

Drones as a tool for the census of aquatic macrophytes in the Valencian Community

•Araucana Sebastián de la Cruz ^{1,2}, Carlos Peña Bretón ^{1,2} & Juan Jiménez Pérez³

¹ VAERSA Avd. de les Corts Valencianes, 20, 46015. Valencia.

² Centro de Conservación Acuática de El Palmar, Dirección General de Medio Natural y Animal. Generalitat Valenciana, Spain. centre_palmar@gva.es

³ Dirección General de Medio Natural y Animal. Generalitat Valenciana. Ciutat Administrativa 9 D'Octubre – Torre 1. C/ de la Democracia 77. 46018. Valencia.

Introduction

The Valencian Community is a place with aquatic ecosystems of great biological importance. Since 1999, the Wildlife Service & Natura 2000 Network, as the competent body in the conservation and recovery of wild species and natural habitats, has carried out a conservation program of the taxa of wild aquatic flora including the so-called "structural species", necessary for the restoration of aquatic habitats, such as those included in the Valencian Catalogue of Threatened Flora Species (CVEFA) (Decree 70/2009; Order 2/2022).

The works are coordinated by the Conservation of Threatened Aquatic Flora team of the Aquaculture Center of El Palmar (Fig. 1). One of the most important *in situ* actions that have been carried out is the census of the listed species, with greater or lesser periodicity according to the degree of threat.



Fig. 2

The censuses of the submerged aquatic species are carried out calculating the area occupied by the species. The size in the middle of the meadow is the value that is taken as a census reference measure. The censuses have been carried out since 2012; the data collection has been manual. A geographic positioning system (GPS) is used and the perimeter of the spot is travelled on foot or by boat, depending on the depth of the lagoon, geo-referencing it by taking waypoints as it is travelled.

In 2023 the census of some threatened taxa has been carried out with drone. The technique consists of taking the data in the field with the use of the aircraft to take an aerial photo with a sufficient scale to be georeferenced later using the appropriate GIS software.



Fig. 1

Methods

To explain the work methodology we will give an example of a *Nymphaea alba* census at the Flora Microreserve Llacuna del Barranc, in Algemesi (P.N. L'Albufera de Valencia) (Fig. 13) carried out in 2023.

Censuses of submerged aquatic species are carried out by calculating the surface area occupied by the census species. The size of the meadow in the middle is the value taken as the census reference measure. Censuses of species classified as Endangered are carried out annually, as in the case of *Nymphaea alba*.



Fig. 13

Since 2012, data collection has been done manually. A geographic positioning system (GPS) is used, traveling the perimeter of the meadow on foot or from a boat, depending on the depth of the lagoon, it is georeferenced by recording waypoints as it is travelled.

This paper describes the results of the different works carried out with drone in 2023 among which are a) the censuses of threatened macrophytes such as *Nymphaea alba* (Fig. 2) or *Ceratophyllum submersum*, both in risk of Extinction, b) the monitoring campaigns of invasive alien species present in the wetlands of the Valencian Community and c) some of the monitoring works on the conservation status of the macrophyte meadows in some areas of the N2000, such as in the L'Albufera Natural Park in Valencia.

a)

censuses of threatened macrophytes

1. *Nymphaea alba* (EP) in P.N. L'Albufera, MRF Llacuna del Barranc, Algemesi. Fig. 3. Manual census using a GPS. Fig. 4. Overhead photograph taken by drone.
2. *Ceratophyllum submersum* (EP). Fig. 5. Clot de Galvany, Elche, Alicante. Fig. 6. WWTP of Santa Pola, Alicante.



Fig. 3



Fig. 5



Fig. 4



Fig. 6

monitoring campaigns of IAS

As in the case of threatened species, exotic species can also be analyzed with the use of this tool, measuring the size and composition of the taxa in a certain area with overhead photos.

- Fig. 7. *Azolla filiculoides*, *Arundo donax* and *Ludwigia grandiflora* in Río Vaca, Xeraco, Valencia
- Fig. 8. *Ludwigia grandiflora*, Carreró de Sueca, Sueca, Valencia



Fig. 7



Fig. 8

The waypoints obtained are projected onto orthophotos with specific analysis software, processing and exploitation of satellite images. With this, the total surface area is calculated and the corresponding layer is prepared for the different management tools of the Wildlife Service and Natura 2000 Network, such as the threatened flora layer of the Generalitat Valenciana cartographic viewer.



Fig. 14



Fig. 15

Figs. 14 and 15. Projection of the waypoints obtained with GPS, in Qgis (left) and elaboration of the layer (right) of the *Nymphaea alba* census in the Llacuna del Barranc de Algemesi for the calculation of the occupied area.

c)

monitoring works on the conservation status of habitats

Other work carried out by the CAEP is the analysis of the state of conservation of the freshwater aquatic habitats of the Valencian Community.



