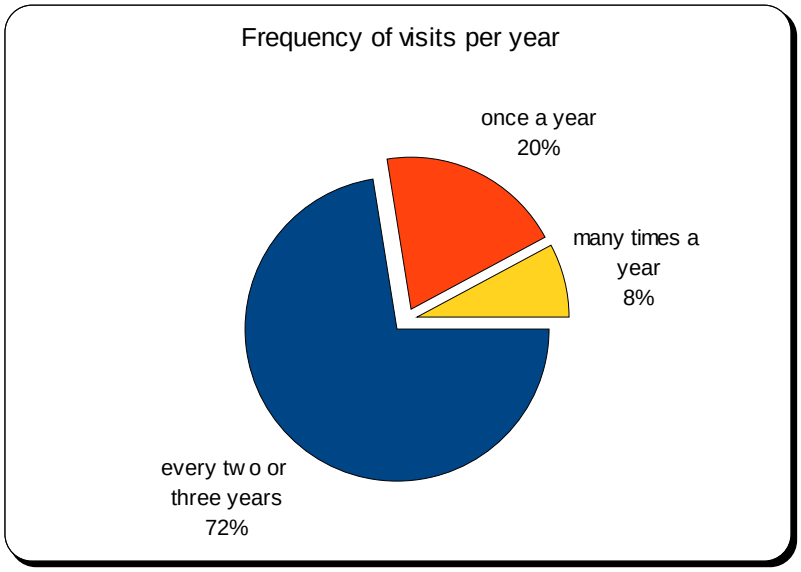

Figure 37 Frequency of visits to Chrysi per year

Activities performed by visitors when on site were mainly beach-based activities. A majority of visitors identified swimming (92%), sun tanning (69%), trekking (33%), beach games (31%), camping (25%), picnic (24%) as their primary activity, while wild-life watching (20%) and fishing (7%) were to a lesser extent performed by visitors (Figure 38).

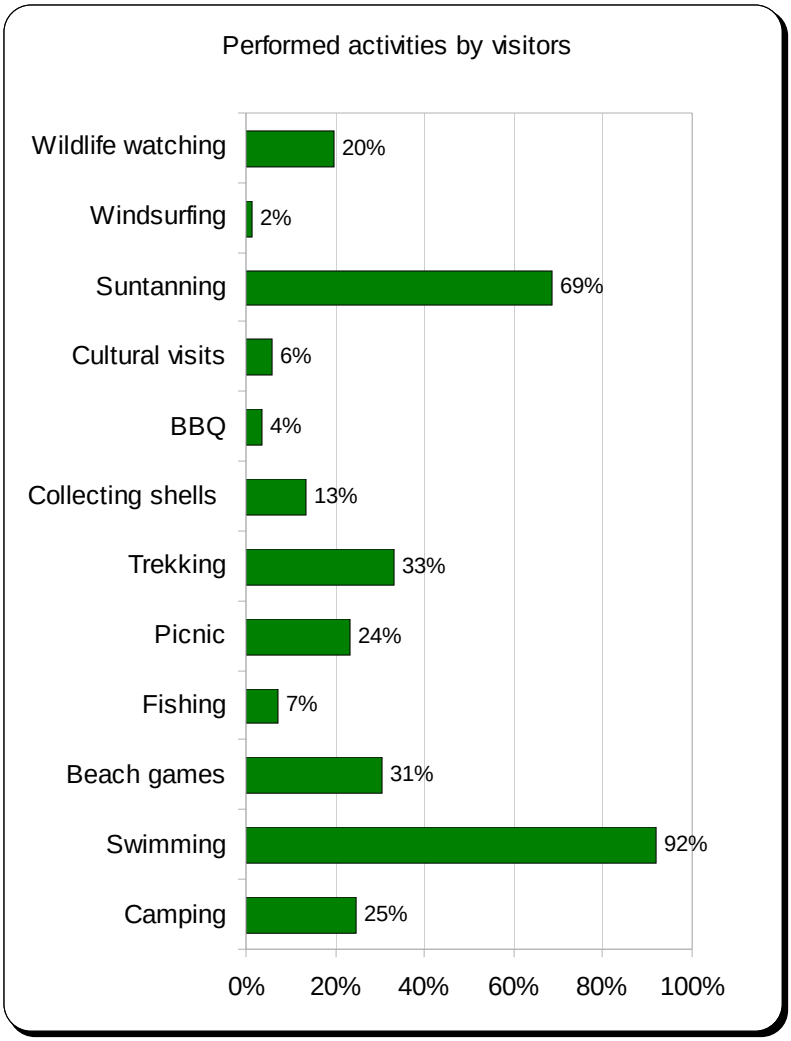

Figure 38 Visitors’ activities in Chrysi

When asked to name the most important reasons for visiting Chrysi, the majority (75%) of the visitors stated “the site natural beauty” and “appealing conditions”, 13% because of the site reputation and 11% for entertainment (Figure 39).

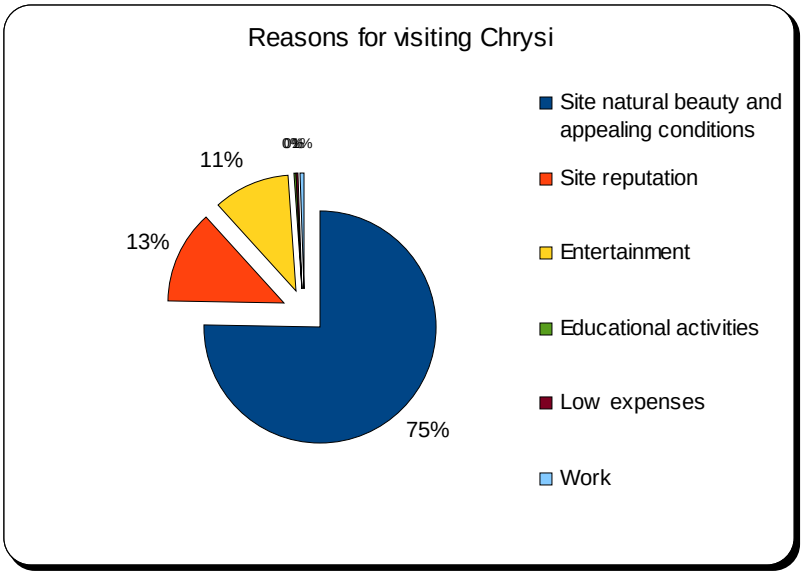

Figure 39 Reasons for visiting Chrysi

The visitors' perception about the crowdedness of Chrysi is shown in figure 40. Around 30% of the visitors reported that Chrysi was medium crowded (average of the period from May to September 2009) while, for the same period, around 15% considered that the site is overcrowded.

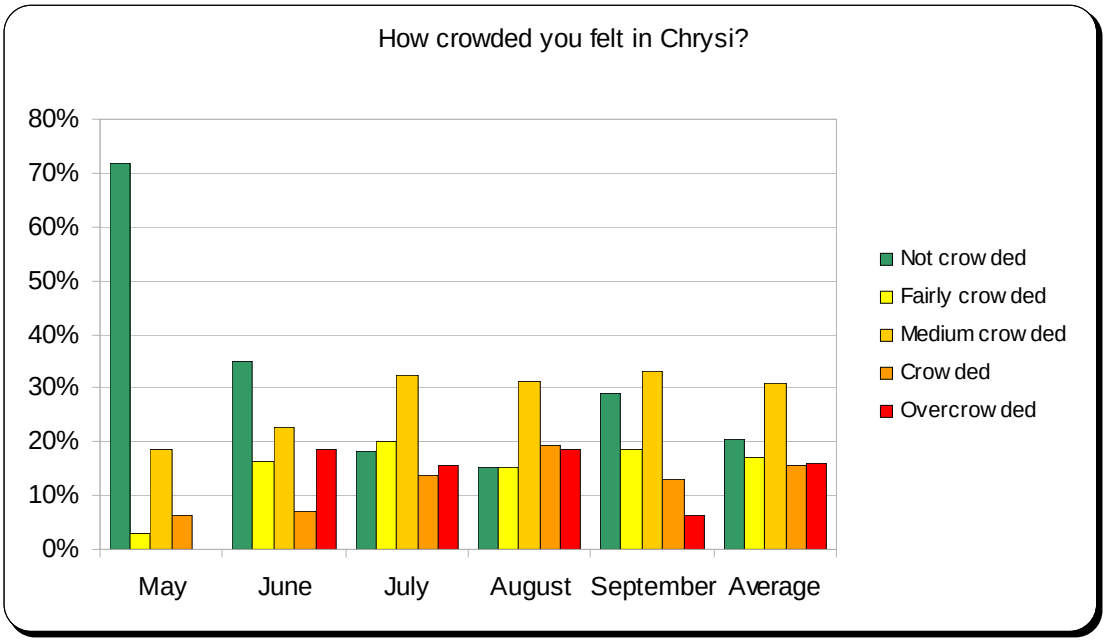

Figure 40 Visitors' perception about the crowdedness of Chrysi

When asked about their opinion on the level of cleanliness of Chrysi, around 50% of the visitors reported that the site is clean (average of the period from May to September 2009) while, for the same period, around 15% considered that the site is

dirty. Around 36% considered the site fairly clean. May was reported to be the cleanest month while September was reported to be the dirtiest (period from May to September 2009) (Figure 41).

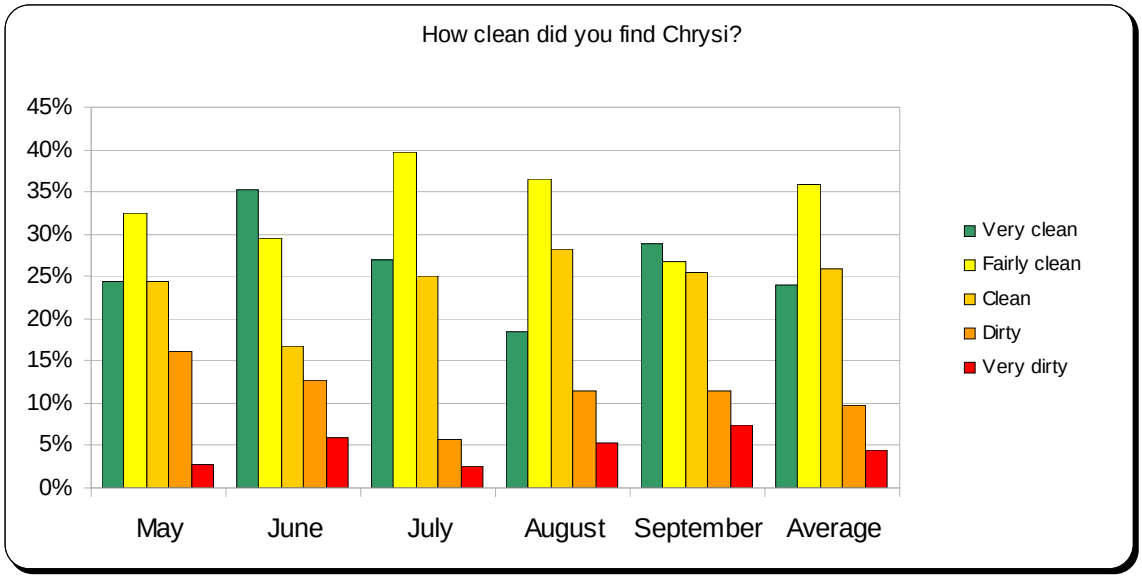

Figure 41 Visitors' opinion about the level of cleanliness of Chrysi

When asked to name the most important things that they did not like during their visit to Chrysi, 20% of the visitors stated the lack of visitors' infrastructure, 17% mentioned the rubbish and human waste, 15% mentioned the excessive visitors pressure and the inappropriate visitor conduct, another 15% did not appreciate the site rough natural conditions and 12 to 14% complained about the high prices and the excessive unfit facilities (Figure 42).

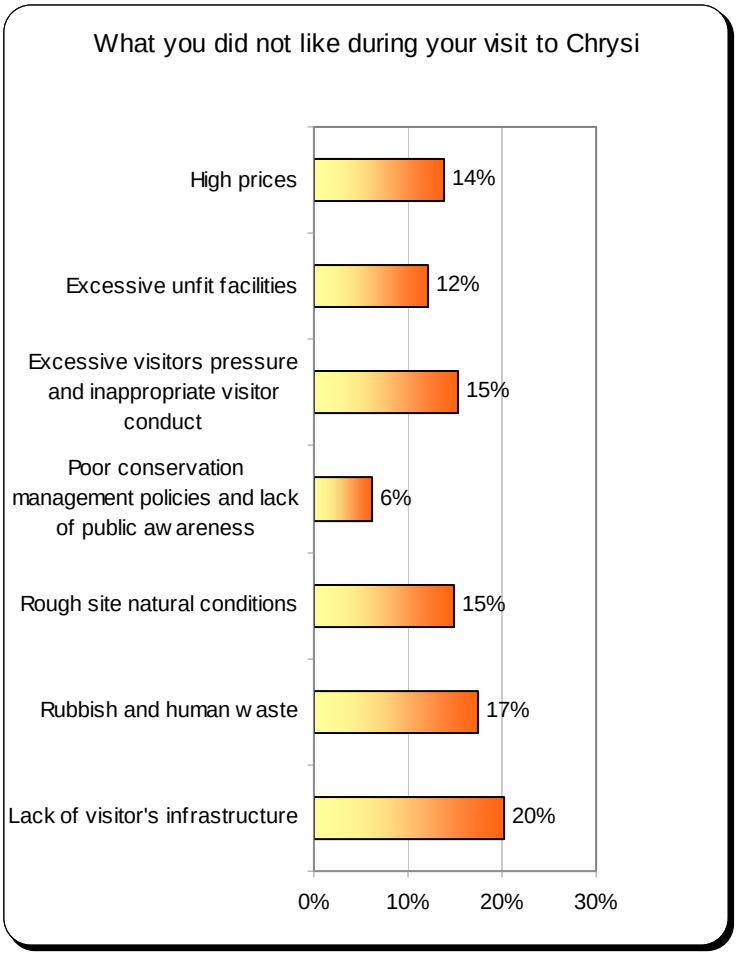

Figure 42 What visitors did not like during their visit to Chrysi

The visitors’ perception about the main threats affecting Chrysi natural environment is shown in figure 43. Rubbish/litter and human waste were seen as a threat by 57% and 47% respectively. 31 to 38% of the visitors considered that campers, fires, cutting juniper branches and/or roots and the lack of public awareness are also a threat, while 7 to 15% of the respondents regarded grazing and the low natural regeneration of the juniper trees respectively as another threat.

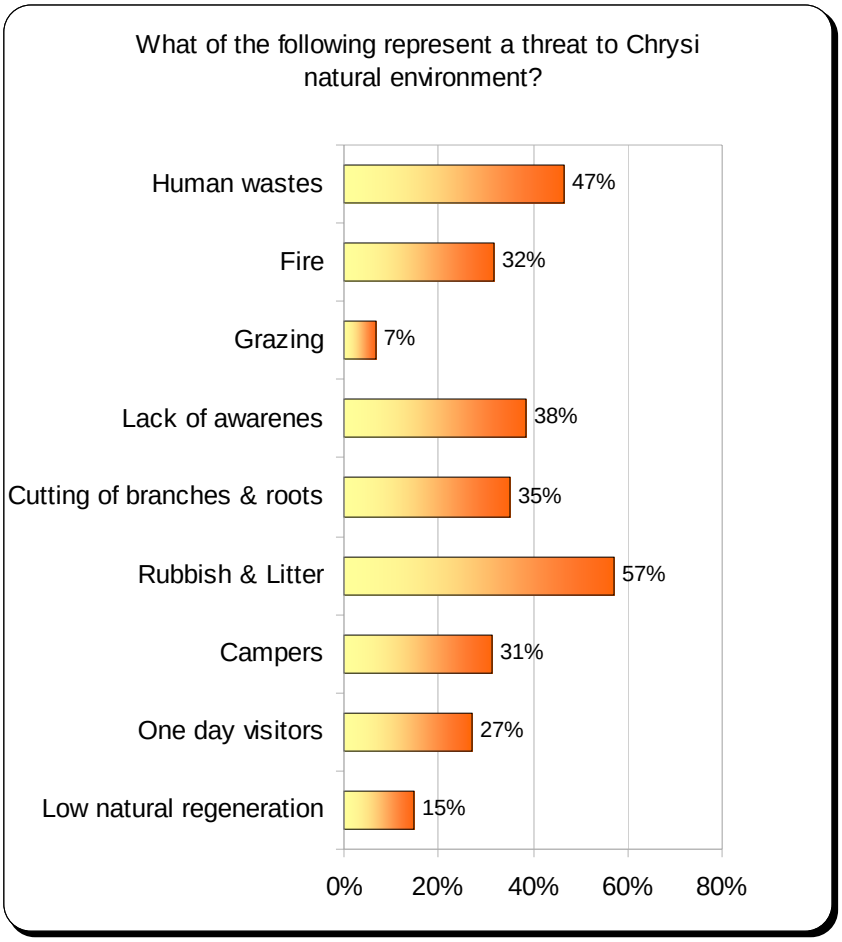

Figure 43 Visitors' perception about the main threats affecting Chrysi natural environment

More then half of the visitors (60%) did not know about Chrysi before coming to Crete while only 40% knew about the island before visiting Crete (Figure 44).

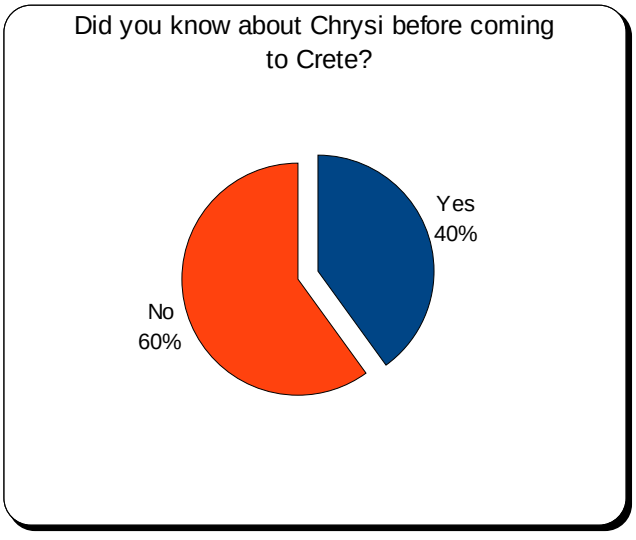

Figure 44 Visitors acquaintance with Chrysi

Furthermore, the level of "environmental awareness" was estimated with the help of environmental and conservation oriented questions. 63 to 67% of the visitors believed that Chrysi is protected because of the presence of sand dunes and juniper trees, 61% thought that the site is protected because of the presence of sea shells, while 15 to 21% assumed that the site is protected because of the presence of *Carretta carretta* and archaeological monuments (Figure 45).

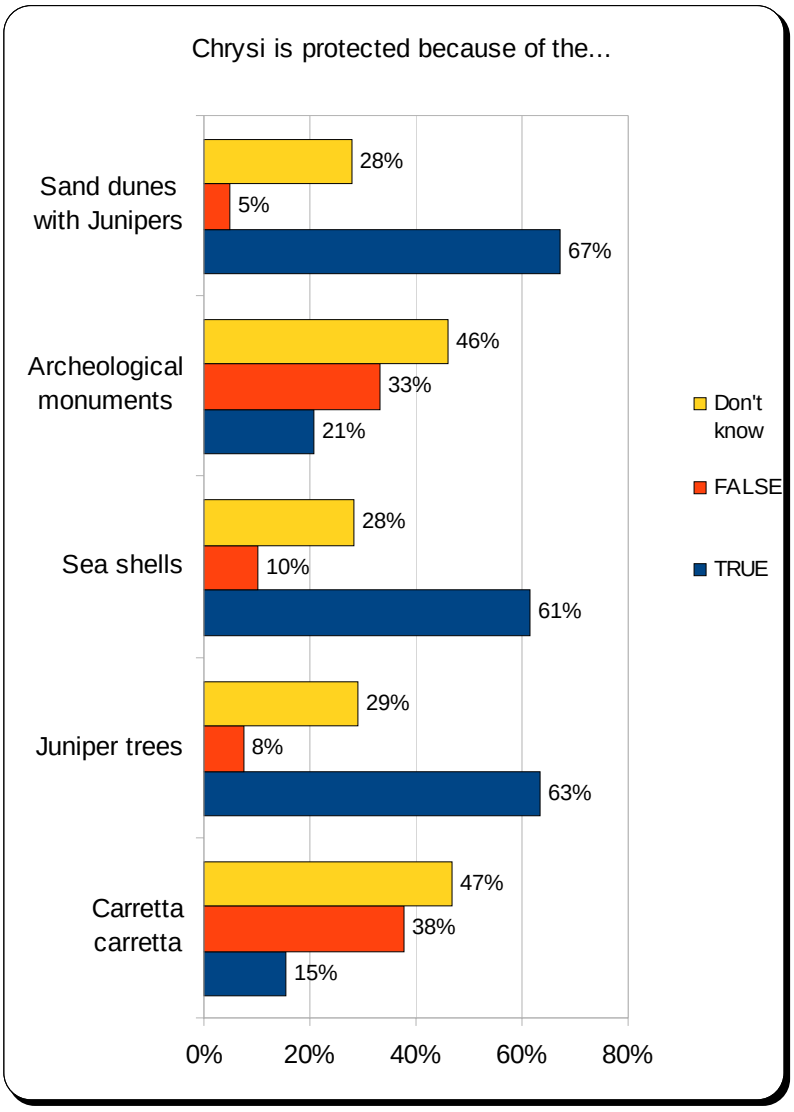

Figure 45 Visitors' opinion about the reasons for the protection of Chrysi

Moreover, only 37% of the visitors knew that the site is included in the Natura 2000 network and 29% that it is a Site of Community Interest. 33% thought that the site is a National Park and 21% thought that the site is a Special Protection Area for birds (Figure 46).

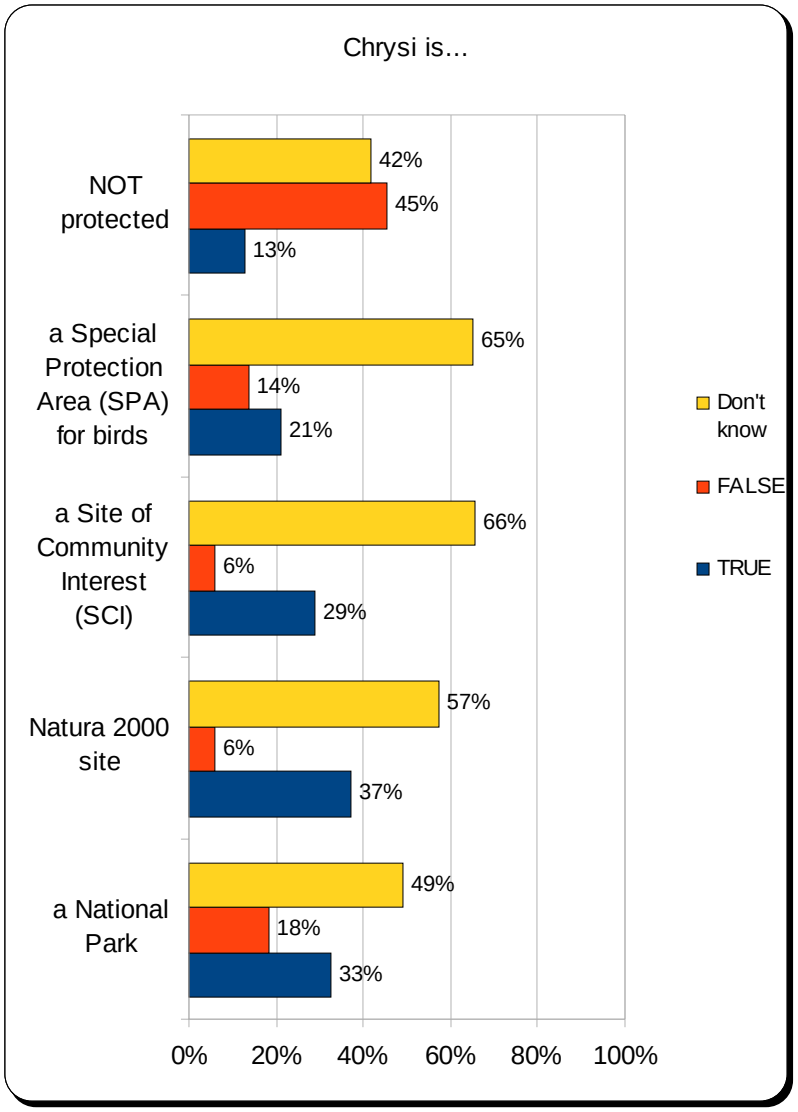

Figure 46 Protection status of Chrysi

67% of the visitors agree to carry out their rubbish when leaving the site, 47% agree that visitors' movement should be restricted only to certain part of the site while only 34% consider that camping damages the sand dunes and the juniper trees. 61% of the visitors believe that Chrysi require further protection and 31% consider that the site is not well managed (Figure 47).

