Guidelines for the definition of monitoring areas and the selection of relevant monitoring parameters

LIFE08 NAT/IT/000342

ACTION A8
Assessment of local biodiversity

Deliverable Date
30/06/2013

DEMETRA

LINEE GUIDA PER LA DEFINIZIONE DELLE AREE DI MONITORAGGIO E LA SELEZIONE DI RILEVANTI PARAMETRI DI MONITORAGGIO

I dati riguardanti il livello di biodiversità nelle aree di studio del progetto DEMETRA e le principali specie individuate come "sensibili" sono state tenute in considerazione per fornire una guida di monitoraggio alla Regione Toscana. Tale guida potrà essere utilizzata dalla Regione per monitorare gli ambienti sensibili nel caso siano realizzate coltivazioni OGM in Toscana. La guida di monitoraggio è in linea con le direttive della CE e le politiche sugli OGM come descritte nella direttiva EC2001/18 e nelle leggi italiane e della Regione Toscana, nonché con altre direttive in materia di conservazione e protezione ambientale e di tutela del consumatore. Inoltre, la guida di monitoraggio è compatibile con le metodologie e le raccomandazioni dell'EFSA (European Food Safety Authority) (Guidance on the post market environmental monitoring of GMOs, EFSA 2011) e con il monitoraggio ambientale sviluppato da DG SANCO e dalle autorità competenti degli Stati membri.

Tale guida si suddivide in due parti, la prima riguarda l'analisi del rischio nelle aree di studio del progetto DEMETRA allargata a tutta l'area del Parco di Migliarino San Rossore e Massaciuccoli. La seconda parte indica come dovrebbe essere condotto il monitoraggio nelle aree considerate a rischio indicando le specie da includere nel monitoraggio ed il periodo in cui questo dovrebbe essere condotto in relazione alla specie GM eventualmente coltivata.

INDEX

1 INTRODUCTION **Page 4**

2 CULTIVATED PLANTS FROM 2010 TO 2012 **Page 4**

3 RISK ASSESSMENTS OF GM CROPS **Page 5**

3.1.1 Environmental Hazards and Risks associated with GM Sunflower cultivation **Page 5**

3.1.2 Risk Management of GM Sunflower crops in or near MSRM Park **Page 9**

3.2.1 Environmental Hazards and Risks associated with GM Oilseed rape cultivation **Page 10**

3.2.2 Risk Management of GM oilseed rape crops in or near MSRM Park **Page 16**

3.3.1 Environmental Hazards and Risks associated with GM maize cultivation **Page 17**

3.3.2 Risk Management of GM maize crops in or near MSRM Park **Page 20**

3.4.1 Environmental Hazards and Risks associated with GM poplar cultivation **Page 21**

3.4.2 Risk Management of GM poplar in or near MSRM Park **Page 27**

4. OTHER CROP TYPES (not currently cultivated within the Park) **Page 27**

5. MONITORING **Page 36**

5.1 Case Specific Monitoring **Page 37**

6. REFERENCES **Page 40**

Annex 1 Lepidoptera Species which feed on *Populus* (and other plants) **Page 42**

Annex 2 Lepidoptera Species found in the MSRM Park **Page 45**

Annex 3. List of Coleoptera found in the MSRM Park **Page 55**

RISK ASSESSMENTS OF GM CROPS IN RELATION TO THE REGIONAL PARK

1 INTRODUCTION

This study assesses the likely impacts that would occur if the poplar plantations and crops grown in 2010-2012 in or close to the Regional Park of Migliarino – San Rossore – Massaciuccoli (the Park) were replaced by GM plants. In addition the introduction of other GM crops into areas close to the Park are also considered. In order to more accurately assess risks to the Park, GM event and case specific information would be needed. Specifically risk assessments of each GM crop that may be cultivated in or close to MSRM Park should consider :

- Existing event specific risk assessments conducted by applicants and risk assessors in other regions or countries
- Information on the specific environments in the Park and the levels of exposure to the GM plants and to hybridizing relatives
- Exposure levels and interactions of specific biota with the GM crops in or around the Park
- Changes in management that may accompany the introduction of each GM crop into the areas.
- Interactions between exposed biota, exposed environments, changes in management and other biota and environments in and around the Park
- The specific protections goals and conservation objectives associated with the biota and each exposed region of the Park.

In this study only general information on the types of GM plants is used and assumptions are made on gene flow, introgression, exposure and interactions with other biota and management, based on available information and experience with GM plants and traits. The likely impacts of GM plants on the Park and the associated farmland are assessed from this general information. However no event specific risk assessments are conducted because of the limited information available.

2 CULTIVATED PLANTS FROM 2010 TO 2012

The crops grown in or close to the Park are mostly grown organically. However a possible future scenario is that some or all of these crops could be genetically modified to express traits which have been utilized in other areas or are currently being developed. Even if no GM crops are intentionally cultivated in the Park, it is likely that cultivation in Italy will result in low level presence of GM material in seeds sown in the Park since admixtures are unavoidable, even in certified seed. In addition GM crops may be grown on land adjacent to but outside the Park area. The potential environmental impacts on poplar plantations established before this time and crops of maize, sunflower and oilseed rape grown during the project are particularly considered. The crops are summarized in the following table:

Locality	Crops in 2010	Crops in 2011	Crops in 2012
1. Massaciuccoli Lake	Private poplar plantation	Private poplar plantation	Private poplar plantation
2. Ontanelli, plot S21	Poplar plantation in MSRM	Poplar plantation in MSRM	Poplar plantation in MSRM
3. Fortino Nuovo	Poplar plantation in MSRM	Poplar plantation in MSRM	Poplar plantation in MSRM
4. Culatta, plot A6	Maize; Sunflower; oilseed rape (autumn sown)	Maize; Sunflower; Oil seed-rape	Maize; Sunflower;
5. Culatta, plot A9	NONE	Maize	NONE
6. Migliarino (close to A11)	Oil seed-rape (cropped by the private Marchese Mazzorosa)		

3 RISK ASSESSMENTS OF GM CROPS

3.1.1 Environmental Hazards and Risks associated with GM Sunflower cultivation

GM sunflower is being cultivated and developed in several areas of the world particularly in N America. Sunflower is an important crop in Central and South Europe as it tolerates hot dry summers and provides seeds with high oil content and nutritional value. Several GM traits are being considered to improve the productivity and quality of sunflowers. Risk assessments of GM sunflowers cultivated in or near MSRM Park need to consider the following factors as well as the general risk assessment issues listed above:

- GM Traits (hazards): Herbicide tolerance (HT), Bt insect resistance (Bt) , Fungal Resistance (FR) , oil quality (OQ)
- Gene flow: hazards associated with cross pollination, introgression into other Asteraceae species, pollen and seed dispersal
- Fitness: ie where changes in plant phenotype may allow the plant to be more dominant, invasive or persistent in different habitats
- Impacts on target and non-target organisms
- Impacts of the specific management of the GM crop

The receiving environments considered are: 1. uncultivated areas of the Park. 2. Cultivated areas.

Table 3.1.1 Asteraceae species in Culatta fallowlands with synchronous flowering to sunflower.

Species	May	June	July	August	Hybridisation with Helianthus spp
Helianthus annuus (sunflower, girasol)			☼	☼ ●	Yes
Matricaria chamomilla L.	☼	☼	●		No reports
Sonchus asper (L.) Hill	☼	☼	●		No reports
Leucanthemum vulgare Lam	☼	☼	☼ ●		No reports
Helminthotheca echioides (L.) Holub		☼	☼	☼ ●	No reports
Picris hieracioides L.		☼	☼	☼ ●	No reports
Cirsium arvense (L.) Scop.			☼	☼ ●	No reports
Glebionis segetum (L.) Fourr.			☼	☼	No reports
Cichorium inthybus L.			☼	☼ ●	Protoplast fusion only
Eupatorium cannabilum L.			☼	☼	No reports
Dittrichia viscosa (L.) Greuter				☼	No reports

☼ = full flowering ● = ripe fruits

Gene Flow : Sunflowers have cross compatability with other Helianthus species and a very few other members of the Asteraceae occurring in and near their centres of origin in N and S America. It is considered very unlikely that outcrossing to the species listed in Table 3.1.1 would produce viable or fertile interspecific hybrids. Therefore it is not anticipated that there will be any risk associated with gene flow to wild species.

Sunflowers have intraspecific hybridization and thus they will outcross with other sunflower crops. In addition sunflower seeds can be dispersed, can persist over winter and germinate in disturbed land. Thus feral GM sunflower may be dispersed over a wider area.

Pollen dispersal in sunflowers is mostly associated with insect activity. However wind dispersal also occurs with pollen concentrations declining rapidly up to approx. 10m and then depositing at a low and fairly constant level for the next 10 meters with most pollen deposited after 20 m. (See Ch 2.1 in DEMETRA book).

Fitness*:* Most sunflower varieties are hybrids so that harvested seed is an F2 segregating population. Occasional F2+ feral plants can occur but cultivated sunflower types tend to have low ferality and rarely establish populations outside of cultivated land. Isolated plants tend to be heavily predated by birds so that little seed survives to allow regeneration. Bt genes have been shown to increase fitness of wild Helianthus spp (Snow et al 200x), but there is no indication of increased ferality in cultivated types as their selected characteristics limit their fitness outside of cultivation, and not particular pest species. Similarly there is no indication that fungal disease resistance alone will increase the ferality of sunflower varieties. However stacks of Bt and fungal resistance genes may have some fitness effects and so there is uncertainty regarding the ferality of segregating populations from GM sunflowers with multiple stacked traits which confer biotic stress tolerance to a range of pests and pathogens.

HT traits will only increase fitness of the GM plants in the presence of the herbicide, which will not be used in uncultivated land or on the agricultural land in the Park (due to organic farming policy). Thus adventitious presence of HT sunflower plants will not have environmental or agricultural impacts in the Park. However impacts may arise in conventionally farmed land where glyphosate tolerant sunflower volunteers will be resistant to glyphosate treatments which are commonly used to eliminate volunteers arising in seed beds and post harvest.

***NTO impacts* :** Sunflowers are exposed to a wide range of organisms which gain nutrients from the plants. The biota confined to fields exposed to the crop will include soil and above ground micro-organisms, microfauna etc. Some of these form close associations with the crop and therefore may be affected by novel genes expressing biocidal or antagonistic products. Thus impacts could occur to microbial associations with the plant and soil nutrient cycling. These are likely to be confined to fields cultivating the GM crop and thus not impact the Park except in farmed land areas of the Park cultivating the GM crop.

A range of biota associated with sunflower crops are mobile and thus may be moving between the GM crop and the Park. These include everything from plant pathogens (virus, bacteria, fungi) through arthropods, invertebrates and vertebrates.

Fungal resistance : Fungal resistance (FR) in GM sunflower would initially reduce populations of specific fungal pathogens. However if the pathogens have the ability to evolve new virulences which overcome the resistance, then the cultivation of FR sunflowers could permit the development of new fungal pathotypes which could present a new hazard to related wild host plants in the Park.

Insect resistance: the use of Cry 1 and 3 genes in sunflower to control lepidopteran and coleopteran pests would remove sunflower as a food plant for certain species and hence reduce some of these species in the food chain. This could have impacts on food supplies for insectivorous predators living in the margins of the Park. Sunflowers could also be a significant alternative food source for some species of lepidoptera and Coleoptera of conservation interest in the Park, particularly for pollen and nectar feeders. There are several species of pollen and nectar feeding lepidoptera and coleoptera that will travel from the Park into the cultivated areas attracted by the large mass of flowers in a sunflower field. This will particularly occur in July when there will be less sources of nectar and pollen than in earlier summer months. Nectar generally contains little or no Cry toxin but it will contain pollen grains which can contain the toxin. Thus both sensitive Lepidoptera and Coleoptera feeding on nectar and pollen will be exposed to the toxin and thus potentially at risk.
The species at risk will include species with adults flying in July, which are attracted to sunflowers and feed on them. The coleoptera will include pollen beetles (*Melegithes* spp) as well as predatory beetles which also supplement their diets with nectar and pollen such as certain coccinelid species etc. The Coleoptera recorded in the Park are listed in Annex 3. Some of these would be exposed to GM sunflower either directly by feeding on plant parts or indirectly through predation on pests of sunflower.
Lepidoptera will include a range of nectar feeding butterflies, such as clouded yellow and some small blue and brown butterflies, and a variety of moths that are flying and feeding in July. The Lepidoptera species recorded in the Park are listed in Annex 2.

Wind mediated pollen dispersal from Sunflower will result in pollen deposition in and around crops of sunflower. Pollen can be deposited on leaves of both sunflower and weeds and wild plants growing within crops and immediately adjacent to them. Insects feeding on these leaves can ingest this pollen. Similarly predators of these insects will be exposed to the pollen ingested by their prey. Some GM sunflowers express cry toxins in their pollen and so phytophagous insects sensitive to the cry toxins can be affected as well as sensitive predators of exposed phytophagous species. The highest levels of exposure will be close to the crops and decline progressively away from the crops (see Perry et al. 2012). However host plants of some sensitive lepidopteran or coleopteran species in field margins and areas of the Park adjacent to fields of may receive sufficient loads of pollen to cause harm to larvae feeding on them. Species particularly at risk will be those with larvae feeding on host plants adjacent to sunflower crops in July during and immediately after pollen release. Similarly coleopteran predators at risk will be those active during July feeding on insects in and close to sunflower crops expressing Cry 3in their pollen. Lepidoptera and Coleoptera species recorded in the Park are listed in Annexes 2 & 3.

HT sunflower: the cultivation of HT crops will involve changing herbicide programmes so that weed control is mainly conducted with the herbicide to which the crop is tolerant (eg. glyphosate or glufosinate) and not with pre-emergent or selective herbicides. The consequence of this can be a change in the weed populations and botanical diversity within fields, including field margins, cultivating these crops (Sweet and Bartsch, 2011) . Changes in botanical diversity will also affect other species through food chain effects so that arthropod diversity is also likely to be affected. The main factors influencing the impacts on botanical diversity and hence biodiversity in fields containing HT crops are : 1. The herbicide programmes used (including dose, application time and number), 2. The crop rotation of the field, 3. The tillage systems used (eg inversion ploughing, minimum tillage), 4. Mitigation and environmental measures taken.

At present all crops grown in the Park are organically grown (ie without herbicides) and thus HT systems would not be adopted. However, assuming that HT crops were grown in or adjacent to the Park, the impacts could be as follows: 1. A reduction in biodiversity within the crops. 2. Reduction in biodiversity in field margins and adjacent areas receiving herbicide spray drift. 3. Increased pest infestations in the crop as normal bio-control by predators in the crop may be reduced. 4. Development of new resistant weed types. It is likely that only spray drift (2.) would have a measurable impact on certain margin areas of the Park, where plant species that are sensitive to the particular broad spectrum herbicides could have populations reduced by the herbicide and also the herbicide might selectively allow weeds with tolerance to flourish and replace less competitive and sensitive species.

Table 3.1.2: Hazards and potential impacts that may be associated with GM sunflower cultivation in or adjacent to MSRM*

Trait	NTOs impacted	TOs	Impact on Park	Impacts on Agric areas		Potential Harm
				Organic/Bio	GM	
Bt (Cry 1….)	Lepidoptera	Pest lepids	Low/medium	low	Low/medium	NTO lepids
Bt (Cry 3….)	Coleoptera	pest coleos	Low/medium	low	Low/medium	NTO Coleos
HT (incl. management)	margin diversity	weeds	low	v.low	Low/medium	Off crop diversity
	Crop biodiversity	weeds	v.low	v.low	Low/medium	Crop biodiversity
FR	micro-orgs	Pathogens	?	?	?	New Pathotypes
Oil quality	0	0	0	0 (coex)	0 (coex)	0
Stacks HT,Bt,FR	Combinations of above		Medium	low	Medium	NTOs, biodiversity

* event and case specific information, including exposure and receiving environments, is needed in order to determine risks

Predictions of the hazards and potential impacts presented by GM sunflowers to the MSRM Park are summarized in Table 3.1.2. However this is a very general approach and in all cases more detailed study and analysis would be needed to accurately assess sensitivities of particular biota and their environmental niches and to determine impacts on populations in different ecosystems within the Park.

The main hazards are predicted from the Bt types because it is known and/or assumed that several sensitive species occur within the Park, they will be exposed to the cry toxins either within their habitats from pollen deposition or when visiting the crops and that some species may already be scarce, at risk, red listed or under other environmental pressures that could result in severe population declines and local extinction.

Stacking of Bt traits is likely to increase the range of NTO species that will be affected by the presence of a GM crop.

Risks associated with fungal resistance to pathogens such as Sclerotinia, Botrytis, Furarium, Peronospora (Plasmopara) etc are more difficult to predict as it is not known how the resistance will affect the diversity of pathotypes within a region and also what effects there will be on micro-flora populations, their associations with plants and their functions. The assumption is that crop resistance would have little influence on micro-organism communities within the Park. However if these crops encourage new pathotypes or virulences to arise that infect other Asteraceae and restrict their regeneration, then this assumption could be incorrect.

HT sunflower impacts are associated with their herbicide management and thus are confined to areas affected by the herbicide applications. However these can include field margins, hedges, ditches, water courses and areas bordering the Park and can result in changes (generally losses) in botanical diversity and hence of diversity of other species.

GM Quality traits in sunflower are unlikely to have additional environmental impacts unless they are associated with changes in management, pesticide inputs etc. Therefore these are generally considered not to present an environmental hazard, but must be risk assessed case-by-case. Cultivation of all GM crops will need to respect co-existence requirements for separation and isolation of non-GM crops to prevent admixtures with GM. These may require barrier crops or other measures to be put in place which may have some additional environmental impacts .

Hazard and Risk Conclusions

If GM sunflower is likely to be cultivated the hazards identified above should be quantified where possible in relation to their consequences for the at-risk species or disrupted environments. In addition uncertainties should be fully documented and scenarios developed in order to show the range of likely consequences that could arise from the release or cultivation of the GM crop in the area. Assessments of the severity and consequences of the risk can then be used to determine the management measures required to reduce the risk to acceptable levels or to remove the risk.

3.1.2 Risk Management of GM Sunflower crops in or near MSRM Park .

Risks to the biota in the Park can be reduced in 2 main ways: 1. By removing or reducing the hazard; 2. by reducing exposure.

Hazard Management : This could include a ban on the cultivation of any GM crop in the Park so that no new hazard is introduced. However this would still mean that conventional crops had adverse environmental impacts, some of which could be reduced by growing GM crops such as growing Bt crops instead of spraying with insecticides and growing disease resistant crops instead of applying fungicides etc..

Exposure management: The risks associated with Bt and HT sunflowers could be largely reduced by reducing exposure of non-target organisms and off crop areas. This can be achieved by having physical separation of the crop and its treatments from the field margins and Park. In relation to dispersal and deposition of Bt pollen, separation of the crop from the field margin by at least 20+ meters would reduce pollen deposition to low levels. In the case of Bt maize 40-50 metres separation is recommended (by EFSA) as a precautionary measure against strong winds causing significant deposition of pollen in conservation areas and allowing for the extreme sensitivity of some (untested/unidentified) species. This distance of 50m would also be appropriate for sunflower cultivation.
Similarly spray drift of broad spectrum herbicides into field margins and adjacent land can be significantly reduced by leaving unsprayed field margins of 12 -15m around fields and in many countries conservation headlands of 15 -20 m are common in ESAs.

Exposure to GM crops can also be managed by following good farming practices which encourage rotational cropping so that the frequency of GM crops is reduced, and treatments are applied less frequently. This reduces environmental exposure to the GM crops and delays the development of novel or resistant pest, weed and disease types. In addition the diversity of crops encourages diversity of other biota and therefore enhances the interaction between the Park and the farmed land.

3.2.1 Environmental Hazards and Risks associated with GM Oilseed rape cultivation

GM rapeseed or oilseed rape is being cultivated as GM canola (generally as types not requiring vernalisation) in several areas of the world particularly in N and S America and Australia. Oilseed rape is an important crop in Central and Northern Europe as it can be autumn sown to avoid hot dry summers or short summer seasons and spring sown. It provides seeds with high oil content and nutritional value. Several GM traits are being developed to improve the productivity and quality of oilseed rape (OSR). Risk assessments of GM OSR cultivated in or near MSRM need to consider the following factors as well as the general risk assessment issues listed above:

- GM Traits (hazards): Herbicide tolerance (HT), Bt insect resistance (Bt) , Fungal Resistance (FR) , oil quality (OQ), male sterility and fertility restorer.
- Gene flow: hazards associated with cross pollination, introgression into other Brassiceae and Cruciferae species, pollen and seed dispersal
- Fitness: ie where changes in plant phenotype may allow the plant to be more dominant, invasive or persistent in different habitats
- Impacts on target and non-target organisms

- Impacts of the specific management of the GM crop

The receiving environments considered are: 1. uncultivated areas of the Park. 2 Cultivated areas.

Table 3.2.1 Phenology of Brassicaceae in the study areas "Culatta" and other areas of the Park (F= fallow lands; MW = mixed wood).

Species	Environment	March	April	May	Compatability with OSR	Traits	Hazard to Park
Brassica napus (winter oilseed rape)	Farmed land	☼	☼	☼ ●	outcrossing	HT, Bt, MS, OQ.	v.low
Sinapis arvensis L.	F	☼	☼	☼ ●	v.low (Warwick et al 2003)		Low
Cardamine hirsuta L.	F/MW	☼	●	○	? no reports		0
Capsella bursa-pastoris (L.) Medicus	F	☼	●	○	v.low		v.low
Cardamine pratensis L.	MW		☼	●	? no reports		0
Alliaria petiolata (Bieb.) Cavara et Grande	MW			☼	? no reports		0
Moricandia arvensis	Park		☼	☼	v.Low (embryo capture. Takata, 1990)		v.low
Raphanus raphanistrum	Park	☼	☼	☼	Low: hybrids have low fertility and fitness		Low

☼ = full flowering ● = ripe fruits ○ = seed dispersion

Gene Flow **:** OSR has intraspecific hybridization as well as self fertility and thus will outcross with other OSR and flowering Brassica crops. OSR is an interspecific cross of *B. rapa* and *B.oleracea* and has cross compatability with other Brassicaceae and low levels of compatability with a few other members of the Cruciferae (Eastham and Sweet, 2004). These include Capsella, Raphanus and Sinapis. OSR crops are frequently infested with these weed species and yet there are few reports of naturally occurring intergeneric hybrids or backcrosses (BCs). However there is some evidence that genes from *B. rapa, B.oleracea* and *B.napus* occur in Sinapis and Raphanus spp. Also some intergeneric hybrid seed has been produced by Sinapis following cross pollination crossing (see Chapter 2.2 in DEMETRA book) and synthetic hybrids and BCs have been generated by plant breeders transferring genes from Capsella, Raphanus and Sinapis into OSR for disease resistance. In many cases the hybrids were partially sterile or had low fertility and fertility of BC generations was often low. Intergeneric hybrids contained features of both parents but often lacked vigour and competitiveness. It is considered very unlikely that outcrossing to Capsella, Raphanus and Sinapis species would produce fertile interspecific hybrids. However if they did occur and backcross to the wild species then gene introgression could occur. Therefore it is anticipated that, while there is a potential hazard of gene introgression into these species, the likelihood of this occurring is very low and will depend on the ability of intergeneric hybrids to survive, produce fertile gametes and back cross. Fitness and survival of the hybrids and backcrosses will be dependent on the GM traits and the environment in which they are growing. Subsequent gene flow from an introgressed population will also be dependent on the fitness of these populations compared with the wild types. It is considered unlikely that Bt and FR genes would provide sufficient fitness advantage to allow extensive introgression of genes into Capsella, Raphanus or Sinapis populations. They are annual pioneer species establishing rapidly in disturbed land producing large numbers of seeds with long term survival characteristics. They have high glucosinolate and erucic acid content which enhances their survival. However some studies have shown that enhanced insect and fungal resistance in Brassicaceae can increase plant vigour (Hails et al 2006) and may also increase fecundity. However these fitness changes are very dependent on a range of biotic and abiotic environmental factors. Any intergeneric hybrids and BCs with Capsella, Raphanus and Sinapis would remain as annual weeds and hence their impact would be confined to disturbed and cultivated land where they would establish annual transient populations and persist in seed banks. It is therefore very unlikely that these plants would have any impact on natural or semi-natural areas of the Park and would be confined to the farmed land. Within the farmed land they would be annual weeds which would be managed along with the other weeds in these areas.

