

CETACEAN RECORDS AND ENCOUNTER RATES IN THE NORTHERN
ADRIATIC SEA DURING THE YEARS 1988–2007*Giovanni BEARZI, Marina COSTA, Elena POLITI, Stefano AGAZZI, Nino PIERANTONIO & Daria TONINI*

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ABSTRACT

We report a total of 156 cetacean sightings made in the northern Adriatic Sea between 1988 and 2007. Confirmed identifications ($n = 97$) involved exclusively common bottlenose dolphins *Tursiops truncatus*. Encounter rates for this species, obtained between 2001 and 2006 during visual cetacean surveys, ranged between 0.42 and 1.67 groups per 100 km of navigation, with no significant differences among years if a consistent methodology was used. Information provided by this study contributes to setting environmental baselines and it can inform the design of surveys aimed to obtain absolute estimates of cetacean abundance in this part of the Adriatic.

Key words: cetaceans, Adriatic Sea, common bottlenose dolphin, *Tursiops truncatus*

OSSERVAZIONI DI CETACEI E FREQUENZE DI AVVISTAMENTO IN ADRIATICO
SETTENTRIONALE NEL PERIODO 1988–2007

SINTESI

Riportiamo un totale di 156 avvistamenti di cetacei in Adriatico settentrionale, dal 1988 al 2007. Le identificazioni confermate ($n = 97$) hanno riguardato esclusivamente il tursiope *Tursiops truncatus*. Le frequenze di avvistamento per questa specie, ottenute nel corso di survey visivi sui cetacei svolti tra il 2001 e il 2006, oscillavano tra 0,42 e 1,67 gruppi per 100 km di navigazione, senza differenze significative tra un anno e l'altro quando la metodologia era omogenea. Le informazioni qui fornite contribuiscono a stabilire dei punti di riferimento sullo stato dell'ambiente e possono essere utili nella progettazione di survey finalizzati all'ottenimento di stime di abbondanza assoluta dei cetacei in questa parte dell'Adriatico.

Parole chiave: cetacei, Mare Adriatico, tursiope, *Tursiops truncatus*

INTRODUCTION

Monitoring cetacean populations is crucial for understanding the changes occurring over time, including the extent of geographic occurrence and shifts in species composition. Of the two cetacean species regularly occurring in the northern Adriatic Sea until the 1960s – the common bottlenose dolphin *Tursiops truncatus* (hereafter "bottlenose dolphin") and the short-beaked common dolphin *Delphinus delphis* – the latter has declined dramatically due to anthropogenic impacts and it has become increasingly rare in this and other parts of the Mediterranean Sea (Bearzi *et al.*, 2003, 2004).

This study reports a total of 156 cetacean sightings recorded in the northern Adriatic Sea between 1988 and 2007. In addition, encounter rates of bottlenose dolphins were obtained through visual surveys conducted between 2001 and 2006. While a comprehensive and dedicated effort would be needed to assess cetacean abundance and gain insight into population status and trends, datasets such as the one presented here are relevant to understanding shifts in species composition and patterns of distribution. Encounter rates have relative value because results depend largely on methodology. However, they may provide preliminary insight in areas with poor quantitative information. Further, they can assist in the design of dedicated aerial or ship surveys by indicating the amount of minimum effort needed to obtain a given number of cetacean sightings (appropriate sample size being a pre-requisite of insightful analyses). The rationale behind the information presented here is therefore twofold: 1) contribute to setting environmental baselines for the understanding of changes occurring over time (e.g. decades or centuries; Sáenz-Arroyo *et al.*, 2005), as requested *inter alia* by the EC Marine Strategy Framework Directive (2008/56/EC of 17 June 2008), and 2) present information that can inform the design of surveys (e.g. Buckland *et al.*, 1993) intended to obtain absolute estimates of cetacean abundance in this part of the Adriatic.

MATERIAL AND METHODS

Cetacean sighting records were collected opportunistically between 1988 and 2007 by observers including experienced cetacean researchers, biologists carrying out other kind of research, Customs Authority officers, pleasure boaters and sailors. Observation platforms included small ships, yachts, sailing vessels and speedboats. Sighting reports were collected through forms distributed *inter alia* at various marinas and nautical clubs and via the world wide web (on the Tethys Research Institute web site). Requested information included date, time, GPS position, duration of the sighting, estimated body size of the animals, estimated group size, behaviour of the animals and their minimum dis-

tance from the boat, sea state, visibility, as well as details on the observation platform and contact information. Reliable reports by observers with extensive field experience on cetaceans as well as reports by inexperienced observers, provided that such reports were documented by videos or photos suitable for species identification, were classified as "confirmed records". Undocumented reports by inexperienced observers as well as uncertain reports were classified as "unconfirmed records".