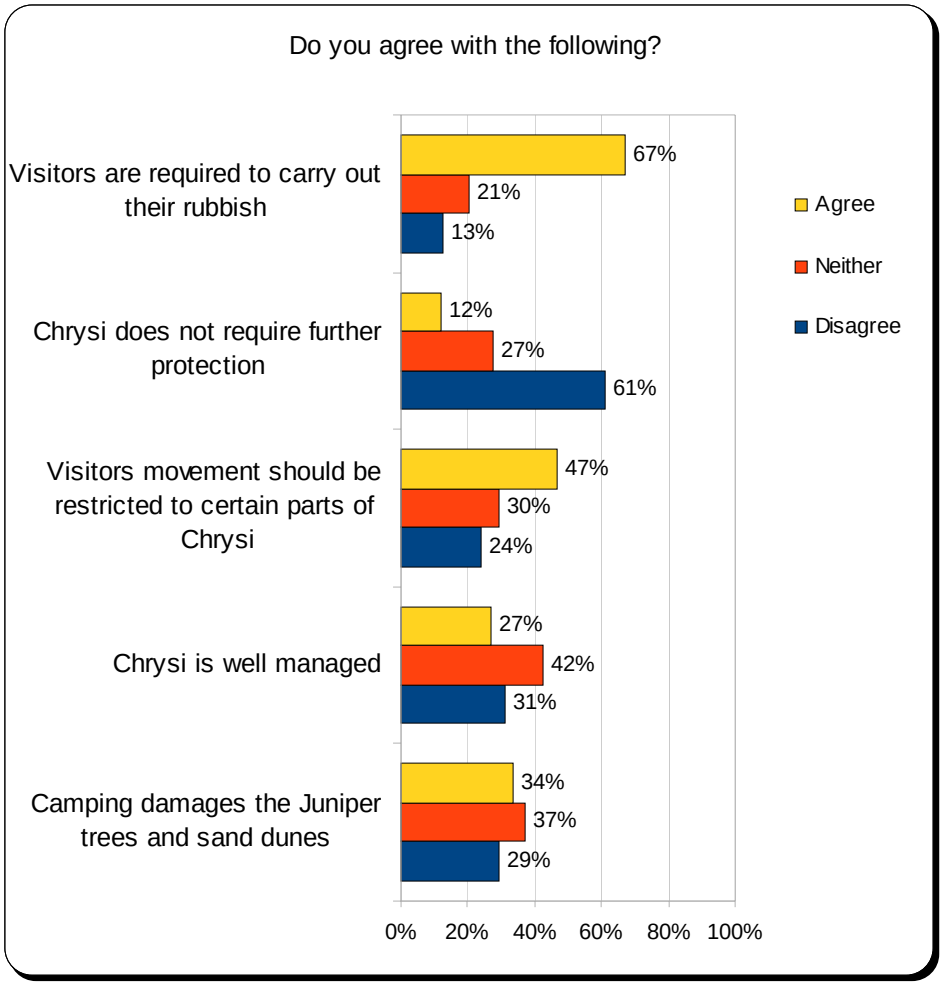

Figure 47 Visitors’ perception about the management of Chrysi

The current condition of the sand dunes and juniper trees were estimated by asking the visitors to rank the health status of the sand dunes and juniper trees (very good, good, average, poor, don’t know). The majority of the respondents have positively ranked the health status of the sand dunes and juniper trees. 24% ranked it as very good, 39% as good, 19% as average and only 9% as poor (Figure 48).

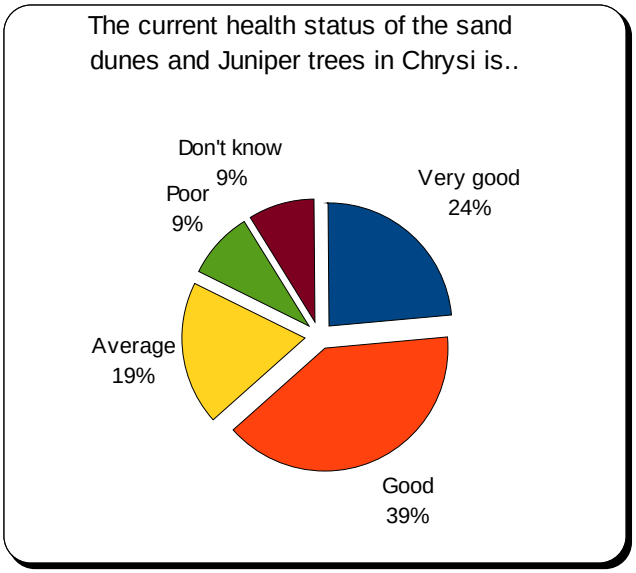

Figure 48 Visitors’ perception about the health status of the sand dunes and Juniper trees in Chrysi

When asked if they would be willing to pay an entry fee for the management of the site, approximately half (48%) of the respondents did not agree to pay any extra entry fee while the remaining 51% agreed to be charged an extra entry fee in the range of one to three euros (Figure 49).

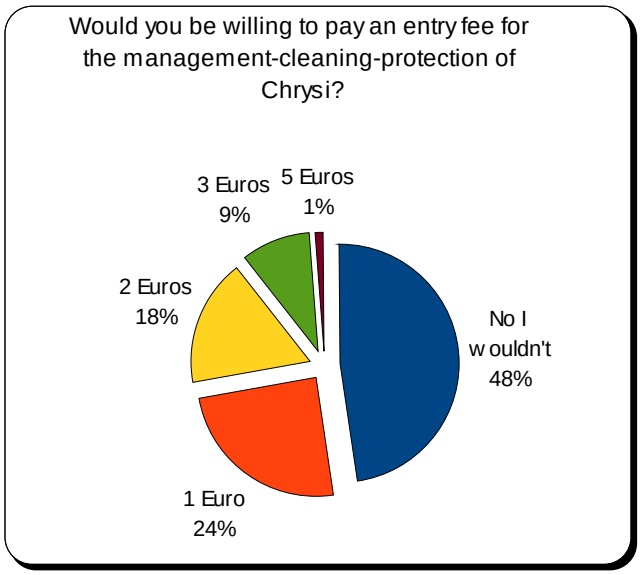

Figure 49 Visitors’ opinion about paying an entry fee

89% of the visitors declared that they would recommend their friends to visit Chrysi while only 6% confirmed that they would not (Figure 50).

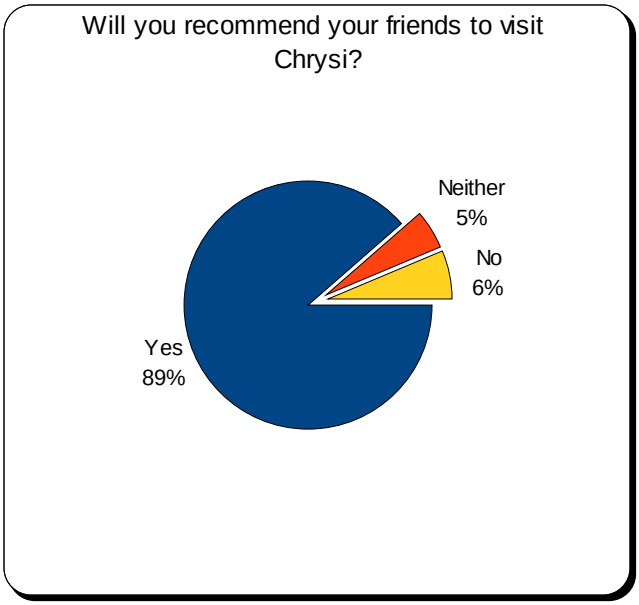

Figure 50 Visitors’ opinion about advising their friends to visit Chrysi

When asked what kind of measures should be taken in order to improve the protection and the management of Chrysi, 22% of the respondents mentioned the improvement of visitors’ infrastructure, 19% mentioned raising the public awareness, and 43% mentioned better law enforcement and improvement of the in-situ conservation measures (Figure 51).

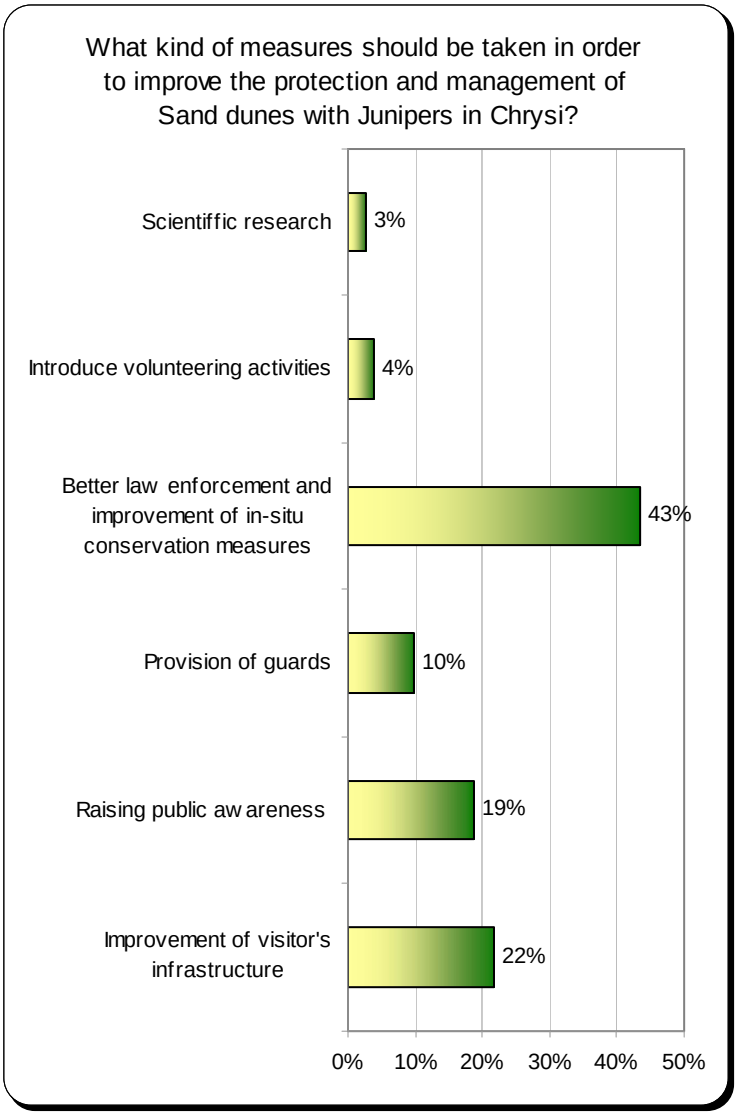

Figure 51 Visitors’ opinion on the kind of measures that should be taken in order to improve the protection and the management of Chrysi

The age of the visitors ranged between 18 and 65 years (Figure 52). Age distribution of the respondents was as follows: 18–24 years constituted 26%, 25-34 years were 43%, 35-44 years were 19% while 45-65 years constituted 11%. 53% of the visitors were male and 47% female (Figure 53).

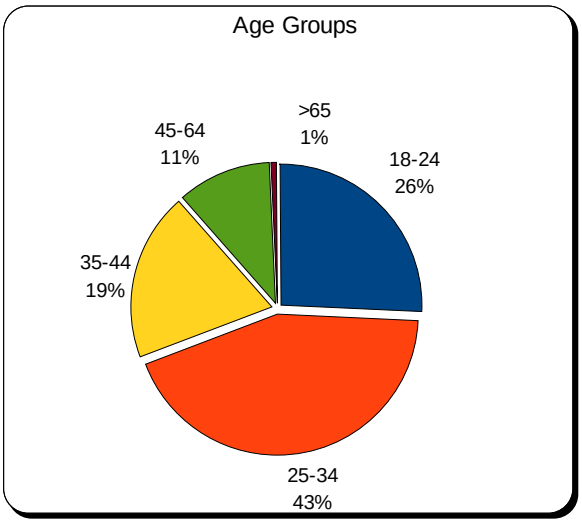

Figure 52 Age groups of the visitors to Chrysi

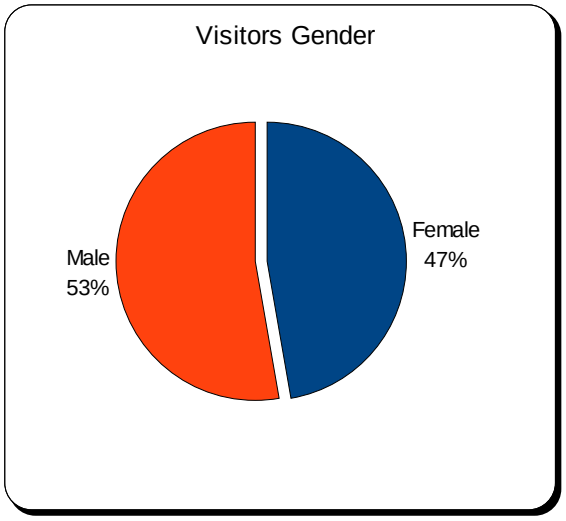

Figure 53 Visitors’ gender

In relation to the education level of the visitors, 73% hold a university degree, 16% have acquired a secondary education while only 11% had a basic education (Figure 54).

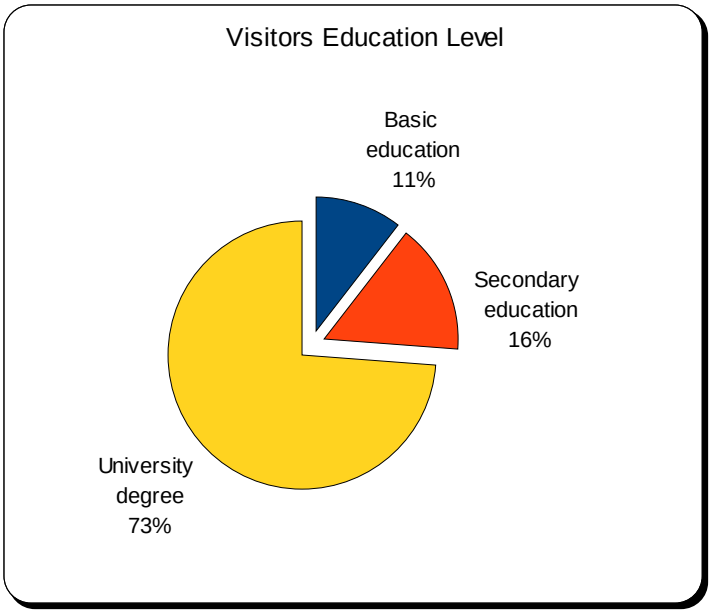

Figure 54 Visitors' education level

57% of the tourists were Greeks and 43% were foreigners (Figure 55).

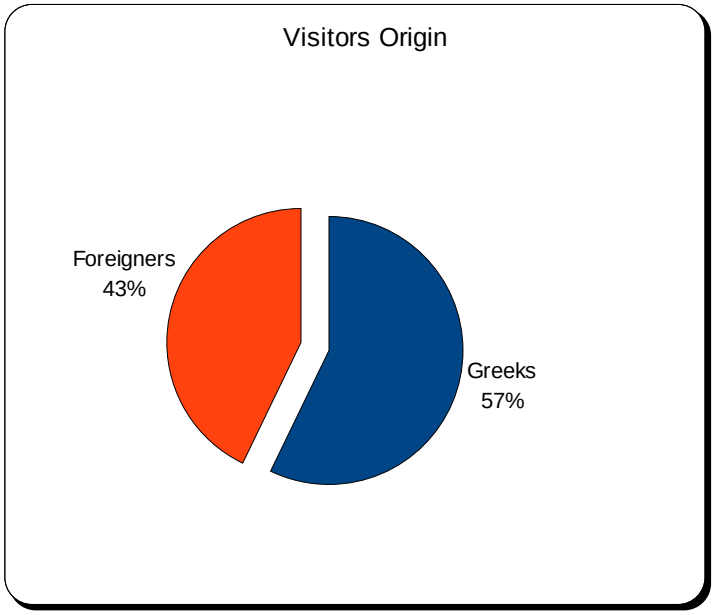

Figure 55 Visitors' origin

The largest group of Greek visitors to Chrysi came from Athens (44%) followed by Crete (33%) and only 23% from the rest of Greece (Figure 56).

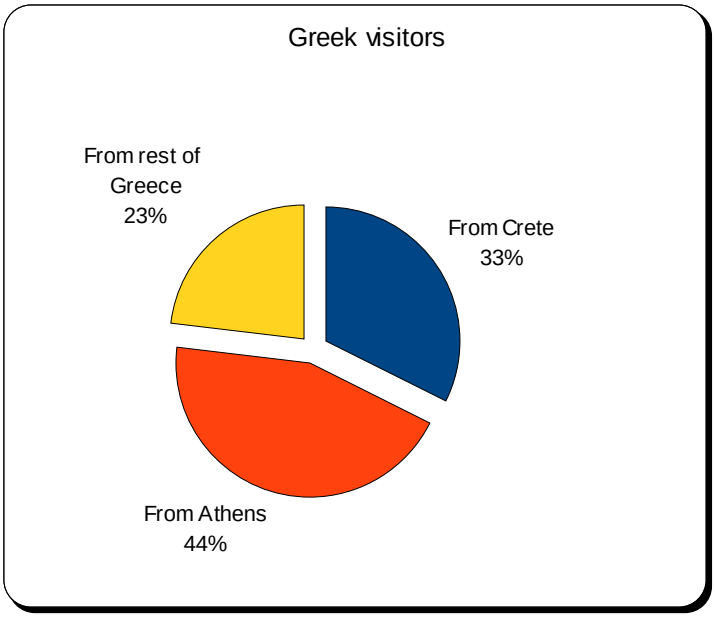

Figure 56 Origin of Greek visitors

The largest group of foreign visitors to Chrysi is from Europe (95%) and only 5% from other countries (Figure 57).

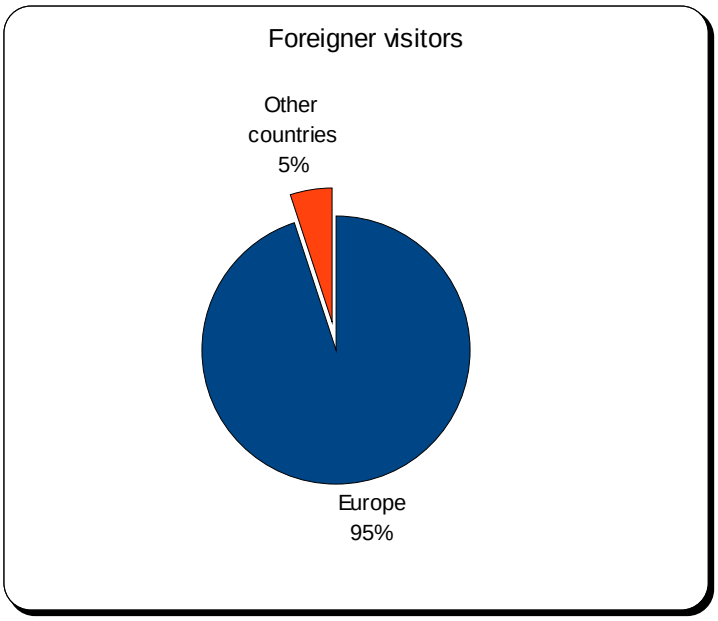

Figure 57 Origin of foreign visitors

6.1.3 Gavdos

The duration of stay of visitors in Gavdos varied significantly with the majority of the visitors (65%) staying in Gavdos for 5 days or more. Visitors going to Gavdos on a daily trip accounted only for 2% (Figure 58).

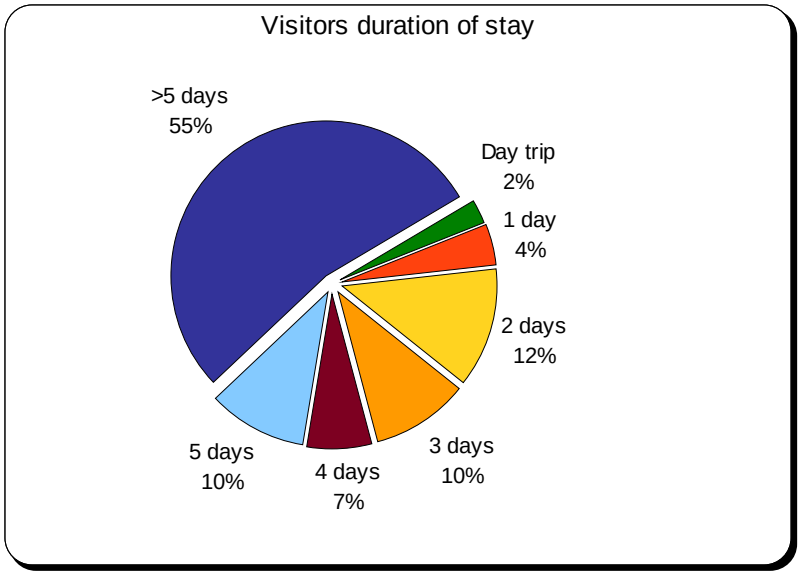

Figure 58 Visitors’ duration of stay in Gavdos

49% of the visitors have never visited Gavdos before their actual trip to the island while 18% have already visited the site once, 6% twice and 27% more than twice (Figure 59).

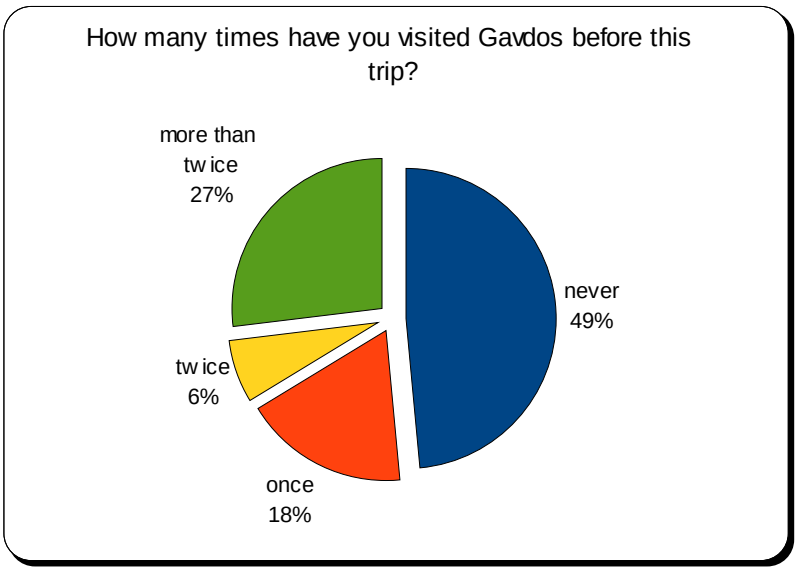

Figure 59 Number of visits to Gavdos before the actual trip

54% of the visitors mentioned that the frequency of their visit to Gavdos is once every two to three years, 34% is once a year and 12% many times per year (Figure 60).

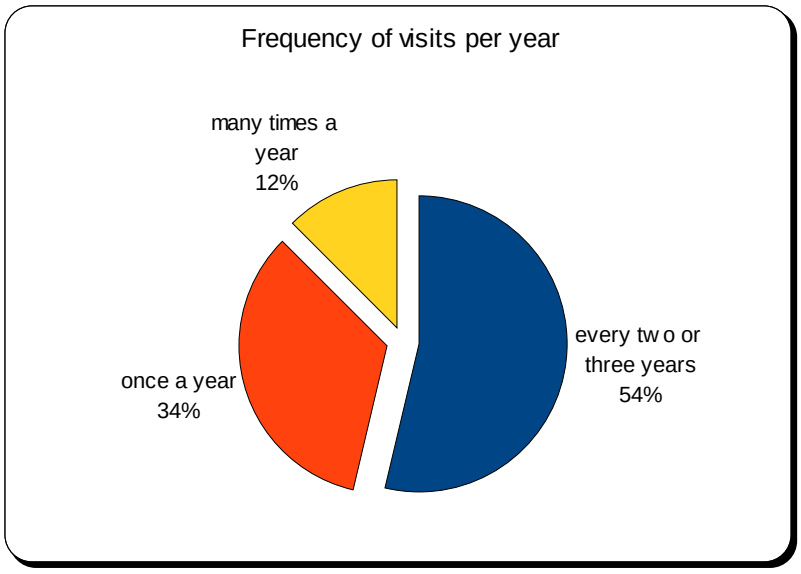

Figure 60 Frequency of visits to Gavdos per year

Activities performed by visitors when on site were mainly beach-based activities. A majority of visitors identified swimming (91%), sun tanning (70%), trekking (67%), camping (66%), beach games (39%), wild-life watching (38%), as their primary activity while on the island, while picnic (27%) and fishing (20%) were to a lesser extent performed by visitors (Figure 61).

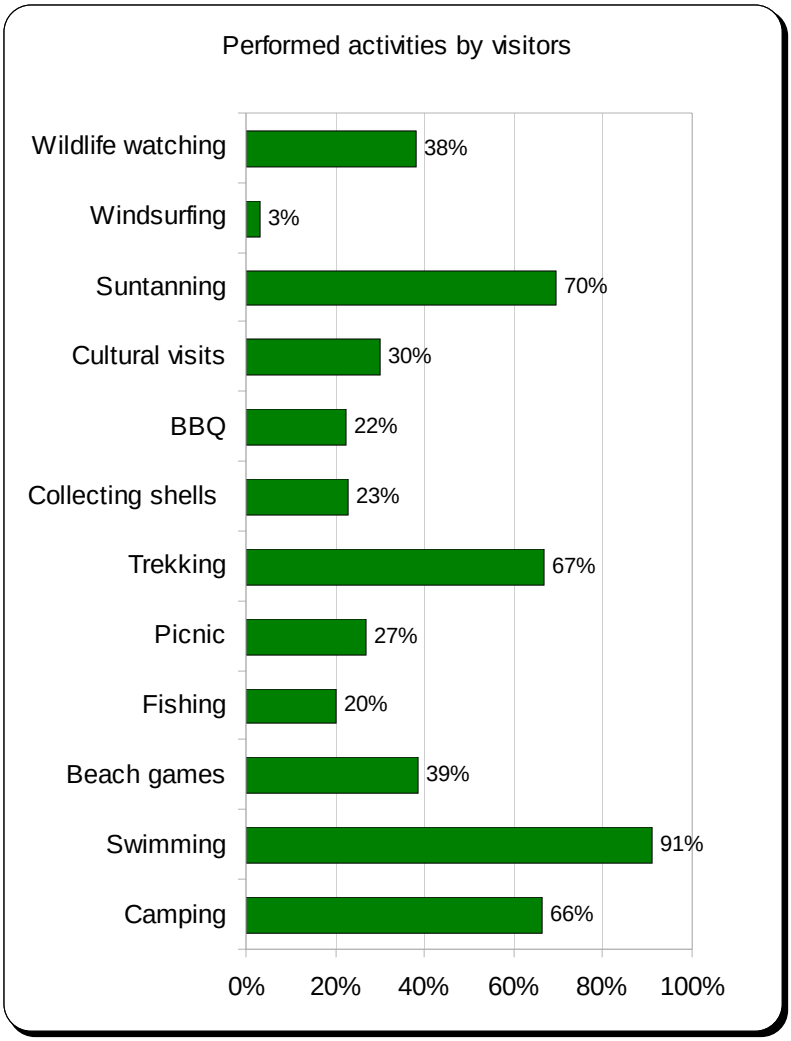

Figure 61 Visitors’ activities in Gavdos

When asked to name the most important reasons for visiting Gavdos, the majority (82%) of the visitors stated “the site natural beauty” and “appealing conditions”, 9% for entertainment and 6% because of the site reputation (Figure 62).