In addition OSR seeds can be dispersed, can persist in soil for many years and germinate in disturbed land. Thus feral GM OSR may be dispersed over a wider area.

Pollen dispersal in OSR is mostly associated with insect activity. However wind dispersal also occurs with pollen concentrations declining rapidly up to approx. 10-15 and then depositing at a low and fairly constant level over long distances. (Walklate et al, 2006, Simpson et al 2006, Eastham and Sweet 2004, See Ch. 2.2 in DEMETRA book) .

Fitness*:* Most OSR varieties are inbred lines but some are hybrids so that harvested seed is an F2 segregating population. Feral plants frequently occur where seed is deposited on disturbed or marginal land and establish populations outside of cultivated land. Most populations are transient and disappear after one or two years but can reappear following soil disturbance of seed in the seed bank. Transgenes have not been shown to increase fitness of feral plants (Crawley et al, 2001), as their selected characteristics limit their fitness outside of cultivation, and they are particularly vulnerable to plant competition from perennial species. However stacks of Bt and fungal resistance genes may have some fitness effects and so there is uncertainty regarding the ferality of GM oilseed rape with multiple stacked traits which confer biotic stress tolerance to a range of pests and pathogens.

HT traits will only increase fitness of the GM plants in the presence of the herbicide, which will not be used in uncultivated land or on the agricultural land in the Park (due to organic farming policy). Thus adventitious presence of HT OSR or intergeneric hybrids and BCs with Sinapis and Raphanus will not have environmental or agricultural impacts in the Park. However impacts may arise in conventionally farmed land where glyphosate tolerant OSR volunteers and Sinapis and Raphanus hybrids/BCs will be resistant to glyphosate treatments which are commonly used to eliminate volunteers and weeds arising in seed beds and post harvest.

NTO impacts : OSR is exposed to a wide range of organisms which gain nutrients from the plants. The biota confined to fields exposed to the crop will include soil and above ground micro-organisms, microfauna etc. Some of these form close associations with the crop and therefore may be affected by novel genes expressing biocidal or antagonistic products. Thus impacts could occur to microbial associations with the plant and soil nutrient cycling. These are likely to be confined to fields cultivating the GM crop and thus not impact the Park except in farmed land areas of the Park cultivating the GM crop.
A range of biota associated with sunflower crops are mobile and thus may be moving between the GM crop and the Park. These include everything from plant pathogens (virus, bacteria, fungi) through arthropods, invertebrates and vertebrates.

Fungal resistance : Fungal resistance (FR) in GM OSR would initially reduce populations of specific fungal pathogens. However if the pathogens have the ability to evolve new virulences which overcome the resistance, then the cultivation of FR sunflowers could permit the development of new fungal pathotypes which could present a new hazard to related wild host plants in the Park. However related Crucifers are mainly confined to the agricultural areas and so impacts on the Park will be minimal.

Insect resistance: the use of Cry 1 and 3 genes in OSR to control lepidopteran and coleopteran pests would remove OSR as a food plant for certain species and hence reduce some of these species in the food chain. This could have impacts on food supplies for insectivorous predators living in the margins of the Park. OSR could also be a significant alternative food source for some species of lepidoptera and Coleoptera of conservation interest in the Park, particularly for pollen and nectar feeders. There are several species of pollen and nectar feeding lepidoptera and coleoptera that will travel from the Park into the cultivated areas attracted by the large mass of flowers in a crop in March and April. Nectar generally contains little or no Cry toxin but it will contain pollen grains which can contain the toxin. Thus both sensitive Lepidoptera and Coleoptera feeding on nectar and pollen will be exposed to the toxin and thus potentially at risk.
The species at risk will include species with adults flying in March and April, which are attracted to the flowers and feed on them. The coleoptera will include pollen beetles (*Melegithes* spp) as well as some predatory beetles which also supplement their diets with nectar and pollen such as certain coccinelid species etc. The Coleoptera recorded in the Park are listed in Annex 3. Some of these would be exposed to GM OSR either directly by feeding on plant parts or indirectly through predation on pests of OSR.
Lepidoptera will include a range of nectar feeding butterflies, such as Pieris spp, clouded yellow and some small blue and brown butterflies, and a variety of moths that are flying and feeding in July. The Lepidoptera species recorded in the Park are listed in Annex 2.

Wind mediated pollen dispersal from OSR will result in pollen deposition in and around crops. Pollen can be deposited on leaves of both OSR and weeds and wild plants growing within crops and immediately adjacent to them. Insects feeding on these leaves can ingest this pollen. Similarly predators of these insects will be exposed to the pollen ingested by their prey. Some GM OSR express cry toxins in their pollen and so phytophagous insects sensitive to the cry toxins can be affected as well as sensitive predators of exposed phytophagous species. The highest levels of exposure will be close to the crops and decline progressively away from the crops (see Perry et al. 2012). However host plants of some sensitive lepidopteran or coleopteran species in field margins and areas of the Park adjacent to fields of may receive sufficient loads of pollen to cause harm to larvae feeding on them. Species particularly at risk will be those with larvae feeding on host plants adjacent to OSR crops in March and April during and immediately after pollen release. Similarly coleopteran predators at risk will be those active during March/April feeding on insects in OSR crops expressing Cry 3 in their pollen. The Lepidoptera and Coleoptera recorded in the Park are listed in Annexes 2 & 3.

HT OSR: the cultivation of HT crops will involve changing herbicide programmes so that weed control is mainly conducted with the herbicide to which the crop is tolerant (eg. glyphosate or glufosinate) and not with pre-emergent or selective herbicides. The consequence of this can be a change in the weed populations and botanical diversity within fields, including field margins, cultivating these crops (Sweet and Bartsch, 2011) . Changes in botanical diversity will also affect other species through food chain effects so that arthropod diversity is also likely to be affected. The main factors influencing the impacts on botanical diversity and hence biodiversity in fields containing HT crops are : 1. The herbicide programmes used (including dose, application time and number), 2. The crop rotation of the field, 3. The tillage systems used (eg inversion ploughing, minimum tillage), 4. Mitigation and environmental measures taken.

At present most crops grown in the Park are organically grown (ie without herbicides) and thus HT systems would not be adopted. However, assuming that HT crops were grown in or adjacent to the Park, the impacts could be as follows: 1. A reduction in biodiversity within the crops. 2. Reduction in biodiversity in field margins and adjacent areas receiving herbicide spray drift. 3. Increased pest infestations in the crop as normal bio-control by predators in the crop may be reduced. 4. Development of new resistant weed types. It is likely that only spray drift (2.) would have a measurable impact on certain margin areas of the Park, where plant species that are sensitive to the particular broad spectrum herbicides could have populations reduced by the herbicide and also the herbicide might selectively allow weeds with tolerance to flourish and replace less competitive and sensitive species.

Predictions of the hazards and potential impacts presented by GM OSR to the MSRM Park are summarized in Table 3.2.2. However this is a very general approach and in all cases more detailed study and analysis would be needed to accurately assess sensitivities of particular biota and their environmental niches and to determine impacts on populations in different ecosystems within the Park.

The main hazards are predicted from the Bt types because it is known and/or assumed that several sensitive species occur within the Park, they will be exposed to the cry toxins either within their habitats from pollen deposition or when visiting the crops, and that some species may already be scarce, at risk, red listed or under other environmental pressures that could result in severe population declines and local extinction.

Stacking of Bt traits is likely to increase the range of NTO species that will be affected by the presence of a GM crop.

Risks associated with fungal resistance to pathogens such as Alternaria, Phoma, Sclerotinia, Botrytis, etc are more difficult to predict as it is not known how the resistance will affect the diversity of pathotypes within a region and also what effects there will be on micro-flora populations, their associations with plants and their functions. The assumption is that crop resistance would have little influence on micro-organism communities within the Park. However if these crops encourage new pathotypes or virulences to arise that infect other Cruciferae and restrict their regeneration, then this assumption could be incorrect.

HT OSR impacts are associated with their herbicide management and thus are confined to areas affected by the herbicide applications. However these can include field margins, hedges, ditches, water courses and areas bordering the Park and can result in changes (generally losses) in botanical diversity and hence of diversity of other species.

GM Quality traits in oilseed rape are unlikely to have additional environmental impacts unless they are associated with changes in management, pesticide inputs etc. Therefore these are generally considered not to present an environmental hazard, but must be risk assessed case-by-case. Cultivation of all GM crops will need to respect co-existence requirements for separation and isolation of non-GM crops to prevent admixtures with GM. These may require barrier crops or other measures to be put in place which may have some additional environmental impacts.

Table 3.2.2 : Hazards and potential impacts that may be associated with GM oilseed rape cultivation in or adjacent to MSRM*

Trait	NTOs impacted	Target Organisms	Impact on Park	Impacts on Agricultural areas		Potential Primary Harm
				Organic/ Bio	GM	
Bt (Cry 1….)	Lepidoptera	Pest Lepids	Low/ medium	low	low	NTO Lepids
Bt (Cry 3….)	Coleoptera	Pest coleops	low	low	low	NTO Coleos
HT (incl.management)	margin plants	weeds	v.low	v.low	Low/ medium	Off crop Biodiversity
HT	NTOs in Crop	weeds	v.low	v.low	Low/ medium	In crop Biodiversity
HT	Gene flow to Sinapis, Raphanus.	weeds	0	v.low	medium	HT Sinapis, Raphanus weeds
FR	micro-orgs	Pathogens	?	?	?	New Pathotypes ?
Oil quality	0		0	0 (coex)	0 (coex)	0
Stacks HT,Bt,FR	Combinations of above		Low/ Medium	low	Medium	NTOs & Biodiversity

* event and case specific information, including exposure and receiving environments, is needed in order to determine risks.

Hazard and Risk Conclusions

If GM OSR is likely to be cultivated the hazards identified above should be quantified where possible in relation to their consequences for the at-risk species or disrupted environments. In addition uncertainties should be fully documented and scenarios developed in order to show the range of likely consequences that could arise from the release or cultivation of the GM crop in the area. Assessments of the severity and consequences of the risk can then be used to determine the management measures required to reduce the risk to acceptable levels or to remove the risk.

3.2.2 Risk Management of GM oilseed rape crops in or near MSRM Park .

Risks to the biota in the Park can be reduced in 2 main ways : 1. By removing or reducing the hazard 2. by reducing exposure.

Hazard Management : This could include a ban on the cultivation of any GM crop in the Park so that no new hazard is introduced. However this would still mean that conventional crops had adverse environmental impacts, some of which could be reduced by growing GM crops such as growing Bt crops instead of spraying with insecticides and growing disease resistant crops instead of applying fungicides etc..

Exposure management: The risks associated with Bt and HT OSR could be largely reduced by reducing exposure of non-target organisms and off crop areas. This can be achieved by having physical separation of the crop and its treatments from the field margins and Park. In relation to dispersal and deposition of Bt pollen, separation of the crop from the field margin by at least 20+ meters would reduce pollen deposition to low levels. In the case of Bt maize 40-50 metres separation is recommended (by EFSA, Perry et al 2011) as a precautionary measure against strong winds causing significant deposition of pollen in conservation areas and allowing for the extreme sensitivity of some (untested/unidentified) species. This distance of 50m would also be appropriate for OSR cultivation.

Similarly spray drift of broad spectrum herbicides into field margins and adjacent land can be significantly reduced by leaving unsprayed field margins of 12 -15m around fields and in many countries conservation headlands of 15 -20 m are common in ESAs.

OSR, Raphanus and Sinapis seeds are very persistent in soil so that plants can emerge for several years following cultivation. Good management of weeds and volunteers is important for reducing the spread of GM plants on farms and into neighbouring fields. Exposure to these GM crops and plants can also be managed by following good farming practices which encourage rotational cropping so that the frequency of GM crops is reduced, and treatments are applied less frequently and are more varied. This reduces environmental exposure to the GM crops and delays the development of novel or resistant pest, weed and disease types. In addition the diversity of crops encourages diversity of other biota and therefore enhances the interaction between the Park and the farmed land.

3.3.1 Environmental Hazards and Risks associated with GM maize cultivation

GM maize (corn) is being cultivated in Europe and in several areas of the world particularly in N and S America and South Africa. Maize is an important crop in Europe as it can be grown for grain and for forage. It provides seeds with both oil and starch which are used for both human and animal feeds. Several GM traits are being cultivated and developed to improve the productivity and quality of maize . Risk assessments of GM maize cultivated in or near MSRM need to consider the following factors as well as the general risk assessment issues listed above:

- GM Traits (hazards): Herbicide tolerance (HT), Bt insect resistance (Bt), drought tolerance , seed quality (SQ).
- Gene flow: hazards associated with pollen and seed dispersal
- Fitness: ie where changes in plant phenotype may allow the plant to be more dominant, invasive or persistent in different habitats
- Impacts on target and non-target organisms
- Impacts of the specific management of the GM crop

The receiving environments considered are : 1. uncultivated areas of the Park. 2 Cultivated areas.

Gene Flow **:** Maize originates from Central America and has no wild relatives in Europe and thus gene flow to wild relatives is not an issue. Maize has intraspecific hybridization as well as self fertility and thus will outcross with other maize crops. Maize seeds are held in cobs until harvest and tend not to be widely dispersed due to their size.

Maize has separate male and female flowers and pollen dispersal is mostly associated with wind though some pollinating insect visit male flowers to collect pollen but do not visit female flowers. Pollen grains are relatively large so that pollen concentrations decline rapidly with distance with most pollen deposited within 10m.

Fitness: Most maize varieties are hybrids so that harvested seed is an F2 segregating population. Feral plants rarely occur outside of cultivated land but volunteers can emerge from overwintering seeds in warmer parts of Europe. Transgenes have not been shown to increase fitness of feral plants as their selected characteristics limit their fitness outside of cultivation, and they are particularly vulnerable to plant competition during early growth.

HT traits will only increase fitness of the GM plants in the presence of the herbicide, which will not be used in uncultivated land or on the agricultural land in the Park (due to organic farming policy). Thus adventitious presence of HT maize plants will not have environmental or agricultural impacts in the Park. However impacts may arise in conventionally farmed land where glyphosate tolerant maize volunteers will be resistant to glyphosate treatments which are used to eliminate volunteers arising in seed beds and post harvest.

Drought Tolerance *:* drought tolerant (DT) GM maize responds to water stress by senescing (abscising) leaves prematurely while retaining the cob and its grain, thus protecting the grain yield. This adaptation will improve survival of maize when moisture stressed, but is not likely to increase the ferality of maize. Thus it is unlikely that current DT maize types will have any adverse impacts on the Park or the farmed land. However other new drought tolerance genes may have some fitness effects and so there is uncertainty regarding the ferality of GM maize with other new traits which confer abiotic stress tolerance such as drought.

NTO impacts : maize is exposed to a range of organisms which gain nutrients from the plants. The biota confined to fields exposed to the crop will include soil and above ground micro-organisms, microfauna etc. Some of these form close associations with the crop and therefore may be affected by novel genes expressing biocidal or antagonistic products. Thus impacts could occur to microbial associations with the plant and soil nutrient cycling. These are likely to be confined to fields cultivating the GM crop and thus not impact the Park except in farmed land areas of the Park cultivating the GM crop.

A range of biota associated with maize crops are mobile and thus may be moving between the GM crop and the Park. These include everything from plant pathogens (virus, bacteria, fungi) through arthropods, invertebrates and vertebrates.

Insect resistance: the use of Cry 1 and 3 genes in maize to control lepidopteran and coleopteran pests would remove maize as a food plant for certain species and hence reduce some of these species in the food chain. This could have impacts on food supplies for insectivorous predators living in the margins of the Park. Maize could also be a significant alternative food source for some species of Coleoptera of conservation interest in the Park, particularly for pollen feeders. There are a few species of pollen feeding insects that will travel from the Park into the cultivated areas attracted by the large mass of flowers in a crop in July when other sources of pollen may be limiting.

The species at risk will include species with adults flying in July which are attracted to the flowers and feed on them. The coleoptera may include pollen beetles (Melegithes spp) as well as some predatory beetles which also supplement their diets with pollen such as certain coccinelid species etc. The Coleoptera recorded in the Park are listed in Annex 3. Some of these would be exposed to GM maize either directly by feeding on plant parts or indirectly through predation on pests of maize.

Wind mediated pollen dispersal from maize will result in pollen deposition in and around crops. Pollen can be deposited on leaves of weeds and wild plants growing within crops and immediately adjacent to them. Insects feeding on these leaves can ingest this pollen. Similarly predators of these insects will be exposed to the pollen ingested by their prey. Some GM maize express cry toxins in their pollen and so phytophagous insects sensitive to the cry toxins can be affected as well as sensitive predators of exposed phytophagous species. The highest levels of exposure will be close to the crops and decline progressively away from the crops (see Perry et al. 2012). However host plants of some sensitive lepidopteran or coleopteran species in field margins and areas of the Park adjacent to fields of may receive sufficient loads of pollen to cause harm to larvae feeding on them. Species particularly at risk will be those with larvae feeding on host plants adjacent to maize crops in July during and immediately after pollen release. Similarly coleopteran predators at risk will be those active during July feeding on insects in and close to maize crops expressing Cry 3in their pollen.

HT maize: the cultivation of HT crops will involve changing herbicide programmes so that weed control is mainly conducted with the herbicide to which the crop is tolerant (eg. glyphosate or glufosinate) and not with pre-emergent or selective herbicides. The consequence of this can be a change in the weed populations and botanical diversity within fields, including field margins, cultivating these crops (Sweet and Bartsch, 2011). Changes in botanical diversity will also affect other species through food chain effects so that arthropod diversity is also likely to be affected. The main factors influencing the impacts on botanical diversity and hence biodiversity in fields containing HT crops are : 1. The herbicide programmes used (including dose, application time and number), 2. The crop rotation of the field, 3. The tillage systems used (eg inversion ploughing, minimum tillage), 4. Mitigation and environmental measures taken.

At present most crops grown in the Park are organically grown (ie without herbicides) and thus HT systems would not be adopted. However, assuming that HT crops were grown in or adjacent to the Park, the impacts could be as follows: 1. A reduction in biodiversity within the crops. 2. Reduction in biodiversity in field margins and adjacent areas receiving herbicide spray drift. 3. Increased pest infestations in the crop as normal bio-control by predators in the crop may be reduced. 4. Development of new resistant weed types. It is likely that only spray drift (2.) would have a measurable impact on certain margin areas of the Park, where plant species that are sensitive to the particular broad spectrum herbicides could have populations reduced by the herbicide and also the herbicide might selectively allow weeds with tolerance to flourish and replace less competitive and sensitive species.

Table 3.3.1: Hazards and potential impacts that may be associated with GM maize cultivation in or adjacent to MSRM*

Trait	**NTOs impacted**	**TOs**	**Impact on Park**	**Impacts on Agric areas**		**Potential Primary Harm**
				Organic/Bio	GM	
Bt (Cry 1….)	Lepidoptera	Pest Lepids	Low	low	low	NTO Lepids
Bt (Cry 3….)	Coleoptera	Pest coleops	Low	low	low	NTO Coleos
HT (incl. management)	margin plants	weeds	v.low	v.low	Low	Off crop Biodiversity
HT	NTOs in Crop	weeds	v.low	v.low	Low	In crop Biodiversity
Drought tolerance	0	0	0	0	v.low	volunteers
Seed quality	0	0	0	0	0	0 (coex issue only)
Stacks HT,Bt,DT	Combinations of above	Combinations of above	Low/medium	low	low	NTOs & Biodiversity

* event and case specific information, including exposure and receiving environments, is needed in order to determine risks.

Predictions of the hazards and potential impacts presented by GM maize to the MSRM Park are summarized in Table 3.3.1. However this is a very general approach and in all cases more detailed study and analysis would be needed to accurately assess sensitivities of particular biota and their environmental niches and to determine impacts on populations in different ecosystems within the Park.

The main hazards are predicted from the Bt types because it is known and/or assumed that several sensitive species occur within the Park, they will be exposed to the cry toxins either within their habitats from pollen deposition or when visiting the crops, and that some species may already be scarce, at risk, red listed or under other environmental pressures that could result in severe population declines and local extinction.

Stacking of Bt traits is likely to increase the range of NTO species that will be affected by the presence of a GM crop.

HT maize impacts are associated with their herbicide management and thus are confined to areas affected by the herbicide applications. However these can include field margins, hedges, ditches, water courses and areas bordering the Park and can result in changes (generally losses) in botanical diversity and hence of diversity of other species.

GM drought tolerance and quality traits in maize are unlikely to have additional environmental impacts unless they are associated with changes in management, pesticide inputs etc. Therefore these are generally considered not to present an environmental hazard, but must be risk assessed case-by-case. Cultivation of all GM crops will need to respect co-existence requirements for separation and isolation of non-GM crops to prevent admixtures with GM. These may require barrier crops or other measures to be put in place which may have some additional environmental impacts .

Hazard and Risk Conclusions

If GM maize is likely to be cultivated the hazards identified above should be quantified where possible in relation to their consequences for the at-risk species or disrupted environments. In addition uncertainties should be fully documented and scenarios developed in order to show the range of likely consequences that could arise from the release or cultivation of the GM crop in the area. Assessments of the severity and consequences of the risk can then be used to determine the management measures required to reduce the risk to acceptable levels or to remove the risk.

3.3.2 Risk Management of GM maize crops in or near MSRM Park .

Risks to the biota in the Park can be reduced in 2 main ways : 1. By removing or reducing the hazard 2. by reducing exposure.

Hazard Management : This could include a ban on the cultivation of any GM crop in the Park so that no new hazard is introduced. However this would still mean that conventional crops had adverse environmental impacts, some of which could be reduced by growing GM crops such as growing Bt crops instead of spraying with insecticides and growing disease resistant crops instead of applying fungicides etc..

Exposure management: The risks associated with Bt and HT maize could be largely reduced by reducing exposure of non-target organisms and off crop areas. This can be achieved by having physical separation of the crop and its treatments from the field margins and Park. In relation to dispersal and deposition of Bt pollen, separation of the crop from the field margin by at least 10 meters would reduce pollen deposition to low levels. EFSA, Perry et al recommended that Bt maize should be 40-50 metres from environmental sensitive areas as a precautionary measure against strong winds causing significant deposition of pollen in conservation areas and allowing for the extreme sensitivity of some (untested/unidentified) species.

Similarly spray drift of broad spectrum herbicides into field margins and adjacent land can be significantly reduced by leaving unsprayed field margins of 12 -15m around fields and in many countries conservation headlands of 15 -20 m are common in ESAs.

Exposure to GM crops can also be managed by following good farming practices which encourage rotational cropping so that the frequency of GM crops is reduced, and treatments are applied less frequently. This reduces environmental exposure to the GM crops and delays the development of novel or resistant pest, weed and disease types. In addition the diversity of crops encourages diversity of other biota and therefore enhances the interaction between the Park and the farmed land.

