# Relationships between the dynamics of two *Talitrus saltator* populations and the impacts of activities linked to tourism

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**KEYWORDS**
*Talitrus saltator*
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**Abstract**

The study considered two ecologically similar coastal areas in Tuscany (Italy). One site belongs to a protected natural area and the other one is in front of a camping site. We analysed the impact of human activities, such as trampling and mechanical beach cleaning, on *Talitrus saltator*. It turned out that the population density was affected in that it first disappeared from the area at the camping site, then recolonised it once the peak of the tourist season at the camping site had passed. The results confirm the sensitivity of this species and its plasticity in adapting to different conditions on the one hand, and the positive effects of diversification in resource management on the other hand.

## 1. Introduction

Sandy beach coastal ecosystems present characteristics of extreme variability in physical and biotic features, both in time and space, and

these have a relative predictability, depending on daily and seasonal periodicity, such as tides, and day and night alternation. The same can be said for human disturbance, which is on the increase in this particular environment and presents characteristics of massive daily and seasonal impact. The human factor must therefore be considered in any analysis of coastal environments. According to the World Tourism Organisation (WTO), 'Tourism comprises the activities of persons travelling to and staying in places outside their usual environment for not more than one consecutive year for leisure, business and other purposes' (Rogers 1994, cit. in GFANC 1997). In Europe, the use of the shores as social product began in the middle of the 19th century, when seaside holidaymaking became a fashion or status symbol. This has burgeoned since the Second World War, reaching the dimensions of a mass phenomenon. In this context, seaside holidaymaking is significant because of its massive impact, even if it is temporary, with seasonal periodicity. Some trends predicted by WTO laid stress on increasing criticism and the specialisation of demand on the part of tourists. Moreover, coastal tourism is expected to remain the main segment of global tourism, but nature and cultural tourism are likely to take on a greater significance (GFANC 1997).

The development of tourism on coasts creates increasing competition between natural and other resources, such as fresh water, space, transportation, waste disposal, and between different stakeholders. So there is a need to define concepts such as 'development' and 'quality' of the environment in order to promote the sustainable use of resources. Also, indicators of quality and sustainability are required so as to be able to evaluate and plan the management of a fragile ecosystem such as a sandy beach, which represents the border between land and sea, and is threatened by impacts from both sides. The World Tourism Organisation also proposed five criteria for evaluating the goodness of an indicator (Table 1, left).

The issue can be studied on different scales: we have chosen the scale of the littoral and supralittoral zone, a few tens of metres in width and several kilometres in length. The crustacean amphipod *Talitrus saltator* (Montagu 1808) (sandhopper), which lives in the intertidal and supratidal zones of the beach, is a potential indicator of changes in the sandy shore, because it is influenced by the instability of this environment and the beach tourism mentioned above. This animal also fulfils the requirements proposed above as a suitable bioindicator of human impact (Table 1, right). Most studies regarding this species have addressed its orientation behaviour from the back beach to the shore, a peculiar adaptation to the intertidal and supratidal zones. Behavioural variation was related to impacts such as removal of wrack and shoreline instability (Borgioli et al. 1999, ElGtari

**Table 1.** WTO's definition of the suitability of an indicator (left), and the usefulness of *Talitrus saltator* as a bioindicator of the impact of tourism on sandy beaches (right)

| Suitability of an indicator (WTO, cit. in Caffyn et al. 2002) | Known characteristics of *Talitrus saltator* |
|---|---|
| 1. Whether the data are obtainable; | 1. Ubiquity in the littoral zone on sandy shores; |
| 2. Whether the indicator is both credible and easy to understand; | 2. Life cycle with two generations, overlapping during the year; |
| 3. Whether the indicator enables the detection of trends over time and comparison across areas; | 3. Capacity to synchronise its activities, as a response to periodic stimuli; |
| 4. Whether the indicator can predict sustainability; | 4. Plasticity as a response to variations in an extremely variable environment. |
| 5. Whether reference value thresholds are available. | |

et al. 2000). This study takes into consideration the response of *T. saltator* populations to direct human impact on sandy shores. It was chosen because it is widespread and can adapt itself well to environmental features, and thus because comparison of different localities in which populations are found is possible.

## 2. Material and methods

### 2.1. Characteristics of the study sites

The study was carried out in two different coastal sites in southern Tuscany, Italy, both in the province of Grosseto, which are near to each other (about 15 km apart), but are subject to different human impacts. One is the beach in front of the tower of Collelungo, in the Regional Park of Maremma, a protected area since 1975, while the other is the beach in front of the Le Marze camping site (Fig. 1). A third study site had been planned at Principina a Mare, which lies between the other two sites and is subject to a stronger impact from tourism, with structures erected on the beach for leisure bathing. But as no talitrids were found at this site for three consecutive months during the reproductive period of the species, we assumed that there were no resident populations of sandhoppers.