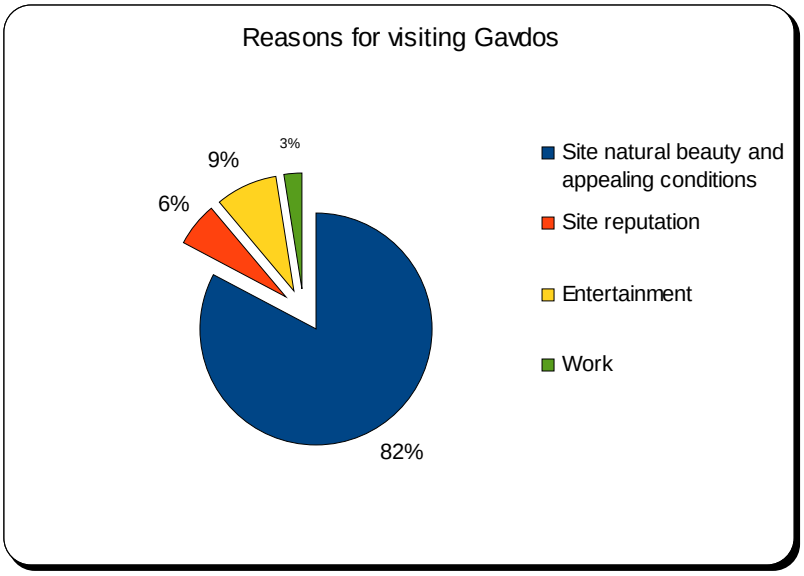

Figure 62 Reasons for visiting Gavdos

In Sarakiniko, 30% of the visitors rent a room whereas 24% were camping onsite. 56% of the visitors to Agios Ioannis camped on site, while in Lavrakas 29% of the visitors camped on site (Figure 63).

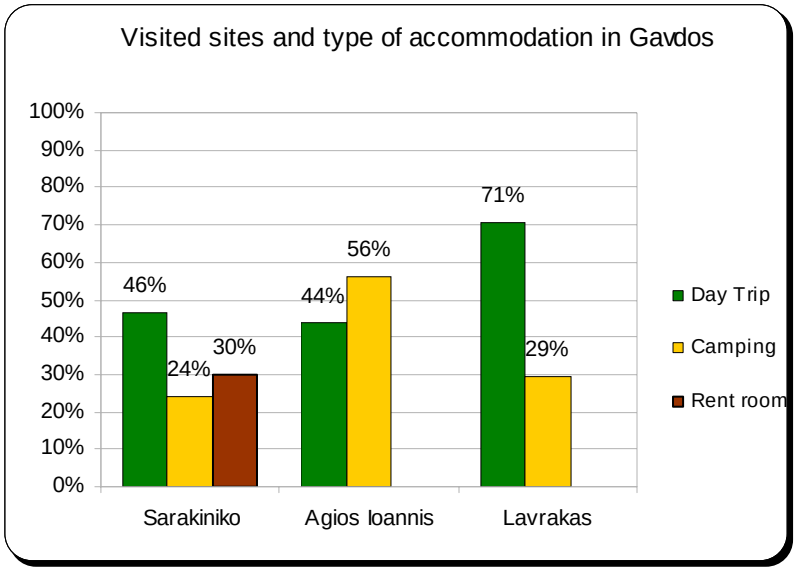

Figure 63 Visited sites and type of accommodation in Gavdos

The duration of stay of campers in Sarakiniko varied significantly with the majority of campers (60%) staying for one to 5 days, around 20% staying for 6 to 10 days and almost 20% for more then 10 days. The duration of stay of campers in Agios Ioannis varied slightly with the majority of campers (36%) staying for one to 5 days, around 28% staying for 6 to 10 days and almost 32% for more then 10 days. The

duration of stay of campers in Lavrakas varied significantly with the majority of campers (48%) staying for one to 5 days, around 11% staying for 6 to 10 days and almost 40% for more then 10 days (Figure 64).

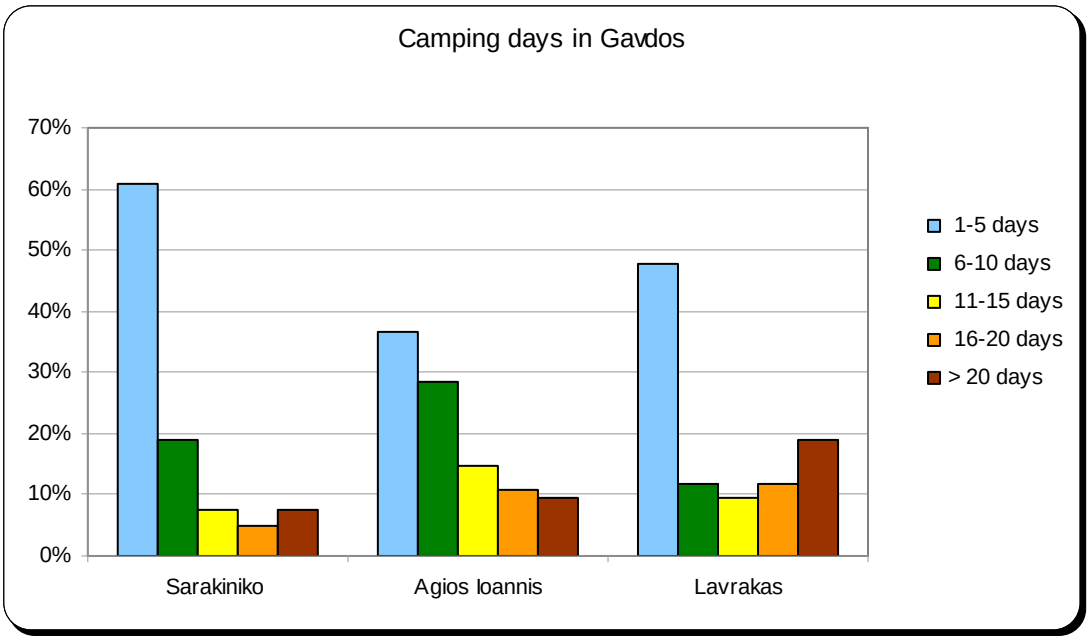

Figure 64 Camping days in Gavdos per site

The visitors' perception about the crowdedness of Sarakiniko is shown in figure 65. Around 38% of the visitors reported that Sarakiniko was not crowded (average of the period from July to September 2009) while, for the same period, around 26% considered that the site is medium crowded and 11% considered that it was overcrowded.

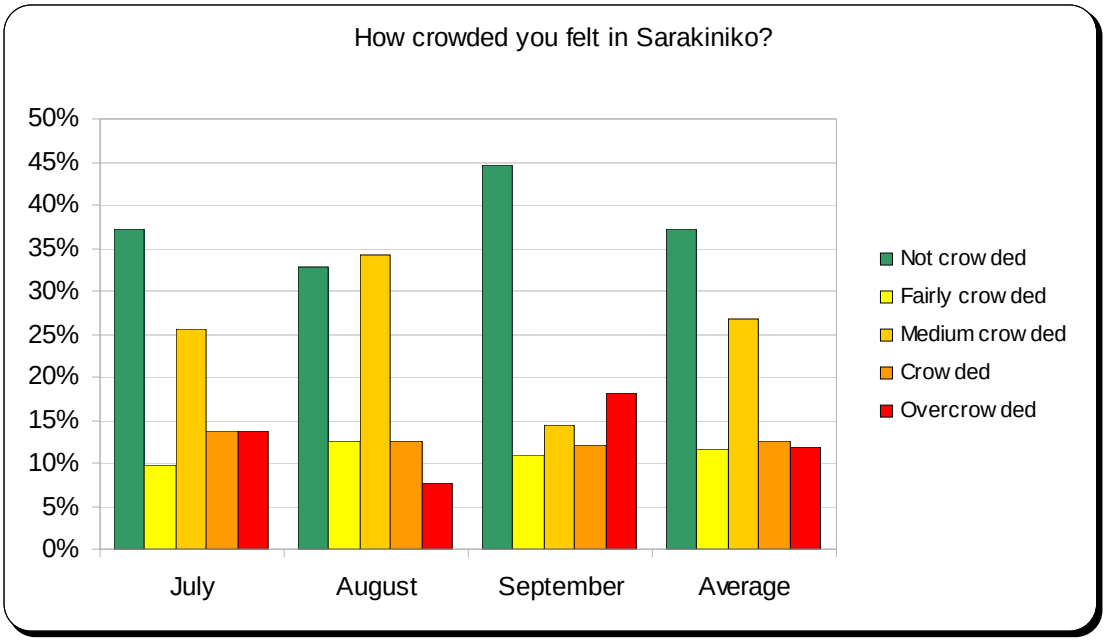

Figure 65 Visitors' perception about the crowdedness of Sarakiniko

The visitors' perception about the crowdedness of Agios Ioannis is shown in figure 66. Around 26% of the visitors reported that Agios Ioannis was medium crowded (average of the period from July to September 2009) while, for the same period, around 28% considered that the site is overcrowded.

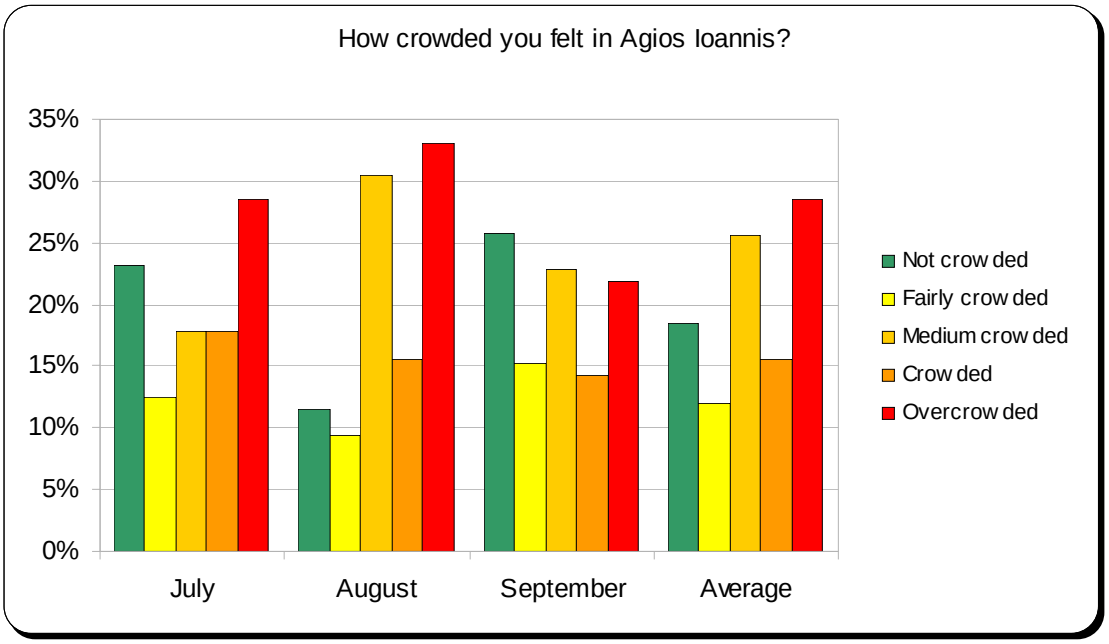

Figure 66 Visitors' perception about the crowdedness of Agios Ioannis

The visitors' perception about the crowdedness of Lavrakas is shown in figure 67. Around 31% of the visitors reported that Lavrakas was not crowded (average of

the period from July to September 2009) while, for the same period, around 25% considered that the site is medium crowded and around 15% considered that it was overcrowded.

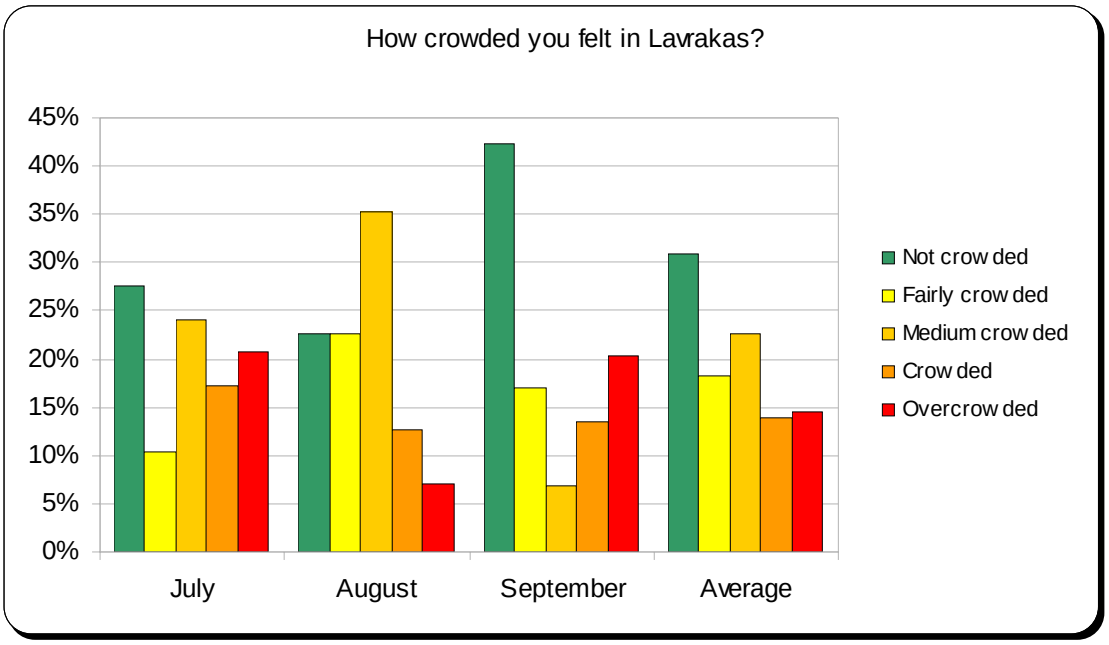

Figure 67 Visitors' perception about the crowdedness of Lavrakas

When asked about their opinion on the level of cleanliness of Sarakiniko, around 47% of the visitors reported that the site is clean (average of the period from July to September 2009) while, for the same period, around 23% considered that the site is dirty. Around 30% considered the site fairly clean (Figure 68).

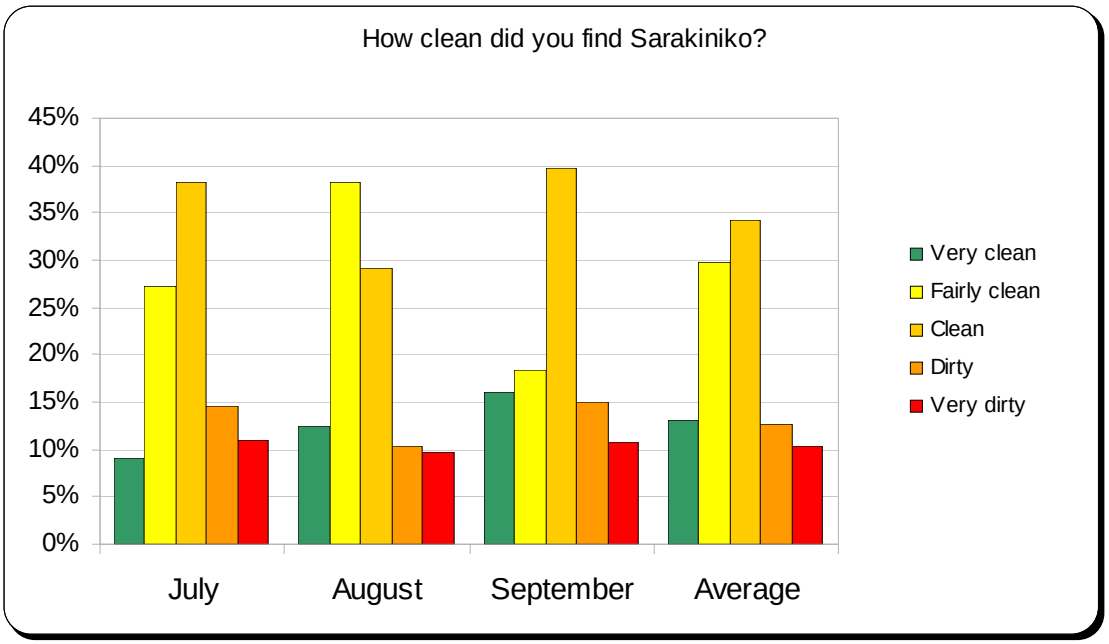

Figure 68 Visitors' opinion about the level of cleanliness of Sarakiniko

When asked about their opinion on the level of cleanliness of Agios Ioannis, around 49% of the visitors reported that the site is clean (average of the period from July to September 2009) while, for the same period, around 23% considered that the site is dirty. Around 28% considered the site fairly clean (Figure 69).

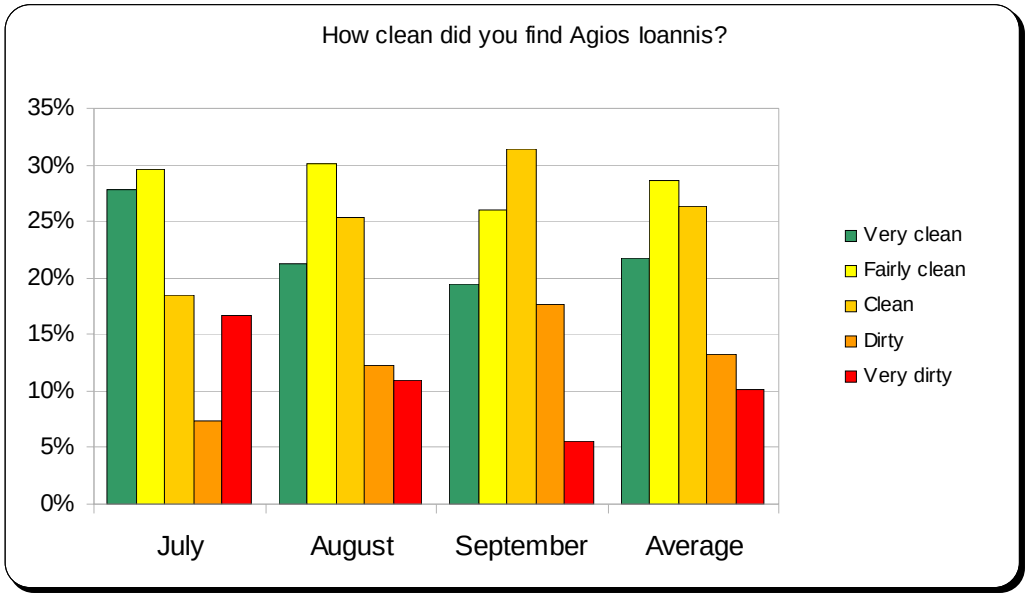

Figure 69 Visitors' opinion about the level of cleanliness of Agios Ioannis

When asked about their opinion on the level of cleanliness Lavrakas, around 48% of the visitors reported that the site is clean (average of the period from July to September 2009) while, for the same period, around 14% considered that the site is dirty. Around 38% considered the site fairly clean (Figure 70).

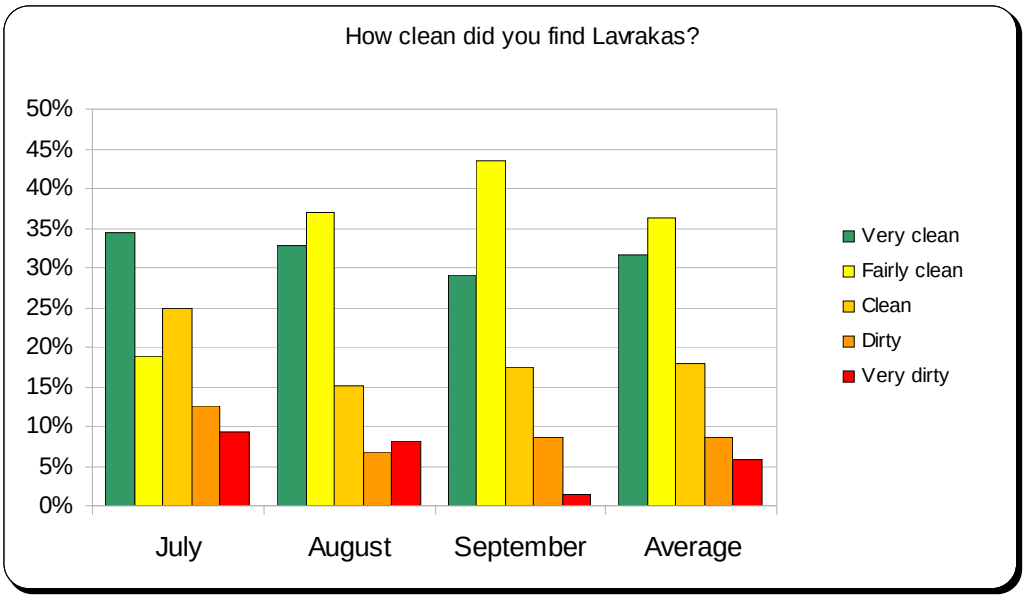

Figure 70 Visitors' opinion about the level of cleanliness of Lavrakas

When asked to name the most important things that they did not like during their visit to Gavdos, 27% of the visitors stated the excessive visitors’ pressure and the inappropriate visitor conduct, 25% mentioned the rubbish and human waste and 15% to 19% mentioned the lack of visitors’ infrastructure and excessive unfit facilities (Figure 71).

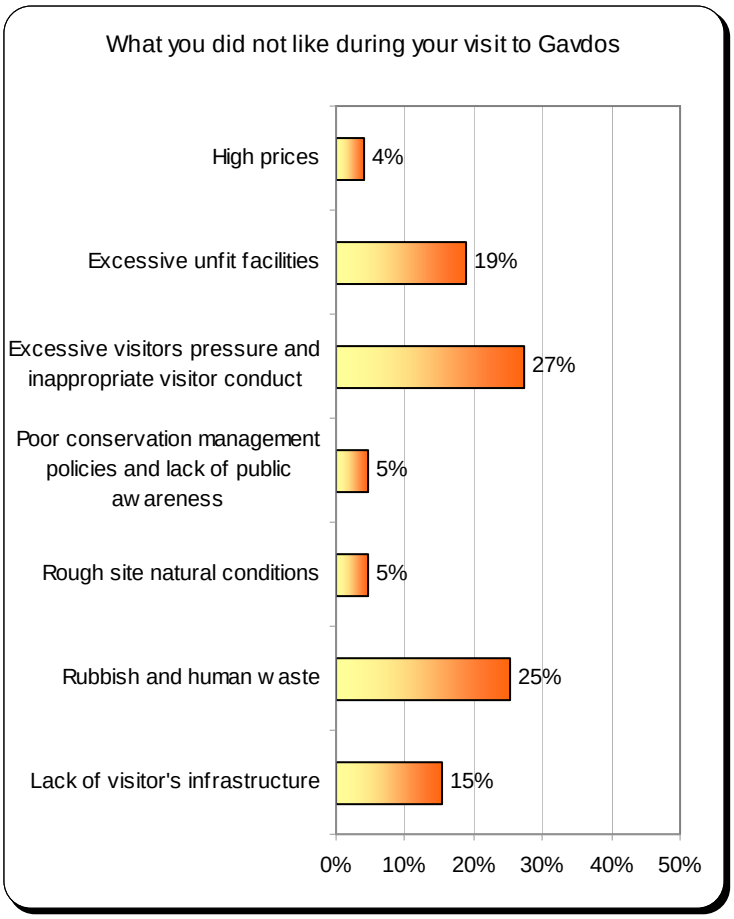

Figure 71 What visitors did not like during their visit to Gavdos

The visitors’ perception about the main threats affecting the sand dunes with junipers in Gavdos is shown in figure 72. Rubbish, litter and human waste were seen as threat by 63 to 75% of the visitors. 46 to 62% of the visitors considered that fires and cutting juniper branches and/or roots are also a threat, while around 26% of the respondents regarded grazing, the low natural regeneration of the juniper trees and campers as another threat.