Visual surveys of cetaceans were conducted between 2001 and 2006 within an area delimited by the Italian coast to the west, 13°29'E, 44°12'N and 45°37'N (Fig. 1). The area covered by the surveys encompasses approximately 9,500 km² of sea surface (Fig. 2). Data were obtained from the following platforms: 1) fibreglass speedboat of 7 m (eye elevation of 1.8 m); 2) oceanographic ship of 24 m (eye elevation 4.0 m); 3) oceanographic ship of 35 m (eye elevation 7.2 m); and 4) oceanographic ship of 61 m (eye elevation 12.0 m). The survey effort totalled 114 days at sea. Survey data were collected under the following conditions, qualifying "on effort": 1) daylight and long-distance visibility; 2) sea state of Douglas 1 or less; 3) swell 1 or less; and 4) survey speeds of 15–36 km h⁻¹. Binoculars were not used to look for cetaceans during navigation, but could be used to confirm species identification whenever necessary.

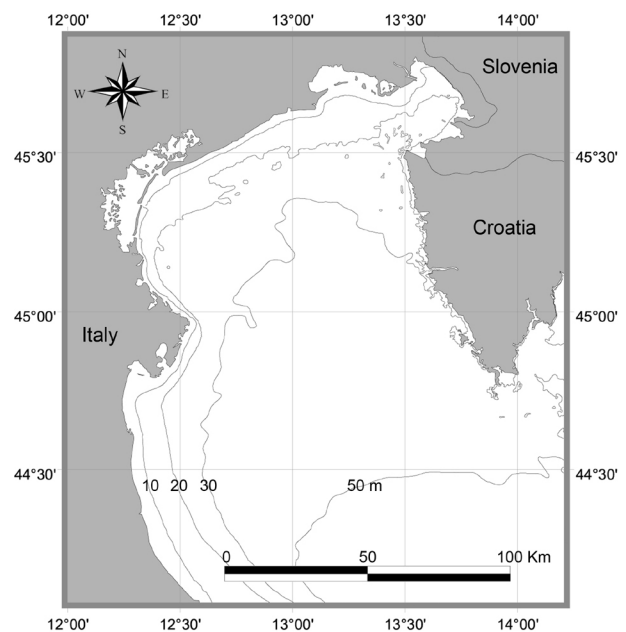


Fig. 1: Map of the upper portion of the northern Adriatic Sea, showing bathymetric contour lines.

Sl. 1: Zemljevid zgornjega dela severnega Jadranskega morja z označenimi izobatami.