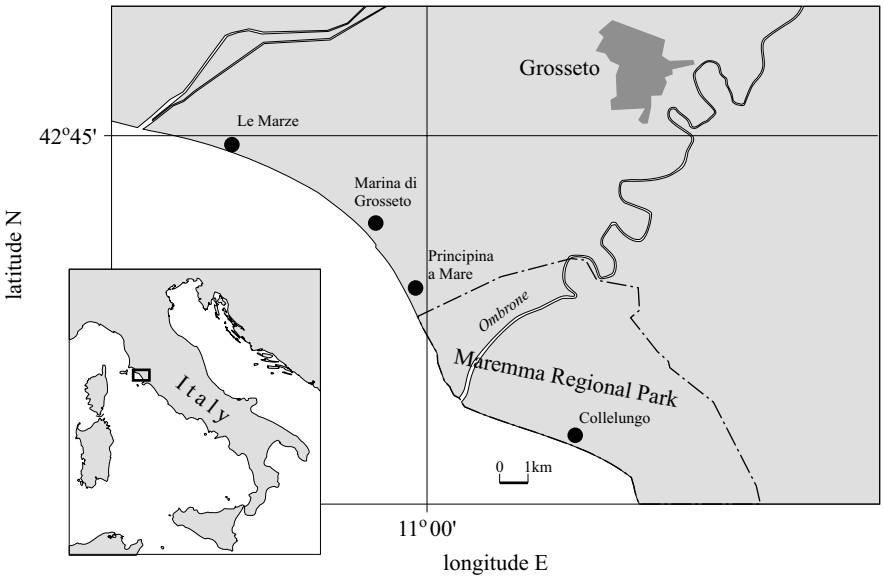


**Fig. 1.** Map of the coast where the study sites were located in Grosseto province: 42°38′N, 11°04′E, at both sides of the mouth of the river Ombrone

The two beaches studied have similar ecological characteristics, with the same orientation and exposure of the shoreline, and similar sand characteristics; both have a preserved dune behind the shore, so it was possible to isolate features linked to the human impact on the littoral zone. These were trampling and mechanical beach cleaning, the effects of which differed between the two sites. Moreover, the two sites are under different management, and consequently different typologies of tourism and a different seasonality of visitor flow can be observed between the two areas.

### 2.2. Monitoring tourism density and the trampling by tourists

At the same time as the samples of *T. saltator* were being taken, the numbers of visitors coming onto the beach were counted. As it was difficult to count the number of people in a given area on a crowded beach, an estimate was made by drawing an imaginary line at the entrance to the beach and counting the number of people crossing it. In the Park, the number of people arriving at the Collelungo beach off itinerary A2 were counted. During the summer months visitors who came from the sea by boat or had arrived at Collelungo along the beach were also counted. A threshold value of 150 people arriving was chosen, and figures higher than 150 arrivals were included in the maximum trampling evaluation. The decision to conduct the samplings in the late morning for estimating the density of tourists at each beach also turned out to be useful, as peak

numbers of holidaymakers are present on the beach at this time of day (Caffyn et al. 2002). Samples were taken on weekdays. At the camp site the number of people on the beach is more constant during the week than at the week-end, and most school visits to the Park take place in mid-week. The data on the flow of tourists in the 1998–2001 in the Province were supplied by the ISTAT (Istituto Nazionale di Statistica) and the Grosseto Tourist Office. From these data, the probable trend over the four-year period preceding the study could be highlighted. For the same period, data on visitors were also collected from the Park's and the camp site's databases. The number of tourists entering the Park was quantified by the number of entrance tickets sold, while the number of visitors at the camping site were supplied by its management. The information about the visitors of the area was integrated by the statistics of IRPET (Istituto Regionale per la Programmazione Economica Toscana) on tourism in protected natural areas (Pagni 2002).

Information about the beach cleaning was supplied by the company Co.Se.Ca. SpA., which carried out this activity along the whole sandy shore of the Grosseto province during the study period. Only the camping site beach is cleaned mechanically. The seasonality and intensity of this activity were estimated. The intensity varied with respect to the depth of sand digging, the mesh size of the sieves used and the frequency of cleaning. Six arbitrary classes of impact were determined (Table 2) with regard to depth, mesh size and frequency of cleaning.

**Table 2.** Classes of impact due to mechanical beach cleaning. Data supplied by Co.Se.Ca. SpA., who were in charge of beach cleaning along the whole littoral of Grosseto province. All beach cleaning was carried out between 8 p.m. and 9 a.m.

| Class | Action |
|---|---|
| 0 | No mechanical beach cleaning |
| 1 | Monthly removal of superficial coarse detritus |
| 2 | Twice-monthly levelling of the sand and removal of superficial coarse detritus |
| 3 | Twice-monthly levelling of the sand and removal of the coarse detritus to a depth of 30 cm |
| 4 | Weekly riddling of the sand to a depth of 8 cm to remove fine detritus (described as the 'cigarette-end dimension') |
| 5 | Twice-weekly riddling of the sand to a depth of 8 cm to remove fine detritus (described as the 'cigarette-end dimension') |