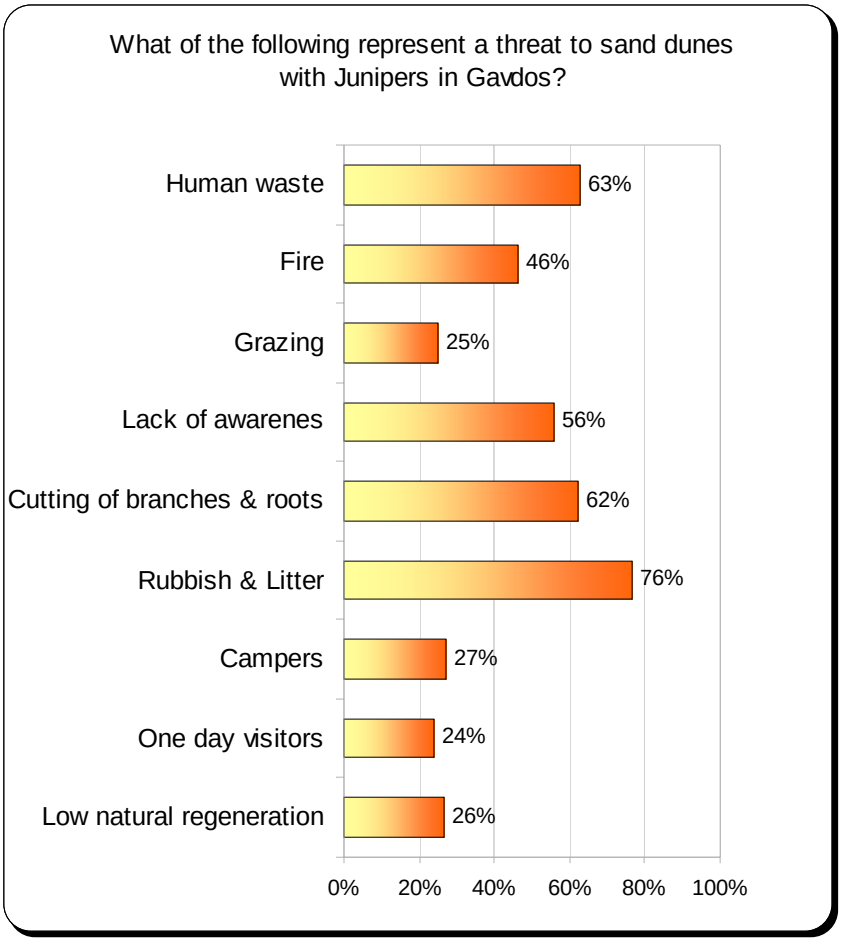

Figure 72 Visitors' perception about the main threats affecting the sand dunes with Junipers in Gavdos

The majority of the visitors (87%) knew about Gavdos before coming to Crete while only 13% did not know about the island before visiting Crete (Figure 73).

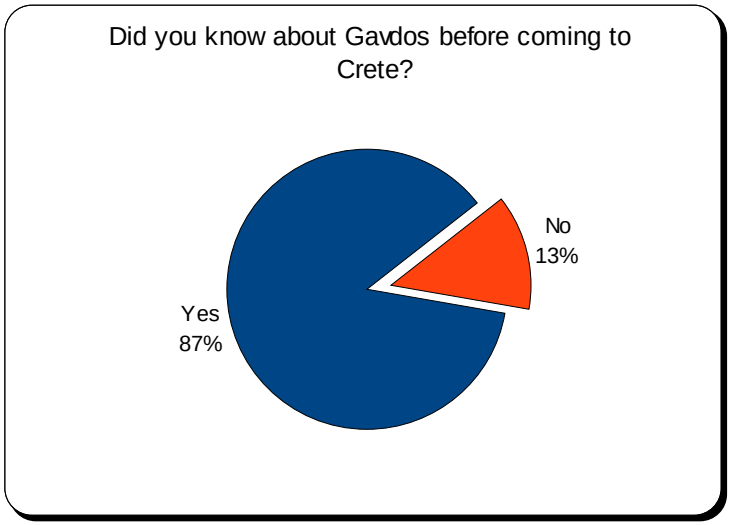

Figure 73 Visitors acquaintance with Gavdos

Furthermore, the level of "environmental awareness" was estimated with the help of environmental and conservation oriented questions. 66 to 67% of the visitors believed that Gavdos is protected because of the presence of sand dunes and juniper trees, 39% thought that the site is protected because of the archaeological monuments, while 17% assumed that the site is protected because of the presence of *Carretta carretta* and sea shells (Figure 74).

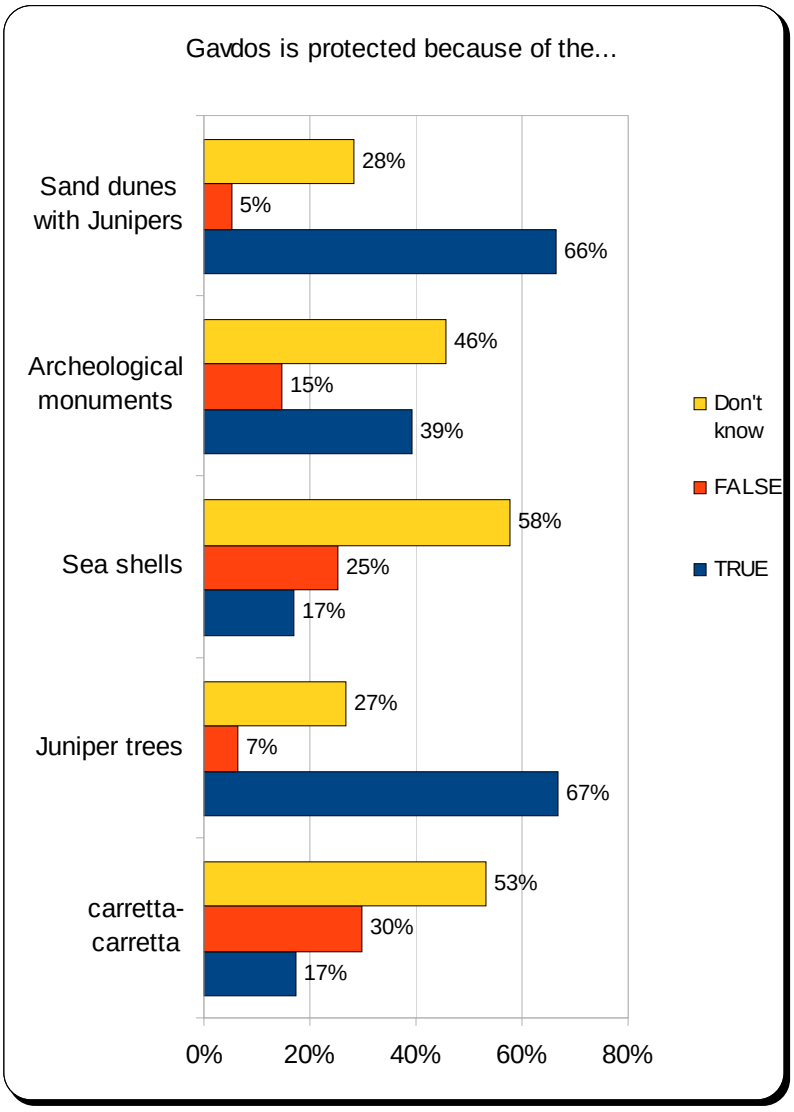

Figure 74 Visitors' opinion about the reasons for the protection of Gavdos

Moreover, only 43% of the visitors knew that the site is included in the Natura 2000 network and 27% that it is a Site of Community Interest. 18% thought that the site is a National Park, 24% thought that the site is a Special Protection Area for birds (Figure 75).

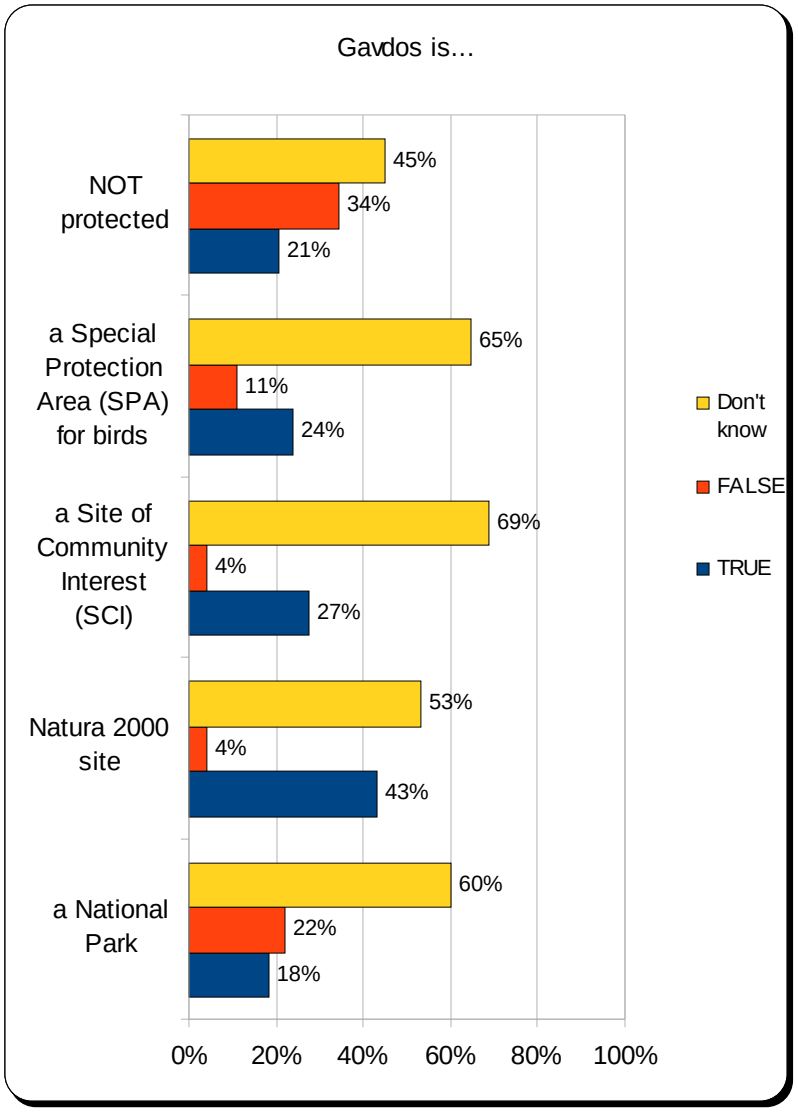

Figure 75 Protection status of Gavdos

82% of the visitors agree to carry out their rubbish when leaving the site, 27% agree that visitors' movement should be restricted only to certain part of the site while only 22% consider that camping damages the sand dunes and the juniper trees. 61% of the visitors believe that Gavdos requires further protection and 34% consider that the sites are not well managed (Figure 76).

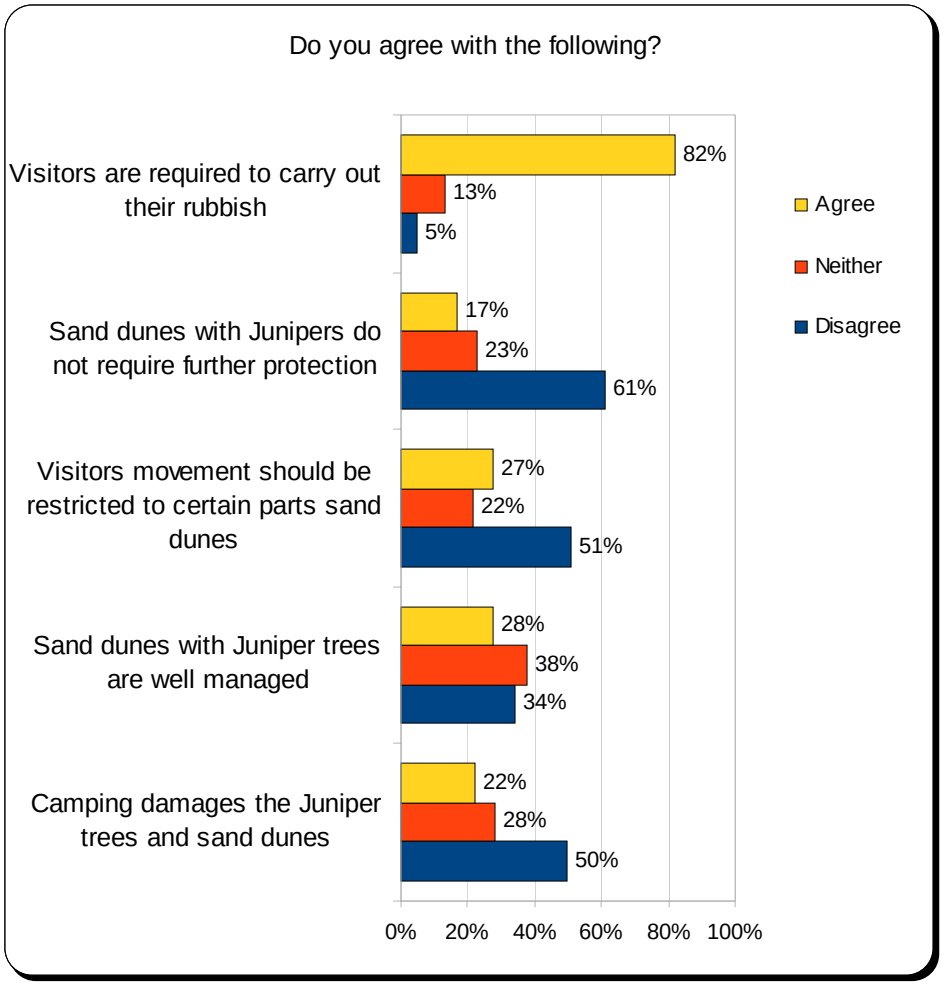

Figure 76 Visitors' perception about the management of Gavdos

The current condition of the sand dunes and juniper trees were estimated by asking the visitors to rank the health status of the sand dunes and juniper trees (very good, good, average, poor, don't know). The majority of the respondents have positively ranked the health status of the sand dunes and juniper trees. 15% ranked it as very good, 44% as good, 22% as average and only 9% as poor (Figure 77).

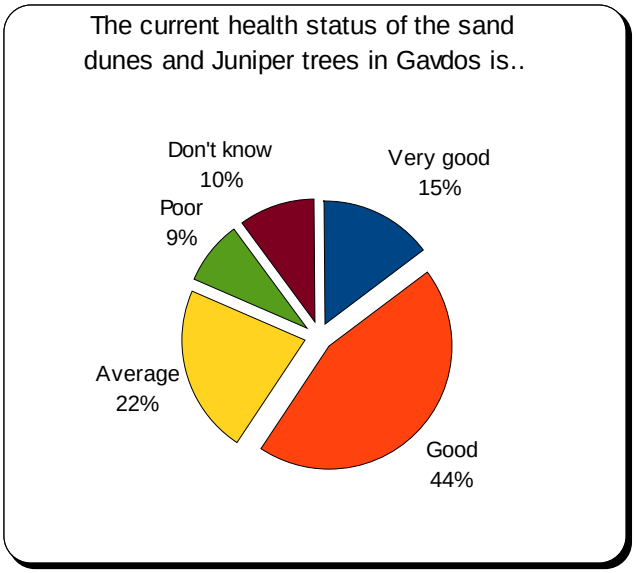

Figure 77 Visitors' perception about the current health status of the sand dunes and Juniper tress in Gavdos

When asked if they would be willing to pay an entry fee for the management of the sites, 39% of the respondents did not agree to pay any extra fee while the other 61% agreed to be charged an extra fee in the range of one to five euros (Figure 78).

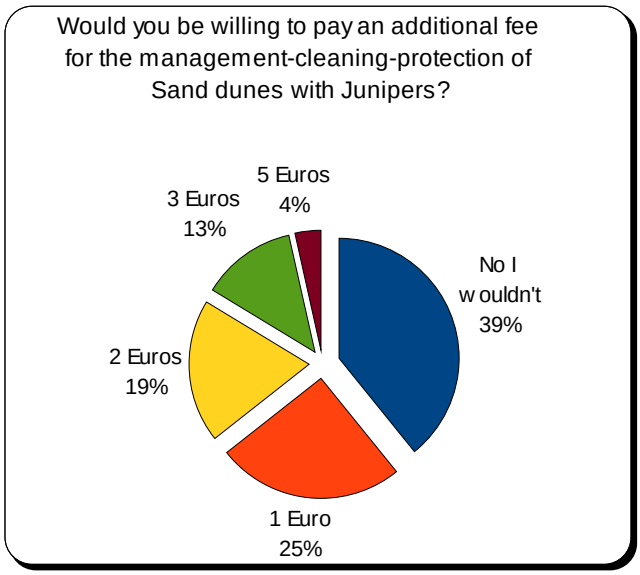

Figure 78 Visitors' opinion about paying an entry fee for the management of habitats in Gavdos

78% of the visitors declared that they would recommend their friends to visit Gavdos while only 11% confirmed that they would not (Figure 79).

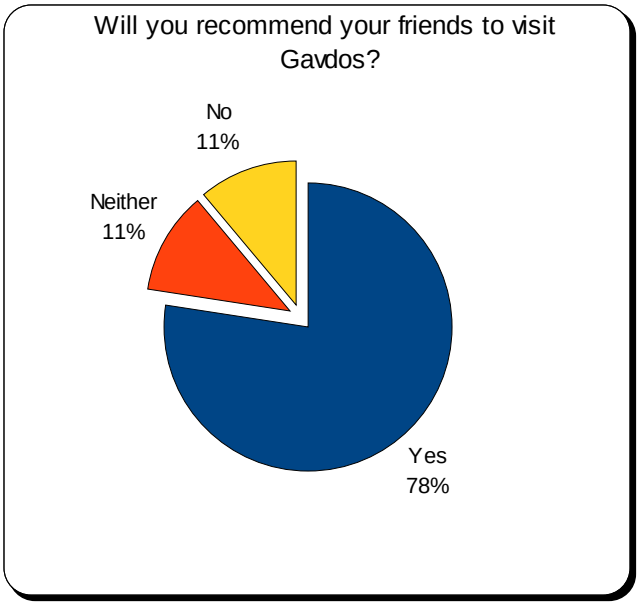

Figure 79 Visitors’ opinion about advising their friends to visit Gavdos

When asked what kind of measures should be taken in order to improve the protection and the management of the sand dunes with junipers in Gavdos, 24% of the respondents mentioned the improvement of visitors’ infrastructure, 23% mentioned raising the public awareness, and 48% mentioned better law enforcement and improvement of the in-situ conservation measures (Figure 80).

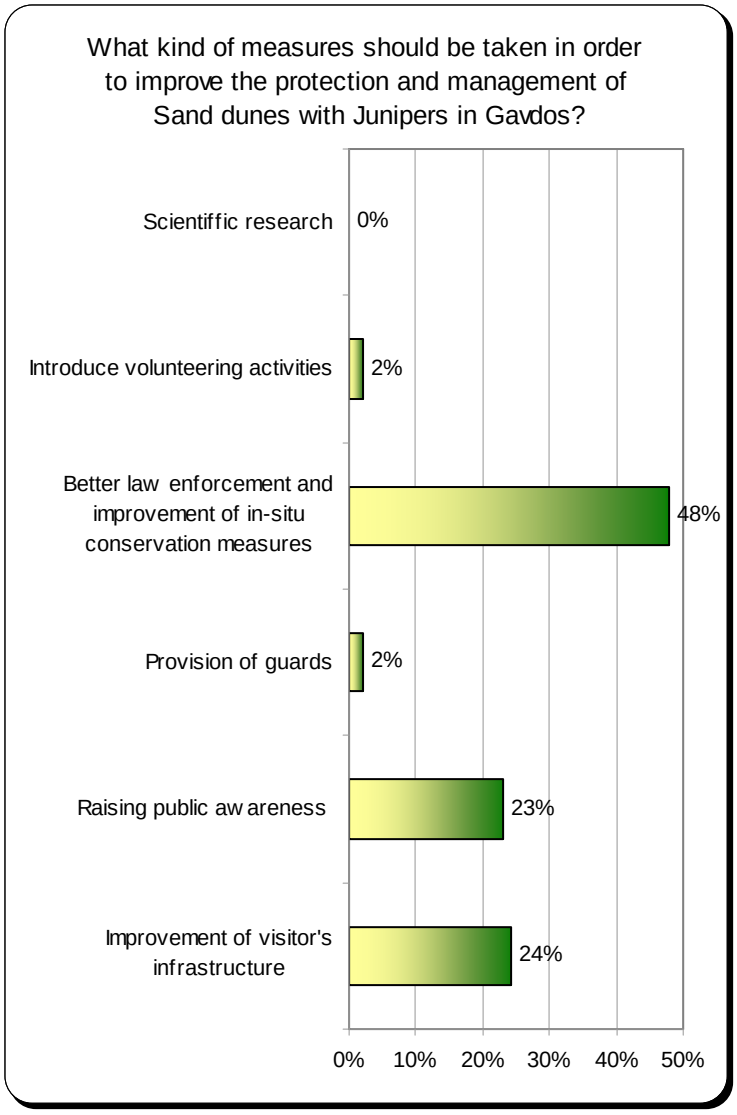

Figure 80 Visitors' opinion on the kind of measures that should be taken in order to improve the protection and the management of the sand dunes with Juniper trees in Gavdos

The age of the visitors ranged between 18 and 65 years (Figure 81). Age distribution of the respondents was as follows: 18–24 years constituted 18%, 25-34 years were 40%, 35-44 years were 24% while 45-65 years constituted 17%. 46% of the visitors were males and 54% were females (Figure 82).

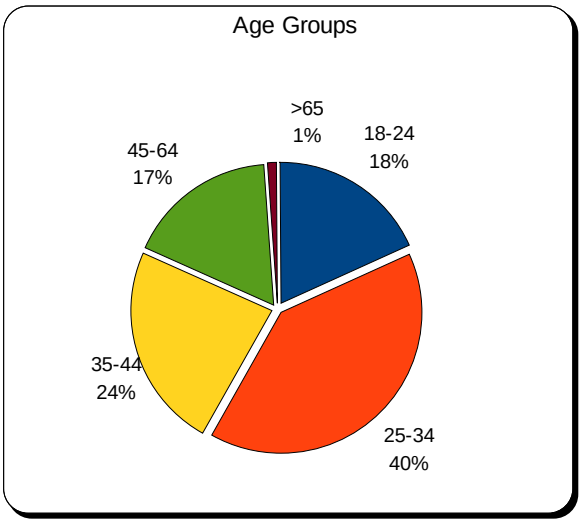

Figure 81 Age groups of the visitors to Gavdos

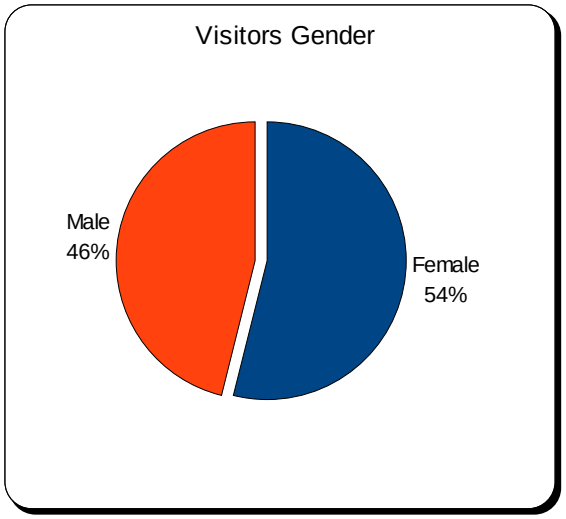

Figure 82 Visitors’ gender

In relation to the education level of the visitors, 82% hold a university degree, 11% have acquired a secondary education while only 7% had a basic education (Figure 83).

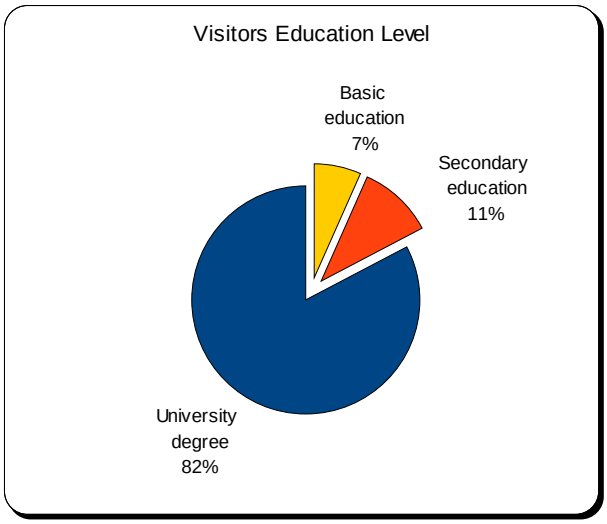

Figure 83 Visitors’ education level

84% of the tourists visiting Gavdos were Greeks and 16% were foreigners (Figure 84).

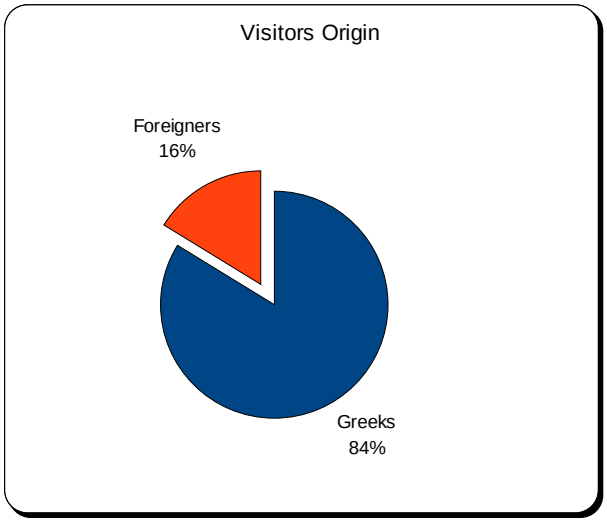

Figure 84 Visitors’ origin

The largest group of Greek visitors to Gavdos came from Athens (51%) followed by Crete (29%) and only 10% from the rest of Greece (Figure 85).