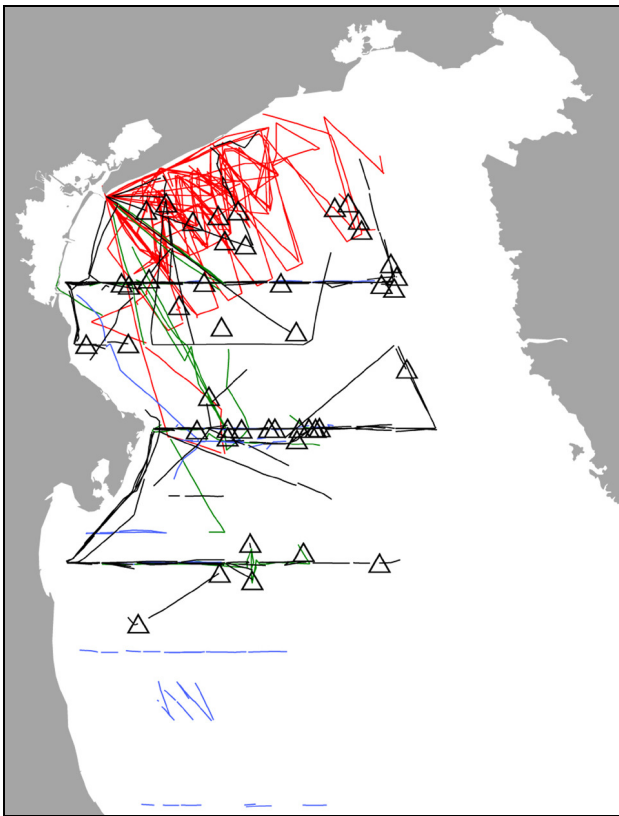


Fig. 2: Navigation "on effort" during cetacean surveys conducted between 2001 and 2006. Red line: speedboat of 7 m; green: research ship of 24 m; blue line: research ship of 61 m; black line: research ship of 35 m; triangles: position of 53 bottlenose dolphin groups sighted during navigation "on effort".

Sl. 2: Namenska plovba tekoma popisa kitov in delfinov med letoma 2001 in 2006. Rdeča črta: gliser, dolg 7 m; zelena črta: raziskovalna ladja, dolga 24 m; modra črta: raziskovalna ladja, dolga 61 m; črna črta: raziskovalna ladja, dolga 35 m; trikotniki: položaj 53 skupin velikih pliskavk, opaženih med namensko plovbo.

Observation sessions were interrupted if 1) sea state, visibility or weather conditions deteriorated; or 2) the boat stopped. Sightings made off effort during cetacean surveys were not used to compute encounter rates, but were added to the dataset of opportunistic cetacean records.

Encounter rates of dolphin groups were computed based on cells of 4' latitude by 5' longitude (7,470 by 6,590 m), containing a minimum navigation "on effort" equal or greater than a cell's diagonal (9,961 m). Encounter rates were calculated by the ratio n/L , where n is the total number of sightings in a cell and L is the total number of km spent on effort in the same cell (Bearzi *et al.*, 2008).

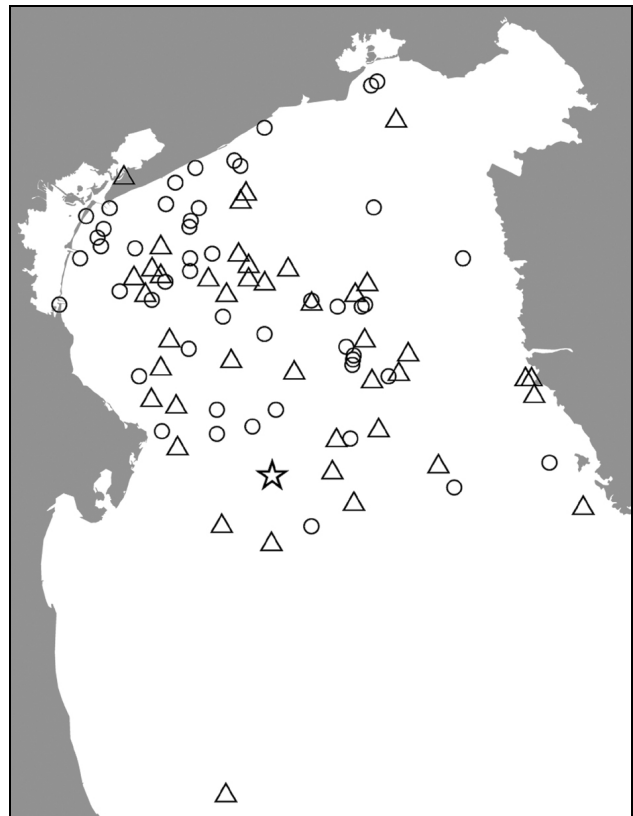


Fig. 3: Distribution of 103 sightings reported between 1988 and 2007 in the northern Adriatic Sea. Confirmed bottlenose dolphin sightings are indicated by triangles, unidentified small Delphinidae by white dots. The star shows the position of an animal reported to be a "12 m long fin whale" (unconfirmed).

Sl. 3: Distribucija 103 opažanj, zabeleženih med letoma 1988 in 2007 v severnem Jadranskem morju. Potrjena opažanja velike pliskavke so označena s trikotniki, opažanja neidentificiranih malih primerkov delfinov pa z belimi pikami. Zvezda prikazuje pozicijo živali, opisano kot "12-metrski brazdasti kit" (nepotrjeno).