### 2.3. Monitoring *Talitrus saltator*

For 13 months (from March 2001 to March 2002), samples of sandhoppers from different parts of the shore were taken monthly in both localities. The aim was to collect a sample of 150 individuals each time in order to analyse the population structure. So the areas sampled varied depending on the density (calculated as the number of individuals per $m^2$). If it was not possible to find 150 individuals, collection was stopped after 30 minutes of unsuccessful continuous searching. The sampling zone was determined each time by digging a rectilinear furrow from the shoreline towards the dunes and stopping where the first *T. saltator* was seen jumping out of the sand. This method followed previous investigations on the same coast (Scapini et al. 1992, Fallaci et al. 2003, Marques et al. 2003), which provided information about the distribution of *T. saltator* during their daily and seasonal displacements along the beach. Samples were taken up to a depth of 10 cm of sand and animals were collected by means of an entomological aspirator. The area sampled was then measured, as well as the distance from the area to the dune (the first dune plants) and the distance from the area to the shoreline at low tide. In order to perform as many samplings as possible under similar conditions, the collections were made at the same time of day, in the late morning on consecutive days at different sites. For every sample, the air temperature and air humidity were measured during collection. Solar time and the duration of sampling were also recorded. The data for air temperature and humidity were compared with the monthly averages supplied by the ARSIA network (Agenzia Regionale per lo Sviluppo e l'Innovazione nel settore Agricolo-forestale) centres, which are deployed across the territory. This allowed us to obtain a more general picture of the weather conditions during the samplings. Monthly rainfall figures were also supplied. Profiles of the two beaches were taken in March 2002. The diversity of dune plants was checked in July 2002, when the largest numbers of people were around, in order to integrate the results obtained with *T. saltator* with information about the dune ecosystem backing the beach. Quadrats of 5 square metres were chosen at random along a transect parallel to the shoreline and covering 100 metres, with two transect replicates at each site.

The sampled animals were preserved in 75% alcohol immediately after collection. In the laboratory, the animals were measured under the microscope (25 ×) for cephalic length (mm), number of tagma of the second antennae, both left and right, sex and, if present, the numbers of eggs and embryonic stages. Individuals in which no appendices characteristic of males or females were found were classified as juveniles. Information on the size of the animals can be inferred from the cephalic length, so that bias due to

the difficulty in measuring the telson can be avoided (Marques & Anastácio 2002). The formula:

$$\text{Log}\,(\text{number of tagma of right antenna}/\text{number of tagma of left antenna})$$

was used to obtain an asymmetry index according to Scapini et al. (1999).

### 2.4. Statistical analysis

The aim of the first analysis was to assess the possible differences between the two sites, using the *t*-test for the cephalic lengths of the individuals of the two populations and the asymmetry indexes, and the chi-square for the sex ratios. Linear regressions were calculated between the meteorological factors and population density. ANOVA was performed using the density of *T. saltator* as response variable, and the features linked to human impact, trampling and beach cleaning as factors. For the purposes of the ANOVA, the factors were divided into classes: low, medium and high.

## 3. Results

A brief description of the two study sites, together with their ecological and management characterisations is presented in Table 3. Minor ecological differences between the two sites were found in the beach profiles (Fig. 2), and in the plant biodiversity of the dunes. Both differences could be related to the shoreline dynamics, which was more stable at Le Marze than at Collelungo, and to the protection of the dunes. But major differences between the two sites were related to human uses.

### 3.1. Management and visitor numbers at the two sites

According to the data of 1999, tourism in Grosseto province was generated more by seaside holidaymaking than by other motives, such as cultural or business aims (Fig. 3). The trend was similar to that found in the Mediterranean region as a whole (The Economist 2004), and is increasing, following the expected seasonality typical of seaside holidaymaking. However, statistical indices of arrivals and the presence of tourists revealed that the places where tourists spent their time were camping sites or 'rural houses' (agriturismo in Italy) rather than hotels, and the mean length of stay in the former was higher than the mean national duration of stay in other coastal areas (ISTAT, data for 1998–2000; Fig. 4). Many localities along the coast of southern Tuscany are active in summer only, and were built in the 1960s purely for the purposes of tourism; one of these places is Principina a Mare, where no *T. saltator* populations were found on the beach. Considering the phenomenon on smaller scales, there were some differences between the areas analysed in

**Table 3.** Brief description of the sites

| Locality | Le Marze | Collelungo |
|---|---|---|
| shoreline dynamics | dynamic equilibrium; shoreline direction 122° | slow accretion; shoreline direction 115° |
| dune system | presence of dune, preserved in a natural state | presence of dune, preserved in a natural state |
| dune plant biodiversity (Shannon index) | S = 7; H = 1.188 | S = 5; H = 1.013 |
| beach width | 25 m | 40 m |
| mean beach slope | 18° | 14° |
| sand characteristics (CNR atlas 1984) | fine sand; 40% carbonate, 30% quartz, gneiss, basic vulcanite, granite | fine sand; 40% carbonate, 30% quartz, gneiss, basic vulcanite, granite |
| management | camping with private access to the beach | natural park with visits controlled by regulation |
| access | April–October | all the year round, but strictly limited in July and August |
| beach cleaning | by mechanical means | not carried out |
| goal of the majority of visitors on the beach | seaside holidaymaking | seaside holidaymaking, interest in nature |