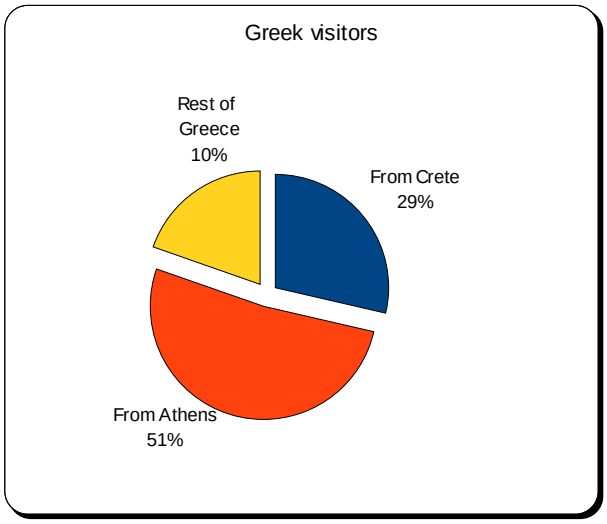

Figure 85 Origin of the Greek visitors

The largest group of foreign visitors to Gavdos is from Europe (82%) and only 18% from other countries (Figure 86).

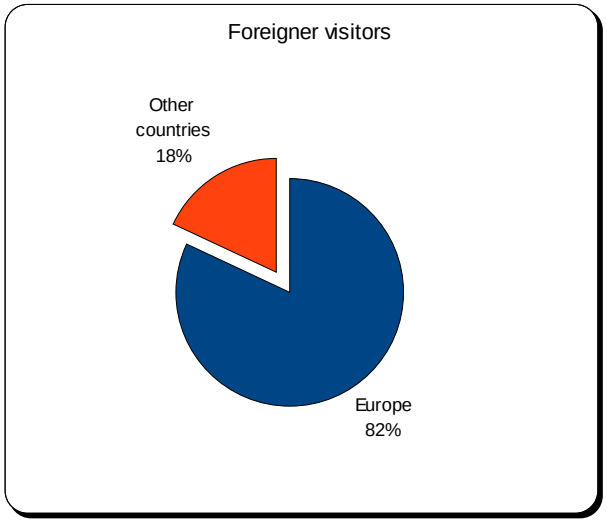

Figure 86 Origin of the foreign visitors

6.2 Documenting trail and camping site conditions

6.2.1 Kedrodasos

The distribution of the main and secondary trails, the camping sites and the number of tents (density) in Kedrodasos were recorded with a GPS and imported into GIS. Two main trails have been identified in Kedrodasos (Figure 87) representing the main entry points to the habitat. The first main trail represents the E4 European Walking Path connecting the west and east parts of the habitat. The second main trail connects the parking area located outside the habitat on the north and is used by the visitors arriving by car. Several secondary trails leading in different directions have been also identified and mapped. They are not well developed and represent access routes between the different camping sites.

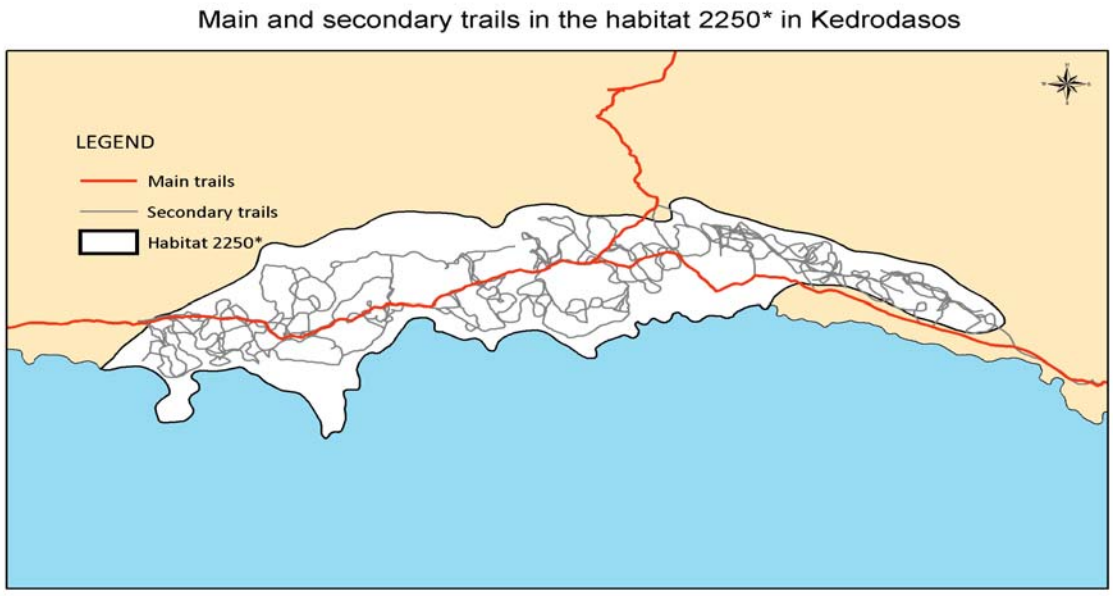

Figure 87 Main and secondary trails in Kedrodasos

Moreover, the spatial distribution of tents per sampled day per month (on weekends) and the levels of use (intensity) have been recorded in Kedrodasos (Figure 88). The eastern part of the habitat in Kedrodasos included the highest number of tents within the habitat. A total of 45 tents per sampled day were counted on June, 57 tents per sampled day on July, 158 tents per sampled day on August and 48 tents per sampled day on September. The majority of camping sites (60%) showed high use intensity (more than 3 tents during the period June-September), 16% showed medium use intensity (2 tents during the period June-

September), 20% showed low use intensity (one tent during the period June-September) and only 4% showed no use intensity.

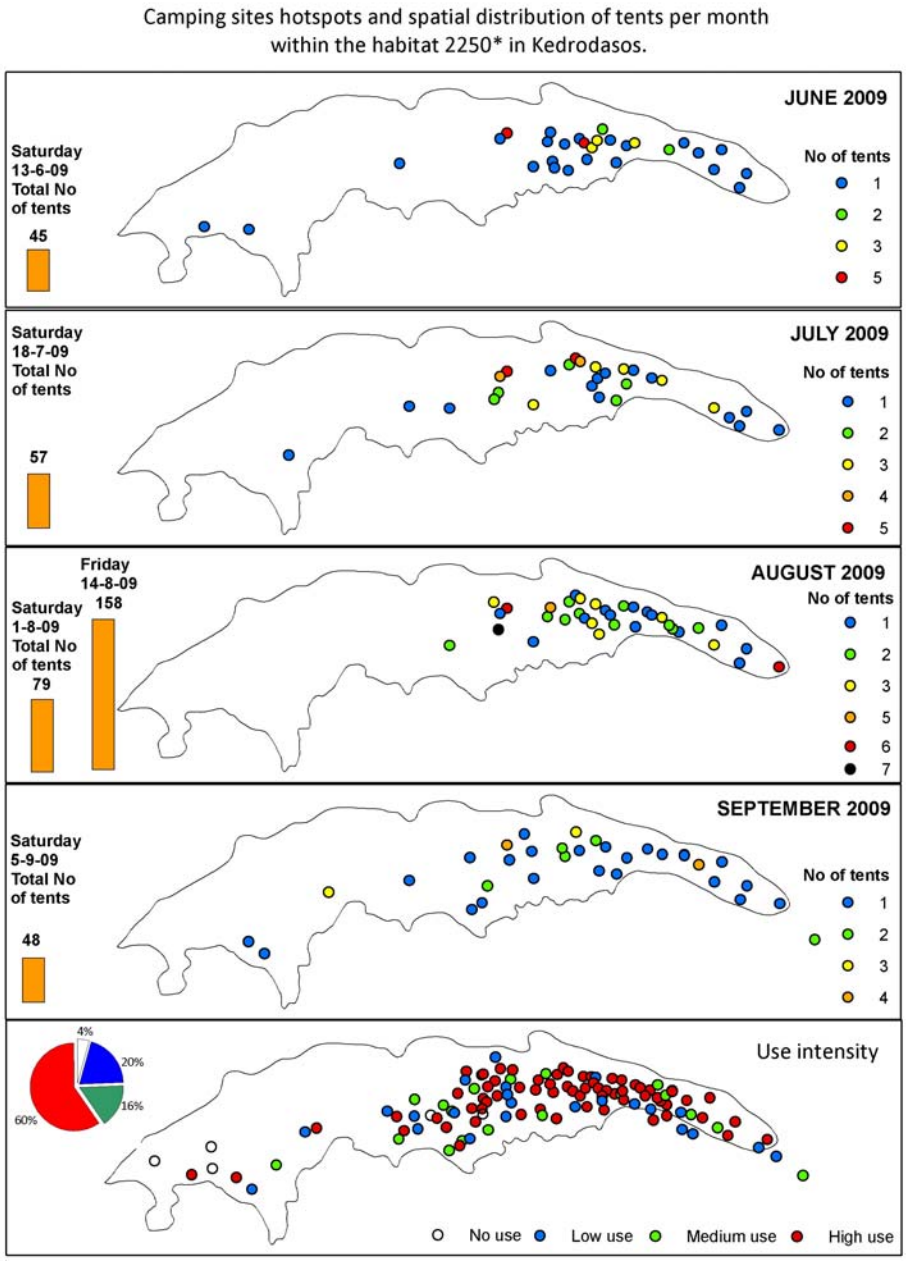

Figure 88 Camping sites hotspots and spatial distribution of tents per month in Kedrodasos

6.2.2 Chrysi

The distribution of the main and secondary trails, the camping sites and the number of tents (density) in the eastern habitat of Chrysi were recorded with a GPS and imported into GIS. In the western habitat of Chrysi, only the main trails were recorded and mapped. Four main trails have been identified in the eastern habitat and two main trails in the western habitat of Chrysi (Figure 89). The 4 main trails in the eastern habitat represent the main routes connecting the South beach (main entry point to the eastern habitat) to the North beach and providing easier access on various locations inside the habitat. Several secondary trails leading in different directions within the eastern habitat have been also identified and mapped. They are not well developed and represent access routes between the different camping sites.

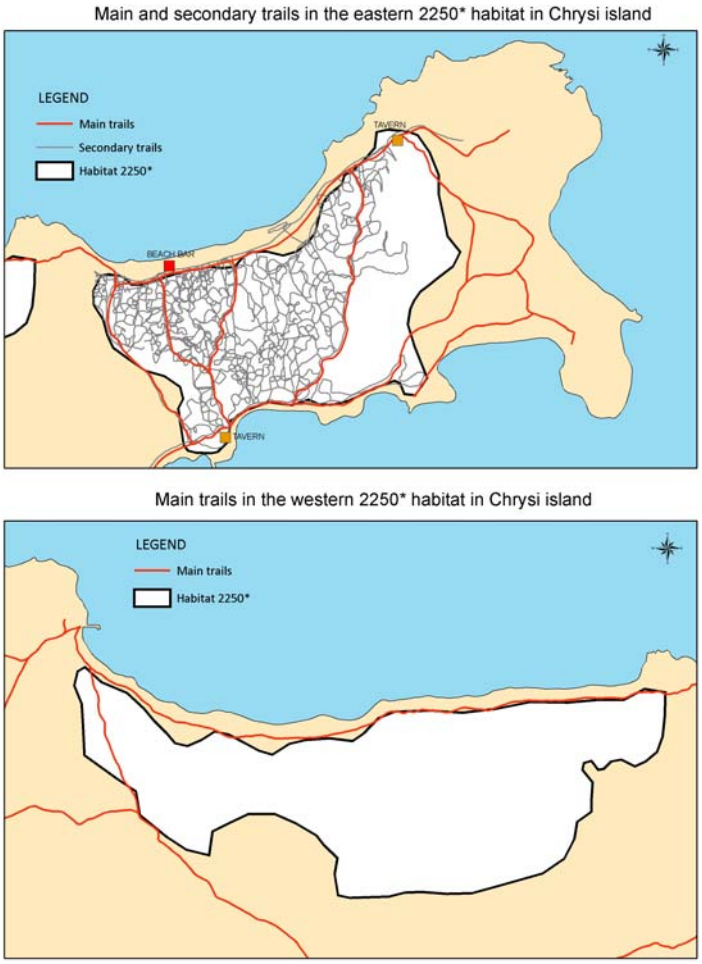

Figure 89 Main and secondary trails in the eastern and western habitats of Chrysi

Moreover, the spatial distribution of tents per sampled day per month and the levels of use (intensity) have been recorded in the eastern habitat (Figure 90). A total of 140 tents per sampled day were counted on June, 118 tents per sampled day on July, 254 tents per sampled day on August and 77 tents per sampled day on September. The majority of camping sites (38%) showed no use intensity, 18% showed high use intensity (more than 3 tents during the period June-September), 16% showed medium use intensity (two tents during the period June-September) and 28% showed low use intensity (one tent during the period June-September).

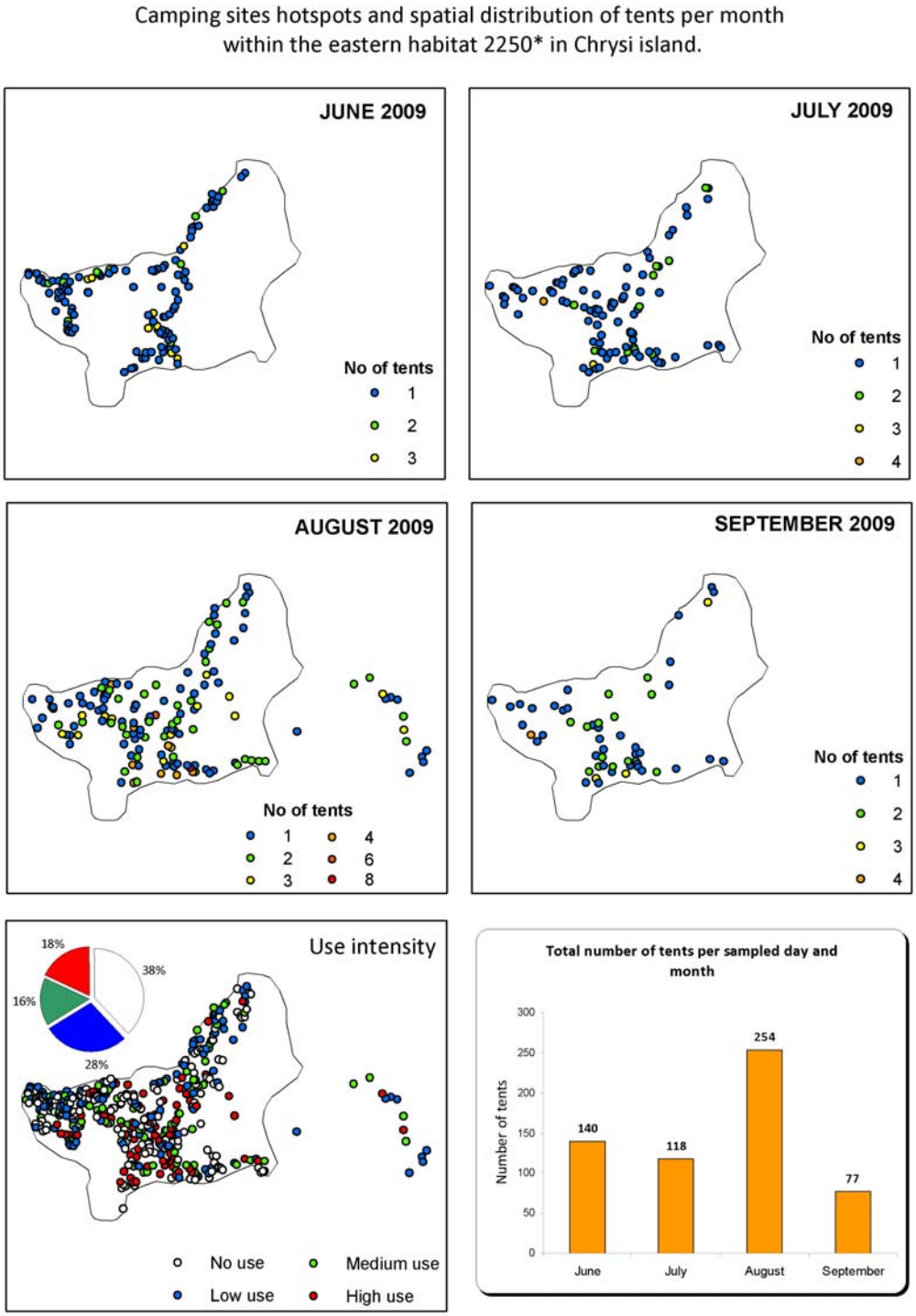

Figure 90 Camping sites hotspots and spatial distribution of tents per month in the eastern habitat of Chrysi

6.2.3 Gavdos

The distribution of the main trails in Sarakiniko, Agios Ioannis and Lavrakas were recorded with a GPS and imported into GIS. Three main trails have been identified in Sarakiniko, four in Agios Ioannis and three in Lavrakas (Figure 91). The main trails in each habitat represent the main entry points to the habitat.

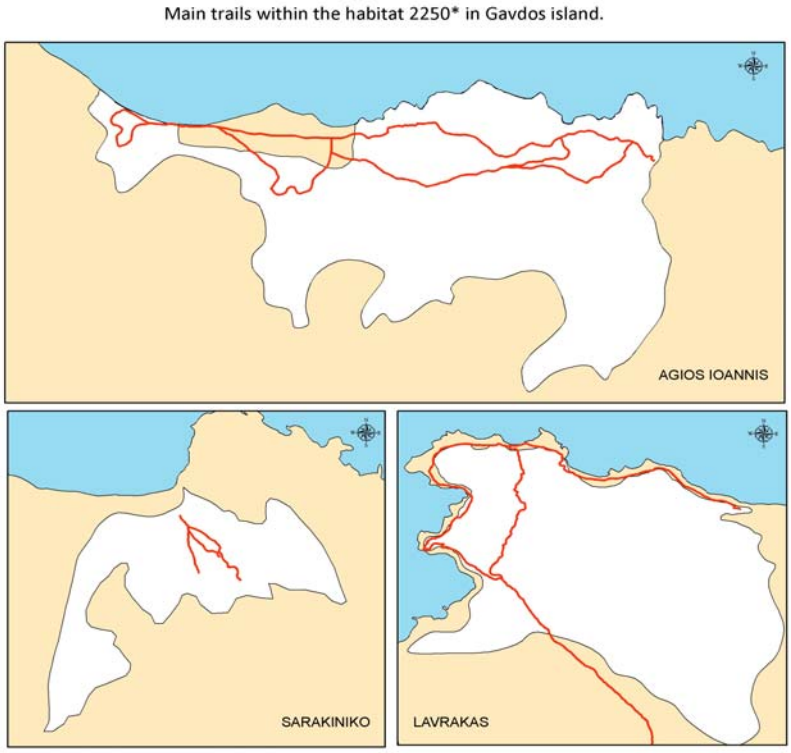

Figure 91 Main trails within the three 2250* habitats in Gavdos

Moreover, the number of tents per sampled day per month in all the habitats of Gavdos (Sarakiniko, Agios Ioannis and Lavrakas) was measured (Figure 92). The spatial distribution of tents was not recorded with a GPS because at some point, visitors were bothered and started complaining. Therefore, each habitat in Gavdos was separated into four different zones and the number of tents in each zone was measured. A total of 16 tents per sampled day were counted in Sarakiniko on July and 116 tents per sampled day on August. A total of 135 tents per sampled day were counted in Agios Ioannis on July, 314 tents per sampled day on August, and 126 per sampled day on September. A total of 31 tents per sampled day were counted in Lavrakas on July, 81 tents per sampled day on August, and 50 per sampled day on September.

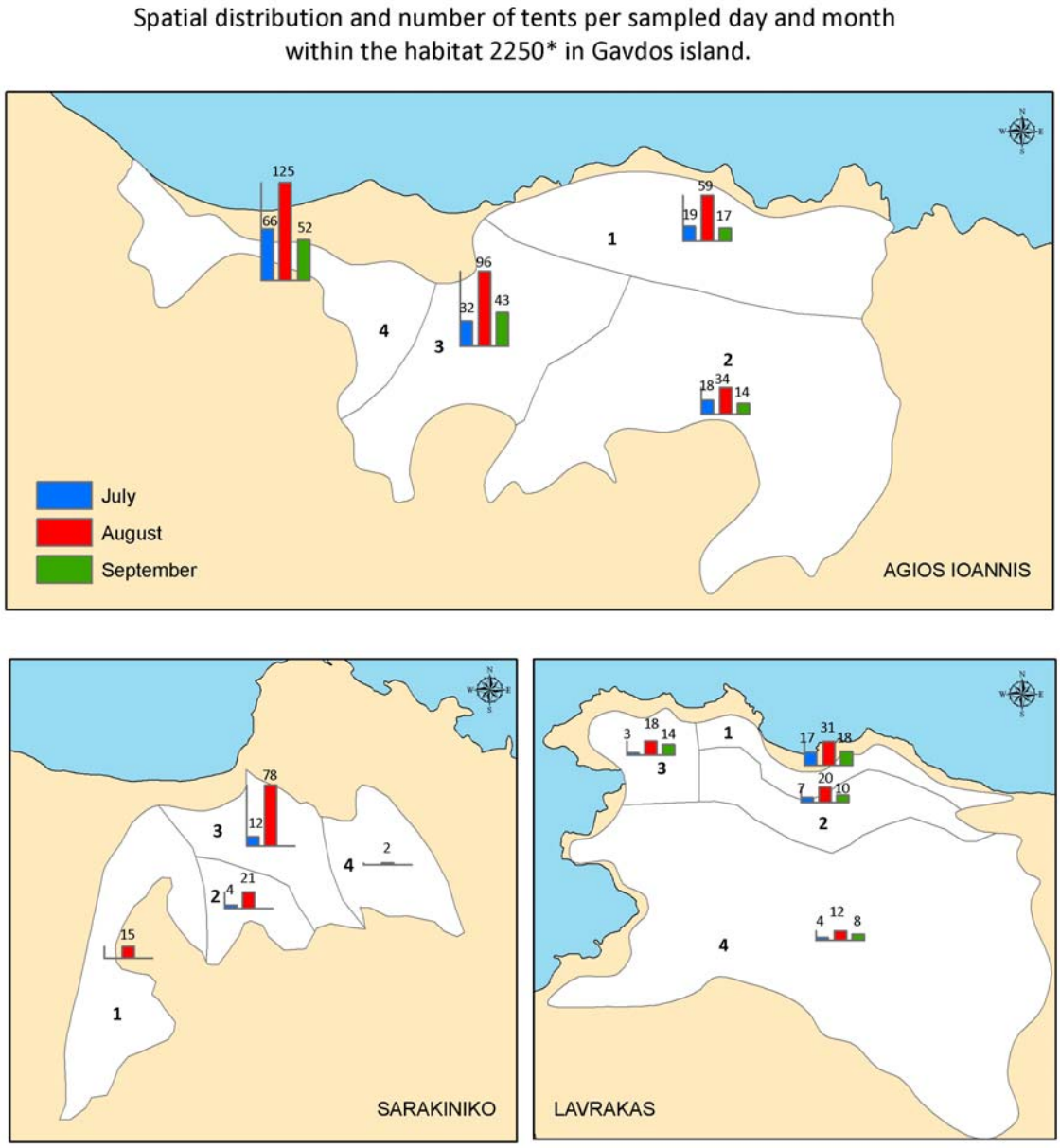

Figure 92 Spatial distribution and number of tents per sampled day and month within the three 2250* habitats in Gavdos

6.3 Damage on vegetation

6.3.1 Damage on Juniper trees

The number of broken branches per tree (BB/TREE) in all 10x10m plots is showed in the following table:

SITE	PLOT No	USE	No of Trees	No of Broken Branches	BB/TREE
Kedrodasos	1	Unused	15	67	4.47
	2	Unused	11	5	0.45
	3	Used	13	33	2.54
	4a	Used	18	96	5.33
	4b	Used	12	65	5.42
	5	Used	26	167	6.42
	6	Used	8	42	5.25
	TOTAL		**103**	**471**	**4.57**
Sarakiniko	1	Used	8	41	5.13
	2	Used	14	35	2.50
	3	Unused	10	34	3.40
	4	Unused	6	13	2.17
	TOTAL		**38**	**123**	**3.24**
Agios Ioannis	1	Unused	11	0	0.00
	2	Used	7	7	1.00
	3	Used	8	28	3.50
	4	Used	6	25	4.17
	5	Unused	16	0	0.00
	6	Unused	13	0	0.00
	TOTAL		**105**	**196**	**1.87**
Lavrakas	1	Unused	7	0	0.00
	2	Unused	5	3	0.60
	3	Unused	6	3	0.50
	4	Unused	22	0	0.00
	5	Unused	8	11	1.38
	6	Unused	12	0	0.00
	7	Unused	3	0	0.00
	8	Unused	7	0	0.00
	9	Used	6	12	2.00
	TOTAL		**76**	**29**	**0.38**
Chrysi-West	1	Unused	1	4	4.00
	2	Unused	9	0	0.00
	3	Unused	2	0	0.00
	4	Unused	1	7	7.00
	TOTAL		**13**	**11**	**0.85**
Chrysi-East	1	Unused	5	12	2.40
	2	Unused	5	13	2.60
	3	Unused	1	0	0.00
	4	Unused	1	10	10.00
	5	Unused	3	0	0.00
	6	Used	3	19	6.33
	TOTAL		**18**	**54**	**3.00**
Falasarna	1	Unused	13	0	0.00
	2	Unused	11	13	1.18
	TOTAL		**24**	**13**	**0.54**

The highest values of “broken branches per tree” were found in Kedrodasos (4.57), Sarakiniko (3.24) and in the eastern site of Chrysi Island (3.0) (Figure 93).