RESULTS

A total of 103 cetacean sighting reports were obtained. Of these, all of the 44 confirmed records involved bottlenose dolphins. The remaining 59 unconfirmed records involved unidentified small Delphinidae that were most likely to be bottlenose dolphins, but could also include other species. There was a single observation of a large cetacean reported to be a "12 m long fin whale *Balaenoptera physalus*", sighted in 1993. The position of all the sighting reports obtained opportunistically, as well as of 33 sightings recorded off effort during cetacean surveys, is shown in figure 3. Cetacean surveys yielded an additional 53 sightings on effort, all of which were of bottlenose dolphins (Fig. 2).

Tab. 1: Survey effort, number of sightings and encounter rates of bottlenose dolphins during cetacean surveys (2001–2006).**Tab. 1: Podatki o popisu, številu opažanj in stopnji srečevanj velikih pliskavk tekom popisa kitov in delfinov (2001–2006).**

	2001	2002		2003		2004	2005	2006
	Speed-boat	Speed-boat	Research ship	Research ship	Research ship	Research ship	Research ship	Research ship
Boat length (m)	7	7	24	61	35	35	35	35
Eye elevation (m)	1.8	1.8	4.0	12.0	7.2	7.2	7.2	7.2
Survey speed (km/h)	15–36	15–36	15–18	15–24	15–24	15–24	15–24	15–24
Navigation "on effort" (km)	1591	794	548	342	290	376	536	347
Sightings total	4	7	7	12	12	10	19	15
Sightings "on effort"	3	6	5	9	6	6	9	9
Encounter rate / 100 km	0.42	0.65	0.67	1.67	0.84	1.42	1.02	0.82
SD	1.757	2.153	2.092	3.131	2.784	3.299	2.700	2.605
SE	0.311	0.393	0.427	1.107	0.839	0.778	0.697	0.824
N (cells sampled)	32	30	24	8	11	18	15	10

Navigation "on effort" during cetacean surveys totalled 4,824 km. Encounter rates of bottlenose dolphins obtained from different observation platforms are shown in Table 1. Encounter rates were not merged because of the considerable heterogeneity in vessel kind, speed, eye elevation and/or geographic distribution of the survey effort. The elevation of observers' eyes resulting from the different deck heights of survey platforms is an important factor affecting encounter rates, the probability to spot dolphins from small speedboats being generally lower than that of seeing the animals from the upper deck of oceanographic ships. While encounter rates in this study did not show significant differences according to eye elevation of observers (Kruskal-Wallis $H = 1.65$, $p = 0.65$, $df = 3$, $n = 148$), a trend was apparent and the correlation between encounter rates and eye elevation was rather strong ($R^2 = 0.9337$; Fig. 4). Encounter rates obtained with consistent methods showed some variability. For instance, encounter rates recorded between 2003 and 2006 from the same oceanographic ship (eye elevation 7.2 m) ranged between 0.82 and 1.42 groups per 100 km of navigation. However, there were no significant differences for either of the two platforms used in multiple years (35-m ship₂₀₀₃₋₂₀₀₆: Kruskal-Wallis $H = 0.431$, $p = 0.93$, $df = 3$, $n = 54$; speedboat₂₀₀₁₋₂₀₀₂: Kruskal-Wallis $H = 0.023$, $p = 0.88$, $df = 1$, $n = 62$).

DISCUSSION

This study complements existing knowledge on cetaceans in the northern Adriatic Sea. Bottlenose dolphins were the only cetacean species observed over a total of 97 confirmed sightings recorded in the study area across 20 years (1988–2007). Sighting reports and visual surveys yielded no sightings of short-beaked common dolphins, further confirming that this species is no longer a

regular component of the northern Adriatic fauna. These findings are consistent with changes occurred since 1960s, having resulted in almost exclusive presence of bottlenose dolphins (Bearzi *et al.*, 2004; Genov *et al.*, 2008). While several cetacean species have been recorded over the past decades in this part of the northern Adriatic Sea (Krystufek & Lipej, 1993; Bearzi *et al.*, 2004; Lipej *et al.*, 2004; Francese *et al.*, 2007; Genov *et al.*, 2009), none of these species were observed or confirmed during this study, apart from a single unconfirmed sighting of a fin whale.