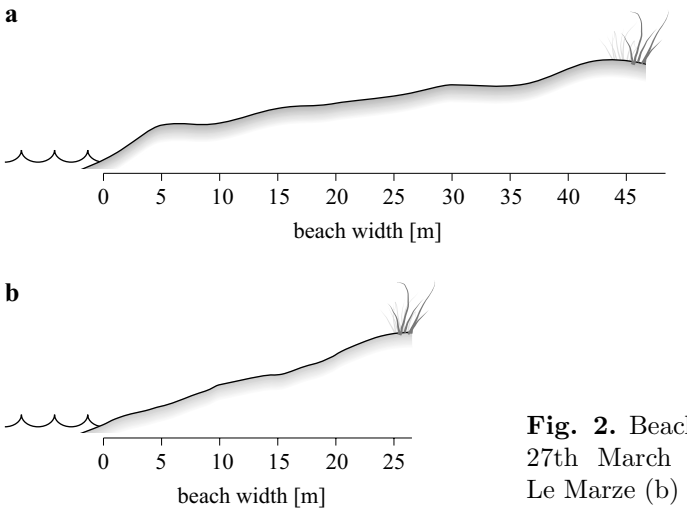


**Fig. 2.** Beach profiles measured on 27th March 2002, Collelungo (a), Le Marze (b)

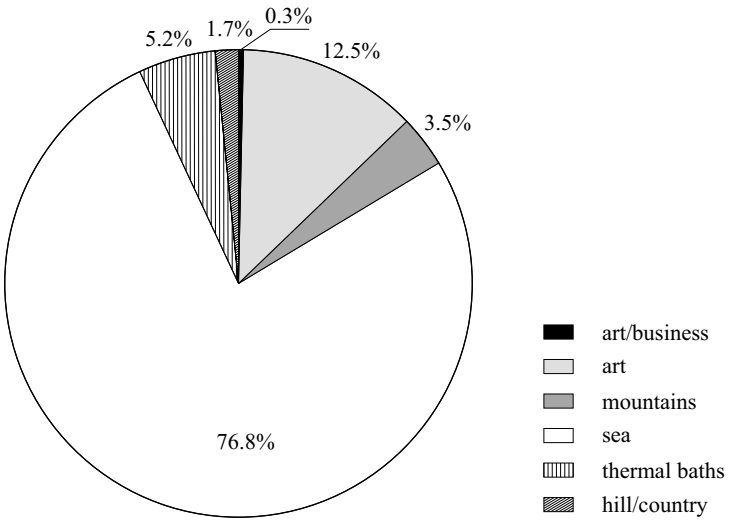


**Fig. 3.** Aims of tourist visits to Grosseto Province in 1999. 76.8% of the total number (757 782 arrivals) were people that chose the locality for seaside holidaymaking (Grosseto province database)

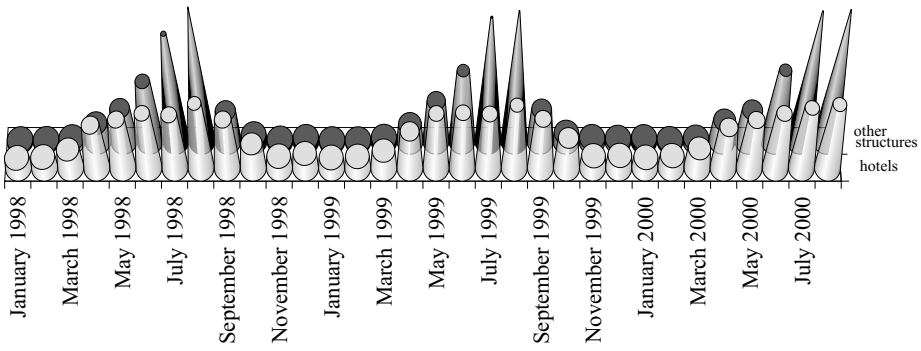


**Fig. 4.** Seasonality of tourism in Grosseto Province (indicator: arrivals of tourists) from January 1998 to August 2000 (ISTAT) ($x$-axis – months; $y$-axis – number of arrivals)

this study (Figs 5 and 6). The distribution of visitors to the Maremma Regional Park was bimodal, showing a different seasonality with respect to neighbouring areas under different kinds of management. The main peak in April was due to school trips, which generally choose the itinerary A2 leading to the beach of Collelungo, while the other peak was in August, following the expected dynamics for seaside holidaymaking. It is important to note that during July and August there is limited access to the itinerary A2 in the Park, because of the high risk of fires. It is also important to note

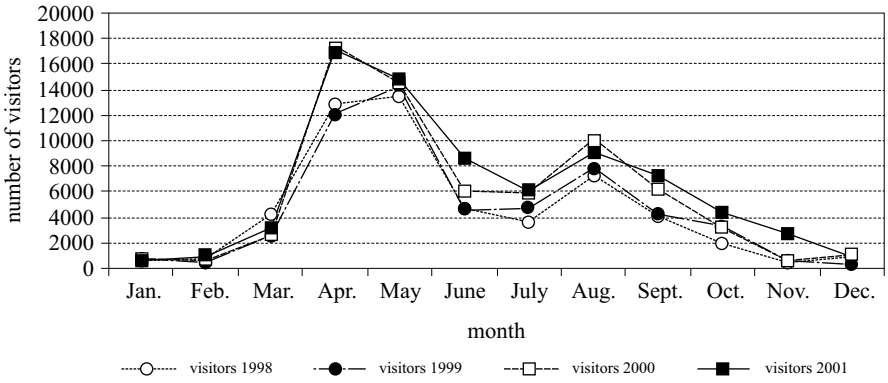


**Fig. 5.** Seasonality of visits to the Maremma Regional Park from 1998 to 2001; data obtained from the Maremma Regional Park's database