3.4.1 Environmental Hazards and Risks associated with GM poplar cultivation

GM poplar is being cultivated in China (Bt poplar) and developed in Europe and in several areas of the world particularly in N America. Poplar is a plantation crop in Europe and is grown for a range of materials and uses. It provides timber for pulping and paper making, matches, veneer, construction materials and can be processed into animal feeds. Poplars are also used for erosion protection, land reclamation, shade and shelter belts, and bioremediation. Several poplar species are indigenous to Europe occurring in a range of habitats and environments and several poplar species and hybrids occur in the Park (see section 2.2 in DEMETRA book). Some Populus species have invasive traits and have the ability to invade and spread both vegetatively through root suckers, and through seed. Bt poplar has been grown in China for several years and several GM traits are being cultivated and developed to improve the productivity and timber quality of poplar. Risk assessments of GM poplar cultivated in or near MSRM need to consider the following factors as well as the general risk assessment issues listed in the introduction:

- GM Traits (hazards): Herbicide tolerance (HT), Bt insect resistance (Bt), API (proteinase inhibitor from *Sagittaria sagittifolia*) insect resistance , Fungal disease resistance (FR), timber quality, including modified lignin and cellulose composition (TQ), modified growth and productivity (MG), gamete or reproductive sterility (S) and bioremediation traits such as ability to accumulate heavy metals (BR).
- Gene flow: hazards associated with pollen and seed dispersal, hybridization, and introgression

- Fitness: ie where changes in plant phenotype may allow the plant to be more dominant, invasive or persistent in different habitats
- Impacts on target and non-target organisms associated with poplar
- Impacts of the specific management of the GM poplar

The receiving environments considered are : 1. uncultivated areas of the Park. 2 Plantation areas adjacent to the Park

Gene Flow **:** Populus is generally outcrossing with many species being dioecious (male and female flowers on separate plants). Populus pollen is mostly wind dispersed and has been tracked over long distances. In addition seeds are wind dispersed often over considerable distances. Poplar can hybridise between species and intergeneric hybridisation with willow (Salix species) using embryo rescue has been reported. Cultivated/plantation poplar has wild relatives within the Park woodland areas and thus gene flow to these wild poplar species is an issue.

Fitness: Many of the transformations of poplar are designed to improve its productivity or competitiveness and thus can change the fitness of poplar by :

- providing resistance to biotic stresses such as diseases and pests : eg Combined Bt insect resistance to leaf feeding lepidopteran pests, some stem boring coleopteran pests, with API resistance to a range of other pests which can severely constrain the growth of poplar.
- Providing resistance to abiotic stresses such as heavy metals and other toxins.
- Changing growth patterns of poplar so that trees are more vigorous and produce more vegetative growth in a season
- Reducing sexual fertility so that trees produce more vegetative growth.

Consequences of Gene Flow and Fitness

The combination of the ability of poplar to widely disperse genes through pollen and seed, and the enhanced fitness of many of the transformation traits indicates that some GM poplars could either introduce genes directly by invasion with GM plants or through hybridization with native poplars and introgression into their populations. The consequences of this are that either new provenances or species of poplar would establish in the Park or the existing poplar population would gradually adopt new transgenes and may in turn become more dominant or invasive within the Park. In both cases new genetic types of poplar would establish in the Park, possibly displacing or replacing existing types and also displacing other competing plant species. In addition the association of these novel poplars with existing biota would change. They would support different flora and fauna and probably have different soil microbial interactions. The ecological consequences would be difficult to predict.

However it is likely that these invasions and/or introgressions would be very slow, occurring over tens or, more likely, hundreds of years. The reasons being that 1. Life cycles of poplar trees are slow, 2. Reproductive fertility of the GM poplars will be low (eg they may be female only). 3. There are high levels of grazing and predation in the Park which severely reduce survival of seedlings and suckers thus inhibiting regeneration.

HT traits are useful when establishing nurseries and young plantations of trees and will only increase fitness of the GM plants in the presence of the herbicide, which will not be used in uncultivated land or on the agricultural land in the Park (due to organic farming policy). Thus it is unlikely that HT poplars will have environmental impacts in the Park.

NTO impacts : Poplar supports a range of organisms which gain nutrients from the plants. Some of these form close associations and therefore may be affected by novel genes expressing biocidal or antagonistic products. Thus impacts could occur to microbial associations with the plant and soil nutrient cycling. Initially these are likely to be confined to plantation areas and thus only impact the plantation areas of the Park.

Poplar is a significant food source for approximately 500 insects in Europe (Deplanque, 1998) and is associated with a range of insect species in the Park, some of them of conservation interest. These insects in turn are a food source for a range of species from parasitoids to birds.

A range of biota associated with poplar are mobile and thus can move between the Park and poplar plantations. These include everything from plant pathogens (virus, bacteria, fungi) through arthropods, invertebrates and vertebrates.

Insect resistance (IR) : the use of Cry 1 and 3 and API genes to control lepidopteran, coleopteran and other pests would remove poplar as a food plant for several insect species and also reduce some of these insect species in the food chain. Species such as *Tethea ocularis* feed almost exclusively on poplar and there are several Lepidoptera and Coleoptera and other species for which poplar is a main food source. The Lepidopteran species known to feed on poplar are listed in Annex 1. and some of these species occur within MSRM Park (see Annex 2.). Adults of these species are likely to be attracted to IR poplar plantations and will lay eggs on the trees, but the subsequent larvae will either die or not develop. The species affected would include species of conservation interest and so insect resistant poplar could have significant effects on their populations. In addition within insect resistant GM poplar plantations it is likely that the absence of sensitive insect larvae would reduce food supplies to other organisms and so reduce numbers of predators. Predators from the park visiting the plantations would thus have reduced food supplies and this could affect their populations. This could in turn result in unaffected pests (eg aphids) becoming more common and causing damage to trees as predation pressure on them is reduced.

If insect resistance genes introgressed into the “native” poplar population within the Park then these trees would also support a reduced diversity of insects and their associated predators and again may threaten certain species that depend on poplar for a food source.

Case specific studies and simulations are required to attempt to determine the adverse effects on exposed insect species, which consider sensitivity to the toxins and levels of exposure in specific areas and at the wider Park scale.

Fungal Resistance (FR). Fungal pathogens are a problem in poplar plantations as most propagation of poplar is clonal and thus there is little genetic variability within a plantation. Pathogens adapted to poplar clones can thus cause serious harm to plantations. Resistant lines and species of poplar are available for some diseases. However many of the pathogens have frequent sexual recombination and high genetic diversity (eg rusts) so that they respond to the selective pressure from resistance and rapidly adapt to these resistant lines. Some of the pathogen variability is associated with wild poplars, which due to their genetic variability, support a diversity of pathotypes. GM Fungal resistance would reduce pathogen damage to plantation poplars but the durability of the resistance depends on the resistance mechanisms involved. FR genes could spread from GM plants to wild type poplars in the Park and introgress into regenerating populations. In addition GM FR plants could disperse as seed and grow within the Park. These plants could exhibit some fitness benefit particularly if there is high disease pressure in the Park, but it is unclear what the selective advantage would be and whether it would actually enhance plant fitness and invasiveness. Case specific studies would need to be conducted to confirm any fitness changes and environmental impacts.
In addition novel FR traits such as oxalic oxidase might alter relationships with rhizosphere microflora such as beneficial mycorrhizal fungi, symbiotic bacteria and pathogenic fungi and bacteria. The consequences of this are difficult to predict but a worst case would result in loss of some root function and reduced growth of the poplar. The consequences of this will be mostly apparent in the poplar plantations but introgression of FR genes into regenerating wild types in the Park could also reduce the fitness of future wild type populations.

Modified Growth and Development Traits : Novel types of poplar are being produced which have changed apical and axillary bud, shoot and branch development so that they have changed dormancy and developmental characteristics and produce more biomass in a season. Some types will therefore have increased vigour and competitiveness and could be more invasive of natural/semi-natural habitats.
Other types have modified fertility so that they either do not flower unless treated with hormones or have changed maturation characterisitics and so flower at different developmental stages. Types which flower earlier and release more pollen or seed may have greater introgression or invasiveness tendancies. Case-by-case studies are required to determine whether novel growth and and development traits significantly alter tree survival, establishment and invasiveness characteristics.

Timber Quality (TQ) Traits: these include modified lignin and cellulose composition and formation in the GM poplar. These traits are likely to be introduced together with improved vigour and growth characteristics and thus may change some of the fitness characteristics of poplar, including susceptibility to wind damage and cold temperatures. Case-by-case studies are required to determine whether novel growth and timber quality traits significantly alter tree survival, establishment and invasiveness characteristics. In addition these traits may have impacts on biotic interactions since changes to the wood of trees could affect certain stem boring insects and wood invading pathogens. Generally it is not thought that TQ traits will have significant impacts on biota associated with poplar but case-by case risk assessment studies of the associated biota would need to be conducted to determine the scale of effects.

HT poplar: the cultivation of HT poplar will involve changing herbicide programmes so that weed control is mainly conducted with the herbicide to which the poplar is tolerant (eg. glyphosate or glufosinate). The consequence of this can be a change in the weed populations and botanical diversity within plantations and their field margins (Sweet and Bartsch, 2011). Changes in botanical diversity will also affect other species through food chain effects so that arthropod diversity is also likely to be affected. The main factors influencing the impacts on botanical diversity and hence biodiversity in HT plantations are: 1. The herbicide programmes used (including dose, application time and number), 2. The duration of the herbicide treatments, 3. The other weed control measures used (eg tillage), 4. Mitigation and environmental measures taken.
It is likely that herbicide usage will mainly only occur during the establishment of a plantation and thereafter the weed flora will recover so that environmental effects will be temporary. In addition spray drift could have a measurable impact on certain margin areas of the Park, where plant species that are sensitive to the particular broad spectrum herbicides could have populations reduced by the herbicide and also the herbicide might selectively allow weeds with tolerance to flourish and replace less competitive and sensitive species. However these effects would also be temporary for the duration of the time that herbicides are applied.

Table 3.4.1 : Hazards and potential short term impacts that may be associated with GM poplar cultivation in or adjacent to MSRM*

Trait	NTOs impacted	Target Organisms	Impact on Park	Impacts on plantation areas		Potential Primary Harm
				Organic	GM	
Bt (Cry 1….)	Lepidoptera	Pest Lepids	Low/medium	v.low	Low/medium	NTO Lepids
Bt (Cry 3….)	Coleoptera	Pest coleops	Low/medium	v.low	Low/medium	NTO Coleos
API	Lepids and Coccinelidae	Pest lepids and Coleos	medium	v.low	medium	NTOs
HT (incl. management)	margin plants	weeds	v.low	v.low	v.Low	Off crop Biodiversity
	NTOs in Crop	weeds	v.low	v.low	Low	In plantation Biodiversity
Growth/develop changes (MG)	0	0	v.low	0	v.low	volunteers
Timber quality	Stem borers ?	0	v.low	0	v.low	0
Fungal Resistance	Beneficial microbial associations	Pathogens	v.low	low	Low/medium	Microbial soil functions changed
Stacks HT,Bt,API,FR, TQ, MG	Combinations of above	Combinations of above	Medium/high	low	Medium/high	NTOs & Biodiversity

Table 3.4.2 : Hazards and potential long term impacts that may be associated with GM poplar cultivation in or adjacent to MSRM and following invasion/introgression and establishment of GM poplar and/or transgenes in the Park poplar populations*.

Trait	NTOs	Target	Impact	Impacts on	Potential Primary

	impacted	Organisms	on Park	plantation areas		Harm
				Organic /Bio	GM	
Bt (Cry 1….)	Lepidoptera	Pest Lepids	Medium/high	v.low	Medium/ high	NTO Lepids
Bt (Cry 3….)	Coleoptera	Pest coleops	medium	v.low	Medium/ high	NTO Coleos
API	Lepids and Coccinelidae	Pest lepids and Coleos	Medium/high	v.low	Medium/ high	NTO insects
HT (incl. management)	margin plants	weeds	v.low	v.low	v.Low	Off crop Biodiversity
HT	NTOs in Crop	weeds	v.low	v.low	Low	In plantation Biodiversity
Growth/develop changes (MG)	0	0	Low/medium	0	v.low	Fitness/invasiveness
Timber quality	Stem borers ?	0	v.low	v.low	low	Stem borers ?
Fungal Resistance	Beneficial microbial associations	Pathogens	low	v.low	Low/ medium	New Pathotypes. Soil microbial associations/functions
Stacks HT,Bt,API,FR, TQ, MG	Combinations of above	Combinations of above	Medium/high	low	Medium/ high	NTOs & Biodiversity

* event and case specific information, including exposure and receiving environments, is needed in order to determine risks.

Predictions of the hazards and potential short and longer term impacts presented by GM poplar to the MSRM Park are summarized in Tables 3.4.1 and 3.4.2. However this is a very general approach and in all cases more detailed study and analysis would be needed to accurately assess sensitivities of particular biota and their environmental niches and to determine impacts on populations in different ecosystems within the Park.

GM insect resistance, fungal resistance, growth and timber quality traits in poplar may increase fitness and invasiveness of GM poplar and permit establishment or introgression of transgenes into poplar populations within the Park, especially if these traits are combined. FR, TQ and MG may also cause different interactions with NTOs and thus have additional environmental impacts.

The main hazards are predicted from the insect resistant types (Bt and API) because it is known and/or assumed that several sensitive insect species occur within the Park, they will be exposed to the insecticidal toxins initially when visiting GM plantations, and subsequently from GM poplar that establish within the Park. Some insect species may already be scarce, at risk, red listed or under other environmental pressures that could result in severe population declines and local extinction.

Stacking of Bt traits and API is likely to increase the range of NTO species that will be affected by the presence of the GM poplars.

HT poplar impacts are associated with their herbicide management and thus are confined to areas affected by the herbicide applications. However these can include field margins, hedges, ditches, water courses and areas bordering the Park and can result in changes (generally losses) in botanical diversity and hence of diversity of other species. However these are likely to be temporary and reversible effects as herbicide use will cease as trees mature.

__Hazard and Risk Conclusions__

If GM poplar is likely to be cultivated in or near the Park the identified hazards should be quantified where possible in relation to their consequences for the at-risk species or disrupted environments. In addition uncertainties should be fully documented and scenarios developed in order to show the range of likely consequences that could arise from the release or cultivation of GM poplar in the area. Assessments of the severity and consequences of the risk can then be used to determine the management measures required to reduce the risk to acceptable levels or to remove the risk.

3.4.2 Risk Management of GM poplar in or near MSRM Park .

Risks to the biota in the Park can be reduced in 2 main ways: 1. By removing or reducing the hazard; 2. by reducing exposure.

Hazard Management : This could include a ban on the cultivation of any GM poplar in or near the Park so that no new hazard is introduced. However this would still mean that the Park may be exposed to low levels of long distance dispersal of seed or pollen from GM poplar grown elsewhere.

Exposure management: The risks associated with GM poplar could be largely reduced by reducing the fertility of poplar so that there is no production and dispersal of pollen or seed. This can be achieved either by harvesting the plantation before it reaches flowering maturity or utilizing sterile lines induced by conventional or GM breeding techniques. This would mean that there would be little or no invasion of areas outside the GM poplar plantations except from vegetative root suckers. Exposure of non-target organisms would be confined to those visiting or residing in the GM plantations and immediate off crop areas so that impacts on mobile insect populations from the Park would still occur within the plantations, as well as associated food chain effects. Because of the long distance dispersal of pollen and seed by poplar, the use of physical separation of the GM plants within the area of the Park is not considered a feasible option unless associated with other measures to reduce flowers, pollen or seed production.

Spray drift of broad spectrum herbicides into field margins and adjacent land can be significantly reduced by leaving unsprayed field margins of 12 -15m around plantation fields.

4. OTHER CROP TYPES (not currently cultivated within the Park)

Other crops cultivated in or near the MSRM Park may in future be substituted with GM crops and thus could present potential hazards to the Park. These crops could include some of the crops currently or recently being developed and/or tested in Italy such as: Sugar beet, Grapevine, olives, strawberries, plum, peach, nectarine, eggplant (melanzana), wheat.

In addition other crops are being developed in Europe and worldwide that might eventually be cultivated in Tuscany or adventitiously appear as feral types. These include apple, rice, cotton, beans (*Vicia* and *Phaseolus* spp), Lucerne (alfalfa – *Medicago* species), grasses (eg. *Agrostis* spp), papaya, citrus types (eg oranges), pine and many other crop and plant types.

Some of these crop and plant types have hybridizing wild relatives within the Park and thus there is a theoretical potential for transgenes to flow into the Park. Table 4.1 lists the crop wild relatives data base for Italy (www.cwrdiversity.org) and their recorded presence within the Park. This shows that there is the potential that these species could be recipients of transgenes from related GM crops. Wild relatives of some crops (eg minor vegetable crops such as Chicory) and non-food crop species (eg: Pinus spp) are not listed and so the table is only indicative and should not be considered as a comprehensive list of all crop wild relatives in Italy or the Park.

Assessments of the specific risks to the Park from these new GM crops and plants would need to be done on a case-by-case basis considering the plant type, its biology, the GM trait, the already conducted risk assessments in different countries, the different areas of the Park that might be exposed and the biota that might be exposed.

The need for performing the environmental risk assessments of any of the above crops will be triggered by monitoring of the GM crops passing through EU regulations and their cultivation or use in Italy.

Table 4.1. List of Crop Wild relatives in Italy from CWR Web site www.cwrdiversity.org **with locations in the MSRM Park where the species are also present. Note that this is not a comprehensive set of all crop wild relatives as it does not include some minor vegetable relatives (eg *Cichorium* spp) and forest trees (eg: *Populus, Pinus*).**

Common Name	Scientific Name	Location in MSRM Park	Location and Notes
	Aegilops biuncialis		
ovate goat grass	Aegilops geniculata		Present in Park
three-awn goat grass	Aegilops neglecta		Present in Park
barb goat grass	Aegilops triuncialis		
barb goat grass	Aegilops triuncialis var. triuncialis		
	Aegilops uniaristata		
swollen goat grass	Aegilops ventricosa		
	Allium ampeloprasum	INCOLTO ONTANELLI , plot S21	identified as Allium spp.
	Allium angulosum	INCOLTO ONTANELLI , plot S21	identified as Allium spp.
	Allium atroviolaceum	INCOLTO ONTANELLI , plot S21	identified as Allium spp.

	Allium commutatum	INCOLTO ONTANELLI , plot S21	identified as Allium spp.
	Allium lineare	INCOLTO ONTANELLI , plot S21	identified as Allium spp.
	Allium saxatile	INCOLTO ONTANELLI , plot S21	identified as Allium spp.
	Allium senescens	INCOLTO ONTANELLI , plot S21	identified as Allium spp.
	Allium sphaerocephalon	INCOLTO ONTANELLI , plot S21	identified as Allium spp.
	Asparagus acutifolius	PINETA	
	Asparagus albus		
	Asparagus aphyllus		
	Asparagus horridus		
	Asparagus maritimus		
	Asparagus tenuifolius		Present in Park
	Avena atherantha		
Barbed oat	Avena barbata	PINETA	Massaciuccoli Lake
	Avena clauda		
Spring wild oat	Avena fatua	INCOLTO ONTANELLI , plot S21	INCOLTO in CULATTA CLOSE TO PARCELLA A6
	Avena insularis		
	Avena longiglumis		
	Avena lusitanica		
	Avena matritensis		
Sterile oat	Avena sterilis	INCOLTO in CULATTA CLOSE TO PARCELLA A6	
	Avena trichophylla		
	Avena wiestii		
	Barbarea bracteosa		
	Barbarea intermedia		
	Barbarea rupicola		
	Barbarea sicula		
	Barbarea vulgaris		
	Beta macrocarpa		

Sea beet	Beta vulgaris subsp. maritima		
	Brassica drepanensis		
	Brassica fruticulosa		
	Brassica fruticulosa subsp. fruticulosa		
	Brassica gravinae		
	Brassica incana		
	Brassica insularis		
	Brassica macrocarpa		
	Brassica montana		
	Brassica repanda		
	Brassica rupestris		
	Brassica souliei subsp. amplexicaulis		
	Brassica tournefortii		
	Brassica villosa		
	Carthamus lanatus subsp. lanatus		
	Chenopodium ficifolium		
	Coincya monensis		
Turkish hazel	Corylus colurna		
	Crambe hispanica subsp. hispanica		
	Cynara cardunculus var. sylvestris		
Wild carrot	Daucus carota subsp. carota	INCOLTO ONTANELLI , plot S21	INCOLTO in CULATTA CLOSE TO PARCELLA A6
	Daucus carota subsp. fontanesii		
	Daucus carota subsp. major		
Mediterranean carrot	Daucus carota subsp. maritimus	Massaciuccoli Lake	INCOLTO ONTANELLI , plot S21
	Daucus carota subsp. maximus		
	Daucus carota subsp. rupestris		
	Digitaria debilis		Present in Park

	Digitaria ischaemum		
	Digitaria sanguinalis		
	Diplotaxis erucoides		
	Diplotaxis harra		
	Diplotaxis muralis		
	Diplotaxis viminea		
	Erucastrum gallicum		
	Erucastrum virgatum		
	Fragaria moschata		
	Fragaria vesca		Present in Park
	Fragaria vesca subsp. vesca		
	Fragaria viridis		
	Hirschfeldia incana		
Bulbous barley	Hordeum bulbosum	BOSCO MISTO: in front at the CULATTA area	identified as Hordeum spp.
Sea barley	Hordeum marinum	BOSCO MISTO: in front at the CULATTA area	identified as Hordeum spp.
False barley	Hordeum murinum	INCOLTO in CULATTA CLOSE TO PARCELLA A6. BOSCO MISTO: in front at the CULATTA area	identified as Hordeum spp.
False-rye barley	Hordeum secalinum	LAME. BOSCO MISTO: in front at the CULATTA area	identified as Hordeum spp.
	Imperata cylindrica		Present in Park
	Isatis allionii		
	Isatis praecox		
	Lactuca longidentata		
	Lactuca quercina		
	Lactuca quercina subsp. quercina		
	Lactuca saligna		
	Lactuca serriola	Massaciuccoli Lake	
	Lactuca viminea		
	Lactuca viminea subsp.		

	chondrilliflora		
	Lactuca viminea subsp. ramosissima		
	Lactuca viminea subsp. viminea		
	Lactuca virosa		
	Lactuca virosa subsp. virosa		
	Lathyrus amphicarpos		
annual vetchling	Lathyrus annuus	INCOLTO ONTANELLI , plot S21	
	Lathyrus cirrhosus		
Spanish vetchling	Lathyrus clymenum		
	Lathyrus gorgoni		
everlasting-pea	Lathyrus grandiflorus		
	Lathyrus heterophyllus		
Hairy vetchling	Lathyrus hirsutus	INCOLTO ONTANELLI , plot S21	Massaciuccoli Lake
perennial-pea	Lathyrus latifolius		
flat-pea	Lathyrus sylvestris	Massaciuccoli Lake	
Tangier-pea	Lathyrus tingitanus		
tuberous-vetch	Lathyrus tuberosus		
	Lens ervoides		
	Lens nigricans		
	Lupinus micranthus		
	Malus crescimannoi		
	Malus florentina		
European crab apple	Malus sylvestris	Natural Poplar forest in Fortino Nuovo	
	Medicago doliata		
disc medic	Medicago italica		
	Medicago lesinsii		
strand medic	Medicago littoralis		
	Medicago marina		Present in Park
	Medicago murex		
	Medicago pironae		
	Medicago prostrata		

Tifton medic	Medicago rigidula		
	Medicago sativa subsp. falcata var. falcata	Massaciuccoli Lake	INCOLTO in CULATTA CLOSE TO PARCELLA A6
	Medicago turbinata		
	Moricandia arvensis		Present in Park (Brassicaceae)
	Olea europaea subsp. europaea var. sylvestris		Present in Park
	Patellifolia patellaris		
	Phoenix humilis		
Chios mastictree	Pistacia lentiscus		Present in Park
Cyprus turpentine	Pistacia terebinthus		
	Pistacia terebinthus subsp. terebinthus		
	Pisum sativum subsp. elatius var. elatius		
	Potentilla palustris		
	Prunus cocomilia		
	Prunus fruticosa		
	Prunus mahaleb		
	Prunus prostrata		
Blackthorn	Prunus spinosa		Present in Park
	Prunus webbii		
	Pyrus communis subsp. pyraster		
	Pyrus spinosa		
	Raphanus raphanistrum		Present in Park
	Raphanus raphanistrum subsp. landra		
	Raphanus raphanistrum subsp. raphanistrum		
	Ribes multiflorum		
	Ribes petraeum		
	Rorippa amphibia		
	Rorippa austriaca		
	Rorippa islandica		

	Rorippa lippizensis		
	Rorippa palustris		
	Rorippa pyrenaica		
	Rorippa sylvestris		
	Saccharum ravennae		
	Saccharum spontaneum		
	Saccharum spontaneum subsp. aegyptiacum		
	Saccharum strictum		
	Secale strictum		
	Sinapis arvensis	INCOLTO in CULATTA CLOSE TO PARCELLA A6	
	Sinapis pubescens		Present in Park
	Vicia barbazitae		
Bithynian vetch	Vicia bithynica		Present in Park
	Vicia grandiflora		
	Vicia hybrida		Present in Park
	Vicia johannis		
	Vicia johannis var. procumbens		
Spring vetch	Vicia Latharoides		Present in Park
Yellow vetch	Vicia lutea		
	Vicia melanops		
	Vicia narbonensis var. jordanica		Present in Park
Subterranean vetch	Vicia sativa subsp. amphicarpa	LAME: wetland marine area in front at the pineta .	INCOLTO in CULATTA CLOSE TO PARCELLA A7 . BOSCO MISTO: in front at the CULATTA area
	Vicia sativa subsp. incisa	LAME: wetland marine area in fron at the pineta	INCOLTO in CULATTA CLOSE TO PARCELLA A7 . BOSCO MISTO: in front at the CULATTA area
	Vicia sativa subsp. macrocarpa	LAME: wetland marine area in fron at the pineta	INCOLTO in CULATTA CLOSE TO PARCELLA A8. BOSCO MISTO: in front at the CULATTA area
Black pod vetch	Vicia sativa subsp. nigra	LAME: wetland marine area in fron at the pineta	INCOLTO in CULATTA CLOSE TO PARCELLA A9. BOSCO MISTO: in front at the CULATTA area

	Vicia serratifolia		
	Vitis vinifera subsp. sylvestris	Massaciuccoli Lake	

5. MONITORING

In order to protect the MSRM Park from any potential hazards associated with GM crop cultivation in or near the Park the following Monitoring and management procedures are proposed :

1. Establish an information system that gives notice of all GM crop and plant approvals for experimental release in Italy and all EU approvals for import, processing and cultivation of GM plants. This can be done by accessing information from the Italian Regulatory Authority, from SNIFS (Summary Notifications of Field Studies) issued by EC-JRC at Ispra, by contacting DG SANCO for information on GMO applications, and from EFSA on published scientific opinions.