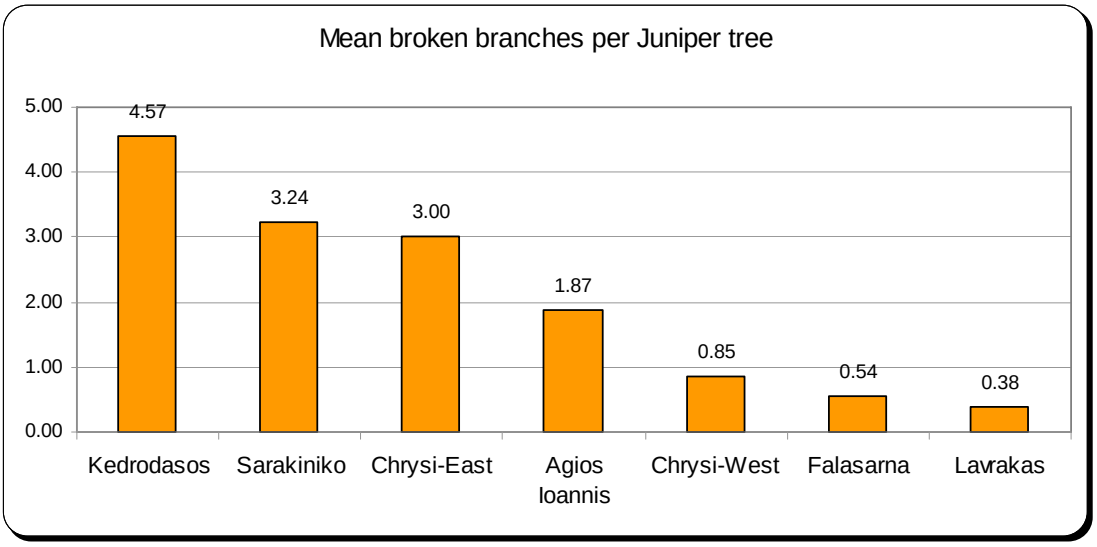

Figure 93 Mean numbers of broken branches per tree in each site

The variable “broken branches per tree” (BB) was transformed using “square root transformation”. The mean value of the new variable (square root BB) was 0.88 (SE=0.18) and 1.94 (SE=0.14) in unused and used plots respectively (Figure 94).

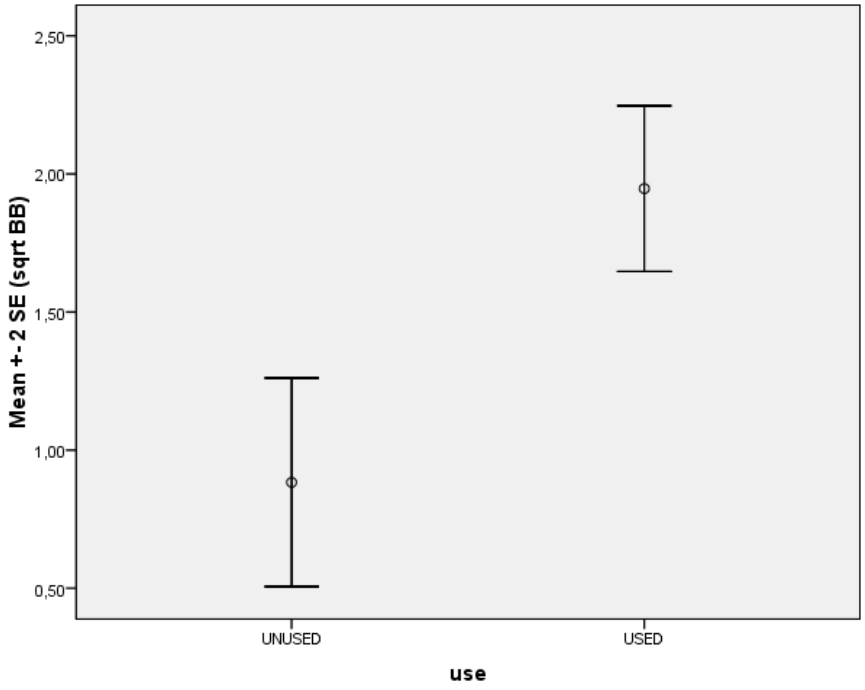

Figure 94: Error bar of “square root BB” in unused and used plots, SE: Standard error

Comparison between “used” and “unused” plots for all sites using t-Test (independent samples, confidence interval 95%) **showed significant difference** between used and unused plots: *t*(33.9) = -4.413, *p* = 0.0001".

6.3.2 Cover of root exposure

The percentage cover of exposed roots inside the 10X10m plots varied from 0% to 30%. The maximum values were 30% in Kedrodasos (plot 6) and 20% in the eastern site of Chrysi (plot 1). The mean values of exposed root cover were higher in Kedrodasos 6.95%, in the eastern site of Chrysi 5.33% and in the western site of Chrysi 3.12% (Figure 95).

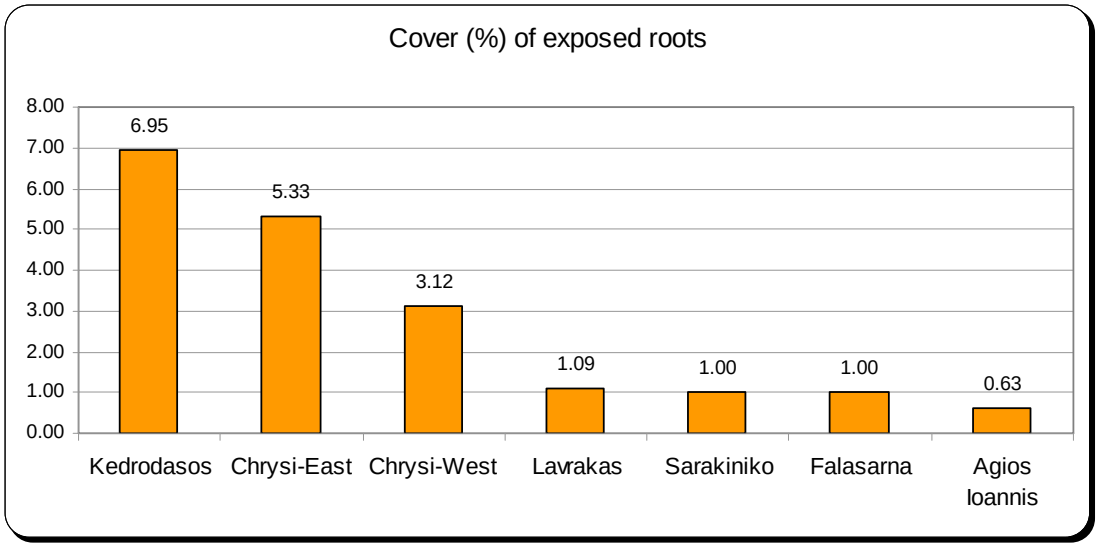

Figure 95 Mean percentage cover of exposed roots in all sites

The variable “cover of exposed roots” (RE) was transformed using “arcsine transformation”. The mean value of the new variable (arcsine RE) was 0.08 (SE=0.02) and 0.18 (SE=0.05) in unused and used plots respectively (Figure 96).

The comparison between “unused” and “used” plots for all sites using t-Test (independent samples, confidence interval 95%) **showed significant difference** between used and unused plots: *t*(36) = -2.073, *p* = 0.045".

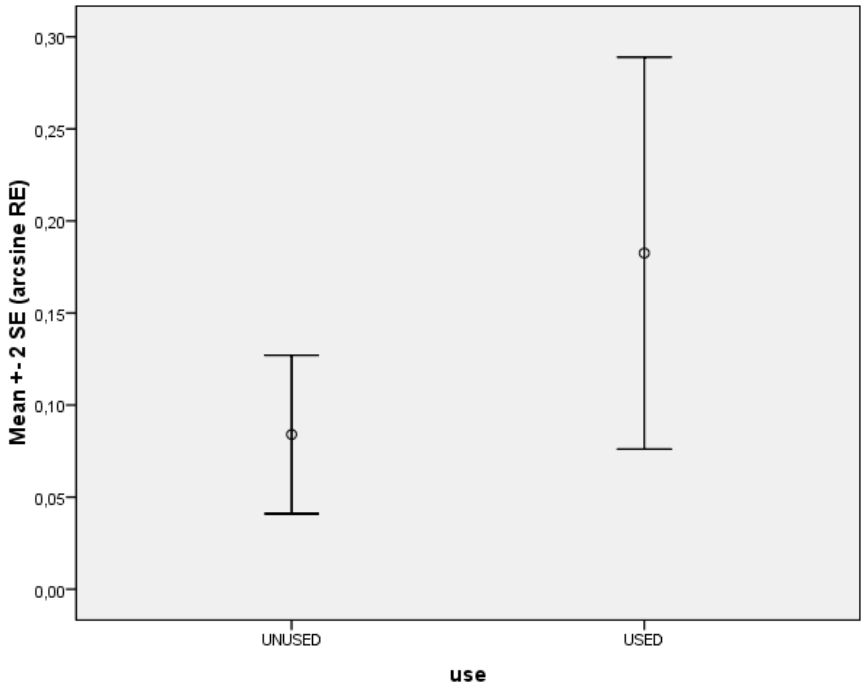

Figure 96: Error bar of “arcsine RE” in unused and used plots, SE: Standard error

6.3.3 Ground vegetation cover

The Ground Vegetation Cover represents the total cover of forbs, phrygana and shrubs inside the 10X10m plots. It was higher in Falasarna (57.5%), Sarakiniko (53%) and Kedrodasos (36.1%) (Figure 97)

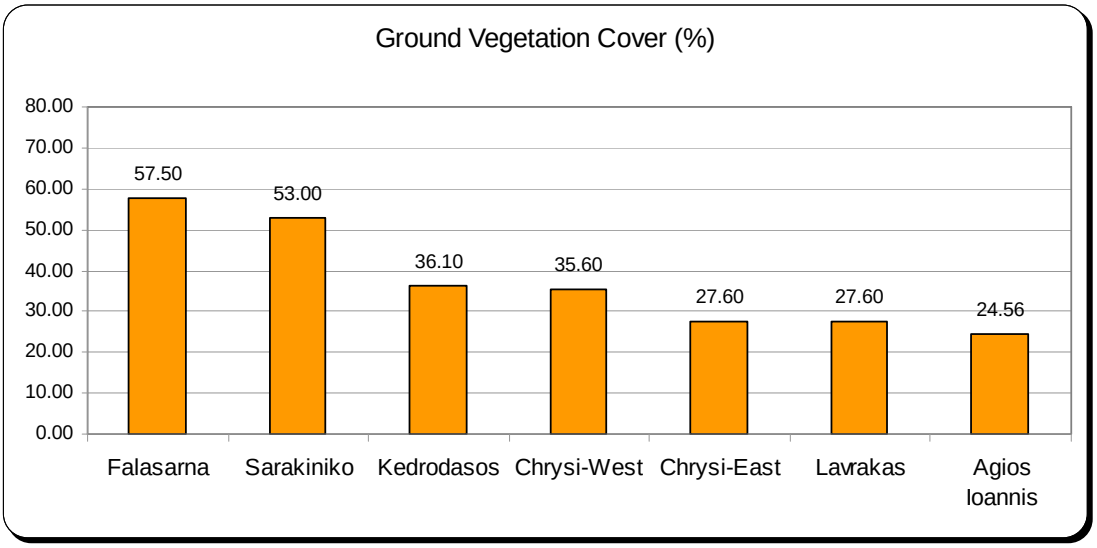

Figure 97 Mean value of Ground Vegetation Cover in all sites

The variable “Ground Vegetation Cover” (GVC) was transformed using “arcsine transformation”. The mean value of the new variable (arcsine GVC) was 0.68 (SE=0.05) and 0.37 (SE=0.06) in unused and used plots respectively (Figure 98).

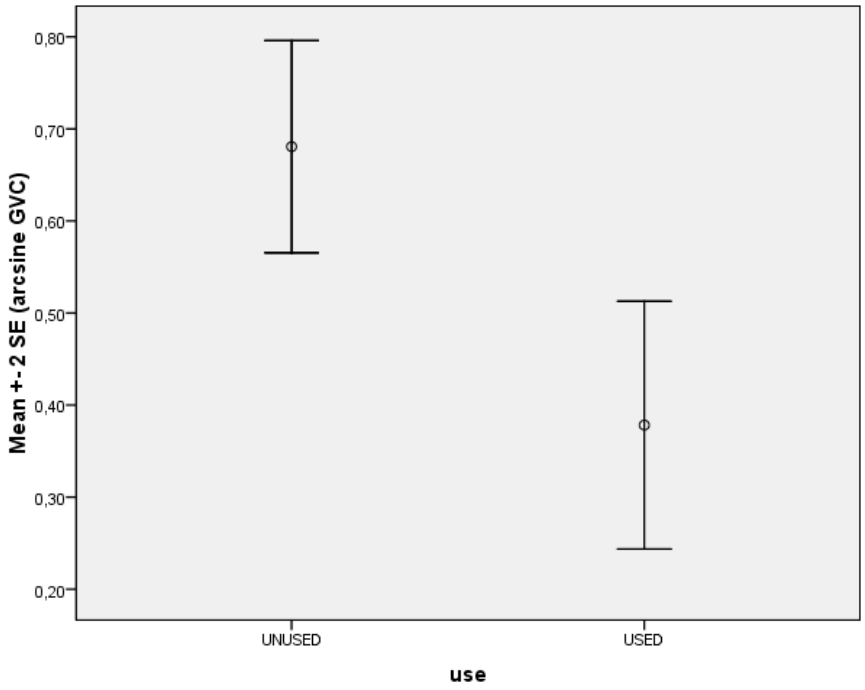

Figure 98: Error bar of “arcsine GVC” in unused and used plots, SE: Standard error

The comparison between “unused” and “used” plots for all sites using t-Test (independent samples, confidence interval 95%) **showed significant difference** between used and unused plots: $t(36) = 3.016$, $p = 0.005$".

6.3.4 Number of species

The total number of species in all 10x10m plots is 135. The most richness sites are Kedrodasos (78 species) and Chrysi island (66 species) (Figure 99).The total number of species in unused plots was 118 while in used plots was 88. The mean number of species was 20.85 (SE=2.09) and 17.36 (SE=2.73) in unused and used plots respectively (Figure 100).

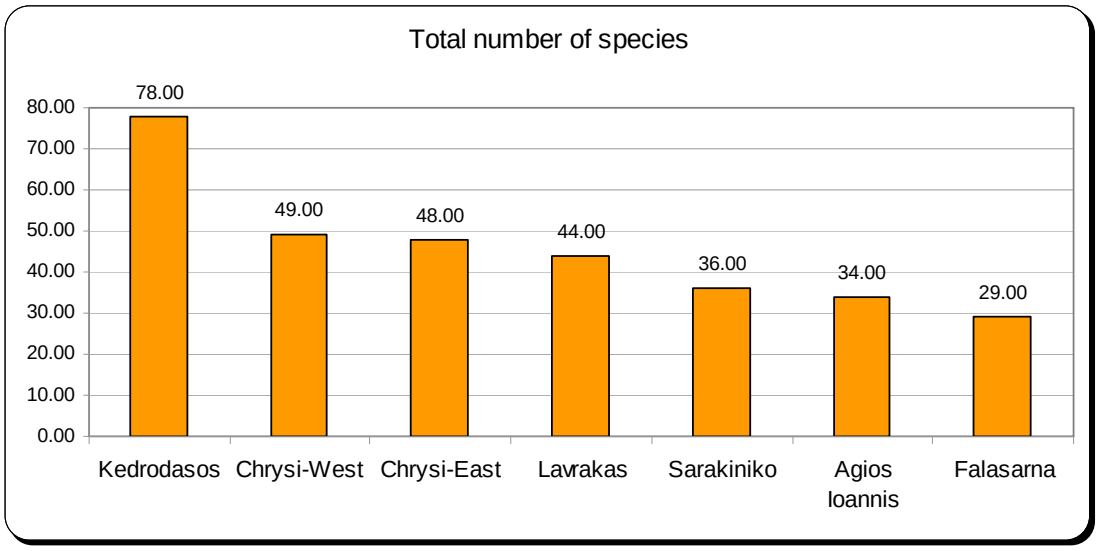

Figure 99 Total number of species in all sites

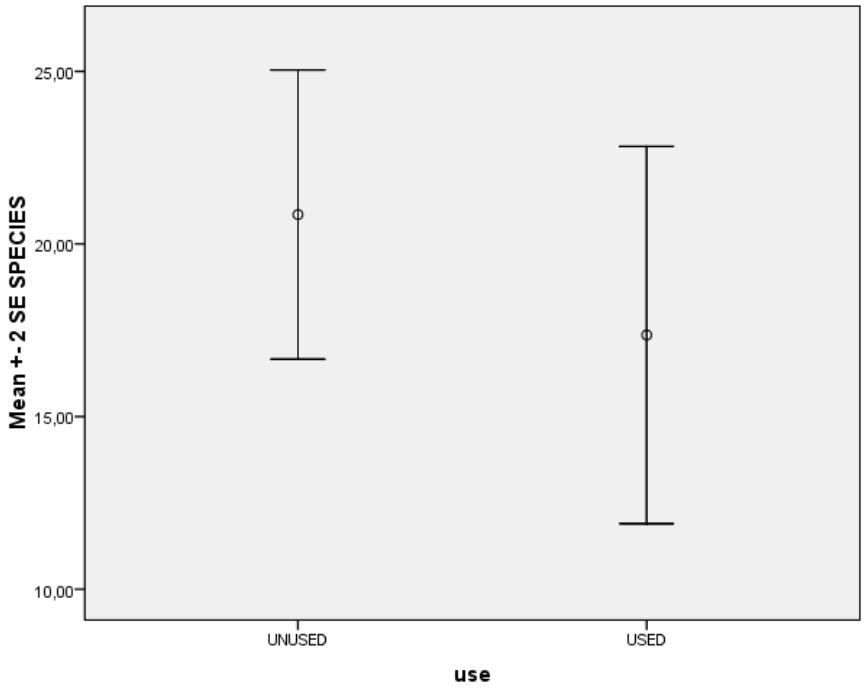

Figure 100: Error bar of “number of species” in unused and used plots, SE: Standard error

The comparison between “unused” and “used” plots for all sites using t-Test (independent samples, confidence interval 95%) **did not show any significant difference** between used and unused plots: $t(36) = 0.937$, $p = 0.355$".

6.3.5 Number of *Juniperus oxycedrus* spp. *macrocarpa* seedlings

The total number of seedlings in all 10x10m plots is 52. The mean number of seedlings is higher in Sarakiniko (4.5) and Lavrakas (2.0) (Figure 101).The total number of seedlings in unused plots was 41 while in used plots was only 11. The mean number of seedlings was 1.51 (SE=0.46) and 1.00 (SE=0.90) in unused and used plots respectively (Figure 102).

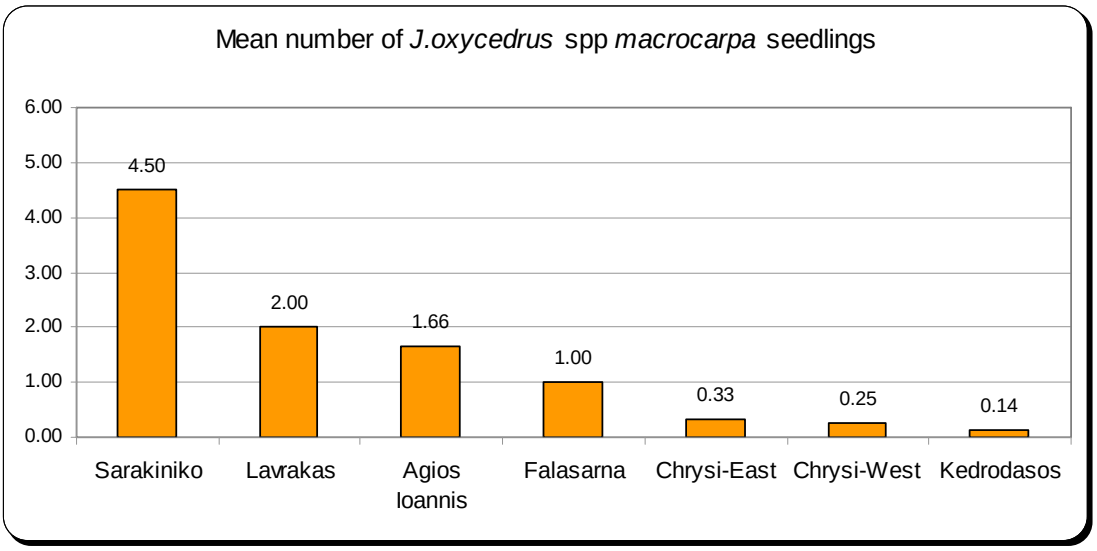

Figure 101 Mean number of *J. oxycedrus* spp. *macrocarpa* seedlings in all sites

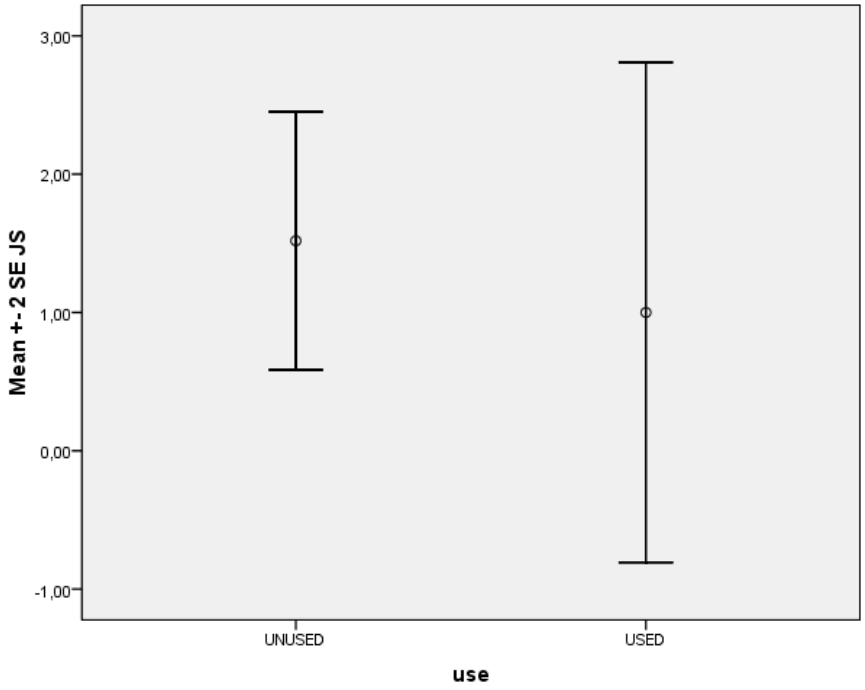

Figure 102: Error bar of "number of seedlings" in unused and used plots, SE: Standard error

The comparison between “unused” and “used” plots for all sites using t-Test (independent samples, confidence interval 95%) **did not show any significant difference** between used and unused plots: $t(36) = 0.558$, $p = 0.580$".

6.3.6 Ground vegetation cover and number of species along trails subjected to high visitors use

The Ground Vegetation Cover represents the total cover of shrubs, phrygana and forbs inside the 1X1m quadrats. The change in the ground vegetation cover between the middle and left/right quadrats was very strong. The mean ground vegetation cover was 1.14% (SE= 0.072) in the middle of the trail while on the left/right of the trail the mean ground vegetation cover was 17.78% (SE= 3.6). The ground vegetation cover using t-Test (independent samples, confidence interval 95%) **showed significant difference** between the middle, left and right 1x1m quadrats: $t(74.3) = -4.478$, $p = 0.000027$". The change in the number of species between the middle and left/right quadrats was very sharp. The mean number of species was 0.8 (SE= 0.28) in the middle of the trail while on the left/right of the trail the mean number of species was 1.9 (SE= 0.3). The total number of species using t-Test (independent samples, confidence interval 95%) **showed significant difference** between the middle, left and right 1x1m quadrats: $t(96.2) = -2.616$, $p = 0.010$".

6.4 Litter survey

6.4.1 Kedrodasos

Plastic materials (food bags, water bottles, fishing lures and floats, oil and lube bottles, etc.) and papers were amongst the most abundant debris found in Kedrodasos (Figure 103). Their distribution covered the entire habitat. Plastic materials were more abundant next to the shoreline (south part of the habitat) which might indicates that a percentage of the observed debris mainly the plastic floats has been transported to the site from the sea. Papers were more abundant in the northern part of the habitat where most of the campers use this part of the site for their natural needs. Glasses and cans (food and beverage items) were also scattered around the habitat but they were less abundant then plastic materials and papers. Camping material (tents, iron sticks, kitchen utensils, etc.) left behind by campers were also found around the habitat. They were more abundant in the parts

of the habitat where the utmost number of campers erects their tents (see figure 88).