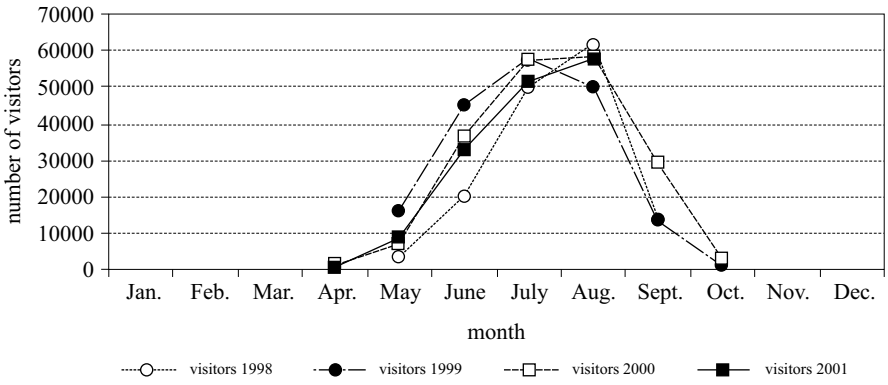


**Fig. 6.** Seasonality at the Le Marze camping site from 1998 to 2001 (data supplied by the camping site owner). The opening period also varied during these years, shifting from May to April and from September to August (data were available until August 2001)

that 98% of people who visited the Park were aware of being in a protected natural area (Pagni 2002). The distribution of visitors in Le Marze follows the expected seasonality of a seaside locality, with a peak in July–August. Fig. 7 compares the measured human impacts (trampling and cleaning) which the two *T. saltator* populations were subjected to during the period considered in this study.

Although the dunes in both localities are protected, cows often stray into the Park's dune belt. In front of the camping site, access to the dune is prevented by netting, and people can only walk or ride a bicycle along the walks. This could affect plant biodiversity on the dunes (Table 3).

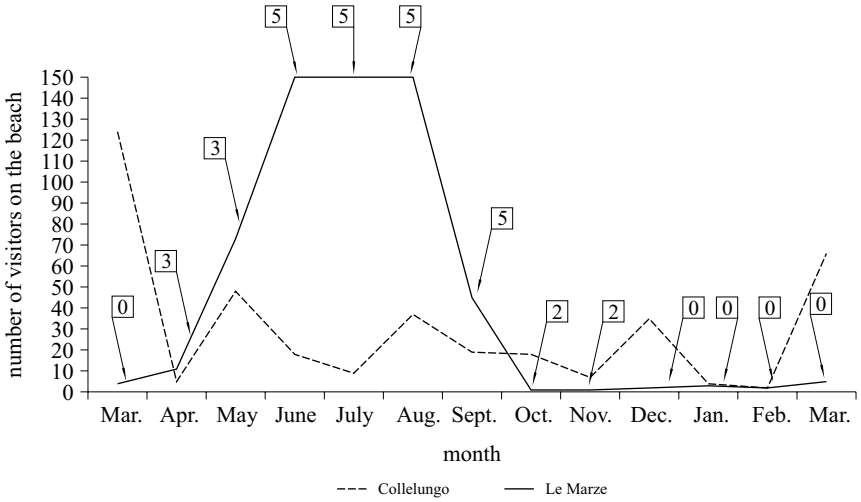


**Fig. 7.** Human impact measured directly at the two sites from March 2001 to March 2002. Lines represent the presence of people on the beach and squares represent the estimated class of impact due to mechanical beach cleaning (0–5)

### 3.2. *Talitrus saltator* populations

The density of sandhoppers and the presence of juveniles tended to be positively correlated with meteorological variables, such as air temperature and humidity, but the linear regressions were not significant (Table 4).

**Table 4.** Results of the linear regression of the *Talitrus saltator* population density with meteorological features. Monthly mean values were supplied by the ARSIA network

| Site | Air temperature [°C] | Relative humidity of the air [%] | Precipitation [mm] |
|---|---|---|---|
| Collelungo | multiple $R^2$ 0.2557<br>$p$ value 0.0935 | multiple $R^2$ 0.0018<br>$p$ value 0.8933 | multiple $R^2$ 0.0015<br>$p$ value 0.9056 |
| | range of mean values 5.8°C–26°C | range of mean values 69%–83% | range of mean values 0 mm–75 mm |
| Le Marze | multiple $R^2$ 0.0272<br>$p$ value 0.6714 | multiple $R^2$ 0.0219<br>$p$ value 0.7034 | multiple $R^2$ 0.0002<br>$p$ value 0.9701 |
| | range of mean values 9.6°C–28.2°C | range of mean values 63%–76% | range of mean values 3.5 mm–65.5 mm |

The effects of human impact were assessed with ANOVA (Table 5). No significance was found for the interactions with trampling and beach

**Table 5.** ANOVA results of the impact of mechanical beach cleaning on the density of *Talitrus saltator* populations (estimated as the number of individuals per $m^2$)

| | Immediate trampling | Immediate beach cleaning | Short-term trampling | Short-term beach cleaning |
|---|---|---|---|---|
| Le Marze | not significant | $p < 0.001$ $F = 26.124$ *df* 2, 10 | not significant | $p < 0.001$ $F = 23.299$ *df* 2, 9 |
| Collelungo | not significant | no beach cleaning in the area | not significant | no beach cleaning in the area |

cleaning. A time-scale of one month was used to evaluate the short-term effect of the impact, since the moult interval for *T. saltator* at this latitude is 20–30 days (F. Scapini, personal observations). The trampling factor was not significant with regard to density in either case, but the mechanical beach cleaning result was highly significant for Le Marze, with respect to the intensity of cleaning both in the same month and in the previous one.