2. If a GM plant (GMP) is likely to be grown for experimental field studies, imported or commercially cultivated, then detailed information is required. This includes:
   a. A full description of the GMP including its GM trait(s) and expression levels in different plant tissues.
   b. The environmental risk assessment as performed by the applicant and any scientific opinions on it from regulatory authorities (eg USDA) and EFSA.
   c. Any risk management or monitoring requirements specified/recommended by the applicant, regulatory authorities , EFSA and DG Sanco.
   d. The location of the GMP within Italy including transport routes of imported viable plant materials, and cultivation locations of field studies or commercial cultivation.

3. If it becomes likely that a GMP will enter or be grown in land close to or within the Park then the following information, which can be obtained from EFSA, DG Sanco, JRC at Ispra or the Italian Competent Authority, is required:
   a. Full description of the GM plant, ie species and cultivar characteristics and its unique identifier information,
   b. Full description of the GM trait including expression levels in all plant tissues
   c. Information on the fertility, fecundity, and fitness characteristics (eg seedling vigour, growth, competitiveness, ferality and weediness) of the GMP.
   d. The precise location and area of the GMP that will be grown and the cultivation system and practices that will be adopted by the farmer/grower.

   In order to facilitate this it is suggested that the Park contact all neighbouring farmers and land owners and notify them that the Park requires this information in advance of any cultivation of GM crops, and that Farmers/landowners are invited to discuss their plans to cultivate GMPs with the Park authorities. In addition the Park could develop guidance for farmers so that, when they are considering cultivation of GM crops, they are informed of the safety and coexistence requirements for protecting both the Park and the genetic purity of crops grown in the Park.

4. If any of the GM plants described in Sections 1-4 above are being cultivated in or near the Park then:
    a. The Risk Management options described in Sections 1-4 should be put in place to reduce exposure of the Park and Park biota .
    b. Monitoring should be conducted to ensure :
        i. That risk management measures are being implemented
        ii. To verify that the management measures are appropriate for reducing exposure and specific identified risks.

5.1 Case Specific Monitoring

Monitoring of the GM crops listed in Sections 1-4 should be based on the hazards described in each of their risk assessments and any specific risks to the Park or its biota that have been identified . It is suggested that the EFSA approaches to Case Specific Monitoring (CSM) are followed (EFSA 2006 and 2011, Bartsch et al 2007). This means that CSM studies should be designed as experimental studies with a clear objective or hypothesis to test, sufficient statistical power and should be comparative. Thus areas or biota exposed to GM crops/plants should be compared with unexposed areas or biota where possible (Albajes et al, 2012). If this is not practical then the data collected from the exposed areas/biota should be compared with historical data or other background data in order to determine whether recorded exposure or effects are different from comparable areas and/or from previously collected data. The data collected in the DEMETRA study provide some useful information on the current status of some biota in the Park and some annual flux data. However in order to strengthen the existing data base, more baseline studies may need to be conducted, particularly of the species that can be predicted as being potentially impacted by the future GM plant cultivation, and/or species that are useful indicators of these impacts. In addition particularly vulnerable, sensitive or at risk species that are exposed to and likely to be impacted by the GM plant can be selected. However if their populations are already low then it may not be possible to generate sufficient data to determine whether effects are occurring and so more common substitutes with similar sensitivities and exposure should be used as surrogates for the at-risk species.

Table 5.1 gives examples of some of the monitoring approaches that could be adopted for some of the potentially more hazardous crop trait combinations described in Sections 1-4.

Monitoring should be conducted over several seasons and in different locations in order to determine whether effects on biota that are recorded are influenced more by seasonal or locational factors than by any association with the GMP. Similarly, if GM plants are not removed from the Park, establishment and survival of GM plants should be tracked over several seasons to determine whether adventitious populations are transient or establish and spread. Feral GM plants and hybrids should be mapped in order to determine dispersal patterns.

Results of monitoring studies should be used to: 1. Update and inform the risk assessments that were initially conducted, 2. Determine whether management measures are sufficient or proportional to the exposure and risks anticipated in the risk assessment or whether they should be adjusted to achieve acceptable levels of risk or proportionate levels of management.

In addition results of monitoring studies should be compared with results from other monitoring studies being conducted with similar GMPs in other regions. Results of the studies should be reported to the Italian Competent authority, EFSA, DG SANCO and the consent holder of the GMP.

Table 5.1: Examples of Case Specific Monitoring options for some GM sunflower, maize, oilseed rape and poplar types

Crop	**Trait**	**Exposure**	**Biota to monitor**	**Area to monitor**	**Monitoring Options**	Notes
Sunflower, Oilseed rape, Maize . Poplar.	Bt	GM Pollen	Lepidoptera (Cry 1) and Coleoptera (Cry 3)	Park boundary areas, GM fields and plantations	Pollen deposition on plants or in traps. Feeding Larvae. Flower visiting adults (not maize)	During pollen production and deposition period
Sunflower, Oilseed rape. Poplar	Bt	GM Plant	Lepidoptera (Cry 1) and Coleoptera (Cry 3)	GM fields, plantations	Feeding Larvae.	Sample during growing season
Sunflower, Oilseed rape. Poplar.	Disease resistance	Pathogens	Related plant species	in Park	Disease levels. New Pathotypes.	Sample during growing season
Sunflower, Oilseed rape, Maize . Poplar.	HT	Herbicides and management	Any suitable indicators of biodiversity, eg: weeds	Fields, plantations and margins	Plant species and numbers. Arthropod numbers.	Sample after herbicide applications
Sunflower, Oilseed rape, Poplar.	Biotic and abiotic Stress tolerance and fitness traits	Gene flow via GM Pollen	Related plant species	Park, field margins.	Seedlings and plants of related species with synchronous flowering	Test for presence of transgene
Sunflower, Oilseed rape, Maize .	Biotic and abiotic Stress tolerance	GM Plant establishment following Seed	Feral GM plants	Park	Feral GM plants	Test for presence of transgene

Poplar.	and fitness traits	dispersal				

6. REFERENCES

Ahmadia, A., D. Azadfarb, A. Jafari Mofidabadic (2010). Study of inter-generic hybridization possibility between Salix aegyptica and Populus caspica to achieve new hybrids. International Journal of Plant Production 4 (2), 1735

Albajes, R. , G. P. Farinós, M. Pérez-Hedo1, M. de la Poza, B. Lumbierres, F. Ortego, X. Pons and P. Castañera. (2012). Post-market environmental monitoring of Bt maize in Spain: Non-target effects of varieties derived from the event MON810 on predatory fauna. Spanish Journal of Agricultural Research 2012 10(4), 977-985

Bartsch D., A. Gathmann, S. Hartley, N. B. Hendriksen, R. Hails, K. Lheureux, J. Kiss, S. Mesdagh, G. Neemann, J. Perry, S. Renckens, J. Schiemann and J. Sweet (2007). First EFSA experiences with monitoring plans. J. Verbr. Lebensm. 2 (2007) Supplement 1: 33 – 36.

Crawley M.J., Brown S.L., Hails R.S., Kohn D.D., Rees M. (2001). Transgenic crops in natural habitats. Nature 409:682–683.

Crop Wild Relatives and Climate Change (2013). Online resource. Accessed on 24-08-2013. www.cwrdiversity.org

Delplanque A., (1998). Les insectes associés aux peupliers. Ed. Memor, Bruxelles, 350 p.

EASTHAM, K & SWEET, J B (2002) Genetically Modified Organisms: the significance of gene flow through pollen transfer. European Environment Agency, Environmental Issue Report 28, 75 pp.

EFSA. (2006). Opinion of the scientific panel on genetically modified organisms on the post market environmental monitoring (PMEM) of genetically modified plants. EFSA Journal; 319: 1-27.

EFSA. (2011). EFSA Panel on GMO; scientific opinion on guidance on the post-market environmental monitoring (PMEM) of genetically modified plants. EFSA Journal 9(8): 2316.

Haggman, H., Raybould, A., Borem, A., Fox, T., Handley, L., Hertzberg, M., Lu, M.-Z., Macdonald, P., Oguchi, T., Pasquali, G., Pearson, L., Peter, G., Quemada, H., Seguin, A., Tattersall, K., Ulian, E., Walter, C. and McLean, M. (2013). Genetically engineered trees for plantation forests: key considerations for environmental risk assessment. Plant Biotechnol. J., doi: 10.1111/pbi.12100

Hails, Rosie S.; Bullock, James M.; Morley, Kate; Lamb, Caroline; Bell, Pippa; Horsnell, Richard; Hodgson, Dave J.;Thomas, Jane. (2006). Predicting fitness changes in transgenic plants: testing a novel approach with pathogen resistant Brassicas. *IOBC/WPRS Bulletin,* 29 (5). 63-70.

Hails Rosie, Timms-Wilson Tracey. (2007). Genetically modified organisms as invasive species? In: Nentwig, Wolfgang, (ed.) *Biological Invasions.* Springer, 293-310. (Ecological Studies, 193).

Hails, R.. (2006). The potential invasiveness of insect resistant transgenic plants. In: *Proceedings of the 9th international symposium on the Biosafety of Genetically Modified Organisms, Jeju Island, South Korea, 24 - 29 September 2006*. 83-87.

Hu, Q.,S. Andersen,C. Dixelius,L. Hansen. (2002). Production of fertile intergeneric somatic hybrids between *Brassica napus* and*Sinapis arvensis* for the enrichment of the rapeseed gene pool. Plant Cell Reports, Volume 21, Issue 2, pp 147-152

Lecomte J., Bagger Jorgensen R. Bartkowiak-Broda I., Devaux C., Dietz-Pfeilstetter A., Gruber S. Husken, A Kuhlmann M, Lutman P, Rakousky S, Sausse C, Squire G, Sweet J, Aheto D. W. (2007). Geneflow in oilseed rape: what the datasets of the UE Project SIGMEA tell us for coexistence? Proceedings GMCC07: Third International Conference on Coexistence between Genetically Modified and non-GM based agriculture supply chains. Luxembourg OOPEC. 49-52

Perry, J.N., Devos, Y., Arpaia, S., Bartsch, D., Gathmann, A., Hails, R.S., Kiss, J., Lheureux, K., Manachini, B., Mestdagh, S., Neemann, G., Ortego, F., Schiemann, J., Sweet, J.B., (2010). A mathematical model of exposure of non-target Lepidoptera to Bt-maize pollen expressing Cry1Ab within Europe. *Proceedings of the Royal Society B – Biological Sciences,* 277: 1417-1425.

Perry JN, Devos Y, Arpaia S, Bartsch B, Ehlert C , Gathmann A, Hails RS, Hendriksen NB, Kiss J, Messéan A, Mestdagh S, Neemann G, Nuti M, Sweet JB, Tebbe CC, (2012). Estimating the effects of Cry1F *Bt*-maize pollen on non-target Lepidoptera using a mathematical model of exposure. Journal of Applied Ecology, 49, 29-37

Simpson E, Mcroberts N. and Sweet J. (2006). Out-crossing between genetically modified herbicide tolerant and other winter oilseed rape cultivars. Plant Genetic Resources, Volume 4, Number 2, pp. 96-107(12)

Sweet, Jeremy & Bartsch, Detlef (2011). Guidance on risk assessment of herbicide tolerant GM plants by the European Food Safety Authority. *Journal für Verbraucherschutz und Lebensmittelsicherheit* (Journal of Consumer Protection and Food Safety) 6, supplement 1, 65-72

Sweet J (2008). The environmental risk assessment of GM herbicide tolerant plants and the interplay between Directive 2001/18/EC and Directive 91/414/EC. *Journal für Verbraucherschutz und Lebensmittelsicherheit* Volume 3, Supplement 2, 52-53,

Takahata, Y. & T. Takeda (1990). Intergeneric (intersubtribe) hybridization between *Moricandia arvensis* and *Brassica* A and B genome species by ovary culture. Theoretical and Applied Genetics 80, Issue 1, 38-42.

Veronique de Tillesse, , Ludovic Nef, John Charles, Anthony Hopkin & Sylvie Augustin (2000). DAMAGING POPLAR INSECTS: Internationally important species. Published under the auspices of the International Poplar Commission. FAO publication.

Walklate P J, Hunt J C R, Higson H L, Sweet J B. (2004). A model of pollen mediated gene flow for oilseed rape. *Proc. Royal. Soc. Lond. B.* **271**, 441-449

Warwick S. I., M.-J. Simard, H. J. Beckie, L. Braun, B. Zhu, P. Mason, G. Seguin-Swartz, C. N. Stewart (2003) Hybridization between transgenic Brassica napus L. and its wild relatives: Brassica rapa L., Raphanus raphanistrum L., Sinapis arvensis L., and Erucastrum gallicum (Willd.) O.E. Schulz. Theor Appl Genet 107:528–539

Wilkinson Mike J., Luisa J. Elliott, Joel Allainguillaume, Michael W. Shaw, Carol Norris, Ruth Welters, Matthew Alexander, Jeremy Sweet**,** David C. Mason. (2003). Hybridization between *Brassica napus* and *B. rapa* on a National Scale in the United Kingdom. *SCIENCE* 302, 457-459

Yang, M. S., H. Y. Lang, B. J. Gao, J. M. Wang and J. B. Zheng (2003). Insecticidal Activity and Transgene Expression Stability of Transgenic Hybrid Poplar Clone 741 Carrying two Insect-Resistant Genes. Silvaegenetica, 52, 197.

Annex 1. Lepidoptera Species which feed on *Populus* (and other plants)

Batrachedridae

Batrachedra praeangusta – recorded on White Poplar (*P. alba*) and Common Aspen (*P. tremula*)

Coleophoridae

Coleophora malivorella

Coleophora pruniella

Geometridae

Agriopis marginaria (Dotted Border)[*verification needed*]

Cabera exanthemata (Common Wave) – recorded on aspens

Cabera pusaria (Common White Wave) – recorded on aspens

Colotois pennaria (Feathered Thorn) – recorded on Black Poplar (*P. nigra*)

Crocallis elinguaria (Scalloped Oak) – recorded on aspens

Ectropis crepuscularia (The Engrailed)

Epirrita autumnata (Autumnal Moth)

Eupithecia subfuscata (Grey Pug)

Lomaspilis marginata (Clouded Border)

Odontopera bidentata (Scalloped Hazel)

Operophtera brumata (Winter Moth)

Selenia tetralunaria (Purple Thorn) – recorded on Black Poplar (*P. nigra*)

Hepialidae

Korscheltellus gracilis (Conifer Swift)[*verification needed*]

Sthenopis purpurascens

Lymantriidae

Euproctis chrysorrhoea (Brown-tail)

Lymantria dispar (Gypsy Moth)

Noctuidae

Acronicta leporina (The Miller)

Acronicta megacephala (Poplar Grey)

Acronicta psi (Grey Dagger)

Agrochola circellaris (The Brick)

Amphipyra berbera (Svensson's Copper Underwing) – recorded on aspens

Amphipyra tragopoginis (Mouse Moth)

Catocala cara (Darling Underwing)

Catocala junctura (Joined Underwing) – recorded on Fremont Cottonwood (*P. fremontii*)

Discestra trifolii (The Nutmeg)

Orthosia cerasi (Common Quaker)

Orthosia gothica (Hebrew Character)

Notodontidae

Furcula bifida (Poplar Kitten)

Nadata gibbosa (Rough Prominent)

Phalera bucephala (Buff-tip)

Ptilodon capucina (Coxcomb Prominent)

Nymphalidae

Limenitis archippus (Viceroy Butterfly)

Limenitis arthemis (American White Admiral/Red-spotted Purple) – prefers Quaking Aspen (*P. tremuloides*) over Ontario Balsam Poplar (*P. balsamifera*), Eastern Cottonwood (*P. deltoides*) and Bigtooth Aspen (*P. grandidentata*)

Nymphalis antiopa (Camberwell Beauty/Mourning Cloak)

Oecophoridae

Epicallima formosella – recorded in dead wood of poplars and aspens

Papilionidae

Papilio glaucus (Eastern Tiger Swallowtail) – recorded on cottonwoods

Saturniidae

Coloradia pandora (Pandora Pinemoth) – recorded on aspens[*verification needed*]

Pavonia pavonia (Emperor Moth) – recorded on aspens

Sphingidae

Laothoe populi (Poplar Hawk-moth)

Smerinthus jamaicensis (Twin-spotted Sphinx)

Annex 2. Lepidoptera Species found in the MSRM Park.

Species in marked in red are endangered red list speices

Family	Specie	Author	Locality
Noctuidae	*Abrostola triplasia*	(Linné, 1758)	San Rossore
Noctuidae	*Acantholeucania loreyi*	(Duponchel, 1827)	San Rossore
Noctuidae	*Acronicta megacephala*	(Denis & Schiffermüller, 1775)	San Rossore
Noctuidae	*Acronicta rumicis*	(Linnaeus, 1758)	San Rossore
Noctuidae	*Adpyramidcampa effusa*	(Boisduval, 1828)	San Rossore
Noctuidae	*Aedia leucomelas*	(Linnaeus, 1758)	San Rossore
Geometridae	*Agriopis marginaria*	(Fabricius, 1776)	San Rossore
Sphingidae	*Agrius convolvuli*	(Linneo, 1758)	San Rossore
Noctuidae	*Agrochola circellaris*	(Hufnagel, 1766)	San Rossore
Noctuidae	*Agrochola haematidea*	(Duponchel, 1827)	San Rossore
Noctuidae	*Agrotis crassa*	(Hübner, 1803)	San Rossore
Noctuidae	*Agrotis exclamationis*	(Linné, 1758)	San Rossore
Noctuidae	*Agrotis ipsilon*	(Hufnagel, 1766)	San Rossore
Noctuidae	*Agrotis puta*	(Hübner, 1803)	San Rossore
Noctuidae	*Agrotis segetum*	(Denis & Schiffermüller, 1775)	San Rossore
Noctuidae	*Aletia albipuncta*	(Denis & Schiffermüller, 1775)	San Rossore
Noctuidae	*Aletia congrua*	(Hübner, 1817)	San Rossore
Noctuidae	*Aletia l-album*	(Linné, 1767)	San Rossore
Noctuidae	*Aletia riparia*	(Rambur, 1829)	San Rossore
Noctuidae	*Aletia straminea*	(Treitschke, 1825)	San Rossore
Noctuidae	*Aletia vitellina*	(Hübner, 1808)	San Rossore
Noctuidae	*Allophyes corsica*	(Spuler, 1905)	San Rossore
Arctiidae	*Amata phegea*	(Linnaeus, 1758)	San Rossore
Noctuidae	*Amphipyra berbera*	Rungs, 1949	San Rossore
Noctuidae	*Anarta myrtilli*	(Linné, 1761)	San Rossore
Noctuidae	*Apamea scolopacina*	(Esper, 1788)	San Rossore
Limacodinae	*Apodia limacodes*	(Hufnagel, 1766)	San Rossore
Noctuidae	*Aporophyla australis*	(Boisduval, 1829)	San Rossore

Noctuidae	*Aporophyla lutulenta*	(Denis & Schiffermüller, 1775)	San Rossore
Noctuidae	*Aporophyla nigra*	(Haworth, 1809)	San Rossore
Arctiidae	*Arctia villica*	(Linnaeus, 1758)	San Rossore
Lymantridae	*Arctornis l-nigrum*	(Müller, 1764)	San Rossore
Lycaenidae	*Aricia agestis*	(Denis & Schiffermuller, 1775)	San Rossore
Geometridae	*Ascotis selenaria*	(Denis & Schiffermüller, 1775)	San Rossore
Noctuidae	*Autographa gamma*	(Linné, 1758)	San Rossore
Noctuidae	*Axylia putris*	(Linné, 1761)	San Rossore
Nolidae	*Bena bicolorana*	(Fuessly, 1775)	San Rossore
Geometridae	*Biston stratarius*	(Hufnagel, 1767)	San Rossore
Geometridae	*Cabera exanthemata*	(Scopoli, 1763)	San Rossore
Lymantridae	*Calliteara pudibunda*	(Linnaeus, 1758)	San Rossore
Geometridae	*Campaea honoraria*	(Denis & Schiffermüller, 1775)	San Rossore
Geometridae	*Campaea margaritata*	(Linnaeus, 1767)	San Rossore
Geometridae	*Camptogramma bilineatum*	(Linnaeus, 1758)	San Rossore
Noctuidae	*Caradrina morpheus*	(Hufnagel, 1766)	San Rossore
Hesperiidae	*Carcharodus alceae*	(Esper, 1780)	San Rossore
Noctuidae	*Catephia alchymista*	(Denis & Schiffermüller, 1775)	San Rossore
Noctuidae	*Catocala conjuncta*	(Esper, 1787)	San Rossore
Noctuidae	*Catocala dilecta*	(Hübner,1808)	San Rossore
Noctuidae	*Catocala electa*	(Vieweg, 1790)	San Rossore
Noctuidae	*Catocala elocata*	(Esper, 1787)	San Rossore
Noctuidae	*Catocala nupta*	(Linnaeus, 1767)	San Rossore
Noctuidae	*Catocala nymphagoga*	(Esper, 1787])	San Rossore
Noctuidae	*Charanyca trigrammica*	(Hufnagel, 1766)	San Rossore
Nymphalidae	*Charaxes jasius*	(Linnaeus, 1766)	Macchia di San Rossore
Geometridae	*Chloroclystis v-ata*	(Haworth, 1809)	San Rossore
Noctuidae	*Chortodes pygmina*	(Haworth, 1809)	San Rossore
Noctuidae	*Clopophasia platyptera*	(Esper, 1788)	San Rossore
Notodontidae	*Clostera curtula*	(Linnaeus, 1758)	San Rossore
Notodontidae	*Clostera pigra*	(Hufnagel,	San Rossore