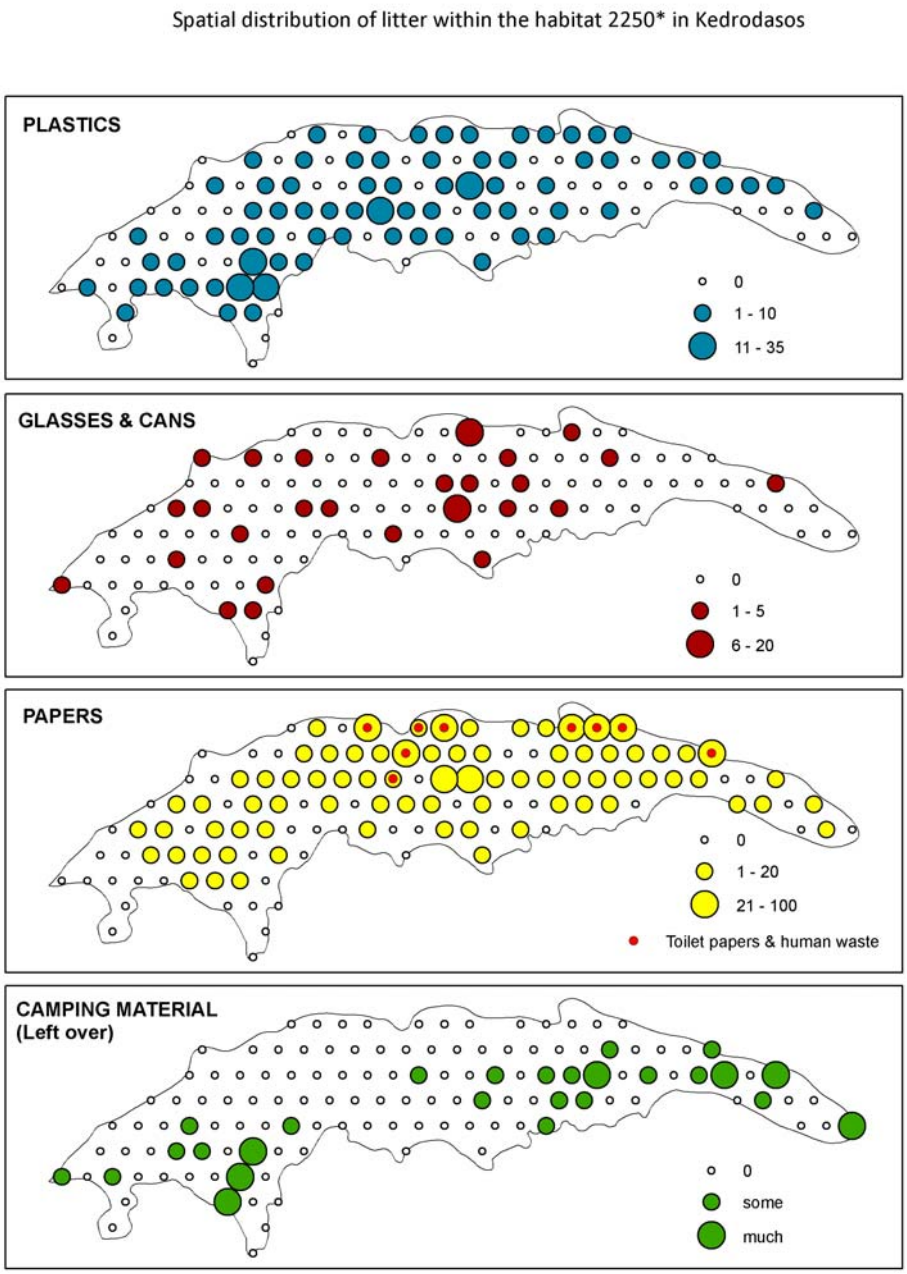

Figure 103 Spatial distribution and type of litter within the 2250* habitat in Kedrodasos

6.4.2 Chrysi

Plastic materials (food bags, water bottles, fishing lures and floats, oil and lube bottles, etc.) and papers were amongst the most abundant debris found in the eastern habitat of Chrysi (Figure 104). Their distribution covered the entire habitat.

Spatial distribution of litter within the eastern habitat 2250* in Chrysi island.

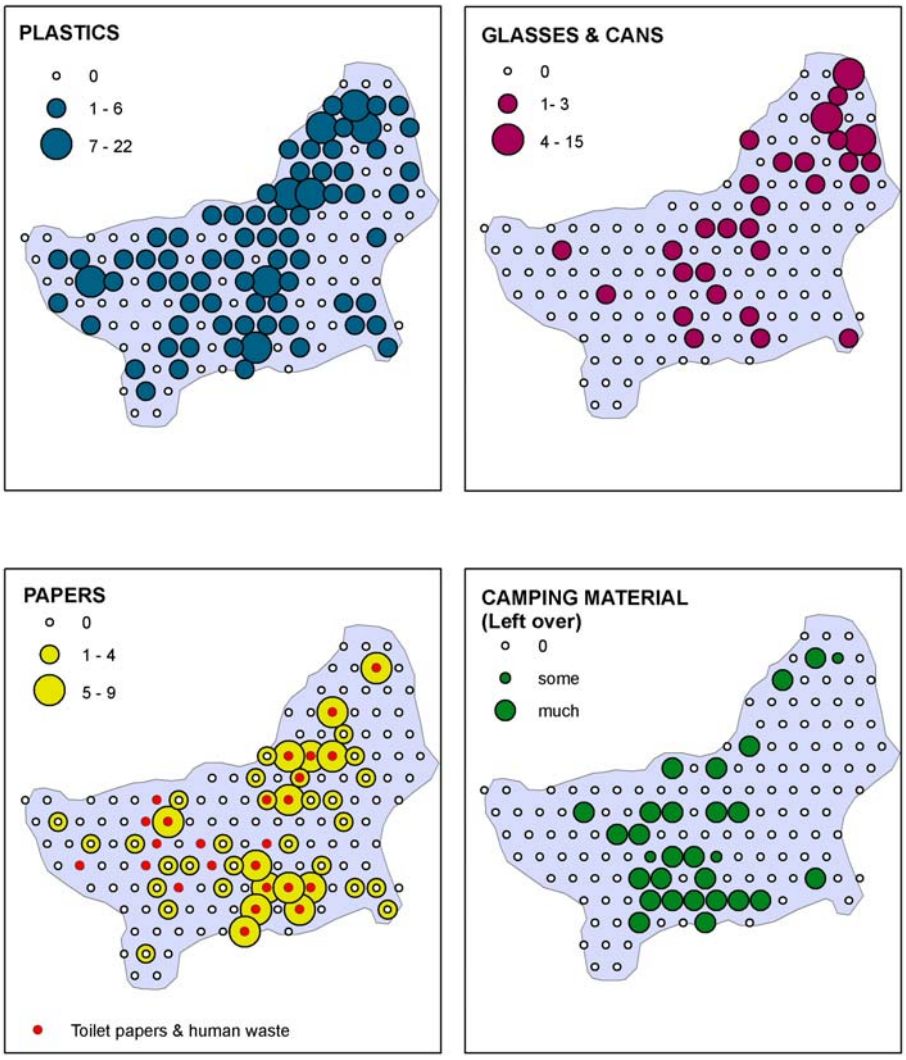

Figure 104 Spatial distribution and type of litter within the east 2250* habitat in Chrysi

Plastic materials were more abundant next to the shoreline (northern and southern south parts of the habitat) which might indicates that a percentage of the observed debris mainly the plastic floats has been transported to the site from the sea. Glasses and cans (food and beverage items) were also scattered around the

habitat but they were less abundant then plastic materials and papers. They were mainly located at the Northeast edge of the habitat. Camping material (tents, iron sticks, kitchen utensils, etc.) left behind by campers were also found around the habitat. They were more abundant in places with sea view where the highest number of campers erects their tents.

In the west 2250* habitat in Chrysi, plastic materials (plastic material from greenhouses, food bags, water bottles, fishing lures and floats, oil and lube bottles, etc.) were amongst the most abundant debris (Figure 105).

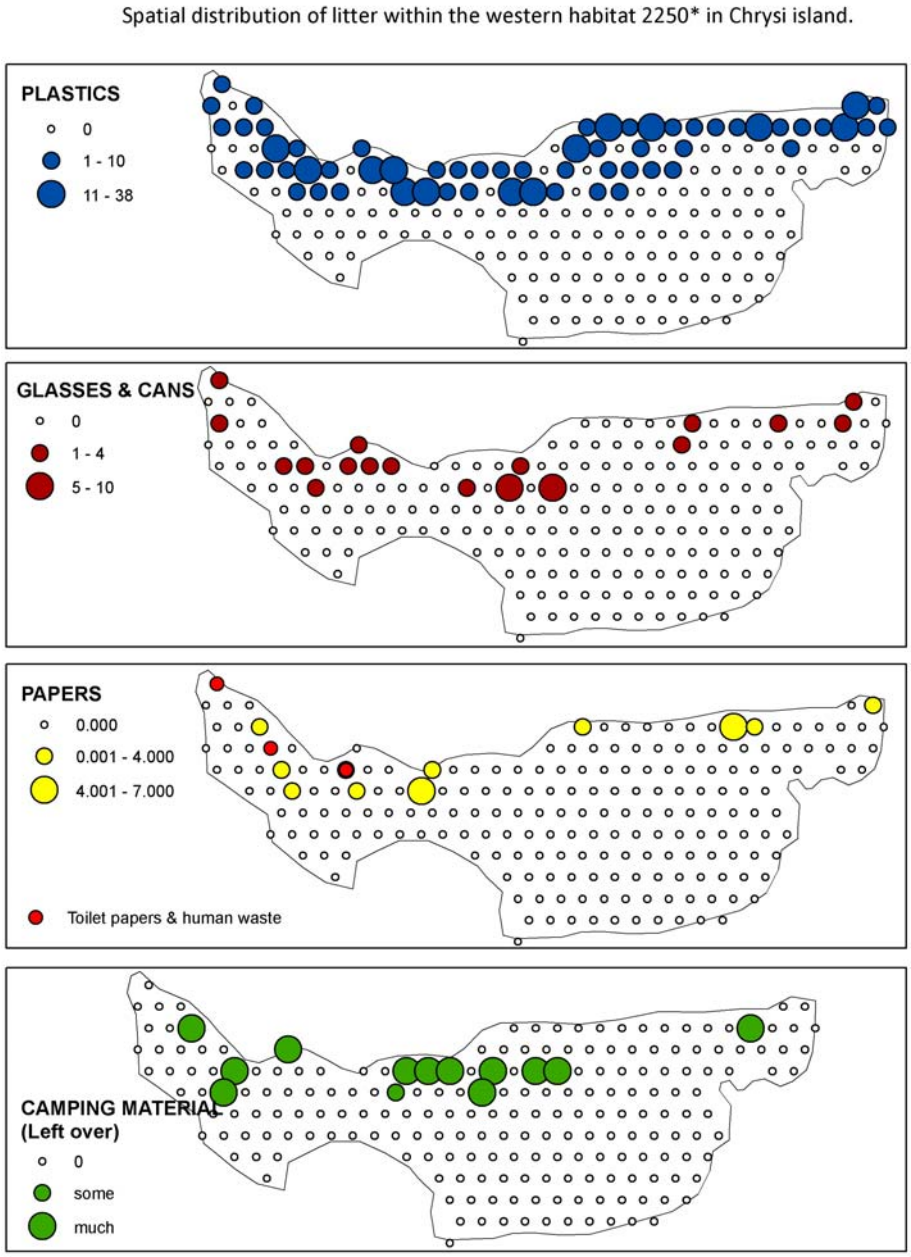

Figure 105 Spatial distribution and type of litter within the west 2250* habitat in Chrysi

Plastic materials were more abundant next to the shoreline (northern part of the habitat) which indicates that a percentage of the observed debris (mainly the greenhouses plastic material) has been transported to the site by the sea from Ierapetra (south Crete) where intensive greenhouse cultivation is practiced. Cans and Glasses, papers and camping left over were also scattered on the northern part of the habitat but they were less abundant then plastic materials. The southern part of the habitat is cleaner than the northern part. Due to the dense/low vegetation and the harsh conditions, the site is not used by visitors.

6.4.3 Gavdos

Plastic materials (food bags, water bottles, fishing lures and floats, oil and lube bottles, etc.) and papers were amongst the most abundant debris found in Sarakiniko and in Agios Ioannis (Figures 106 & 107).

Spatial distribution of litter within the habitat 2250* in Sarakiniko Gavdos.

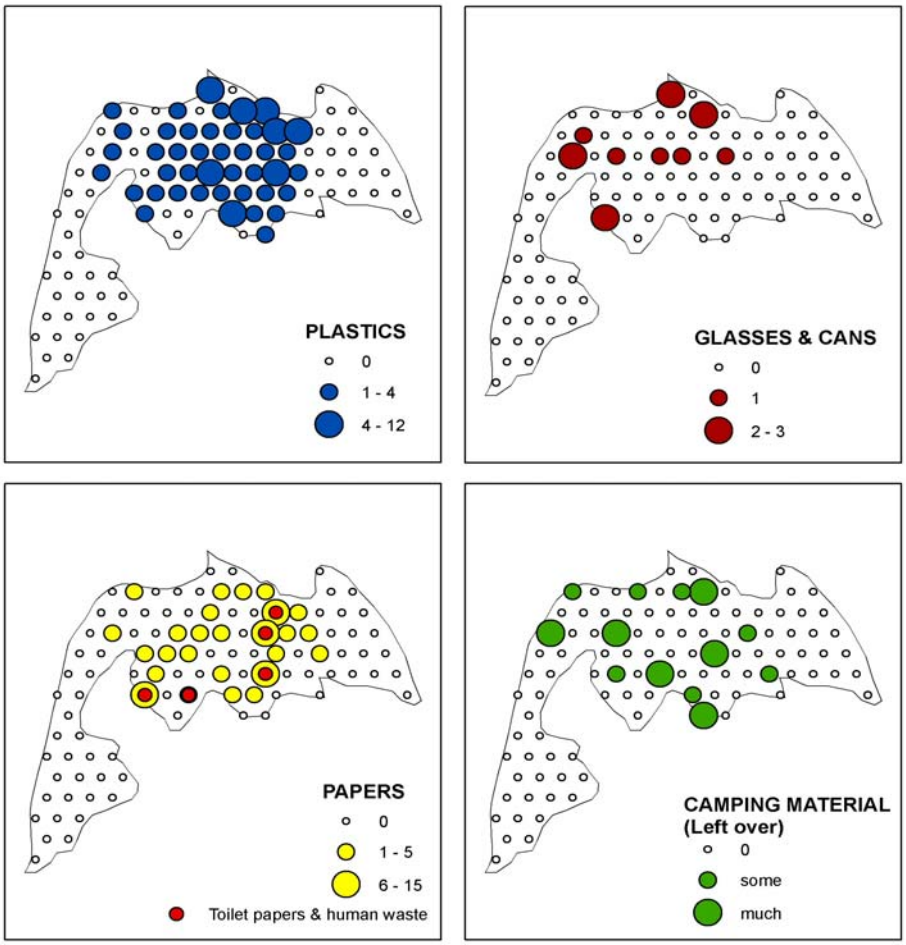

Figure 106 Spatial distribution and type of litter within Sarakiniko-Gavdos

In Sarakiniko, the distribution of plastic materials and papers covered mainly the central part of the habitat which is mostly used by campers. Glasses and cans (food and beverage items) were also scattered around the habitat but they were less abundant then plastic materials and papers. Camping material (tents, iron sticks, kitchen utensils, etc.) left behind by campers were also found around the habitat. They were more abundant in the central part of the habitat where the highest number of campers erects their tents.

In Agios Ioannis, The distribution of plastic materials and papers were scattered throughout the entire habitat. Glasses and cans (food and beverage items) were less abundant. Camping material (tents, iron sticks, kitchen utensils, etc.) left behind by campers were also scattered around the habitat. They were more abundant in the west part of Agios Ioannis where the utmost number of campers erects their tents.

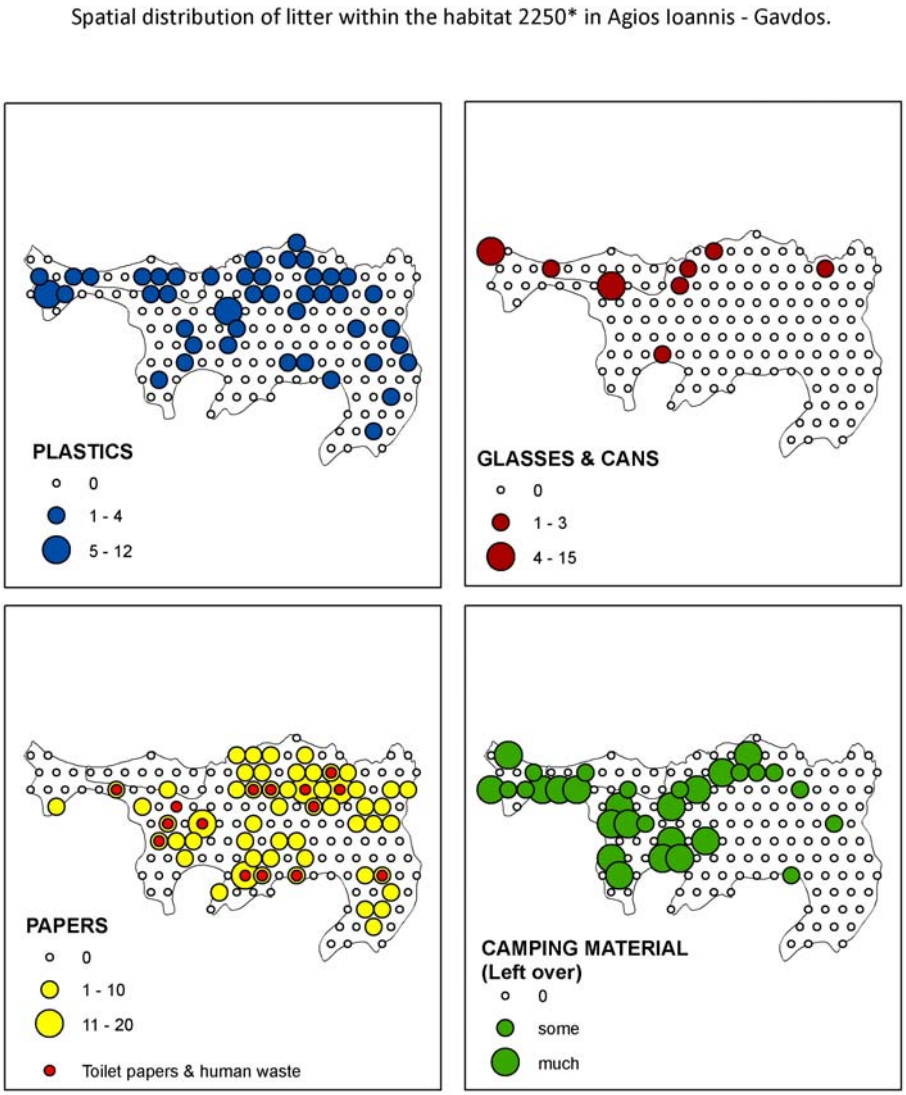

Figure 107 Spatial distribution and type of litter within Agios Ioannis-Gavdos

When visiting Lavrakas on several fieldtrips, the site showed a high degree of cleanliness which is due to the limited number of visitors and the sensitivity of the permanent campers who are constantly collecting the litter. Moreover, due to the huge size of the habitat, the litter survey methodology applied on the other sites was considered extremely time consuming. Thus, the litter survey in Lavrakas was not conducted.

6.4.4 Falasarna

Visitors in Falasarna go to the main sandy beach and do not visit the 2250* habitat as access to the sea is difficult. The new 2250* habitat located north of the main beach is exceptionally clean and free of debris. The old 2250* habitat located

south of the main beach, although relatively small, a big portion of the site is filled with rubbish. This rubbish consists of plastic ropes and tomato shoots (residues from the greenhouses in the area) which are transferred there for animal feeding (Picture 1).

Picture 1 Greenhouse residues in Falasarna site.

Section 7 Discussion and conclusions

Tourism has the potential to impact negatively or positively on the social, economic and physical environment of the destination (Mathieson & Wall, 1982). The context of this report is natural resource oriented and only physical impacts are discussed. Coastal environments, particularly those with sandy shorelines are more vulnerable to negative physical impacts (Wong, 1998; Orams, 1999).

Results from the social survey showed that the main type of tourism performed by visitors when visiting the 2250* habitats in Crete is nature-based tourism and more specifically, beach-based tourism. Commonly pursued activities by visitors when onsite were mainly beach-based (swimming, sun tanning, and fishing) and nature-based activities (camping, picnic, trekking and wildlife watching). In Kedrodasos, almost half of visitors (54%) camp for two or more days and the other half are one-day trippers. In Gavdos the majority of visitors (65%) are staying for 5 or more days. Visitors going to Gavdos on a daily trip accounted only for 2%. In Chrysi, the majority of visitors (67%) are mainly visiting the island on a daily trip and returning to Ierapetra in the afternoon. Only 13% of the visitors to Chrysi are staying for more than 2 days.

Although the level of education of the majority of the visitors is high (university level), the results of the social survey showed that the level of environmental awareness was moderate (e.g. only 35% of the visitors knew that the habitat is included in the Natura 2000 network). Higher levels of education have been previously linked to higher environmental awareness (Lothian 2002).

Visitors were generally aware of the environmental impacts associated with their activities, although to variable extents. This suggests visitor impact management strategies could be implemented in the study areas and visitors will show positive response towards them. However, this does not mean that visitors will act in accordance with their opinions. For example, visitors may say that cutting Junipers branches, fire, littering are highly harmful, but that perception does not necessarily equate to responsible behaviour. Available evidence indicates that often little relationship exists between verbal behaviour or attitude and overt behaviour or action of a person (Mitchell 1989, Mihalic 2000). While this may not be the case with

all visitors, it is certainly the case with some. Moreover, differences in perceptions about the impacts associated with the various activities may suggest possible confusion or lack of understanding among visitors about the impacts. This indicates the need in further visitor education and raising public awareness about the potential impacts associated with recreation activities in natural settings.

Adverse environmental impacts of nature-based tourism are a serious issue. If the resource base declines the potential to attract visitors also diminishes (Priskin, 2001). The adverse impacts of nature-based tourism have been described in detail and a number of common impacts are well recognized (Romeril, 1989; Buckley & Pannell, 1990). On the coast, negative impacts may include the degradation of dunes, loss of biodiversity, erosion, eutrophication and littering (Wong, 1998; German Federal Agency for Nature Conservation, 1997). Some of these impacts are readily observable in the 2250* priority habitats in Crete.

The comparison between the used and the unused plots showed significant difference in the number of broken branches per Juniper tree, the cover of root exposure and the ground vegetation cover. The total number of plant species did not show any significant difference between the used and the unused plots. This might be explained by the fact that the majority of the plant species are annuals and have already completed their short life cycle and are dry when visitors’ pressure is high (summer period). Also, many studies have pointed out that the herbaceous plants, and particularly annuals, are more resistant than other life forms and have adapted themselves over time to recreational stresses (Cole, 1985 and 1993; Kuss, 1986; Dotzenko etal., 1967; Hall and Kuss, 1989). The number of Juniperus seedlings, although higher in unused plots, did not show any significant difference between the used and the unused plots. This might be explained by the fact that the germination and the survival of the seedlings depend on various natural factors. The significant difference in the number of broken branches shows that the visitor effect (damage on the *Juniperus* trees) is very high and that the impact on the dune system (increase in erosion and root exposure) is highly significant since it leads to long-term effects of change, a decade or longer. The significant difference in the cover of root exposure between the used and the unused plots shows that the visitor effect and the damage on the *Juniperus* trees are also high. It should be noted that root

exposure can have a natural origin (wind) as well, and should not be related only to visitors. However, its impact on the dune system (erosion) remains significant since it causes medium-term effects of change, i.e. a number of years. The significant difference in the ground vegetation cover between the used and the unused plots shows that the visitor effect (vegetation cover loss) is important, however, its impact on the dune system is low since it produces at the most seasonal effects of change.

The comparison between the middle and left/right 1x1m quadrats along trails subjected to high visitors use (E4 in Kedrodasos) showed significant difference in the ground vegetation cover and in the total number of species. This significant difference shows that the damage on vegetation (vegetation cover loss, reduction in total number of species) along trails subjected to high visitors use is important and its impact on the dune system is significant since it causes medium-term effects of change, i.e. a number of years. The effect of visitors on plants is immediate and localised in the short term, but in the long term traffic stresses can affect the whole area. The effect may be expressed in geomorphic processes such as overland flow and erosion (Cole, 1987 and 1993; Kleinhauss, 1995) and biotic processes such as fragmentation.

The litter survey showed that the visitor effect on the dune system (hazard introduction and litter import) is important and not only reduces the aesthetic value of the habitat but also increases the risk of fire. Its impact on the dune system is highly significant, since in case of fire, it might lead to long term effects of change, decades or longer. Results from the social survey showed that the majority of the visitors in all sites agree to carry out their rubbish while leaving the sites showing a high level of sensitivity. The application of this code of conduct will be more efficient than the installation of rubbish bins throughout the habitat, which require more efforts to empty and maintain the rubbish bins.

Adverse physical impacts may be reduced if the relationship between nature-based tourism and conservation is symbiotic, that is if tourism is developed in an ecologically sustainable manner. Ecological sustainable development of tourism means that current activities maintain the resource base and do not compromise future generation’s ability to utilise the resource (Ioannides, 1995; Dowling, 1992; Walker, 1988). In many instances, nature-based tourism is dependent on

conservation and cannot survive without the protection of the natural resources (Whelan, 1991). Tourism can also benefit from conservation because the latter provides an array of resources and attractions that form the basis of any type of nature-based tourism. Conservation may also benefit from tourism. The importance of revenue generated from visiting protected areas may create justification for conserving areas which otherwise may have pressures from competing land uses such as farming, mining or urban development (Walker, 1988).

Because coastal dunes with *Juniperus* spp. are so popular for outdoor recreation and since many people will continue to visit the habitats, more effort is needed to mitigate their impacts on those sites; impact control measures would allow minimizing the adverse effects. Short-term recommendations, designed to correct the immediate problems, may include boardwalks, habitat and trails demarcation, vehicle use control (mainly in Chrysi), sign posting, and public education. Off Road Vehicles in Chrysi should be limited to specific trails, and/or travel corridors. All main trails to be used by pedestrians should be clearly marked by brightly coloured posts or boardwalks.