Fig. 8 shows the differences in density during the 13 months at the two study sites. The difference in sizes between the two populations was also analysed. Adults and juveniles were analysed separately in order to avoid bimodality, as males and females of *T. saltator* have similar dimensions

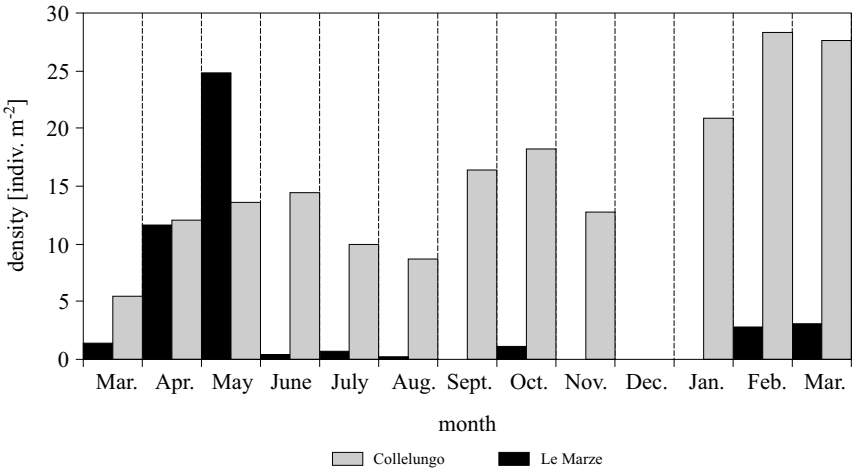


**Fig. 8.** Density of *Talitrus saltator* [indiv. $m^{-2}$] from March 2001 to March 2002. Ranges of density are 0 (December 2001) – 28.26 (February 2002) in Collelungo and 0 (September, November, December 2001 and January 2002) – 24.48 (May 2001) in Le Marze. The 0 value of December 2001 is probably due to the rainy weather, which caused the animals to spread out on the beach

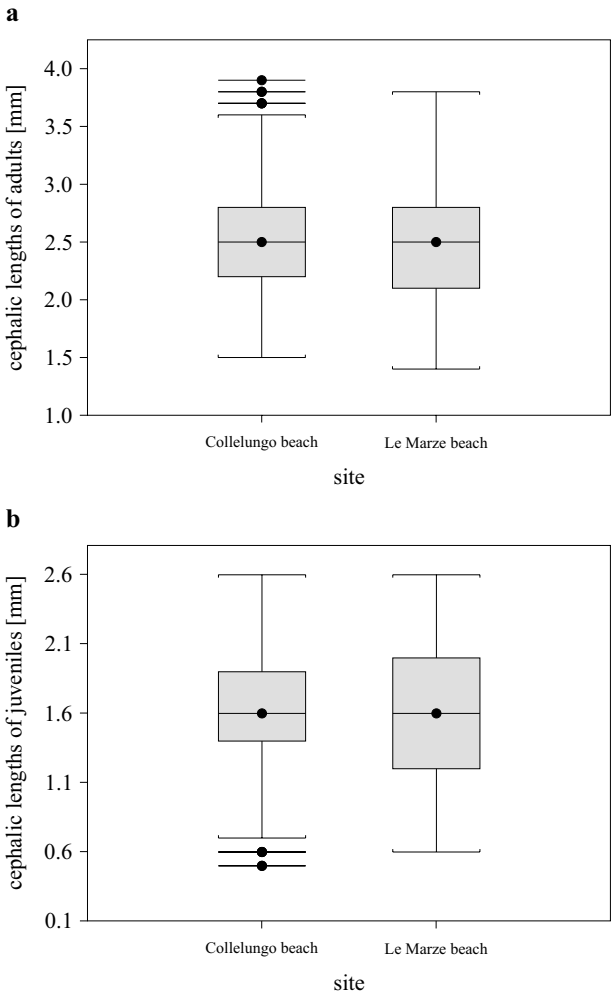


**Fig. 9.** Cephalic lengths of adults (a) and juveniles (b) of *Talitrus saltator*

(Figs 9a and 9b). The $t$-test on the means resulted in lack of significance for both categories.

At the two sites, the population structure followed the expected life-cycle in the Mediterranean, with the reproductive period from spring to autumn, with peaks in late April and late September (Marques et al. 2003). The total sex ratios (males/females) were not significantly different between the two sites (chi-square test). But there were local differences between the two sites considering the seasonal variation of sex ratios (Figs 10a and 10b). The rate of juveniles reached 81% at Le Marze in late April, and the maximum juvenile rate at Collelungo was 74%, observed in November (Figs 10a and 10b).