		1766)	
Noctuidae	*Clytie illunaris*	(Hübner, 1813)	San Rossore
Nymphalidae	*Coenonympha pamphilus*	(Linneo, 1758)	San Rossore
Pieridae	*Colias crocea*	(Fourcroy, 1785)	San Rossore
Noctuidae	*Colobochyla salicalis*	(Denis & Schiffermüller, 1775)	San Rossore
Pantheidae	*Colocasia coryli*	(Linné, 1758)	San Rossore
Geometridae	*Colostygia pectinataria*	(Knoch, 1781)	San Rossore
Noctuidae	*Conistra erythrocephala*	(Denis & Schiffermüller, 1775)	San Rossore
Noctuidae	*Conistra vaccinii*	(Linné, 1761)	San Rossore
Arctiidae	*Coscinia cribraria*	(Linnaeus, 1758)	San Rossore
Geometridae	*Cosmorhoe ocellata*	(Linnaeus, 1758)	San Rossore
Cossidae	*Cossus cossus*	(Linneo, 1758)	San Rossore
Geometridae	*Costaconvexa polygrammata*	(Borkhausen, 1794)	San Rossore
Noctuidae	*Craniophora ligustri*	(Denis & Schiffermüller, 1775)	San Rossore
Geometridae	*Crocallis elinguaria*	(Linnaeus, 1758)	San Rossore
Noctuidae	*Cryphia algae*	(Fabricius, 1775)	San Rossore
Noctuidae	*Cryphia muralis*	(Forster, 1771)	San Rossore
Noctuidae	*Cryphia ochsi*	Boursin, 1940	San Rossore
Noctuidae	*Cryphia pallida*	(Bethune-Baker, 1894)	San Rossore
Noctuidae	*Ctenoplusia accentifera*	(Lefebvre, 1827)	San Rossore
Geometridae	*Cyclophora annulata*	(Schulze, 1775)	San Rossore
Geometridae	*Cyclophora punctaria*	(Linnaeus, 1758)	San Rossore
Geometridae	*Cyclophora puppillaria*	(Hübner, 1799)	San Rossore
Geometridae	*Cyclophora ruficiliaria*	(Herrich-Schäffer, 1855)	San Rossore
Noctuidae	*Daubeplusia daubei*	(Boisduval, 1840)	San Rossore
Sphingidae	*Deilephila porcellus*	(Linneo, 1758)	San Rossore
Noctuidae	*Deltote bankiana*	(Fabricius, 1775)	San Rossore
Lasiocampidae	*Dendrolimus pini*	(Linneo, 1758)	San Rossore
Noctuidae	*Diachrysia chrysitis*	(Linné, 1758)	San Rossore
Arctiidae	*Diaphora mendica*	(Clerck, 1759)	San Rossore
Notodontidae	*Drymonia dodonaea*	(Denis & Schiffermüller, 1775)	San Rossore
Notodontidae	*Drymonia ruficornis*	(Hufnagel, 1766)	San Rossore

Noctuidae	*Dryobotodes monochroma*	(Esper, 1790)	San Rossore
Noctuidae	*Dryobotodes tenebrosa*	(Esper, 1813)	San Rossore
Noctuidae	*Dypterygia scabriuscula*	(Linné, 1758)	San Rossore
Arctiidae	*Dysauxes famula*	(Freyer, 1836)	San Rossore
Noctuidae	*Dysgonia algira*	(Linnaeus, 1767)	San Rossore
Geometridae	*Ectropis crepuscularia*	(Denis & Schiffermüller, 1775)	San Rossore
Noctuidae	*Egira conspicillaris*	(Linné, 1758)	San Rossore
Arctiidae	*Eilema caniola*	(Hübner, [1808])	San Rossore
Arctiidae	*Eilema deplana*	(Esper, 1787)	San Rossore
Arctiidae	*Eilema pygmaeola*	(Doubleday, 1847)	San Rossore
Arctiidae	*Eilema sororcula*	(Hufnagel, 1766)	San Rossore
Noctuidae	*Elaphria venustula*	(Hübner 1790)	San Rossore
Noctuidae	*Emmelia trabealis*	(Scopoli, 1763)	San Rossore
Geometridae	*Emmiltis pygmaearia*	(Hübner, 1809)	San Rossore
Geometridae	*Ennomos fuscantarius*	(Haworth, 1809)	San Rossore
Geometridae	*Epione repandaria*	(Hufnagel, 1767)	San Rossore
Geometridae	*Epirrhoe alternata*	(Müller, 1764)	San Rossore
Geometridae	*Epirrita christyi*	(Allen, 1906)	San Rossore
Noctuidae	*Eublemma candidana*	(Fabricius, 1794)	San Rossore
Noctuidae	*Eublemma ostrina*	(Hübner, 1808)	San Rossore
Noctuidae	*Eublemma parva*	(Hübner, 1808)	San Rossore
Noctuidae	*Eublemma purpurina*	(Denis & Schiffermüller, 1775)	San Rossore
Noctuidae	*Eublemma viridula*	(Guenée, 1841)	San Rossore
Geometridae	*Euchoeca nebulata*	(Scopoli, 1763)	San Rossore
Geometridae	*Eucrostes indigenata*	(de Villers, 1789)	San Rossore
Geometridae	*Eupithecia centaureata*	(Denis & Schiffermüller, 1775)	San Rossore
Geometridae	*Eupithecia dodoneata*	Guenée, 1857	San Rossore
Geometridae	*Eupithecia ericeata*	(Rambur, 1833)	San Rossore
Geometridae	*Eupithecia liguriata*	Millière, 1884	San Rossore
Geometridae	*Eupithecia sardoa*	Dietze, 1918	San Rossore
Geometridae	*Eupithecia scopariata*	(Rambur, 1833)	San Rossore
Geometridae	*Eupithecia virgaureata*	Doubleday, 1861	San Rossore
Arctiidae	***Euplagia quadripunctaria* (Jersey Tiger)**	**(Poda, 1761)**	**San Rossore**

Noctuidae	*Eupsilia transversa*	(Hufnagel, 1766)	San Rossore
Noctuidae	*Euschesis janthina*	(Denis & Schiffermüller, 1775)	San Rossore
Noctuidae	*Eutelia adulatrix*	(Hübner, [1813])	San Rossore
Noctuidae	*Euxoa segnilis*	(Duponchel, 1836)	San Rossore
Notodontidae	*Furcula bifida*	(Brahm, 1787)	San Rossore
Notodontidae	*Furcula furcula*	(Clerck, 1759)	San Rossore
Hesperiidae	*Gegenes pumilio*	(Hoffmannegg, 1804)	San Rossore
Geometridae	*Godonella aestimaria*	(Hubner, 1809)	San Rossore
Noctuidae	*Grammodes bifasciata*	(Petagna, 1787)	San Rossore
Geometridae	*Gymnoscelis rufifasciata*	(Haworth, 1809)	San Rossore
Drepanidae	*Habrosyne pyritoides*	(Hufnagel,1766)	San Rossore
Noctuidae	*Hadena confusa*	(Hufnagel, 1766)	San Rossore
Noctuidae	*Hadena luteago*	(Denis & Schiffermüller, 1775)	San Rossore
Noctuidae	*Heliothis peltigera*	(Denis & Schiffermüller, 1775)	San Rossore
Noctuidae	*Herminia grisealis*	(Denis & Schiffermüller, 1775)	San Rossore
Noctuidae	*Herminia tarsicrinalis*	(Knoch, 1782)	San Rossore
Limacodinae	*Heterogenea asella*	(Denis & Schiffermuller, 1775)	San Rossore
Nymphalidae	*Hipparchia statilinus*	(Hufnagel, 1766)	San Rossore
Noctuidae	*Hoplodrina ambigua*	(Denis & Schiffermüller, 1775)	San Rossore
Geometridae	*Horisme tersata*	(Denis & Schiffermüller, 1775)	San Rossore
Sphingidae	*Hyles euphorbiae*	(Linneo, 1758)	San Rossore
Arctiidae	*Hyphoraia testudinaria*	(Geoffroy, 1785)	San Rossore
Geometridae	*Hypomecis punctinalis*	(Scopoli, 1763)	San Rossore
Geometridae	*Hypomecis roboraria*	(Denis & Schiffermüller, 1775)	San Rossore
Geometridae	*Idaea aversata*	(Linnaeus, 1758)	San Rossore
Geometridae	*Idaea degeneraria*	(Hübner, 1799)	San Rossore
Geometridae	*Idaea deversaria*	(Herrich-Schäffer, 1847)	San Rossore
Geometridae	*Idaea dimidiata*	(Hufnagel, 1767)	San Rossore

Geometridae	*Idaea filicata*	(Hübner, 1799)	San Rossore
Geometridae	*Idaea politata*	(Hübner, 1793)	San Rossore
Geometridae	*Idaea rusticata*	(Denis & Schiffermüller, 1775)	San Rossore
Geometridae	*Idaea straminata*	(Borkhausen, 1794)	San Rossore
Geometridae	*Idaea subsericeata*	(Haworth, 1809)	San Rossore
Noctuidae	*Ipimorpha retusa*	(Linné, 1761)	San Rossore
Noctuidae	*Lacanobia oleracea*	(Linné, 1758)	San Rossore
Lymantriidae	*Laelia coenosa*	(Hübner, 1808)	Lago di Massaciuccoli
Noctuidae	*Lampra tirrenica*	(Biebinger, Speidel & Hanigk, 1983)	San Rossore
Sphingidae	*Laothoe populi*	(Linneo, 1758)	San Rossore
Lasiocampidae	*Lasiocampa quercus*	(Linneo, 1758)	San Rossore
Lasiocampidae	*Lasiocampa trifolii*	(Denis & Schiffermuller, 1775)	San Rossore
Nymphalidae	*Lasiommata megera*	(Linné, 1767)	San Rossore
Noctuidae	*Lasionycta calberlai*	(Staudinger, 1883)	San Rossore
Noctuidae	*Laspeyria flexula*	(Denis & Schiffermüller, 1775)	San Rossore
Pieridae	*Leptidea sinapis*	(Linnaeus, 1758)	Marina di Pisa
Lycaenidae	*Leptotes pirithous*	(Linneo, 1767)	San Rossore
Noctuidae	*Leucania obsoleta*	(Hübner, 1803)	San Rossore
Geometridae	*Ligdia adustata*	(Denis & Schiffermüller, 1775)	San Rossore
Nymphalidae	*Limenitis camilla*	(Linnaus, 1764)	Marina di Pisa
Nymphalidae	*Limenitis reducta*	Staudinger, 1901	pineta litoranea, macchia di Migliarino
Arctiidae	*Lithosia quadra*	(Linnaeus, 1758)	San Rossore
Geometridae	*Lobophora halterata*	(Hufnagel, 1767)	San Rossore
Geometridae	*Lomaspilis marginata*	(Linnaeus, 1758)	San Rossore
Geometridae	*Lomographa bimaculata*	(Fabricius, 1775)	San Rossore
Noctuidae	*Luperina dumerilii*	(Duponchel, 1835)	San Rossore
Lycaenidae	*Lycaena alciphron*	(Rottemburg, 1775)	Vione di Sant'Antonio; Stazione di Tombolo
Lycaenidae	***Lycaena dispar* (Large Copper)**	**(Haworth, 1803)**	**Massaciuccoli, Padule di Viareggio, Bonifica della Costanza**
Lycaenidae	*Lycaena phlaeas*	(Linneo, 1761)	San Rossore
Lycaenidae	*Lycaena phlaeas*	(Linnaeus, 1761)	Tenuta di San Rossore

Geometridae	*Lycia hirtaria*	(Clerck, 1759)	San Rossore
Noctuidae	*Lygephila craccae*	(Denis & Schiffermüller, 1775)	San Rossore
Lymantridae	*Lymantria dispar*	(Linnaeus, 1758)	San Rossore
Noctuidae	*Macdunnoughia confusa*	(Stephens, 1850)	San Rossore
Sphingidae	*Macroglossum stellatarum*	(Linneo, 1758)	San Rossore
Lasiocampidae	*Macrothylacia rubi*	(Linneo, 1758)	San Rossore
Noctuidae	*Mamestra brassicae*	(Linné, 1758)	San Rossore
Nymphalidae	*Maniola jurtina*	(Linneo, 1758)	San Rossore
Noctuidae	*Meganephria bimaculosa*	(Linné, 1767)	San Rossore
Nolidae	*Meganola albula*	(Denis & Schiffermüller, 1775)	San Rossore
Nymphalidae	*Melitaea didyma*	(Esper, 1778)	Marina di Pisa
Geometridae	*Menophra abruptaria*	(Thunberg, 1792)	San Rossore
Geometridae	*Menophra japygiaria*	(O. Costa, 1849)	San Rossore
Noctuidae	*Mesapamea secalis*	(Linné, 1758)	San Rossore
Arctiidae	*Miltochrista miniata*	(Forster, 1771)	San Rossore
Sphingidae	*Mimas tiliae*	(Linneo, 1758)	San Rossore
Noctuidae	*Minucia lunaris*	(Denis & Schiffermüller, 1775)	San Rossore
Noctuidae	*Moma alpium*	(Osbeck, 1778)	San Rossore
Noctuidae	*Mythimna turca*	(Linné, 1761)	San Rossore
Noctuidae	*Mythimna unipunctata*	(Haworth, 1809)	San Rossore
Noctuidae	*Noctua pronuba*	(Linné, 1758)	San Rossore
Nolidae	*Nola aerugula*	(Hübner 1793)	San Rossore
Nolidae	*Nola chlamitulalis*	(Hübner, 1813)	San Rossore
Notodontidae	*Notodonta dromedarius*	(Linnaeus, 1767)	San Rossore
Notodontidae	*Notodonta tritophus*	(Denis & Schiffermüller, 1775)	San Rossore
Nolidae	*Nycteola asiatica*	(Krulikowsky, 1904)	San Rossore
Noctuidae	*Ochropleura leucogaster*	(Freyer, 1831)	San Rossore
Noctuidae	*Ochropleura plecta*	(Linné, 1761)	San Rossore
Lasiocampidae	*Odonestis pruni*	(Linneo, 1758)	San Rossore
Noctuidae	*Ophiusa tirhaca*	(Cramer, 1777)	San Rossore
Geometridae	*Orthonama obstipata*	(Fabricius, 1794)	San Rossore
Noctuidae	*Orthosia cerasi*	(Fabricius, 1775)	San Rossore
Noctuidae	*Orthosia gothica*	(Linné, 1766)	San Rossore

Noctuidae	*Orthosia gracilis*	(Denis & Schiffermüller, 1775)	San Rossore
Noctuidae	*Orthosia incerta*	(Hufnagel, 1766)	San Rossore
Geometridae	*Pachycnemia hippocastanaria*	(Hübner, 1799)	San Rossore
Noctuidae	*Paracolax tristalis*	(Fabricius, 1794)	San Rossore
Noctuidae	*Paranoctua comes*	Hübner, 1813	San Rossore
Noctuidae	*Paranoctua interjecta*	Hübner, 1803	San Rossore
Nymphalidae	*Pararge aegeria*	(Linneo, 1758)	San Rossore
Noctuidae	*Parascotia fuliginaria*	(Linné, 1761)	San Rossore
Noctuidae	*Parascotia nisseni*	(Turati, 1905)	San Rossore
Noctuidae	*Paucgraphia erythrina*	(Herrich-Schäffer,1852)	San Rossore
Noctuidae	*Pechipogo plumigeralis*	(Hubner, 1825)	San Rossore
Arctiidae	*Pelosia muscerda*	(Hufnagel, 1766)	San Rossore
Geometridae	*Peribatodes rhomboidarius*	(Denis & Schiffermüller, 1775)	San Rossore
Notodontidae	*Peridea anceps*	(Goeze, 1781)	San Rossore
Noctuidae	*Peridroma saucia*	(Hübner, 1808)	San Rossore
Geometridae	*Perizoma bifaciatum*	(Haworth, 1809)	San Rossore
Notodontidae	*Phalera bucephala*	(Linnaeus, 1758)	San Rossore
Notodontidae	*Phalera bucephaloides*	(Ochsenheimer, 1810)	San Rossore
Notodontidae	*Pheosia tremula*	(Clerck, 1759)	San Rossore
Noctuidae	*Phlogophora meticulosa*	(Linné, 1758)	San Rossore
Arctiidae	*Phragmatobia fuliginosa*	(Linnaeus, 1758)	San Rossore
Noctuidae	*Phyllophila obliterata*	(Rambur, 1833)	San Rossore
Pieridae	*Pieris edusa*	(Linneo, 1758)	San Rossore
Pieridae	*Pieris mannii*	(Mayer, 1851)	Migliarino
Pieridae	*Pieris napi*	(Linneo, 1758)	San Rossore
Pieridae	*Pieris rapae*	(Linneo, 1758)	San Rossore
Noctuidae	*Platyperigea kadenii*	(Freyer, 1836)	San Rossore
Lasiocampidae	*Poecillocampa alpina*	(Frey & Wullschlegel, 1874)	San Rossore
Lycaenidae	*Polymmatus icarus*	(Rottemburg, 1775)	San Rossore
Noctuidae	*Protodeltote pygarga*	(Hufnagel, 1766)	San Rossore
Noctuidae	*Proxenus hospes*	(Freyer, 1831)	San Rossore
Notodontidae	*Pterostoma palpina*	(Clerck, 1759)	San Rossore
Notodontidae	*Ptilodontella cucullina*	(Denis & Schiffermüller, 1775)	San Rossore

Hesperiidae	*Pyrgus armoricanus*	(Oberthur, 1920)	San Rossore
Nymphalidae	*Pyronia tithonus*	(Linneo, 1767)	San Rossore
Noctuidae	*Pyrrhia umbra*	(Hufnagel, 1766)	San Rossore
Geometridae	*Rhinoprora rectangulata*	(Linnaeus, 1758)	San Rossore
Noctuidae	*Rhizedra lutosa*	(Hübner, 1803)	San Rossore
Geometridae	*Rhodometra sacraria*	(Linnaeus, 1767)	San Rossore
Geometridae	*Rhoptria asperaria*	(Hübner, 1817)	San Rossore
Noctuidae	*Rivula sericealis*	(Scopoli, 1763)	San Rossore
Noctuidae	*Rusina ferruginea*	(Esper, 1785)	San Rossore
Noctuidae	*Sablia scirpi*	(Duponchel, 1836)	San Rossore
Saturniidae	*Saturnia pyri*	(Denis & Schiffermuller, 1775)	San Rossore
Noctuidae	*Schrankia costaestrigalis*	(Stephens, 1834)	San Rossore
Geometridae	*Scopula caricaria*	(Reutti, 1853)	San Rossore
Geometridae	*Scopula emutaria*	(Hübner,1809)	San Rossore
Geometridae	*Scopula imitaria*	(Hübner, 1799)	San Rossore
Geometridae	*Scopula marginepunctata*	(Goeze, 1781)	San Rossore
Geometridae	*Scopula minorata*	(Boisduval, 1833)	San Rossore
Geometridae	*Scopula nigropunctata*	(Hufnagel, 1767)	San Rossore
Geometridae	*Scopula ornata*	(Scopoli, 1763)	San Rossore
Geometridae	*Scopula rubiginata*	(Hufnagel, 1767)	San Rossore
Geometridae	*Selenia dentaria*	(Fabricius, 1775)	San Rossore
Geometridae	*Selenia lunularia*	(Hübner, 1788)	San Rossore
Noctuidae	*Sesamia cretica*	Lederer, 1857	San Rossore
Noctuidae	*Sesamia nonagrioides*	(Lefebvre, 1827)	San Rossore
Sphingidae	*Sphinx ligustri*	(Linneo, 1758)	San Rossore
Lymantridae	*Sphrageidus similis*	(Fuessly, 1775)	San Rossore
Arctiidae	*Spilosoma lubricipedum*	(Linnaeus, 1758)	San Rossore
Arctiidae	*Spilosoma luteum*	(Hufnagel, 1766)	San Rossore
Noctuidae	*Spodoptera exigua*	(Hübner, 1808)	San Rossore
Noctuidae	*Spudaea ruticilla*	(Esper, [1791])	San Rossore
Notodontidae	*Stauropus fagi*	(Linnaeus, 1758)	San Rossore
Geometridae	*Stegania trimaculata*	(de Villers, 1789)	San Rossore
Geometridae	*Sthanelia tibiaria*	(Rambur, 1829)	San Rossore
Drepanidae	*Tethea ocularis*	(Linneo, 1767)	San Rossore

Noctuidae	*Thalpophila matura*	(Hufnagel, 1766)	San Rossore
Notodontidae	*Thaumetopea processionea*	(Linnaeus, 1758)	San Rossore
Noctuidae	*Tholera decimalis*	(Poda, 1761)	San Rossore
Drepanidae	*Thyatira batis*	(Linneo, 1758)	San Rossore
Hesperiidae	*Thymelicus acteon*	(Rottemburg, 1775)	San Rossore
Noctuidae	*Trachea atriplicis*	(Linné, 1758)	San Rossore
Notodontidae	*Traumatocampa pityocampa*	(Denis & Schiffermüller, 1775)	San Rossore
Noctuidae	*Trichoplusia ni*	(Hübner, [1803])	San Rossore
Geometridae	*Trichopteryx carpinata*	(Borkhausen, 1794)	San Rossore
Noctuidae	*Trigonophora flammea*	(Esper, 1785)	San Rossore
Noctuidae	*Trisateles emortualis*	(Denis & Schiffermüller, 1775)	San Rossore
Noctuidae	*Tyta luctuosa*	(Denis & Schiffermüller, 1775)	San Rossore
Nymphalidae	*Vanessa atalanta*	(Linneo, 1758)	San Rossore
Nymphalidae	*Vanessa cardui*	(Linneo, 1758)	San Rossore
Drepanidae	*Watsonalla uncinula*	(Borkhausen, 1790)	San Rossore
Noctuidae	*Xanthia aurago*	(Denis & Schiffermüller, 1775)	San Rossore
Noctuidae	*Xanthia gilvago*	(Denis & Schiffermüller, 1775)	San Rossore
Geometridae	*Xanthorhoe ferrugata*	(Clerck, 1759)	San Rossore
Noctuidae	*Xestia agathina*	(Duponchel, 1827)	San Rossore
Noctuidae	*Xestia castanea*	(Esper, 1798)	San Rossore
Noctuidae	*Xestia c-nigrum*	(Linné, 1758)	San Rossore
Noctuidae	*Xestia sexstrigata*	(Haworth, 1809)	San Rossore
Noctuidae	*Xestia xanthographa*	(Denis & Schiffermüller, 1775)	San Rossore
Noctuidae	*Xylena exsoleta*	(Linné, 1758)	San Rossore
Noctuidae	*Zebeeba falsalis*	(Herrich-Schäffer, 1839)	San Rossore
Papilionidae	*Zerynthia cassandra (Z. polyxena* pars)	(Geyer, 1828)	Marina di Pisa