Comparisons among encounter rates obtained in this study are not straightforward, due to heterogeneity in research platforms and methodology (Tab. 1, Fig. 4). The fact that encounter rates from small boats were generally lower than those obtained from the upper deck of large ships does not surprise, because chances of spotting dolphins at sea are expected to increase with observer's height (Buckland *et al.*, 1993).

While encounter rates of bottlenose dolphins obtained with consistent methodology did not show significant inter-annual variations, a greater effort and sample size would be needed to detect changes in distribution occurring annually or seasonally across subareas. The northern Adriatic Sea is characterised by high annual and seasonal variability of hydrological and biological variables (Franco & Michelato, 1992; Socal *et al.*, 2002; Grilli *et al.*, 2005) and its local ecosystem is especially sensitive to seasonal and long-term variations of both climate and anthropogenic nutrient loads (Degobis *et al.*, 2000; Russo *et al.*, 2002). Changes in dolphin distribution over time have been inferred to occur as a result of changes in hydrological and physiographical variables, likely to determine shifts in prey distribution (Bearzi *et al.*, 2008).

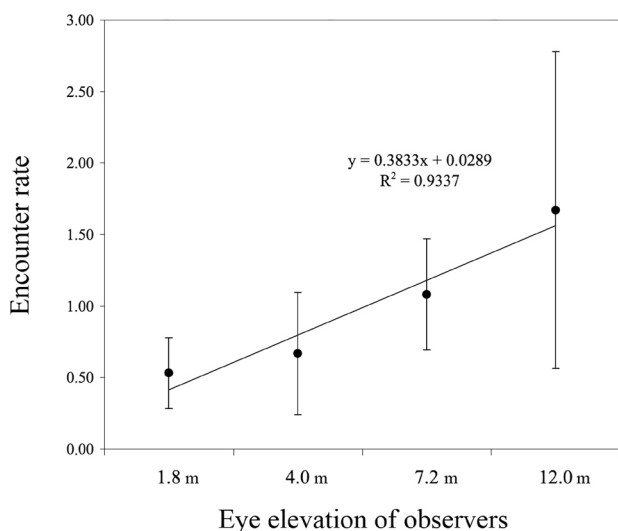


Fig. 4: Correlation between encounter rates and eye elevation of observers standing on the deck of four survey platforms used during this study. Error bars show standard errors.

Sl. 4: Korelacija med stopnjo srečevanj in višino oči opazovalcev, stojećih na štirih različnih opazovalnih ploščadih, uporabljenih v tej raziskavi. Stolpci označujejo standardne napake.

Bottlenose dolphins seemed to occur throughout the continental shelf waters covered by this study, both in-shore and offshore. However, the results of this study suggest that encounter rates of dolphins in this part of

the Adriatic may be expected to be generally low as well as variable. This information can be relevant in the future planning of dedicated aerial and ship surveys aimed to monitor cetacean abundance and trends, e.g. through distance sampling methods (Buckland *et al.*, 1993). Ships offering appropriately high observation decks should be used in order to increase encounter rates and, hence, sample size. Given that bottlenose dolphins are virtually the only species regularly found in this area, and species identification from above would not be an issue, aerial surveys may yield cost-effective information on distribution and abundance.

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PODATKI O DELFINIH IN STOPNJI SREČEVANJ S TO VRSTO V SEVERNEM JADRANSKEM MORJU MED LETOMA 1988–2007

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POVZETEK

Med letoma 1988 in 2007 smo v severnem Jadranskem morju zabeležili skupno 156 opažanj kitov in delfinov. Potrjene identifikacije ($n = 97$) so se nanašale izključno na velike pliskavke *Tursiops truncatus*. Navajamo tudi stopnjo srečevanj za to vrsto; podatki so bili pridobljeni med letoma 2001 in 2006 tekom vizualnega popisa kitov in delfinov z različnih raziskovalnih plovil med 4824 km dolgo namensko plovbo po območju velikem cca. 9,500 km². Stopnja srečevanj se je gibala med 0,42 in 1,67 skupin na 100 km plovbe, brez izrazite razlike v letih, pod pogojem

uporabe konsistentne metodologije. Ugotovljena je bila korelacija med stopnjo srečevanj in višino oči opazovalca, odvisno od različnih višin opazovalnih plosčadi. Izsledki te študije kažejo na to, da je velika pliskavka glavna vrsta kitov in delfinov, ki se tekom zadnjih 20 let redno pojavlja v severnem Jadranskem morju. Te informacije prispevajo k oblikovanju okoljskih izhodišč, lahko pa se uporabijo tudi pri oblikovanju popisov za pridobivanje absolutne ocene številčnosti kitov in delfinov v tem delu Jadranskega morja.