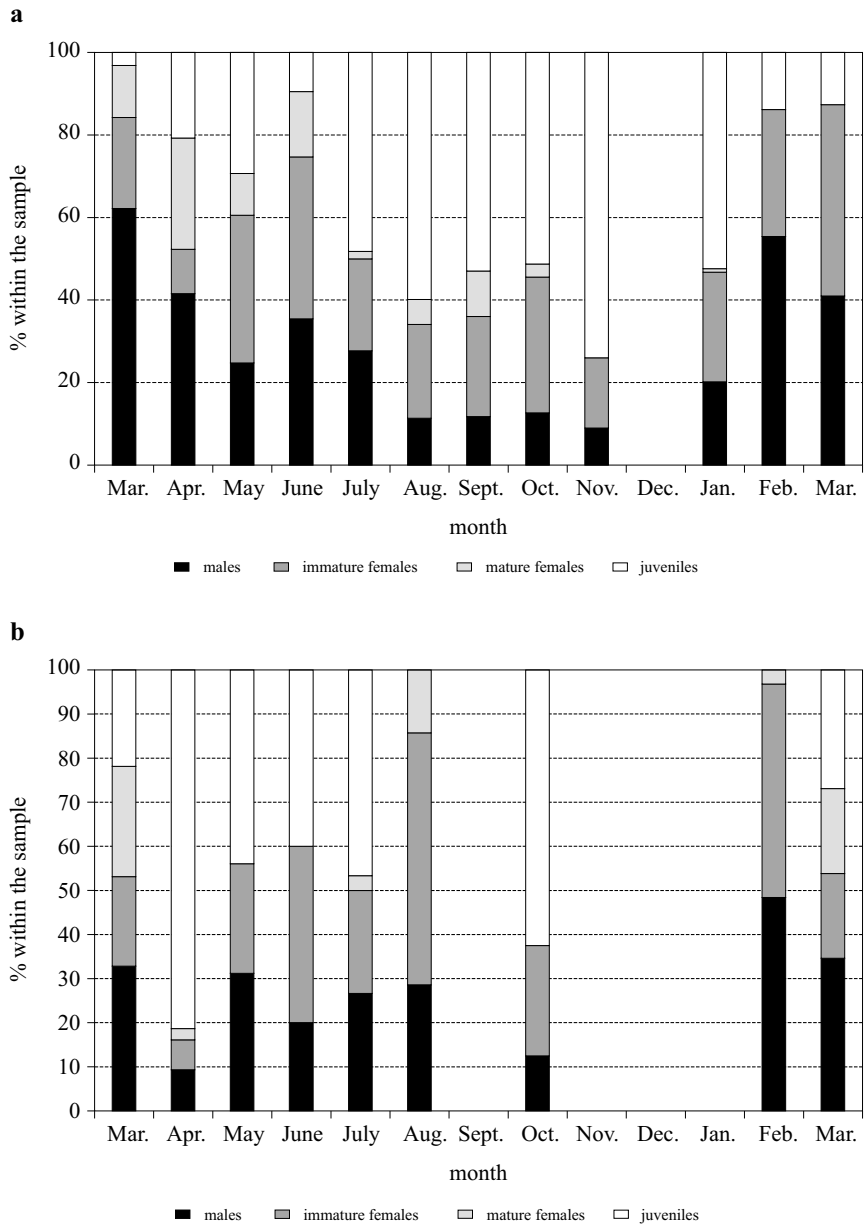


**Fig. 10.** Sample structure at Collelungo (a) and Le Marze (b) study sites from March 2001 to March 2002

The asymmetry of the second antennae follows a fluctuation due to an asymmetric accretion alternating the right and left antennae (A. Libertini, personal communication; Fluctuating Asymmetry, cf. Møller & Swaddle 1997), and does not highlight a difference between the two populations

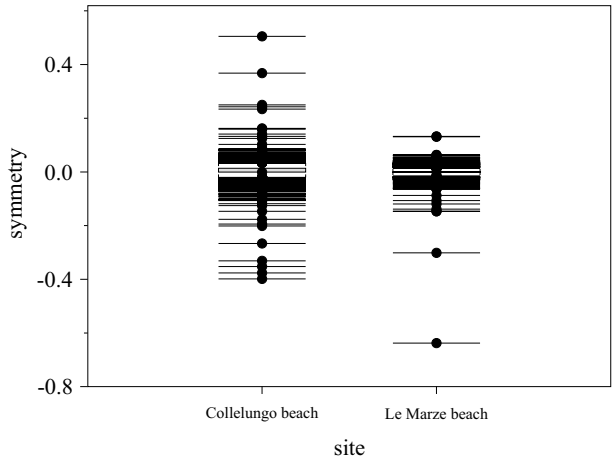


**Fig. 11.** Antennal asymmetry at the two sites, resulting from the equation Log (number of tagma of right antenna/number of tagma of left antenna)

(Fig. 11). The apparent higher fluctuation in the Collelungo sample is probably due to the larger number of individuals measured. The rate of broken or damaged second antennae in adult individuals was higher at Le Marze (2.44%) than at Collelungo (0.9%), but the difference was not significant (chi-square test).

## 4. Discussion

In this study we isolated the effects of human impact by comparing two ecologically similar areas in close proximity to each other, but under different management. Unfortunately, no talitrids were found at the Principina a Mare site, so no comparison was possible with a highly impacted beach. There are no historical data at this site to tell us when the population started disappearing. However, the disappearance of *T. saltator* is to be expected in localities where dune belts have been destroyed and bathing establishments built, and, to put it in a nutshell, where a beach's resources have been exploited to the maximum (personal observations). With respect to the information available about human uses and management, it was possible to interpret the density and characteristics of *T. saltator* populations by integrating environmental features such as ecological and human contexts.