Annex 3. List of Coleoptera found in the MSRM Park. **Species in marked in red are endangered red list species.**

Family	***Specie***	**Author**	**Locality**
Histeridae	*Abraeus perpusillus*	(Marsham, 1802)	Tenuta di San Rossore
Dytiscidae	*Acilius canaliculatus*	(Nicolai, 1822)	Marina di Torre del Lago Puccini, Torre del Lago Puccini, Migliarino, Tenuta del Tombolo
Dytiscidae	*Acilius sulcatus*	(Linnaeus, 1758)	Calambrone, Marina di Torre del Lago Puccini, Tenuta del Tombolo
Buprestidae	*Acmaeodera bipunctata*	(Olivier, 1790)	San Rossore
Histeridae	*Acritus homoeopathicus*	Wollaston, 1857	Marina di Torre del Lago Puccini, dintorni, loc. Torre del Lago Puccini
Carabidae	*Acupalpus maculatus*	(Schaum, 1860)	San Rossore
Carabidae	*Acupalpus notatus*	Mulsant & Rey, 1861	San Rossore
Carabidae	*Acupalpus paludicola*	Reitter, 1884	San Rossore
Elateridae	*Adrastus limbatus*	(Fabricius, 1776)	Gombo
Elateridae	*Adrastus rachifer*	(Fourcroy, 1785)	Gombo; Marina di Pisa
Elateridae	*Aeoloderma crucifer*	(Rossi, 1790)	Tombolo
Dytiscidae	*Agabus biguttatus*	(Olivier, 1795)	Gombo
Dytiscidae	*Agabus bipustulatus*	(Linnaeus, 1767)	Gombo, Marina di Torre del Lago Puccini, Migliarino, Tenuta di San Rossore, Tenuta del Tombolo
Dytiscidae	*Agabus brunneus*	(Fabricius, 1798)	Marina di Torre del Lago Puccini
Dytiscidae	*Agabus conspersus*	(Marsham, 1802)	Migliarino, Tenuta di San Rossore
Dytiscidae	*Agabus didymus*	(Olivier, 1795)	Migliarino
Dytiscidae	*Agabus nebulosus*	(Forster, 1771)	Gombo, Marina di Torre del Lago Puccini, Migliarino, Tenuta di San Rossore, Tenuta del Tombolo
Dytiscidae	*Agabus pederzanii*	Fery & Nilsson, 1993	Marina di Torre del Lago Puccini, Migliarino, Tenuta di San Rossore, Tenuta del Tombolo, Viareggio
Dytiscidae	*Agabus striolatus*	(Gyllenhal, 1808)	San Rossore (negli stagni)
Chrysomelidae	*Agelastica alni*	(Linné, 1758)	San Rossore
Carabidae	*Agonum afro*	(Duftschmid, 1812)	San Rossore
Carabidae	*Agonum longicorne*	(Chaudoir, 1846)	San Rossore
Carabidae	*Agonum lugens*	(Duftschmid,	San Rossore

		1812)	
Carabidae	*Agonum nigrum*	(Dejan, 1828)	San Rossore
Carabidae	*Agonum sordidum gridellii*	(Schatzmayr, 1912)	San Rossore
Aphodiidae	*Agrilinus ater*	(Degeer, 1774)	San Rossore
Aphodiidae	*Agrilinus convexus*	(Erichson, 1848)	San Rossore, Sterpaia, Torre Riccardi
Buprestidae	*Agrilus albogularis artemisiae*	Brisout, 1863	Marina di Pisa
Buprestidae	*Agrilus angustulus*	(Illiger, 1803)	Migliarino
Buprestidae	*Agrilus derasofasciatus*	Lacordaire, 1835	Marina di Pisa
Buprestidae	*Agrilus graminis*	Castelnau & Gory, 1837	Migliarino
Buprestidae	*Agrilus olivicolor*	Kiesenwetter, 1857	Migliarino
Buprestidae	*Agrilus viridicoerulans rubi*	Schaefer, 1937	San Rossore
Elateridae	*Agriotes aequalis*	Schwarz, 1891	Gombo
Elateridae	*Agriotes brevis*	Candèze, 1863	Gombo
Elateridae	*Agriotes lineatus*	(Linnaeus, 1767)	Gombo; Marina di Pisa
Elateridae	*Agriotes proximus*	Schwarz, 1891	Gombo
Elateridae	*Agrypnus crenicollis*	(Ménétriés, 1832)	Gombo
Elateridae	*Agrypnus murinus*	(Linnaeus, 1758)	Tenuta di San Rossore; Tombolo
Cerambycidae	*Alosterna tabacicolor*	(DeGeer, 1775)	San Rossore
Melolonthidae	*Amadotrogus grassii*	(Mainardi, 1902)	Tenuta di San Rossore, Fiume Morto Vecchio
Carabidae	*Amara aenea*	(Degeer, 1774)	San Rossore
Carabidae	*Amara montana*	(Dejan, 1828)	San Rossore
Carabidae	*Amara similata*	(Gyllenhal, 1810)	San Rossore
Carabidae	*Amblystomus levantinus*	(Reitter, 1883)	San Rossore
Carabidae	*Amblystomus niger*	(Heer, 1838)	San Rossore
Elateridae	*Ampedus cardinalis*	(Schiödte, 1865)	Tenuta di San Rossore
Elateridae	*Ampedus glycereus*	(Herbst, 1784)	Gombo
Elateridae	*Ampedus pomorum*	(Herbst, 1784)	Tenuta di San Rossore
Elateridae	*Ampedus praeustus*	(Fabricius, 1792)	Tenuta di San Rossore; Tombolo
Elateridae	*Ampedus sanguinolentus*	(Schrank, 1776)	Tenuta di San Rossore; Tombolo; Migliarino; Marina di Torre del Lago Puccini
Melolonthidae	*Amphimallon solstitiale*	(Linné, 1758)	San Rossore
Hydrophilidae	*Anacaena globulus*	(Paykull, 1798)	Gombo
Hydrophilidae	*Anacaena limbata*	(Fabricius, 1792)	Tenuta di San Rossore; Marina di Torre del Lago Puccini
Carabidae	*Anchomenus dorsalis*	(Pontoppidan, 1763)	San Rossore

Carabidae	*Anillus bordonii*	(Magrini & Vanni, 1993)	San Rossore
Carabidae	*Anisodactylus intermedius*	(Dejan, 1829)	San Rossore
Rutelidae	*Anomala devota*	(Rossi, 1790)	San Rossore, Torre Riccardi, Foce Fiume Morto Vecchio, Il Boschetto
Melolonthidae	*Anoxia matutinalis matutinalis*	Castelnau, 1832	San Rossore, Gombo dint., Stabilimento balneare
Buprestidae	*Anthaxia godeti*	Castelnau & Gory, 1847	Migliarino
Buprestidae	*Anthaxia nigritula*	Ratzeburg, 1837	San Rossore
Buprestidae	*Anthaxia thalassophila*	Abeille, 1900	San Rossore
Carabidae	*Anthracus longicornis*	(Schaum, 1857)	San Rossore
Carabidae	*Anthracus quarnerensis*	(Reitter, 1884)	San Rossore
Buprestidae	*Aphanisticus pusillus*	(Olivier, 1790)	Marina di Pisa
Curculionidae	*Aphanommata filum*	(Mulsant & Rey, 1859)	Tenuta di San Rossore
Aphodidae	*Aphodius biguttatus*	Germar, 1824	Tenuta del Tombolo
Aphodiidae	*Aphodius borealis*	Gyllenhal,1827	San Rossore
Aphodiidae	*Aphodius consputus*	Creutzer, 1799	San Rossore
Aphodiidae	*Aphodius convexus*	Erichson, 1848	San Rossore
Aphodiidae	*Aphodius costans*	Duftschmid, 1805	San Rossore
Aphodiidae	*Aphodius fimetarius*	(Linné, 1758)	San Rossore, Sterpaia
Aphodiidae	*Aphodius foetidus*	(Herbst, 1783)	San Rossore, Sterpaia
Aphodiidae	*Aphodius ghardimaouensis*	Balthasar,1929	San Rossore
Aphodiidae	*Aphodius granarius*	(Linneo, 1767)	San Rossore
Aphodiidae	*Aphodius haemorrhoidalis*	(Linneo, 1758)	San Rossore
Aphodiidae	*Aphodius lineolatus*	Illiger, 1803	San Rossore
Aphodiidae	*Aphodius lividus*	(Olivier, 1789)	San Rossore
Aphodiidae	*Aphodius luridus*	(Fabricius, 1775)	San Rossore
Aphodiidae	*Aphodius paracoenosus*	Balthasar & Hrubant, 1960	San Rossore
Aphodiidae	*Aphodius porcus*	(Fabricius, 1792)	San Rossore
Aphodiidae	*Aphodius prodromus*	(Brahm, 1790)	San Rossore
Aphodiidae	*Aphodius pusillus*	(Herbst, 1789)	San Rossore
Aphodiidae	*Aphodius quadrimaculatus*	(Linneo, 1761)	San Rossore
Aphodiidae	*Aphodius scrofa*	(Fabricius, 1787)	San Rossore
Aphodiidae	*Aphodius sticticus*	(Panzer,1798)	San Rossore
Aphodiidae	*Aphodius stolzi*	Reitter, 1906	San Rossore
Aphodiidae	*Aphodius uliginosus*	(Hardy,1847)	San Rossore
Chrysomelidae	*Aphthona abdominalis*	(Duftschmid, 1825)	Tenuta di San Rossore
Chrysomelidae	*Aphthona flava*	Guillebaume,	Tenuta di San Rossore

		1894	
Chrysomelidae	*Aphthona nonstriata*	(Goeze, 1777)	Tenuta di San Rossore
Chrysomelidae	*Aphthona pygmaea*	Kutschera, 1861	Tenuta di San Rossore
Carabidae	*Apotomus rufithorax*	(Pecchioli, 1838)	San Rossore
Carabidae	*Apotomus rufus*	(Rossi, 1790)	San Rossore
Carabidae	*Argutor cursor*	(Dejan, 1828)	San Rossore
Carabidae	*Argutor vernalis*	(Panzer, 1796)	San Rossore
Cerambycidae	*Arhopalus syriacus*	(Reitter, 1895)	San Rossore
Chrysomelidae	*Arrhenocoela lineata*	(Rossi, 1790)	Tenuta di Coltano
Carabidae	*Artabas punctatostriatus*	(Dejan, 1829)	San Rossore
Carabidae	*Asaphidion curtum*	(Heyden, 1870)	San Rossore
Carabidae	*Asaphidion rossii*	(Schaum, 1857)	San Rossore
Carabidae	*Asaphidion stierlini*	(Heyden, 1880)	San Rossore
Tenebrionidae	*Asida sabulosa*	(Fuesslin, 1775)	Marina di Torre del Lago Puccini
Histeridae	*Atholus bimaculatus*	(Linnaeus, 1758)	Tirrenia
Histeridae	*Atholus corvinus*	(Germar, 1817)	Marina di Pisa
Elateridae	*Athous vittatus*	(Gmelin, 1790)	Gombo
Cryptophagidae	*Atomaria pusilla*	(Paykull, 1798)	Tenuta di San Rossore
Attelabidae	*Attelabus nitens*	(Scopoli, 1763)	Migliarino
Attelabidae	*Auletobius politus*	(Serville, 1825)	Tenuta di Coltano; Migliarino
Carabidae	*Badister meridionalis*	(Puel, 1925)	San Rossore
Carabidae	*Badister unipustulatus*	(Bonelli, 1813)	San Rossore
Curculionidae	*Bagous rufimanus*	Hoffmann, 1954	Torre del Lago Puccini
Pselaphidae	*Batrisodes oculatus*	(Aubé, 1833)	Tenuta del Tombolo
Pselaphidae	*Batrisodes venustus*	(Reichenbach, 1816)	Tenuta del Tombolo
Carabidae	*Baudia dilatata*	(Chaudoir, 1837)	San Rossore
Hydrophilidae	*Berosus affinis*	Brullé, 1835	Tenuta di San Rossore; Marina di Torre del Lago Puccini
Hydrophilidae	*Berosus hispanicus*	Küster, 1847	Marina di Torre del Lago Puccini
Hydrophilidae	*Berosus luridus*	(Linnaeus, 1761)	Marina di Torre del Lago Puccini
Hydrophilidae	*Berosus signaticollis*	(Charpentier, 1825)	Tenuta di San Rossore; Marina di Torre del Lago Puccini
Elateridae	*Betarmon bisbimaculatus*	(Fabricius, 1803)	Marina di Torre del Lago Puccini
Pselaphidae	*Bibloplectus delhermi*	Guillebeau, 1888	Tenuta del Tombolo
Pselaphidae	*Bibloplectus obtusus*	Guillebeau, 1888	Migliarino; Torre del Lago Puccini
Pselaphidae	*Bibloplectus pusillus*	(Denny, 1825)	San Rossore; Tenuta del Tombolo
Pselaphidae	*Biblophorus mayeti*	Guillebeau,	Tenuta del Tombolo

		1888	
Dytiscidae	*Bidessus minutissimus*	(Germar, 1824)	Marina di Torre del Lago Puccini, Migliarino
Dytiscidae	*Bidessus pumilus*	(Aubé, 1836)	San Rossore, via del Gombo
Dytiscidae	*Bidessus unistriatus*	(Goeze, 1777)	Viareggio, Torre del Lago, Marina di Torre del Lago Puccini
Aphodiidae	*Bodiloides ictericus ghardimaouensis*	(Balthasar, 1929)	San Rossore, Sterpaia
Carabidae	*Brachinus crepitans*	(Linné, 1758)	San Rossore
Carabidae	*Brachinus exhalans*	(Rossi, 1792)	San Rossore
Carabidae	*Brachinus immaculicornis*	Dejean, 1825	San Rossore
Carabidae	*Brachinus italicus*	(Dejan, 1831)	San Rossore
Carabidae	*Brachinus nigricornis*	(Gebler, 1829)	San Rossore
Carabidae	*Brachinus psophia*	Serville, 1821	San Rossore
Carabidae	*Brachinus sclopeta*	(Fabricius, 1792)	San Rossore
Pselaphidae	*Brachygluta appennina*	(Saulcy, 1876)	Marina di Pisa; Tenuta del Tombolo
Pselaphidae	*Brachygluta fossulata*	(Reichenbach, 1816)	Marina di Pisa; Migliarino; Bocca d'Arno
Pselaphidae	*Brachygluta foveola*	(Motschulsky, 1840)	Bocca d'Arno; Tenuta del Tombolo
Pselaphidae	*Brachygluta furcata picciolii*	(Saulcy, 1876)	Bocca d'Arno; Tenuta del Tombolo
Pselaphidae	*Brachygluta guillemardi*	(Saulcy, 1876)	Tenuta del Tombolo
Pselaphidae	*Brachygluta helferi helferi*	(Schmidt-Goebel, 1836)	Tenuta del Tombolo
Pselaphidae	*Brachygluta lefebvrei*	(Aubé, 1833)	Marina di Pisa
Pselaphidae	*Brachygluta perforata*	(Aubé, 1833)	Tenuta del Tombolo
Pselaphidae	*Brachygluta tibialis*	(Aubé, 1844)	Tenuta del Tombolo; Marina di Torre del Lago Puccini
Pselaphidae	*Brachygluta trigonoprocta*	(Ganglbauer, 1895)	Tenuta del Tombolo
Cerambycidae	*Brachypteroma ottomanum*	Heyden, 1863	Tenuta di San Rossore; Pineta del Tombolo
Curculionidae	*Brachytemnus porcatus*	(Germar, 1824)	Migliarino
Aphodiidae	*Brindalus porcicollis*	(Illiger, 1803)	San Rossore
Pselaphidae	*Bryaxis bulbifer*	(Reichenbach, 1816)	Bocca d'Arno; Marina di Torre del Lago Puccini
Pselaphidae	*Bryaxis chevrolati*	(Aubé, 1833)	Migliarino; Marina di Torre del Lago Puccini
Pselaphidae	*Bryaxis italicus*	(Baudi, 1869)	Marina di Torre del Lago Puccini
Pselaphidae	*Bryaxis pedator*	(Reitter, 1881)	Tenuta del Tombolo
Pselaphidae	*Bryaxis porsenna*	(Reitter, 1881)	Tenuta del Tombolo
Scarabaeidae	*Bubas bison*	(Linneo, 1767)	San Rossore
Buprestidae	*Buprestis novemmaculata*	Linnaeus, 1767	Marina di Pisa
Elateridae	*Calambus bipustulatus*	(Linnaeus, 1767)	Tombolo

Aphodiidae	*Calamosternus granarius*	(Linné, 1767)	San Rossore, Sterpaia
Carabidae	*Calatus fuscipes latus*	(Serville, 1821)	San Rossore
Buprestidae	*Calcophora mariana*	(Linné, 1758)	San Rossore
Curculionidae	*Callirus abietis*	(Linnaeus, 1758)	Tenuta di San Rossore
Cicindelidae	*Calomera littoralis nemoralis*	(Olivier, 1790)	San Rossore, F. Morto Vecchio, Torre del Lago
Carabidae	*Calosoma inquisitor*	(Linnaeus, 1758)	San Rossore
Carabidae	*Caltus cinctus*	(Motschulsky, 1850)	San Rossore
Carabidae	*Carabus alysidotus*	Illiger, 1798	Paludi del Gombo
Carabidae	*Carabus convexus*	Fabricius, 1775	San Rossore
Carabidae	*Carabus granulatus interstitialis*	Duftschmid, 1812	Tenuta di San Rossore, Tenuta del Tombolo
Carabidae	*Carabus rossii*	Dejean, 1826	San Rossore
Elateridae	*Cardiophorus goezei*	Sanchez-Ruiz, 1996	Gombo
Elateridae	*Cardiophorus eleonorae*	(Géné, 1836)	Gombo; Tombolo
Cebrionidae	*Cebrio dubius*	Rossi, 1790	San Rossore, Gombo dint
Cerambycidae	*Cerambyx cerdo*	Linné, 1758	San Rossore
Cerambycidae	*Cerambyx miles*	Bonelli, 1812	Marina di Pisa
Geotrupidae	*Ceratophyus rossii*	Jekel, 1866	San Rossore; Sterpaia, Torre Riccardi
Sphaeridiidae	*Cercyon convexiusculus*	Stephens, 1829	Tenuta del Tombolo
Sphaeridiidae	*Cercyon tristis*	(Illiger, 1801)	Marina di Torre del Lago Puccini
Cetonidae	*Cetonia aurata pisana*	Heer, 1841	San Rossore, Torre Riccardi
Cetoniidae	*Cetonischema aeruginosa*	(Drury, 1770)	San Rossore
Chrysomelidae	*Morimus funereu*	(Motschulsky, 1838)	Tenuta di San Rossore
Chrysomelidae	*Chaetocnema hortensis*	(Geoffroy, 1785)	Tenuta di San Rossore
Chrysomelidae	*Chaetocnema scheffleri*	(Kutschera, 1864)	Tenuta di Coltano
Buprestidae	*Chalcophora massiliensis*	(Villers, 1789)	Marina di Pisa; Tenuta di San Rossore
Buprestidae	*Chalcophorella fabricii*	(Rossi, 1794)	Tenuta di San Rossore
Hydrophilidae	*Chasmogenus livornicus*	(Kuwert, 1890)	Torre del Lago; Tombolo
Aphodiidae	*Chilothorax lineolatus*	(Illiger, 1803)	San Rossore, Il Boschetto
Carabidae	*Chlaeniellus nigricornis*	(Fabricius, 1787)	San Rossore
Carabidae	*Chlaeniellus nitidus*	(Schrank, 1781)	San Rossore
Carabidae	*Chlaeniellus vestitus*	(Paykull, 1790)	San Rossore
Carabidae	*Chlaenius spoliatus*	(Rossi, 1790)	San Rossore
Buprestidae	*Chrysobothris solieri*	Laporte de Castelnau & Gory, 1893	San Rossore, f. Morto Vecchio
Chrysomelidae	*Chrysolina polita*	(Linné, 1758)	San Rossore
Carabidae	*Cicindela majalis*	(Mandl, 1936)	San Rossore

Carabidae	*Clivia fossor*	(Linneo, 1758)	San Rossore
Cerambycidae	*Clytus arietis*	(Linné, 1758)	San Rossore
Sphaeridiidae	*Coelostoma orbiculare*	(Fabricius, 1775)	Gombo; Marina di Torre del Lago Puccini
Dytiscidae	*Colymbetes fuscus*	(Linnaeus, 1758)	Gombo, Torre del Lago Puccini, Migliarino, Marina di Torre del Lago Puccini, Tenuta del Tombolo
Dytiscidae	*Copelatus haemorrhoidalis*	(Fabricius, 1787)	Marina di Torre del Lago Puccini, Migliarino, Torre del Lago Puccini
Scarabaeidae	*Copris hispanus cavolinii*	(Petagna, 1792)	San Rossore, Il Boschetto
Scarabaeidae	*Copris lunarius*	(Linneo, 1758)	San Rossore
Buprestidae	*Coraebus florentinus*	(Herbst, 1801)	Migliarino
Buprestidae	*Coraebus rubi*	(Linnaeus, 1767)	Marina di Pisa
Cerambycidae	*Corymbia cordigera cordigera*	(Fuesslins, 1775)	San Rossore
Chrysomelidae	*Cryptocephalus androgyne pelleti*	Marseul, 1875	Lago di Massaciuccoli
Chrysomelidae	*Cryptocephalus janthinus*	Germar, 1824	Torre del Lago
Chrysomelidae	*Cryptocephalus nitidus*	(Linné, 1758)	San Rossore
Chrysomelidae	*Cryptocephalus pusillus*	Fabricius, 1777	Torre del Lago Puccini
Chrysomelidae	*Cryptocephalus renatae*	Sassi	San Rossore
Chrysomelidae	*Cryptocephalus samniticus*		San Rossore
Chrysomelidae	*Cryptocephalus variegatus*	Fabricius, 1781	Gombo
Cucujidae	*Cryptolestes fractipennis*	(Motschulsky, 1845)	San Rossore
Cryptophagidae	*Cryptophagus fasciatus*	Kraatz, 1852	Gombo
Cryptophagidae	*Cryptophagus lapponicus*	Gyllenhal, 1828	Migliarino
Cryptophagidae	*Cryptophagus laticollis*	Lucas, 1849	Gombo
Cryptophagidae	*Cryptophagus thomsoni*	Reitter, 1875	Gombo
Cryptophagidae	*Curelius exiguus*	(Erichson, 1846)	Marina di Torre del Lago Puccini
Dytiscidae	*Cybister lateralimarginalis*	(De Geer, 1774)	Marina di Torre del Lago Puccini, Tenuta del Tombolo, Tenuta di San Rossore, Tenuta Salviati
Hydrophilidae	*Cymbiodyta marginella*	(Fabricius, 1792)	Gombo; Marina di Torre del Lago Puccini
Carabidae	*Cymindis axillaris*	(Fabricius, 1794)	San Rossore
Endomychidae	*Dapsa trimaculata*	Motschulsky, 1835	Migliarino
Cerambycidae	*Deilus fugax*	(Olivier, 1790)	Pineta del Tombolo
Dytiscidae	*Deronectes moestus incospectus*	(Leprieur, 1876)	Marina di Torre del Lago Puccini
Carabidae	*Diachromus germanus*	(Linné, 1758)	San Rossore
Buprestidae	*Dicerca aenea*	(Linné, 1761)	San Rossore