The success of conservation and recreation management depends to a large extent on information and education programmes. This is the most important because not all aspects of coastal dune management are obvious and clear to the public, e.g. stabilization or species protection.

Public education is one of the most important tasks. People are more inclined to accept restrictions when they know the reasons for the rules. There are various ways of providing information to visitors. For example, information panels with benches and educational signs could be posted at all main entrances, along main trails and on the beach. Leaflets, brochures, maps and/or audiovisual presentations (video) can be very effective. Visitors should be given a short pamphlet when they enter the habitat explaining management practices and regulations (code of conduct). Moreover, environmental education campaigns, field excursions are also an attractive and very effective means of education. As tourism will increase to the area, levels of degradation need to be monitored and managed. Social research needs to assess visitor satisfaction and acceptability of resource conditions and use characteristics of nature-based tourism resources.

Outdoor recreation often causes difficult dilemmas in coastal dune management. On one hand, recreation is considered a legitimate and appropriate function of many areas, which are sometimes primarily protected and managed for recreation purpose. In such cases, dunes are either treated as extension of sand beaches, with beach-like forms of recreation, or seen as easily accessible areas for enjoying a natural landscape, plants or wildlife. On the other hand, recreation can result in a loss of the natural qualities and, even worse, in a complete destruction of the area. There is no simple solution to the recreation dilemma. Through adequate management, nature-based tourism can be a compatible and a complementary land use (Wight, 1993). The future of nature-based tourism is strongly resource dependent and requires access to high quality natural environments.

List of References

- Apostolopoulos, Y. & Sonmez, S (2001). Greek tourism on the brink: restructuring or stagnation and decline? (Chapter 6) Mediterranean tourism: facets of socioeconomic development and cultural change, eds. Y. Apostolopoulos, P. Loukissas & L. Leontidou, Routledge: London & New York, pp.72-88.
- Barale V. and S. Folving (1996). 'Remote sensing of coastal interactions in the Mediterranean region' Ocean & Coastal Management Vol. 30, Nos 2-3, pp. 217-233.
- Briassoulis, H (1993). Tourism in Greece (Chapter 16). Tourism in Europe: structures and developments, eds. W. Pompl & P. Lavery, CAB International: Oxford, pp. 285-301.
- Buckley, R., and Pannell, J. (1990). Environmental impacts of tourism and recreation in national parks and conservation reserves. The Journal Tourism Studies, 1(1), 24–33.
- Buckley, R. (1998). Tools and indicators of managing tourism in parks. Annals of Tourism Research 25, 208–211.
- Buckley, R .C. (ed.) (2004). Environmental Impacts of Ecotourism. New York: CABI Publishing.
- Carter, R.W.G., (1991). Near future sea level impacts on coastal dunes landscapes. Landscape Ecology, 6(1/2), 29-39.
- Cessford, G.R. (1995). Conservation benefits of public visits to protected islands. Science and Research Series, Number 95, Department of Conservation, Wellington, New Zealand.
- Cessford, G.R. (1997). Impacts of visitors on natural and historic resources of conservation significance: Part 2 - Research and information needs. Science and Research Internal Report, No. 157. Department of Conservation, Wellington, New Zealand, 29 p.
- Cessford, G.R. and Dingwall, P.R. (1997). Impacts of visitors on natural and historic resources of conservation significance: Part 1 - Workshop proceedings. Science and Research Internal Report, No. 156 Department of Conservation, Wellington, New Zealand, 110 p.
- Cole, DN. (1987). Research on soil and vegetation in wilderness: a state-of-knowledge review. In: Proceeding – National Wilderness Research Conference: Issue, State-of-knowledge, Future Directions; 1985 July 23–26; Fort Collins, CO. Gen Tech Rep INT-220. Ogden, UT: USDA Forest Service, Intermountain Research Station, p. 135–77.
- Cole, D.N. and Marion, J.L., (1988). Recreation impacts in some riparian forests of the eastern United States. Environ. Manage. 12, 99–107.
- Cole, D.N. (1993). Minimizing conflict between recreation. a. Ecology of greenways: design and function of linear conservation areas. In: D.S.

Smith and P.C. Hellmund Editors, Univ. of Minnesota Press, Minneapolis, MN, pp. 105–122.

- Cole, D.N., (1995d). Disturbance of natural vegetation by camping: Experimental applications of low-level stress. Environ. Manage. 19, 405–416.
- De Vaus, D., (2007). Surveys in Social research, 5th edition, Routledge, London.
- Dotzenko, A.D., N.T. Papamichos and D.S. Romine, (1967). Effects of recreational use on soil and moisture conditions in Rocky Mountain National Park. *Journal of Soil and Water Conservation* **22** (1967), pp. 196–197.
- Dowling, R. K. (1992). Tourism and environmental integration:the journey from idealism to realism. Progress in Tourism, Recreation and Hospitality Management, 4, 33–46.
- German Federal Agency for Nature Conservation (1997). Biodiversity and tourism. Conflicts of the world's seacoasts and strategies for their solution. Berlin: Springer.
- Gehu J. M. (1985). 'European dune and shoreline vegetation', Council of Europe.
- Hall, C.N. and F.R. Kuss, (1989). Vegetation alternation along trails in Shenandoah National Park. *Virginia. Biological Conservation* **48**, pp. 211–227.
- Holden, A. (2000). Environment and Tourism, Routledge: London & New York.
- Ioannides, D. (1995). A flawed implementation of sustainable tourism: the experience of Akamas, Cyprus. Tourism Management, 16(8), 583–592.
- Kleinhauss, S., (1995). The Sharon Park – ecological sensitivity. Internal summary presented to the National Park Authority.
- Kutiel, P., Zhevelev, H. and Harrison, R. (1999). The effect of recreational impacts on soil and vegetation of stabilized Coastal Dunes in the Sharon Park, Israel. Ocean and Coastal Man. 42:1041-1060.
- Kuss, F.R. (1986). A review of major factors influencing plant response to recreation impacts. *Environmental Management* **10**, pp. 637–650.
- Leung, Y. and Marion, J.L. (2000). Recreation impacts and management in wilderness: A state of-knowledge review. Missoula, Montana, USA: Proceedings US Department of Agriculture, Forestry Service, Rocky Mountain Research Station.
- Liddle, M., (1997). Recreation Ecology. London: Chapman and Hall.

- Mathieson, A., and Wall, G. (1982). Tourism: economic physical and social impacts. New York: Longman.
- Mihalic, T. (2000). Environmental management of a tourist destination. A factor of tourism competitiveness. Tourism Management 21:65–78.
- Mitchell, B. (1989). Geography and resource analysis. Longman Scientific and Technical, London, 399 pp.
- Molloy, J., Davis, A., and Tisdall, C. (1994). Setting Priorities for the Conservation of New Zealand's Threatened Plants and Animals. Second edition. Department of Conservation, Wellington, New Zealand, 64 p.
- Monz, C., and Leung, Y. (2006). Meaningful measures: Developing indicators of visitor impacts in the National Park Service Inventory and Monitoring Program. The George Wright Forum 23, 17–27.
- Moore, S.L., Gregorio, D. & Carreon, M.. (2001). Composition and distribution of beach debris in Orange County, California. Marine Pollution Bulletin 42: 241–245.
- Newsome, D., Moore, S .A. and Dowling, R .K. (2002). Natural Area Tourism: Ecology, Impacts and Management. Clevedon: Channel View Publications.
- Orams, M. B. (1999). Marine tourism. Development, Impacts and Management. London: Routledge.
- Priskin, J. (2001). Assessment of natural resources for nature-based tourism: the case of the Central Coast Region of Western Australia. Tourism Management, 22: 637–648
- Ranwell, D.S., (1972). Ecology of Salt Marshes and Sand Dunes. London, UK: Chapman and Hall: 258 pp.
- Rickard CA, McLachlan A, Kerley GIH., (1994). The effects of vehicular and pedestrian traffic on dune vegetation in South Africa. Ocean & Coastal Management; 23:225-47.
- Romeril, M. (1989). Tourism - the environmental dimension. In: C. P. Cooper (Ed.), Progress in tourism, recreation and hospitality management (pp. 103–113). London: Belhaven.
- Rust I., and Illenberger W., (1996). Coastal dunes: sensitive or not? Landscape and Urban Planning, 34, 165- 169
- Sarantakos S., (1993). Social Research, McMillan Education, Australia, PTY, LTY
- Tzatzanis M. & Wrbka T. (2002). “Sun-beds vs. sand dunes: a conservation – tourism conflict.” In: C.A. Brebbia (ed.) Coastal Environment, pp. 25-34. WIT Press, Southampton-Boston.

- Tzatzanis, M., Wrbka, T., and Sauberer, N., (2003). Landscape and vegetation responses to human impact in sandy coasts of Western Crete, Greece. Journal of Nature Conservation 11, 187–195.
- Walker, B. (1988). Tourism and conservation: facilitation or competition. In: B. Faulkner, & M. Fagance (Eds.), Frontiers of Australian tourism: The search for new perspective’s in policy development research. Canberra: Bureau of Tourism Research.
- Whelan, T. (1991). Nature Tourism: managing for the environment. Washington D.C.: Island Press.
- Wight, P. (1993). Ecotourism: ethics or eco-sell? Journal of Travel Research, 31(3), 3–9.
- Williams, A.T., (1998). Integrated management methods: monitoring environmental change in coastal dune ecosystems. In: Barther, K.G.; Barth, H.; Bohle-Carbonell, M; Fragakis, C.; Lipiatou E.; Martin, P.; Ollier, G. and Weydart, M. (eds.), Proc. 3rd European marine science and technology conference. Brusells, European Commission, 2, 642-653.
- Wong, P. P. (1998). Coastal tourism development in Southeast Asia: relevance and lessons for coastal zone management. Ocean and Coastal Management, 38, 89–109.

ANNEX I Pictures

Visitors completing questionnaires - Chrysi

Visitor traffic on the main trail – Chrysi August 2009

Visitor traffic on the main trail – Chrysi August 2009

Broken branches on Juniper trees – Kedrodasos

Exposed roots of Juniper trees - Chrysi

Exposed roots of Juniper trees - Kedrodasos

Unused plot with high Ground Vegetation Cover – Kedrodasos

Used plot with low Ground Vegetation Cover – Kedrodasos

Seedlings of *Juniperus oxycedrus* spp. *macrocarpa*

Young individuals of *Juniperus oxycedrus* spp. *macrocarpa* protected by visitors

Littering and human waste - Kedrodasos

Littering - Kedrodasos

Campers in Agios Ioannis Gavdos – August 2009

Campers in Sarakiniko Gavdos – August 2009

ANNEX II Templates of visitors’ questionnaire

Kedrodasos Sustainable Tourism Survey

Please complete this questionnaire - Your Opinion Matters!

This research is being carried out through the European LIFE+ JUNICOAST project in order to better understand the nature of tourism in Kedrodasos, thus enabling the proposal of sustainable tourism management and environmental protection measures for the site.

Date Today ……

How long will you stay in Kedrodasos ? Day trip _____ or *No. of nights* = _____

How many times have you visited Kedrodasos before this trip? Please circle your response *never* *once* *twice* *more than twice*

On average, how many times do you visit Kedrodasos in a year? *less than once a year* *once a year* *more than* once a *year*

On this visit to Kedrodasos which of the following activities did you do ? *(please tick each activity - you may tick more than one)*

Camping	☐	*Fishing*	☐	*Collecting shells*	☐	*Sun-tanning*	☐
Swimming	☐	*Picnic*	☐	*Beach barbecue/campfire*	☐	*Windsurfing*	☐
Beach Games	☐	*Trekking*	☐	*Cultural/ antiquities interest trip*	☐	*Wildlife watching*	☐

Other (please specify)

……

What are your two most important reasons for visiting kedrodasos on this occasion?

1st importance……

2nd importance ……

Please indicate how crowded you felt in kedrodasos: *Please circle your response*

Not crowded		Neither		Overcrowded
1	2	3	4	5

Please indicate your view on the level of cleanliness in Kedrodasos : *Please circle your response*

Very Clean		Neither		Very Dirty
1	2	3	4	5

Write the two main things you didn't like during your visit to kedrodasos

a) I didn't like……

b) I didn't like……

What, if any, of the following do you believe represent a threat to kedrodasos's natural environment ? *Please tick all that are relevant*

Reduced natural regeneration	☐	Rubbish and litter waste management	☐	Animal grazing	☐
One day visitors	☐	Cutting of branches and roots	☐	Fire	☐
Campers	☐	Lack of environmental awareness	☐	Human waste management	☐

Other? ……

Did you know about kedrodasos before coming to Crete? Yes ☐ No ☐ I am from Crete ☐

Please indicate whether you believe the following statements are TRUE or FALSE: *Please circle your response*

Kedrodasos is protected because of the presence of:	*TRUE*	*FALSE*	*Don't Know*
… the *carretta carretta* turtle	✓	×	?
… the trees (the juniper trees)	✓	×	?
… its sea shells	✓	×	?
… its antiquities - ancient monuments	✓	×	?
… its sand dunes with juniper trees ecosystem	✓	×	?
Other reason? (please specify)……			
Kedrodasos is a National park	✓	×	?
Kedrodasos is a NATURA 2000 site	✓	×	?
Kedrodasos is a designated Site of Community Interest	✓	×	?
Kedrodasos has a designated Special Protection Area for birds.	✓	×	?
Kedrodasos is NOT protected	✓	×	?

Please indicate your level of agreement or disagreement with the following statements: *Please circle your response*

	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
Visitor camping damages the Juniper trees and sand dunes	*1*	*2*	*3*	*4*	*5*
Kedrodasos is well managed.	*1*	*2*	*3*	*4*	*5*
Visitors should be restricted from going to certain parts of kedrodasos in order to protect the Juniper trees and sand dunes.	*1*	*2*	*3*	*4*	*5*
Kedrodasos does not require further protection	*1*	*2*	*3*	*4*	*5*
Visitors should be required to carry their personal rubbish back from kedrodasos	*1*	*2*	*3*	*4*	*5*

The current health status/ condition of the sand dunes and juniper trees in Kedrodasos is: *Please circle your response*

Very Good ☐ Good ☐ Average ☐ Poor ☐ Don't Know ☐

Would you be willing to pay an entry fee each time you visited kedrodasos for the management/cleaning/protection of the sand dunes and juniper trees?

No I wouldn't ☐ 1 euro ☐ 2 euros ☐ 3 euros ☐ 5euros ☐

What was the approximate amount of money you spent on this trip to kedrodasos (excluding travel) _____ Euros

Will you recommend Kedrodasos as a place to visit to your friends and family: Please circle your response

Very Likely ☐ Likely ☐ Neither ☐ Unlikely ☐ Very Unlikely ☐

Why? ……

How would you enhance the management of kedrodasos's sand dune with juniper tree beach (what actions do you believe should be taken)?. ……
……
……
……

Please indicate your country of residence: Your home town:

Sex: Male ☐ Female ☐ Age Group: 18-24 ☐ 25-34 ☐ 35-44 ☐ 45-64 ☐ 65+ ☐

Your education:

No formal education ☐
Primary education ☐
Lower secondary or second stage of basic education ☐
Upper secondary education ☐
Post-secondary non-tertiary education ☐
Tertiary education (university) ☐

Thank you for completing this survey !

Please return it to the person who gave it to you

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Chrysi Island Sustainable Tourism Survey

Please complete this questionnaire - Your Opinion Matters!

This research is being carried out through the European LIFE+ JUNICOAST project in order to better understand the nature of tourism in Chrysi, thus enabling the proposal of sustainable tourism management and environmental protection measures for the island.

Date Today ……

How long will you stay on Chrysi island ? Day trip _____ or *No. of nights* = _____

How many times have you visited Chrysi before this trip? Please circle your response *never* *once* *twice* *more than twice*

On average, how many times do you visit Chrysi in a year? *less than once a year* *once a year* *more than* once a *year*

On this visit to Chrysi which of the following activities did you do ? *(please tick each activity - you may tick more than one)*

Camping	☐	*Fishing*	☐	*Collecting shells*	☐	*Sun-tanning*	☐
Swimming	☐	*Picnic*	☐	*Beach barbecue/campfire*	☐	*Windsurfing*	☐
Beach Games	☐	*Trekking*	☐	*Cultural/ antiquities interest trip*	☐	*Wildlife watching*	☐

Other (please specify)

……

What are your two most important reasons for visiting Chrysi on this occasion?

1st importance……

2nd importance ……

Please indicate how crowded you felt on Chrysi: *Please circle your response*	Not crowded		Neither		Overcrowded
	1	2	3	4	5
Please indicate your view on the level of cleanliness on Chrysi : *Please circle your response*	Very Clean		Neither		Very Dirty
	1	2	3	4	5

Write the two main things you didn't like during your visit to Chrysi

a) I didn't like……

b) I didn't like……

What, if any, of the following do you believe represent a threat to the island's natural environment ? *Please tick all that are relevant*

Reduced natural regeneration	☐	Rubbish and litter waste management	☐	Animal grazing	☐
One day visitors	☐	Cutting of branches and roots	☐	Fire	☐
Campers	☐	Lack of environmental awareness	☐	Human waste management	☐

Other? ……

Did you know about Chrysi before coming to Crete? Yes ☐ No ☐ I am from Crete ☐

Please indicate whether you believe the following statements are TRUE or FALSE: *Please circle your response*

Chrysi is protected because of the presence of:	*TRUE*	*FALSE*	*Don't Know*
... the *carretta carretta* turtle	✓	×	?
... the trees (the juniper trees)	✓	×	?
... its sea shells	✓	×	?
... its antiquities - ancient monuments	✓	×	?
... its sand dunes with juniper trees ecosystem	✓	×	?
Other reason? (please specify)……			
Chrysi is a National park	✓	×	?
Chrysi is a NATURA 2000 site	✓	×	?
Chrysi is a designated Site of Community Interest	✓	×	?
Chrysi has a designated Special Protection Area for birds.	✓	×	?
Chrysi is NOT protected	✓	×	?

Please indicate your level of agreement or disagreement with the following statements: *Please circle your response*

	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
Visitor camping damages the Juniper trees and sand dunes	*1*	*2*	*3*	*4*	*5*
The island's beaches with Juniper trees and sand dunes are well managed.	*1*	*2*	*3*	*4*	*5*
Visitors should be restricted from going to certain parts of the island in order to protect the Juniper trees and sand dunes.	*1*	*2*	*3*	*4*	*5*
The island's beaches with juniper trees and sand dunes do not require further protection	*1*	*2*	*3*	*4*	*5*
Visitors should be required to carry their personal rubbish back from the island	*1*	*2*	*3*	*4*	*5*

The current health status/ condition of the sand dunes and juniper trees in Chrysi is: *Please circle your response*

Very Good ☐ Good ☐ Average ☐ Poor ☐ Don't Know ☐

Would you be willing to pay an additional fee (e.g. through your boat ticket) for the management/cleaning/protection of the sand dunes with juniper trees?

No I wouldn't ☐ 1 euro ☐ 2 euros ☐ 3 euros ☐ 5euros ☐

What was the approximate amount of money you spent for your trip to Chrysi

Excursion fees…….€ Other travel fees…….€ Food…….€ Souvenirs…….€

Do you feel the cost of the boat fare was *Please circle your response*

Too expensive ☐ About right ☐ Inexpensive ☐ I didn't pay for the boat individually ☐

Will you recommend Chrysi as a place to visit to your friends and family: Please circle your response

Very Likely ☐ Likely ☐ Neither ☐ Unlikely ☐ Very Unlikely ☐

Why? ……

How would you enhance the management of island's sand dune with juniper tree beaches (what actions do you believe should be taken)?. ……
……
……

Please indicate your country of residence: Your home town:

Sex: Male ☐ Female ☐ Age Group: 18-24 ☐ 25-34 ☐ 35-44 ☐ 45-64 ☐ 65+ ☐

Your education:

No formal education ☐
Primary education ☐
Lower secondary or second stage of basic education ☐
Upper secondary education ☐
Post-secondary non-tertiary education ☐
Tertiary education (university) ☐

Thank you for completing this survey ! – please put it in the box on board the boat

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Gavdos Sustainable Tourism Survey

Please complete this questionnaire - Your Opinion Matters!

This research is being carried out through the European LIFE+ JUNICOAST project in order to better understand the nature of tourism in Gavdos, thus enabling the proposal of sustainable tourism management and environmental protection measures for the island.

Date Today ……

How long will/did you stay on Gavdos? *No. of nights* = _____

How many times have you visited Gavdos before this trip? Please circle your response *never* *once* *twice* *more than twice*

On average, how many times do you visit Gavdos in a year? *less than once a year* *once a year* *more than* once a *year*

On this visit to Gavdos which of the following activities did you do ? *(please tick each activity - you may tick more than one)*

Camping	☐	*Fishing*	☐	*Collecting shells*	☐	*Sun-tanning*	☐
Swimming	☐	*Picnic*	☐	*Beach barbecue/campfire*	☐	*Windsurfing*	☐
Beach Games	☐	*Trekking*	☐	*Cultural/ antiquities interest trip*	☐	*Wildlife watching*	☐

Other (please specify)

……

What are your two most important reasons for visiting Gavdos on this occasion?

1st importance……

2nd importance ……

Which, if any, of the following places did you visit during this visit to Gavdos? *Please tick the relevant box*

Sarakiniko	*As a day trip* ☐	or	*Camped overnight* ☐	No. of nights: ____	I rented a room	☐
Agios Ioannis	*As a ay trip* ☐	or	*Camped overnight* ☐	No. of nights: ____		
Lavrakas	*As a day trip* ☐	or	*Camped overnight* ☐	No. of nights: ____		

Please indicate how <u>crowded</u> you felt at these locations: *Please circle your response*

	Not crowded		Neither		Overcrowded
Sarakiniko	*1*	*2*	*3*	*4*	*5*
Agios Ioannis	*1*	*2*	*3*	*4*	*5*
Lavrakas	*1*	*2*	*3*	*4*	*5*

Please indicate your view on the level of cleanliness at these locations: *Please circle your response*

	Very clean		Neither		Very dirty
Sarakiniko	*1*	*2*	*3*	*4*	*5*
Agios Ioannis	*1*	*2*	*3*	*4*	*5*
Lavrakas	*1*	*2*	*3*	*4*	*5*

Write the two main things you didn't like during your visit to the sites

In Sarakiniko I didn't like……

In Agios Ioannis I didn't like……

In Lavrakas I didn't like ……

What, if any, of the following do you believe represent a threat to the island's natural environment ? *Please tick all that are relevant*

Reduced natural regeneration	☐	Rubbish and litter waste management	☐	Animal grazing	☐
One day visitors	☐	Cutting of branches and roots	☐	Fire	☐
Campers	☐	Lack of environmental awareness	☐	Human waste management	☐

Other? ……

Did you know about Gavdos before coming to Crete? Yes ☐ No ☐ I am from Crete ☐

Please indicate whether you believe the following statements are TRUE or FALSE: *Please circle your response*

Gavdos is protected because of the presence of:	*TRUE*	*FALSE*	*Don't Know*
... the *carretta carretta* turtle	✓	×	?
... the trees (the juniper trees)	✓	×	?
... its sea shells	✓	×	?
... its antiquities - ancient monuments	✓	×	?
... its sand dunes with juniper trees ecosystem	✓	×	?
other reason? (please specify)……			
Gavdos is a National park	✓	×	?
Gavdos is a NATURA 2000 site	✓	×	?
Gavdos is a designated Site of Community Interest	✓	×	?
Gavdos has a designated Special Protection Area for birds.	✓	×	?
Gavdos is NOT protected	✓	×	?

Please indicate your level of agreement or disagreement with the following statements: *Please circle your response*

	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
Visitor camping damages the Juniper trees and sand dunes	*1*	*2*	*3*	*4*	*5*
The island's beaches with Juniper trees and sand dunes are well managed.	*1*	*2*	*3*	*4*	*5*
Visitors should be restricted from going to certain parts of the island in order to protect the Juniper trees and sand dunes.	*1*	*2*	*3*	*4*	*5*
The island's beaches with juniper trees and sand dunes do not require further protection	*1*	*2*	*3*	*4*	*5*
Visitors should be required to carry their personal rubbish back from the areas	*1*	*2*	*3*	*4*	*5*

The current health status/ condition of the sand dunes and juniper trees in Gavdos is: *Please circle your response*

Very Good ☐ Good ☐ Average ☐ Poor ☐ Don't Know ☐

Would you be willing to pay an additional fee (e.g. through your boat ticket) for the management/cleaning/protection of the sand dunes with juniper trees?

No I wouldn't ☐ 1 euro ☐ 2 euros ☐ 3 euros ☐ 5euros ☐

What was the approximate amount of money you spent in Gavdos on this trip (excluding travel) _____ Euros

Will you recommend Gavdos as a place to visit to your friends and family: Please circle your response

Very Likely ☐ Likely ☐ Neither ☐ Unlikely ☐ Very Unlikely ☐

Why? ……

How would you enhance the management of island's sand dune with juniper tree beaches (what actions do you believe should be taken)?. ……
……

Please indicate your country of residence: Your home town:

Sex: Male ☐ Female ☐ Age Group: 18-24 ☐ 25-34 ☐ 35-44 ☐ 45-64 ☐ 65+ ☐

Your education:

No formal education ☐
Primary education ☐
Lower secondary or second stage of basic education ☐
Upper secondary education ☐
Post-secondary non-tertiary education ☐
Tertiary education (university) ☐

Thank you for completing this survey ! – please put it in the box on board the boat

To find out more about the JUNICOAST project and join the network visit

www.junicoast.gr