Trends of correlation did appear (but were not statistically significant) between the *T. saltator* density and abiotic features such as air temperature, relative humidity and rainfall, and were no different from the results of previous investigations (Fallaci et al. 2003, Marques et al. 2003). Characteristics such as sex ratio and population dynamics are difficult to use

as bioindicators of impact, because their estimates require repeated, long-term sampling (Scapini 2002). At the individual level, antennal asymmetry, which shows a fluctuating trend highly dependent on population density and structure (Møller & Swaddle 1997), is a feature that is difficult to interpret. In general, adults display a higher incidence of broken antennae, and this could be for probabilistic reasons, such as having a higher number of tagma and a longer life span. The synchronisation in population dynamics in March in two consecutive years shown by the Le Marze population may suggest the hypothesis of an adaptation to a predictable seasonal disturbance such as mechanical beach cleaning, which starts in April. The rate of juveniles could be considered an indicator of recolonisation (Charfi-Cheikhrouha et al. 2001). Seasonal recolonisation by the population would be likely at a 'good' site, where the efforts at recolonisation are justified by the good quality of the beach (at least from autumn to spring) and of the dune behind (protected from trampling). The results of the density analysis show a highly significant sensitivity in the response to mechanical beach cleaning and represent an interesting tool that can be used for impact assessment. The removal of stranded wrack means a seasonal loss of a food resource. The mean cephalic length of the population, however, was not significantly lower at the Le Marze site, as was to be expected as a consequence of the cleaning of the beach (Dugan et al. 2003). So probably, animals avoid this disturbance by displacing whenever possible to a neighbouring area that is less subject to human impact. The importance of the availability of natural corridors is highlighted in this case.

As regards beach cleaning at Le Marze, more details about the time and space of this activity would have been desirable, but these data were denied to us by the agency in charge.

As far as the effects of trampling are concerned, the distribution of tourists on a sandy beach usually follows a gaussian distribution with the mean corresponding to the access to the beach (Caffyn et al. 2002). A sandhopper could easily cover the distance needed to reach a less trampled zone on the beach. This could explain why the effect of direct trampling was not found to be significant in this study. Recolonisation by *T. saltator* was indicated by the high rate of juveniles found at Le Marze beach, the site subject to a strong but time-limited impact. Also, this finding highlights the active movement of sandhoppers along and across the shore. Given a suitable environment, the indigenous population can withstand a spatially and temporally limited disturbance. Particularly in the case of sandy beaches, the availability of corridors (along which animals can move) depends not only on ecological barriers, but also on management. Sustainable exploitation of the beach and the dune allows the animals to

find a safe zone. Studies by Węsławski et al. (2000a, b, c) on the impact of trampling on Polish Baltic shores, which suffer a high impact from seasonal tourism, point to *T. saltator* as a good candidate for an indicator of human pressure on sandy beaches, since it shares the same zone with the tourists in summer. Considering also WTO's suggestions for a good quality indicator, the results obtained are grounds enough for proposing *T. saltator* as a quality indicator of sandy shore ecosystems, since the density of this amphipod was related to the human impact on the beaches analysed. This kind of relationship is easily understood by managers and stakeholders, so it could be proposed as a useful tool in the evaluation of management plans (Scapini 2002).

The state of the dunes is more stable at Le Marze than at Collelungo, because of the higher stability of the shoreline and the protection of the dune belt applied in the former zone. The higher number of plant species found on the dune at Le Marze and the higher estimated diversity index (H) support this hypothesis. It can be concluded that the preservation of the dune, also located in an area subject to large-scale tourism, represents an investment for the future, thus for the sustainability of the beach.

As far as the tourists' demands are concerned, this study confirmed the trends predicted by WTO, that tourists have an interest in nature and in preference to hotels, are happy to accept alternative accommodation. Analysing the differences of people visiting the protected natural area (the Maremma Regional Park) as compared with those visiting Grosseto province as a whole (Pagni 2002), we can propose the hypothesis that different kinds of people behaving differently with respect to the environment are distributed along the coastline (Sammuri G., President of the Park, personal communication). The increasing demand for tourism has given rise on the one hand to an increasing interest in sandy beaches, but on the other to increasing competition for related resources between stakeholders. In this context, the search for differentiation seems to be a good solution in beach management (Węsławski 2000c) and, as our study confirms, also in the conservation of the natural environment. Our study has also highlighted the effects of different methods of managing the same resource. The proximity of a camping site (regulated by sustainability criteria such as dune conservation and the absence of bathing structures) to a natural area, offers a twofold advantage. On the one hand, the quality of the shore can be maintained, permitting the reappearance of a sandhopper population after the summer season, and, on the other hand, it offers a diversification of amenities (Cassar & Vassallo 2002), allowing different types of people with different interests to benefit from the sandy shore and, at the same time, favouring the active conservation of this resource. This outcome is sometimes unintentional

because, as a matter of fact, tourism, which in principle is not linked to ecological aims, nevertheless has an inherent tendency to eliminate a massive seasonality in its sustainability.

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