Elateridae	*Dicronychus cinereus*	(Herbst, 1784)	Migliarino; Tenuta di San Rossore; Tombolo; Marina di Torre del Lago Puccini
Elateridae	*Dicronychus equiseti*	(Herbst, 1784)	Gombo; Migliarino; Marina di Vecchiano
Carabidae	*Dinotes decipiens*	(Dufour, 1820)	San Rossore
Carabidae	*Ditomus clypeatus*	(Rossi, 1790)	San Rossore
Lucanidae	*Dorcus parallelipipedus*	(Linné, 1758)	San Rossore, Torre Riccardi
Elateridae	*Drasterius bimaculatus*	(Rossi, 1790)	Gombo; Migliarino; Marina di Vecchiano; Tenuta di San Rossore
Dryopidae	*Dryops algiricus*	(Lucas, 1849)	Migliarino; Tenuta Salviati; Marina di Torre del Lago Puccini; Spiaggia di Vecchiano
Dryopidae	*Dryops doderoi*	Bollow, 1936	Marina di Torre del Lago Puccini
Dryopidae	*Dryops rufipes*	(Krynicki, 1832)	Tenuta di San Rossore
Dryopidae	*Dryops similaris*	Bollow, 1936	Calambrone
Dryopidae	*Dryops sulcipennis*	(A. Costa, 1883)	Tenuta di San Rossore
Carabidae	*Dyschiriodes aeneus*	(Dejean, 1825)	San Rossore
Carabidae	*Dyschiriodes agnatus*	(Motschulsky, 1844)	San Rossore
Carabidae	*Dyschiriodes apicalis*	(Putzeys, 1846)	San Rossore
Carabidae	*Dyschiriodes chalceus*	(Erichson, 1837)	San Rossore
Carabidae	*Dyschiriodes chalybaeus*	Putzeyes, 1846	San Rossore
Carabidae	*Dyschiriodes globosus*	(Herbst, 1783)	San Rossore
Carabidae	*Dyschiriodes macroderus*	(Muller, 1922)	San Rossore
Carabidae	*Dyschiriodes parallelus ruficornis*	(Putzeys, 1846)	San Rossore
Carabidae	*Dyschirius importunus*	Schaum, 1857	San Rossore
Carabidae	*Dystichus planus*	(Bonelli, 1813)	San Rossore
Dytiscidae	*Dytiscus circumcinctus*	Ahrens, 1811	Migliarino
Dytiscidae	*Dytiscus dimidiatus*	Bergsträsser, 1778	Gombo,Tombolo, Migliarino, San Rossore
Dytiscidae	*Dytiscus marginalis*	Linnaeus, 1758	Marina di Torre del Lago Puccini, Tenuta di San Rossore
Carabidae	*Elaphrus uliginosus*	(Fabricius, 1792)	San Rossore
Carabidae	*Emphanes normannus*	(Dejean, 1831)	San Rossore
Carabidae	*Emphanes rivularis*	(Dejean, 1831)	San Rossore
Hydrophilidae	*Enochrus ater*	(Kuwert, 1888)	Marina di Torre del Lago Puccini
Hydrophilidae	*Enochrus bicolor*	(Fabricius, 1792)	Gombo
Hydrophilidae	*Enochrus coarctatus*	(Gredler, 1863)	Marina di Torre del Lago Puccini
Hydrophilidae	*Enochrus melanocephalus*	(Olivier, 1792)	Marina di Torre del Lago Puccini

Hydrophilidae	*Enochrus nigritus*	(Sharp, 1872)	Marina di Torre del Lago Puccini
Hydrophilidae	*Enochrus testaceus*	(Fabricius, 1801)	Marina di Torre del Lago Puccini
Cryptophagidae	*Ephistemus globulus*	(Paykull, 1798)	Gombo
Histeridae	*Epierus comptus*	Erichson, 1834	Marina di Pisa
Carabidae	*Epomis circumscriptus*	(Duftschmid, 1812)	San Rossore
Cerambycidae	*Ergates faber*	(Linnaeus, 1761)	Migliarino
Scarabaeidae	*Euoniticellus fulvus*	(Goeze, 1777)	San Rossore, Torre Riccardi, Il Boschetto
Scarabaeidae	*Euonthophagus amyntas*	(Olivier, 1789)	San Rossore
Aphodiidae	*Euorodalus paracoenosus*	Balthasar & Hrubant, 1960	San Rossore, Il Boschetto
Pselaphidae	*Euplectus corsicus*	Guillebeau, 1888	Tenuta del Tombolo
Pselaphidae	*Euplectus kirbyi hummleri*	Reitter, 1906	Tenuta del Tombolo
Carabidae	*Eurynebria complanata*	(Linnaeus 1767)	Selva Pisana
Pselaphidae	*Fagniezia impressa*	(Panzer, 1805)	Bocca d'Arno
Geotrupidae	*Geotrupes spiniger*	Marsham, 1802	San Rossore, Sterpaia
Cerambycidae	*Grammoptera ruficornis*	(Fabricius, 1781)	San Rossore
Dytiscidae	*Graphoderus austriacus*	(Sturm, 1834)	Marina di Torre del Lago Puccini
Dytiscidae	*Graphoderus cinereus*	(Linnaeus, 1758)	Tenuta di San Rossore
Dytiscidae	*Graptodytes bilineatus*	(Sturm, 1835)	Migliarino
Dytiscidae	*Graptodytes flavipes*	(Olivier, 1795)	Tenuta del Tombolo
Dytiscidae	*Graptodytes granularis*	(Linnaeus, 1767)	Marina di Torre del Lago Puccini, Tenuta Salviati, Migliarino, Tenuta del Tombolo, Tenuta di San Rossore
Carabidae	*Gynandromorphus etruscus*	(Quensel, 1806)	San Rossore
Gyrinidae	*Gyrinus caspius*	Ménétriés, 1832	Lago di Massaciuccoli; Migliarino; Tenuta del Tombolo
Gyrinidae	*Gyrinus colymbus*	Erichson, 1837	Marina di Torre del Lago Puccini, Tenuta del Tombolo
Gyrinidae	*Gyrinus distinctus*	Aubé, 1838	Tenuta del Tombolo
Gyrinidae	*Gyrinus paykulli*	Ochs, 1927	Selva Pisana, Gombo
Gyrinidae	*Gyrinus substriatus*	Stephens, 1828	Tenuta del Tombolo
Gyrinidae	*Gyrinus suffriani*	Scriba, 1855	Marina di Torre del Lago Puccini; Lago di Massaciuccoli; Migliarino
Gyrinidae	*Gyrinus urinator*	Illiger, 1807	Tenuta del Tombolo
Histeridae	*Haeterius ferrugineus*	(Olivier, 1789)	Marina di Pisa
Histeridae	*Halacritus punctum*	(Aubé, 1842)	Marina di Torre del Lago Puccini, dintorni, loc. Torre del Lago Puccini

Tenebrionidae	*Halammobia pellucida*	(Herbst, 1799)	San Rossore
Haliplidae	*Haliplus flavicollis*	Sturm, 1834	Gombo
Haliplidae	*Haliplus fluviatilis*	Aubé, 1836	Marina di Torre del Lago Puccini, Tenuta del Tombolo
Haliplidae	*Haliplus guttatus*	Aubé, 1836	Gombo, Marina di Torre del Lago Puccini, Tenuta di San Rossore, Tenuta del Tombolo
Haliplidae	*Haliplus heydeni*	Wehncke, 1875	Marina di Torre del Lago Puccini
Haliplidae	*Haliplus laminatus*	(Schaller, 1783)	Migliarino, Tenuta del Tombolo
Haliplidae	*Haliplus lineatocollis*	(Marsham, 1802)	Gombo, Marina di Torre del Lago Puccini, Migliarino, Tenuta di San Rossore, Tenuta del Tombolo
Haliplidae	*Haliplus obliquus*	(Fabricius, 1787)	Migliarino
Haliplidae	*Haliplus ruficollis*	(De Geer, 1774)	Marina di Torre del Lago Puccini, Gombo, Tenuta Salviati, Migliarino, Tenuta di San Rossore, Tenuta del Tombolo
Haliplidae	*Haliplus variegatus*	Sturm, 1834	Gombo, Marina di Torre del Lago Puccini, Massaciuccoli, Tenuta Salviati, Tenuta del Tombolo
Carabidae	*Harpalus anxius*	(Duftschmid, 1812)	San Rossore
Carabidae	*Harpalus cupreus*	Dejean, 1829	San Rossore
Carabidae	*Harpalus dimidiatus*	(Rossi, 1790)	San Rossore
Carabidae	*Harpalus oblitus*	(Dejan, 1829)	San Rossore
Carabidae	*Harpalus serripes*	(Quensel, 1806)	San Rossore
Carabidae	*Harpalus sulphuripes*	(Germar, 1824)	San Rossore
Carabidae	*Harpalus tardus*	(Panzer, 1797)	San Rossore
Hydrophilidae	*Helochares lividus*	(Forster, 1771)	Lago di Massaciuccoli; Tenuta di San Rossore; Tenuta del Tombolo; Marina di Torre del Lago Puccini; Marina di Vecchiano
Helophoridae	*Helophorus alternans*	Gené, 1836	Gombo; Marina di Torre del Lago Puccini
Helophoridae	*Helophorus aquaticus*	(Linnaeus, 1758)	Gombo; Marina di Torre del Lago Puccini
Helophoridae	*Helophorus flavipes*	Fabricius, 1792	Marina di Torre del Lago Puccini
Helophoridae	*Helophorus granularis*	(Linnaeus, 1761)	Tenuta di San Rossore
Helophoridae	*Helophorus griseus*	Herbst, 1793	Gombo; Marina di Torre del Lago Puccini
Helophoridae	*Helophorus minutus*	Fabricius, 1775	Marina di Torre del Lago Puccini

Helophoridae	*Helophorus nanus*	Sturm, 1836	Gombo
Helophoridae	*Helophorus nubilus*	Fabricius, 1776	Gombo
Aphodiidae	*Heptaulacus rasettii*	Carpaneto, 1978	San Rossore, Sterpaia
Heteroceridae	*Heterocerus fenestratus*	(Thunberg, 1784)	Lago di Massaciuccoli, La Piaggetta; Tenuta di San Rossore
Heteroceridae	*Heterocerus fusculus etruscus*	Mascagni, 1986	riva del Lago di Massaciuccoli, La Piaggetta
Histeridae	*Hister illigeri*	Duftschmid, 1805	Marina di Pisa; Tenuta di San Rossore; Tenuta del Tombolo
Histeridae	*Hister quadrimaculatus*	Linnaeus, 1758	Marina di Pisa; Tenuta di San Rossore; Tenuta del Tombolo
Melolonthidae	*Holochelus fraxinicola*	(Sturm & Hagenbach, 1825)	San Rossore, Torre Riccardi dint.
Melolonthidae	*Hoplia dubia*	(Rossi, 1790)	Selva Pisana; Dune litoranee di Torre del Lago
Dytiscidae	*Hydaticus leander*	(Rossi, 1790)	Gombo, Lago di Massaciuccoli, Migliarino, Torre del Lago Puccini
Dytiscidae	*Hydaticus leander*	(Rossi, 1790)	Migliarino
Dytiscidae	*Hydaticus seminiger*	(De Geer, 1774)	Marina di Torre del Lago Puccini, Migliarino, Tenuta di San Rossore, Torre del Lago Puccini
Dytiscidae	*Hydaticus transversalis*	(Pontoppidan, 1763)	Marina di Torre del Lago Puccini, Lago di Massaciuccoli, Tenuta Salviati, Migliarino, Torre del Lago Puccini
Hydraenidae	*Hydraena assimilis*	Rey, 1885	Rio Stiava presso Massarosa, Lago di Massaciuccoli; Marina di Torre del Lago Puccini
Hydraenidae	*Hydraena palustris*	Erichson, 1837	Pineta Reale presso Torre del Lago Puccini sul lago di Massaciuccoli
Hydraenidae	*Hydraena subimpressa*	Rey, 1885	Rio Stiava presso Massarosa, Lago di Massaciuccoli
Hydrophilidae	*Hydrobius fuscipes*	(Linnaeus, 1758)	Gombo; Tenuta di San Rossore; Marina di Torre del Lago Puccini
Hydrophilidae	*Hydrochara caraboides*	(Linné, 1758)	S. Rossore
Hydrochidae	*Hydrochus angustatus*	Germar, 1824	Pineta Reale; Marina di Torre del Lago Puccini
Hydrochidae	*Hydrochus crenatus*	(Fabricius, 1792)	Marina di Torre del Lago Puccini
Hydrochidae	*Hydrochus elongatus*	(Schaller, 1783)	Tenuta di San Rossore; Marina di Torre del Lago Puccini
Hydrochidae	*Hydrochus flavipennis*	Küster, 1852	Tenuta di San Rossore; Marina di Torre del Lago Puccini

Hydrochidae	*Hydrochus grandicollis*	Kiesenwetter, 1870	Migliarino; Marina di Torre del Lago Puccini
Dytiscidae	*Hydroglyphus geminus*	(Fabricius, 1792)	Marina di Torre del Lago Puccini, Lago di Massaciuccoli
Hydrophilidae	*Hydrophilus piceus*	(Linnaeus, 1758)	Gombo
Dytiscidae	*Hydroporus jonicus*	Miller, 1862	Marina di Torre del Lago Puccini, Tenuta Salviati, Migliarino, Tenuta del Tombolo
Dytiscidae	*Hydroporus angustatus*	Sturm, 1835	Marina di Torre del Lago Puccini, Tenuta Salviati, Migliarino
Dytiscidae	*Hydroporus erythrocephalus*	(Linnaeus, 1758)	Marina di Torre del Lago Puccini, Tenuta Salviati, Migliarino
Dytiscidae	*Hydroporus gridellii*	Focarile 1960	Dune litoranee di Torre del Lago
Dytiscidae	*Hydroporus incognitus*	Sharp, 1869	Tenuta del Tombolo, Migliarino
Dytiscidae	*Hydroporus memnonius*	Nicolai, 1822	Tenuta del Tombolo, Tenuta di San Rossore, Migliarino, Torre del Lago Puccini, Marina di Torre del Lago Puccini
Dytiscidae	*Hydroporus obsoletus*	Aubé, 1838	Gombo, Tenuta del Tombolo
Dytiscidae	*Hydroporus palustris*	(Linnaeus, 1761)	Marina di Torre del Lago Puccini, Tenuta Salviati, Migliarino, Tenuta di San Rossore, Tenuta del Tombolo
Dytiscidae	*Hydroporus pubescens*	(Gyllenhal, 1808)	Marina di Torre del Lago Puccini, Tenuta di San Rossore
Dytiscidae	*Hydroporus tristis*	(Paykull, 1798)	Marina di Torre del Lago Puccini, Migliarino, Tenuta di San Rossore, Tenuta del Tombolo
Hydrophilidae	*Hydrous piceus*	(Linnaeus, 1758)	Lago di Massaciuccoli
Dytiscidae	*Hydrovatus cuspidatus*	(Kunze, 1818)	Marina di Torre del Lago Puccini, Torre del Lago Puccini, Tenuta Salviati, Migliarino, Tenuta di San Rossore
Hygrobiidae	*Hygrobia hermanni*	(Fabricius 1775)	Macchia di Migliarino, Tenuta Salviati
Hygrobiidae	*Hygrobia tarda*	(Herbst, 1779)	Selva Pisana
Dytiscidae	*Hygrotus decoratus*	(Gyllenhal, 1810)	Marina di Torre del Lago Puccini, Torre del Lago Puccini, Tenuta Salviati, Migliarino
Dytiscidae	*Hygrotus impressopunctatus*	(Schaller, 1783)	Tenuta Salviati
Dytiscidae	*Hygrotus inaequalis*	(Fabricius, 1777)	Marina di Torre del Lago Puccini, Tenuta Salviati,

			Tenuta di San Rossore, Tenuta del Tombolo
Dytiscidae	*Hygrotus parallelogrammus*	(Ahrens, 1812)	Marina di Torre del Lago Puccini, Tenuta di San Rossore
Cerambycidae	*Hylotrupes bajulus*	(Linnaeus, 1758)	Marina di Pisa
Scolytidae	*Hylurgus ligniperda*	(Fabricius, 1792)	San Rossore
Dytiscidae	*Hyphydrus anatolicus*	Guignot, 1957	Marina di Torre del Lago Puccini, Torre del Lago Puccini, Tenuta Salviati, Migliarino, Tenuta di San Rossore
Dytiscidae	*Hyphydrus aubei*	Ganglbauer, 1892	Gombo, Marina di Torre del Lago Puccini, Tenuta Salviati, Migliarino
Histeridae	*Hypocacculus rubripes*	(Erichson, 1834)	Migliarino, litorale; Torre Riccardi, dintorni (= Marina di Vecchiano)
Histeridae	*Hypocaccus brasiliensis*	(Paykull, 1811)	Torre Riccardi, dintorni (= Marina di Vecchiano); Spiaggia di Vecchiano
Histeridae	*Hypocaccus dimidiatus*	(Illiger, 1807)	Pineta di Tombolo; Migliarino; Torre Riccardi; Marina di Torre del Lago Puccini; Spiaggia di Vecchiano
Histeridae	*Hypocaccus rugifrons*	(Paykull, 1798)	Marina di Pisa; Torre Riccardi; Marina di Torre del Lago Puccini
Dytiscidae	*Ilybius ater*	(De Geer, 1774)	Marina di Torre del Lago Puccini, Migliarino
Dytiscidae	*Ilybius fuliginosus*	(Fabricius, 1792)	Marina di Torre del Lago Puccini
Dytiscidae	*Ilybius quadriguttatus*	(Lacordaire, 1835)	Marina di Torre del Lago Puccini, Migliarino, Torre del Lago Puccini, Tenuta di San Rossore
Attelabidae	*Involvolus caeruleus*	(De Geer, 1775)	Tenuta di Coltano
Scolytidae	*Ips sexdentatus*	(Boerner, 1767)	San Rossore
Elateridae	*Isidus moreli*	Mulsant & Rey, 1874	Tenuta di San Rossore
Histeridae	*Kissister minimus*	(Laporte, 1840)	Sterpaia
Aphodiidae	*Labarrus lividus*	(Olivier, 1789)	San Rossore, Sterpaia,Torre Riccardi dint.
Hydrophilidae	*Laccobius albescens*	Rottenberg, 1874	Marina di Torre del Lago Puccini
Dytiscidae	*Laccophilus hyalinus testaceus*	Aubé, 1837	Gombo, Marina di Torre del Lago Puccini, Tenuta Salviati, Tenuta di San Rossore,
Dytiscidae	*Laccophilus minutus*	(Linnaeus, 1758)	Gombo; Marina di Torre del Lago Puccini; Lago di Massaciuccoli; Tenuta Salviati; Tenuta di San Rossore; Tenuta del

			Tombolo
Dytiscidae	*Laccophilus variegatus*	(Germar, 1812)	Marina di Torre del Lago Puccini; Lago di Massaciuccoli; Migliarino; Tenuta Salviati; Tenuta di San Rossore; Tenuta del Tombolo
Elateridae	*Lacon punctatus*	(Herbst, 1779)	Tenuta di San Rossore; Tenuta del Tombolo
Attelabidae	*Lasiorhynchites sericeus*	(Herbst, 1797)	Migliarino
Carabidae	*Leistus fulvibarbis*	(Dejean, 1826)	San Rossore
Carabidae	*Leja articulata*	(Panzer, 1796)	San Rossore
Curculionidae	*Lepretius noxius*	(Boheman, 1843)	Macchia di Migliarino; Tenuta di San Rossore; Tirrenia; Tenuta del Tombolo; Torre del Lago Puccini
Staphylinidae	*Leptusa apennina*	Holdhaus, 1924	Tenuta del Tombolo
Carabidae	*Licinus silphoides*	(Rossi, 1790)	San Rossore
Carabidae	*Limnastis galilaeus*	(La Brulerie, 1875)	San Rossore
Carabidae	*Limnastis luigionii*	(Dodero, 1899)	San Rossore
Hydraenidae	*Limnebius aluta*	(Bedel, 1881)	Pineta Reale presso Torre del lago Puccini sul Lago di Massaciuccoli
Hydraenidae	*Limnebius nitidus*	(Marsham, 1802)	Cascine di Pisa; Gombo lungo il litorale pisano
Hydraenidae	*Limnebius papposus*	Mulsant, 1844	Cascine di Pisa; Torre del Lago Puccini sul Lago di Massaciuccoli
Hydrophilidae	*Limnoxenus niger*	(Gmelin, 1790)	Marina di Torre del Lago Puccini
Chrysomelidae	*Longitarsus ordinatus*	(Foudras, 1860)	Tenuta di San Rossore
Carabidae	*Lophyridia litoralis nemoralis*	(Olivier, 1790)	Dune litoranee di Torre del Lago
Aphodiidae	*Loraphodius suarius*	(Faldermann, 1835)	San Rossore, Sterpaia
Lucanidae	*Lucanus cervus*	(Linnaeus, 1758)	Migliarino
Histeridae	*Margarinotus brunneus*	(Fabricius, 1775)	Marina di Pisa
Histeridae	*Margarinotus ruficornis*	(Grimm, 1852)	Migliarino
Curculionidae	*Meirella florentina*	(Stierlin, 1884)	Marina di Pisa; Tenuta del Tombolo
Dytiscidae	*Meladema coriacea*	Laporte, 1835	Gombo
Dytiscidae	*Melanodytes pustulatus*	(Rossi, 1792)	Gombo, Torre del Lago Puccini, Migliarino, Marina di Torre del Lago Puccini
Buprestidae	*Melanophila acuminata*	(De Geer, 1774)	Tirrenia
Elateridae	*Melanotus crassicollis*	(Erichson, 1841)	Gombo; Tombolo
Elateridae	*Melanotus punctolineatus*	(Pelerin, 1829)	Gombo
Nitidulidae	*Meligethes brevis*	Sturm, 1845	Presso il Lago di