Ključne besede: kiti in delfini, Jadransko morje, velika pliskavka, *Tursiops truncatus*

REFERENCES

- Bearzi, G., R. R. Reeves, G. Notarbartolo di Sciara, E. Politi, A. Cañadas, A. Frantzis & B. Mussi (2003):** Ecology and conservation status of short-beaked common dolphins (*Delphinus delphis*) in the Mediterranean Sea. *Mamm. Rev.*, 33(3), 224–252.
- Bearzi, G., D. Holcer & G. Notarbartolo di Sciara (2004):** Past and present status of cetaceans in the northern Adriatic Sea with respect to historical takes and recent habitat degradation. *Aquat. Conserv.*, 14, 363–379.
- Bearzi, G., A. Azzellino, E. Politi, M. Costa & M. Bastianini (2008):** Influence of seasonal forcing on habitat use by bottlenose dolphins *Tursiops truncatus* in the northern Adriatic Sea. *Ocean Sci. J.*, 43(4), 175–182.
- Buckland, S. T., D. R. Anderson, K. P. Burnham & J. L. Laake (1993):** Distance sampling: estimating abundance of biological populations. Chapman & Hall, London, 446 p.
- Degobbis, D., R. Precali, I. Ivancic, N. Smodlaka, D. Fuks & S. Kveder (2000):** Long-term changes in the northern Adriatic ecosystem related to anthropogenic eutrophication. *Int. J. Environ. Pollut.*, 13, 495–533.
- Francese, M., M. Picciulin, M. Tempesta, F. Zuppa, E. Merson, A. Intini, A. Mazzatenta & T. Genov (2007):** The presence of striped dolphins (*Stenella coeruleoalba*) in the Gulf of Trieste. *Annales, Ser. Hist. Nat.*, 17(2), 185–190.
- Franco, P. & A. Michelato (1992):** Northern Adriatic Sea: oceanography of the basin proper and of the western coastal zone. *Sci. Total Environ., Suppl.*, 35–62.
- Genov, T., P. Kotnjek, J. Lesjak, A. Hace & C. M. Fortuna (2008):** Bottlenose dolphins (*Tursiops truncatus*) in Slovenian and adjacent waters (northern Adriatic Sea). *Annales, Ser. Hist. Nat.*, 18(2), 227–244.
- Genov, T., P. Kotniak & L. Lipej (2009):** New record of the humpback whale (*Megaptera novaeangliae*) in the Adriatic Sea. *Annales, Ser. Hist. Nat.*, 19(1), 25–30.
- Grilli, F., M. Marini, D. Degobbis, C. R. Ferrari, P. Fornasiero, A. Russo, M. Gismondi, T. Djakovac, R. Precali & R. Simonetti (2005):** Circulation and horizontal fluxes in the northern Adriatic Sea in the period June 1999–July 2002. Part II: Nutrients transport. *Sci. Total Environ.*, 353, 115–125.
- Krystufek, B. & L. Lipej (1993):** Kiti (Cetacea) v severnem Jadraniu. *Annales*, 3, 9–20.
- Lipej, L., J. Dulcic & B. Krystufek (2004):** On the occurrence of the fin whale (*Balaenoptera physalus*) in the northern Adriatic. *J. Mar. Biol. Assoc. UK*, 84, 861–862.
- Russo, A., S. Rabitti & M. Bastianini (2002):** Decadal climatic anomalies in the northern Adriatic Sea inferred from a new oceanographic data set. *Mar. Ecol., Evol. Persp.*, 23, 340–351.
- Sáenz-Arroyo, A., C. M. Roberts, J. Torre, M. Carino-Olvera & R. R. Enriquez-Andrade (2005):** Rapidly shifting environmental baselines among fishers of the Gulf of California. *Proc. R. Soc. B*, 272, 1957–1962.
- Socal, G., A. Pugnetti, L. Alberghi & F. Acri (2002):** Observations on phytoplankton productivity in relation to hydrography in the Northern Adriatic. *Chem. Ecol.*, 18, 61–73.