			Massaciuccoli, radure xeriche
Nitidulidae	*Meligethes egenus*	Erichson, 1845	Marina di Torre del Lago Puccini
Nitidulidae	*Meligethes fuscus*	(Olivier, 1790)	Marina di Torre del Lago Puccini
Nitidulidae	*Meligethes gagathinus*	Erichson, 1845	Marina di Torre del Lago Puccini
Nitidulidae	*Meligethes immundus*	Kraatz, 1858	Marina di Torre del Lago Puccini
Nitidulidae	*Meligethes ochropus*	Sturm, 1845	Marina di Torre del Lago Puccini
Aphodiidae	*Melinopterus consputus*	(Creutzer, 1799)	San Rossore, Il Boscetto, Sterpaia
Aphodiidae	*Melinopterus prodromus*	(Brahm, 1790)	San Rossore, Sterpaia
Aphodiidae	*Melinopterus reyi*	(Reitter, 1892)	San Rossore, Sterpaia
Aphodiidae	*Melinopterus stolzi*	(Reitter, 1906)	San Rossore, Il Boschetto
Aphodiidae	*Melinopterus tingens*	(Reitter, 1892)	Sterpaia, San Rossore
Melolonthidae	*Melolontha hippocastani*	Fabricius, 1801	San Rossore, Torre Riccardi dint.
Melolonthidae	*Melolontha melolontha*	(Linné, 1758)	San Rossore, Loc. Il Boschetto
Curculionidae	*Mesites cunipes*	(Boheman, 1837)	Tombolo
Curculionidae	*Mesites pallidipennis*	(Boheman, 1837)	Tenuta di San Rossore; Torre del Lago Puccini
Carabidae	*Metallina lampros*	(Herbst, 1784)	San Rossore
Carabidae	*Metallina properans*	(Stephens, 1828)	San Rossore
Carabidae	*Metallina pygmaea*	(Fabricius, 1792)	San Rossore
Carabidae	*Microlestes corticalis*	(Dufour, 1820)	San Rossore
Carabidae	*Microlestes fissuralis*	(Reitter, 1900)	San Rossore
Carabidae	*Microlestes fulvibasis*	(Reitter, 1900)	San Rossore
Carabidae	*Microlestes luctuosus*	(Holdhaus, 1904)	San Rossore
Carabidae	*Microlestes maurus*	(Sturn, 1827)	San Rossore
Carabidae	*Microlestes minutulus*	(Goeze, 1777)	San Rossore
Carabidae	*Microlestes seladon*	Holdhaus, 1912	San Rossore
Melolonthidae	*Miltotrogus fraxinicola*	(Sturm & Hagenbach, 1825)	San Rossore
Rutelidae	*Mimela junii junii*	(Duftschmid, 1805)	San Rossore
Cerambycidae	*Morimus asper*	(Sulzer, 1776)	San Rossore
Mycteridae	*Mycterus curculioides*	(Fabricius, 1781)	San Rossore
Dytiscidae	*Nartus grapii*	(Gyllenhal, 1808)	Migliarino, Torre del Lago Puccini
Carabidae	*Nebria brevicollis*	(Fabricius, 1792)	San Rossore
Chrysomelidae	*Neocrepidodera ferruginea*	(Scopoli, 1763)	Tenuta di San Rossore
Chrysomelidae	*Neocrepidodera*	(Fabricius,	Tenuta di Coltano; Pineta

	impressa	1801)	del Tombolo
Cetoniidae	*Netocia morio*	(Fabricius, 1781)	San Rossore, Foce Morto Vecchio
Aphodiidae	*Nimbus johnsoni*	(Baraud, 1976)	San Rossore, Sterpaia
Carabidae	*Notaphus varius*	(Olivier, 1795)	San Rossore
Noteridae	*Noterus clavicornis*	(De Geer, 1774)	Gombo; Marina di Torre del Lago Puccini; Tenuta Salviati; Migliarino; Tenuta di San Rossore
Carabidae	*Notiophilus rufipes*	(Curtis, 1829)	San Rossore
Cerambycidae	*Oberea erythrocephala*	(Schrank, 1776)	San Rossore
Hydraenidae	*Ochthebius dilatatus*	Stephens, 1829	Gombo presso Pisa
Hydraenidae	*Ochthebius foveolatus*	Germar, 1824	Gombo presso Pisa
Hydraenidae	*Ochthebius gagliardii*	D’Orchymont, 1940	Torre del Lago
Hydraenidae	*Ochthebius halbherri*	Reitter, 1890	Gombo presso Pisa
Hydraenidae	*Ochthebius impressipennis*	Rey, 1886	Tombolo di Pisa
Hydraenidae	*Ochthebius meridionalis*	(Rey, 1885)	Fossi del Gombo presso Pisa
Hydraenidae	*Ochthebius minimus*	(Fabricius, 1792)	Stagno retrodunale presso Torre del Lago Puccini sul Lago di Massaciuccoli
Hydraenidae	*Ochthebius pusillus*	Stephens, 1835	Fossi del Gombo presso Pisa
Hydraenidae	*Ochthebius viridis*	(Peyron, 1858)	Pineta Reale presso Torre del lago Puccini sul Lago di Massaciuccoli
Carabidae	*Ocydromus callosus*	(Kuster, 1847)	San Rossore
Carabidae	*Ocydromus latinus*	(Netolitzky, 1911)	San Rossore
Carabidae	*Ocydromus subcostatus javurkovae*	(Fassati, 1944)	San Rossore
Carabidae	*Ocydromus tetragrammus illigeri*	(Netolitzky, 1941)	San Rossore
Staphylinidae	*Ocypus olens*	(O. F. Müller, 1764)	Marina di Pisa; Tenuta di San Rossore
Staphylinidae	*Ocypus ophthalmicus*	(Scopoli, 1763)	Marina di Torre del Lago Puccini
Staphylinidae	*Ocypus sericeicollis*	(Ménétriés, 1832)	Tenuta di San Rossore
Carabidae	*Ocys harpaloides*	(Serville, 1821)	San Rossore
Carabidae	*Odocantha melanura*	(Linné, 1766)	San Rossore
Carabidae	*Odontium foraminosum*	(Sturm, 1827)	San Rossore
Carabidae	*Oedes helopioides*	(Fabbricius, 1792)	San Rossore
Carabidae	*Omaseus aterrimus ausonicus*	Bucciarelli & PerisSìnotto, 1959	Tenuta del Tombolo
Carabidae	*Omaseus elongatus*	(Duftschmid, 1812)	San Rossore
Carabidae	*Omophron limbatus*	(Fabricius, 1776)	San Rossore

Staphylinidae	*Ontholestes murinus*	(Linnaeus, 1758)	Tenuta di San Rossore
Scarabaeidae	*Onthophagus coenobita*	(Herbst, 1783)	San Rossore, Torre Riccardi, Il Boschetto
Scarabaeidae	*Onthophagus fracticornis*	(Preyssler, 1790)	San Rossore
Scarabaeidae	*Onthophagus furcatus*	(Fabricius, 1781)	San Rossore, Sterpaia
Scarabaeidae	*Onthophagus grossepunctatus*	Reitter, 1905	San Rossore, Torre Riccardi, Sterpaia
Scarabaeidae	*Onthophagus illyricus*	(Scopoli, 1763)	San Rossore, Il Boschetto
Scarabaeidae	*Onthophagus opacicollis*	Reitter, 1893	San Rossore, Il Boschetto
Scarabaeidae	*Onthophagus ruficapillus ruficapillus*	Brullé, 1832	San Rossore, Il Boschetto
Scarabaeidae	*Onthophagus semicornis*	(Panzer, 1798)	San Rossore
Scarabaeidae	*Onthophagus taurus*	(Schreber, 1759)	San Rossore, Il Boschetto
Scarabaeidae	*Onthophagus vacca*	(Linné, 1767)	San Rossore, Sterpaia
Scarabaeidae	*Onthophagus verticicornis*	(Laicharting, 1781)	San Rossore, Il Boschetto
Histeridae	*Onthophilus affinis*	Redtenbacher, 1849	Sterpaia; Tenuta del Tombolo; Marina di Torre del Lago Puccini, dintorni, loc. Torre del Lago Puccini
Histeridae	*Onthophilus striatus striatus*	(Forster, 1771)	San Rossore, Sterpaia
Carabidae	*Ophonus diffinis*	(Dejan, 1829)	San Rossore
Gyrinidae	*Orectochilus villosus*	(Müller, 1776)	Migliarino
Scolytidae	*Orthotomicus erosus*	(Wollaston, 1857)	San Rossore
Dynastidae	*Oryctes nasicornis corniculatus*	Villa A. & Villa G. B., 1833	San Rossore, Il Boschetto
Dynastidae	*Oryctes nasicornis laevigatus*	Heer, 1841	San Rossore, Il Boschetto
Cetonidae	*Osmoderma eremita*	(Scopoli, 1763)	San Rossore
Curculionidae	*Otiorhynchus frescati*	Boheman, 1843	Tenuta di San Rossore
Aphodidae	*Oxyomus sylvestris*	(Scopoli, 1763)	Tenuta di San Rossore
Carabidae	*Panagaeus cruxmajor*	(Linné, 1758)	San Rossore
Pselaphidae	*Panaphantus atomus*	Kiesenwetter, 1858	Bocca d'Arno; Tenuta del Tombolo
Elateridae	*Paracardiophorus musculus*	(Erichson, 1840)	Gombo
Cerambycidae	*Paracorymbia fulva*	(DeGeer, 1775)	San Rossore
Carabidae	*Paradromius linearis*	(Olivier, 1795)	San Rossore
Carabidae	*Parallelomorphus terricola*	(Bonelli, 1813)	San Rossore
Carabidae	*Paratachys bistriatus*	(Duftschmid, 1812)	San Rossore
Histeridae	*Paromalus flavicornis*	(Herbst, 1792)	Migliarino; Tenuta del Tombolo
Histeridae	*Paromalus parallelepipedus*	(Herbst, 1792)	Marina di Pisa
Carabidae	*Parophorus maculicornis*	(Duftschmid, 1812)	San Rossore

Cerambycidae	*Pedostrangalia revestita*	(Linnaeus, 1767)	Pineta del Tombolo
Haliplidae	*Peltodytes caesus*	(Duftschmid, 1805)	Marina di Torre del Lago Puccini, Tenuta Salviati, Tenuta di San Rossore, Tenuta del Tombolo
Haliplidae	*Peltodytes rotundatus*	(Aubé, 1836)	Marina di Torre del Lago Puccini, Migliarino, Marina di Vecchiano, Tenuta del Tombolo
Dynastidae	*Pentodon bidens punctatum*	(Villers, 1789)	San Rossore, Foce Fiume Morto Vecchio
Carabidae	*Perileptus areolatus*	(Creutzer, 1799)	Marina di Torre del Lago Puccini
Curculionidae	*Peritelus sphaeroides*	Germar, 1824	Tenuta del Tombolo
Aphodiidae	*Phalacronothus biguttatus*	(Germar, 1824)	San Rossore, Sterpaia
Aphodiidae	*Phalacronothus quadrimaculatus*	(Linné, 1761)	San Rossore, Il Boschetto
Tenebrionidae	*Phaleria provincialis*	Fauvel, 1901	San Rossore
Carabidae	*Philochthus inoptatus*	(Schaum, 1857)	San Rossore
Carabidae	*Philochthus lunulatus*	(Fourcroy, 1785)	San Rossore
Carabidae	*Phonias ovoideus mainardii*	(Straneo, 1934)	Tenuta del Tombolo
Carabidae	*Phonias strenuus*	(Panzer, 1797)	San Rossore
Chrysomelidae	*Phratora vitellinae*	(Linné, 1758)	San Rossore
Carabidae	*Phyla tethys*	(Netolitzky, 1926)	San Rossore
Staphylinidae	*Phyllodrepa palpalis*	Luze, 1906	Tenuta del Tombolo
Cerambycidae	*Phytoecia virgula*	(Charpentier, 1825)	Tenuta di Coltano
Tenebrionidae	*Pimelia bipunctata papii*	Canzoneri, 1963	San Rossore, Foce F. Morto Vecchio
Nitidulidae	*Pityophagus laevior*	Abeille, 1872	Tenuta del Tombolo
Aphodiidae	*Planolinoides borealis*	(Gyllenhal 1827)	San Rossore, Il Boschetto
Aphodiidae	*Planolinus fasciatus*	(Olivier, 1789)	San Rossore, Torre Riccardi
Dytiscidae	*Platambus maculatus*	(Linnaeus, 1758)	Migliarino
Carabidae	*Platyderus neapolitanus*	(Reiche, 1855)	San Rossore
Staphylinidae	*Platydracus fulvipes*	(Scopoli, 1763)	Marina di Pisa
Histeridae	*Platylomalus complanatus*	(Panzer, 1797)	Migliarino; Tenuta di San Rossore
Carabidae	*Platynus krynickii*	(Sperk, 1835)	San Rossore
Carabidae	*Platysma anthracinum hespericum*	Bucciarelli & Sopracordevole, 1958	Tombolo, Massaciuccoli, Tenuta di San Rossore
Carabidae	*Platysma gracile*	(Dejan, 1828)	San Rossore
Carabidae	*Platysma rhaeticum*	(Heer, 1837)	Tenuta di San Rossore
Histeridae	*Platysoma elongatum*	(Thunberg, 1787)	Marina di Pisa
Aphodiidae	*Platytomus tibialis*	(Fabricius, 1798)	San Rossore, Sterpaia

Aphodiidae	*Pleurophorus caesus*	(Creutzer, 1796)	Il Boschetto, San Rossore
Aphodiidae	*Pleurophorus mediterranicus*	Pittino & Mariani, 1984	San Rossore, Boschetto
Aphodiidae	*Pleurophorus pannonicus*	(Creutzer, 1796)	San Rossore
Nitidulidae	*Pocadius ferrugineus*	(Fabricius, 1775)	Tenuta di San Rossore
Carabidae	*Poecilus cupreus*	(Linné, 1758)	San Rossore
Carabidae	*Poecilus cursorius*	(Dejean, 1828)	San Rossore
Carabidae	*Poecilus striatopunctatus*	(Duftschmid, 1812)	Gombo
Carabidae	*Pogonus littoralis*	(Duftschmid, 1812)	San Rossore
Carabidae	*Pogonus riparius*	(Dejan, 1828)	San Rossore
Dytiscidae	*Porhydrus lineatus*	(Fabricius, 1775)	Marina di Torre del Lago Puccini, Migliarino
Dytiscidae	*Potamonectes luctuosus*	(Aubé, 1838)	Calambrone
Nitidulidae	*Pria dulcamarae*	(Scopoli, 1763)	Marina di Torre del Lago Puccini
Cerambycidae	*Prionus coriarius*	(Linnaeus, 1758)	Tenuta di San Rossore, Fiume Morto Vecchio
Cetonidae	*Protaetia morio morio*	(Fabricius, 1781)	San Rossore, Il Boschetto
Aphodidae	*Psammodius basalis*	(Mulsant & Rey, 1871)	Marina di Torre del Lago Puccini; Foce del Fiume Serchio
Aphodiidae	*Psammodius pierottii*	Pittino, 1979	San Rossore
Curculionidae	*Pselactus spadix*	(Herbst, 1795)	Tenuta di San Rossore
Pselaphidae	*Pselaphaulax longicornis*	(Saulcy, 1863)	Bocca d'Arno; Tenuta del Tombolo
Pselaphidae	*Pselaphus parvus*	Karaman, 1940	Cascine di Pisa; Migliarino; Marina di Torre del Lago Puccini
Cerambycidae	*Pseudalosterna livida*	(Fabricius, 1776)	San Rossore
Curculionidae	*Pseudomeira parvula*	(Seidlitz, 1865)	Marina di Pisa; Macchia di Migliarino
Curculionidae	*Pseudomeira rudis*	(Boheman, 1843)	Tenuta di Coltano; Marina di Pisa; Torre del Lago Puccini; Macchia di Migliarino; Tenuta di San Rossore; Tenuta del Tombolo
Carabidae	*Pseudophonus rufipes*	(Degeer, 1774)	San Rossore
Chrysomelidae	*Psylliodes kiesenwetteri*	Kutschera, 1864	Tenuta di San Rossore
Chrysomelidae	*Psylliodes marcidus*	(Illiger, 1807)	Marina di Pisa; Vecchiano
Chrysomelidae	*Psylliodes napi*	(Fabricius, 1792)	Tenuta di San Rossore
Chrysomelidae	*Psylliodes puncticollis*	Rosenhauer, 1856	Vecchiano
Buprestidae	*Ptosima flavoguttata*	(Illiger, 1803)	Tenuta di San Rossore
Elateridae	*Quasimus minutissimus*	(Germar, 1817)	Gombo
Pselaphidae	*Reichenbachia chevrieri*	(Aubé, 1844)	Marina di Torre del Lago Puccini

Pselaphidae	*Reichenbachia nigriventris*	(Schaum, 1859)	Marina di Torre del Lago Puccini
Dytiscidae	*Rhantus bistriatus*	(Bergsträsser, 1778)	Gombo
Dytiscidae	*Rhantus pulverosus*	(Stephens, 1828)	Migliarino
Dytiscidae	*Rhantus suturellus*	(Harris, 1828)	Migliarino
Melolonthidae	*Rhizotrogus grassii*	Mainardi, 1902	San Rossore, Gombo dint
Melolonthidae	*Rhizotrogus marginipes*	Mulsant, 1842	San Rossore, Il Boschetto
Attelabidae	*Rhynchites auratus*	(Scopoli, 1763)	Tenuta di Coltano
Curculionidae	*Rhyncolus elongatus*	(Gyllenhal, 1827)	Tenuta di San Rossore
Aphodiidae	*Rhyssemus germanus*	(Linneo, 1767)	San Rossore
Aphodiidae	*Rhyssemus sulcatus*	(Olivier, 1789)	San Rossore, Boschetto
Pselaphidae	*Rybaxis longicornis*	(Leach, 1817)	Migliarino; Tenuta di San Rossore; Marina di Torre del Lago Puccini
Histeridae	*Saprinus caerulescens caerulescens*	(Hoffmann, 1803)	San Rossore
Histeridae	*Saprinus chalcites*	(Illiger, 1807)	Marina di Torre del Lago Puccini, dintorni, loc. Torre del Lago Puccini
Histeridae	*Saprinus detersus*	(Illiger, 1807)	Spiaggia di Vecchiano; Marina di Pisa
Histeridae	*Saprinus furvus*	Erichson, 1834	Marina di Torre del Lago Puccini, dintorni, loc. Torre del Lago Puccini
Histeridae	*Saprinus planiusculus*	Motschulsky, 1849	Marina di Torre del Lago Puccini, dintorni, loc. Torre del Lago Puccini; Spiaggia di Vecchiano
Histeridae	*Saprinus semistriatus*	(Scriba , 1790)	Marina di Pisa; Pineta di Tombolo; Marina di Torre del Lago Puccini
Histeridae	*Saprinus subnitescens*	Bickhardt, 1909	Marina di Pisa; Pineta di Tombolo; Marina di Torre del Lago Puccini
Scarabaeidae	*Scarabaeus typhon*	Fischer de Waldheim, 1823	San Rossore, Torre Riccardi
Carabidae	*Scarites buparius*	(Forster, 1771)	San Rossore
Buprestidae	*Scintillatrix mirifica*	(Mulsant, 1855)	Pineta, Migliarino
Melolonthidae	*Serica brunnea*	(Linné, 1758)	San Rossore
Geotrupidae	*Sericotrupes niger*	(Marsham, 1802)	San Rossore, Torre Riccardi
Aphodiidae	*Sigorus porcus*	(Fabricius, 1792)	San Rossore, Sterpaia
Chrysomelidae	*Smaragdina vitellinae*	(Linné, 1767)	San Rossore
Sphaeridiidae	*Sphaeridium bipustulatum*	Fabricius, 1781	Tenuta del Tombolo
Carabidae	*Sphaerotachys haemorrhoidalis*	(Ponza, 1805)	San Rossore
Staphylinidae	*Staphylinus dimidiaticornis*	Gemminger, 1851	Tenuta di San Rossore

Carabidae	*Stenolophus discophorus*	(Fischer, 1823)	San Rossore
Carabidae	*Stenolophus teutonus*	(Schrank, 1781)	San Rossore
Curculionidae	*Stenopelmus rufinasus*	Gyllenhal 1836	Torre del Lago (dintorni)
Tenebrionidae	*Stenosis intermedia*	(Solier, 1838)	Tenuta di San Rossore
Cerambycidae	*Stenurella nigra*	(Linnaeus, 1758)	Pineta del Tombolo
Carabidae	*Steropus melas italicus*	(Dejan, 1828)	San Rossore
Dytiscidae	*Stictonectes optatus*	(Seidlitz, 1887)	Tenuta del Tombolo
Carabidae	*Stomis pumicatus*	(Panzer, 1796)	Marina di Torre del Lago Puccini
Aphodiidae	*Subrinus sturmi*	(Harold, 1870)	San Rossore, Sterpaia
Elateridae	*Synaptus filiformis*	(Fabricius, 1781)	Gombo
Carabidae	*Synechostictus dahli*	(Dejean, 1831)	San Rossore
Carabidae	*Synechosticus elongatus*	(Dejan, 1831)	San Rossore
Carabidae	*Syntomus impressus*	(Dejan, 1825)	San Rossore
Carabidae	*Syntomus obscuroguttatus*	(Duftschmid, 1812)	San Rossore
Carabidae	*Syntomus truncatellus*	(Linné, 1761)	San Rossore
Carabidae	*Tachys scutellaris*	(Stephens, 1828)	San Rossore
Carabidae	*Tachyta nana*	(Gyllenhal, 1810)	San Rossore
Staphylinidae	*Tasgius falcifer falcifer*	(Nordmann, 1837)	Marina di Pisa
Staphylinidae	*Tasgius winkleri*	(Bernhauer, 1906)	Macchia di Migliarino; Tenuta di San Rossore
Cryptophagidae	*Telmatophilus typhae*	(Fallén, 1802)	Marina di Torre del Lago Puccini
Geotrupidae	*Thorectes intermedius*	(Costa, 1827)	San Rossore, Il Boschetto
Buprestidae	*Trachys minutus*	(Linnaeus, 1758)	Tenuta di San Rossore
Buprestidae	*Trachys scrobiculatus*	Kiesenwetter, 1857	Massaciuccoli
Carabidae	*Trechus fairmairei*	(Pandellé, 1867)	San Rossore
Carabidae	*Trechus quadristriatus*	(Schrank, 1781)	San Rossore
Histeridae	*Tribalus minimus*	(P. Rossi, 1790)	Marina di Pisa; Tenuta del Tombolo
Histeridae	*Tribalus scaphidiformis*	(Illiger, 1807)	San Piero a Grado, sponde fiume Arno
Aphodiidae	*Trichonotulus scrofa*	(Fabricius, 1787)	San Rossore, Sterpaia
Pselaphidae	*Trimium brevicorne*	Aubé, 1833	Migliarino
Pselaphidae	*Trissemus antennatus antennatus*	(Aubé, 1833)	Bocca d'Arno; Macchia di Migliarino; Tenuta di San Rossore; Marina di Torre del Lago Puccini
Trogidae	*Trox scaber*	(Linné, 1767)	San Rossore, Sterpaia
Trogidae	*Trox hispidus*	(Pontoppidan, 1763)	San Rossore, Il Boschetto
Trogidae	*Trox ispidus*	(Rossi, 1792)	San Rossore
Trogidae	*Trox scaber*	(Linneo, 1767)	San Rossore

Pselaphidae	*Tychobythinus glabratus*	(Rye, 1870)	Migliarino; Tenuta del Tombolo
Pselaphidae	*Tychus dalmatinus*	Reitter, 1880	Tenuta di San Rossore; Tenuta del Tombolo
Pselaphidae	*Tychus monilicornis*	Reitter, 1880	Marina di Lucca; Tenuta del Tombolo
Pselaphidae	*Tychus normandi*	Jeannel, 1950	Marina di Torre del Lago Puccini
Geotrupidae	*Typhaeus typhoeus*	(Linné, 1758)	San Rossore, Il Boschetto
Cucujidae	*Uleiota planata*	(Linnaeus, 1761)	San Rossore
Tenebrionidae	*Uloma culinaris*	(Linné, 1758)	San Rossore
Cetoniidae	*Valgus hemipterus*	(Linné, 1758)	San Rossore
Cerambycidae	*Vesperus luridus*	(Rossi, 1794)	Tenuta di San Rossore
Aphodiidae	*Volinus sticticus*	(Panzer, 1798)	San Rossore, Il Boschetto
Chrysomelidae	*Xanthogaleruca luteola*	(O. F. Müller, 1766)	San Rossore
Scolytidae	*Xyleborus monographus*	(Fabricius, 1792)	San Rossore
Scolytidae	*Xyleborus saxesenii*	(Ratzeburg, 1837)	San Rossore
Scolytidae	*Xylosandrus crassiusculus*	(Motschulsky, 1866)	San Rossore
Elateridae	*Zorochros alysidotus*	(Kiesenwetter, 1858)	Gombo; Marina di Torre del Lago Puccini
Elateridae	*Zorochros boubersi*	Leseigneur, 1970	Marina di Torre del Lago Puccini
Elateridae	*Zorochros demustoides*	(Herbst, 1806)	Marina di Torre del Lago Puccini
Elateridae	*Zorochros meridionalis*	(Castelnau, 1840)	Gombo
Carabidae	*Zuphium olens*	(Rossi, 1790)	San Rossore