Fig. 9



Fig. 10



Fig. 11



Fig. 12

- Fig. 9. Evaluation of the state of reed islands in Albufera lake, Natural Park of L'Albufera, Valencia.
- Fig. 10. Survey of macrophytes in the lake of La Albufera in Valencia, spring campaign of 2023.
- Fig. 11. Analysis of the state of the macrophyte meadow in a coastal lagoon in the south of the Natural Park Prat de Cabanes-Torreblanca, Cabanes.
- Fig. 12. State of evolution of the island "La Manseguerota", in Albufera lake, Natural Park of L'Albufera, Valencia.

In 2023 the census of the Algemesi water lily has also been carried out with a drone. The technique for collecting data is carried out by the aircraft by means of taking an aerial photo with sufficient scale to include the meadow occupied by the species and part of its most immediate environment to be able to georeference it later.

The images taken by the drone are georeferenced using the appropriate GIS and the surface of the meadow is calculated by drawing the area directly on the projected image of the drone.

Figure 18. Projection and georeferencing of aerial photos taken with a drone in the field on April 26, 2023.



Fig. 16

Fig. 17

Figs. 16 and 17. Aerial photos taken with the drone for the *Nymphaea alba* census in the Llacuna del Barranc Reserve, L'Albufera Natural Park on April 26, 2023.

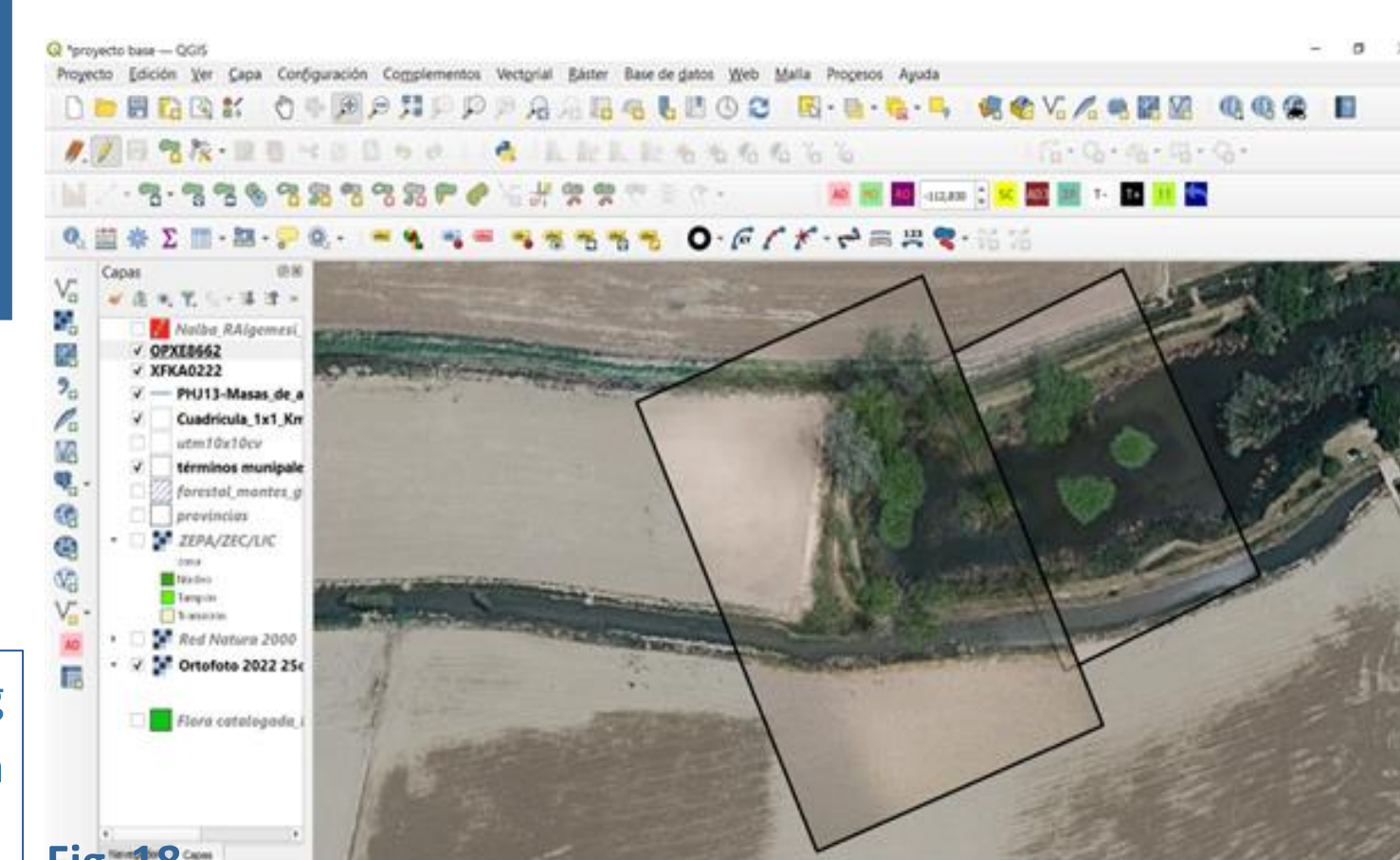


Fig. 18

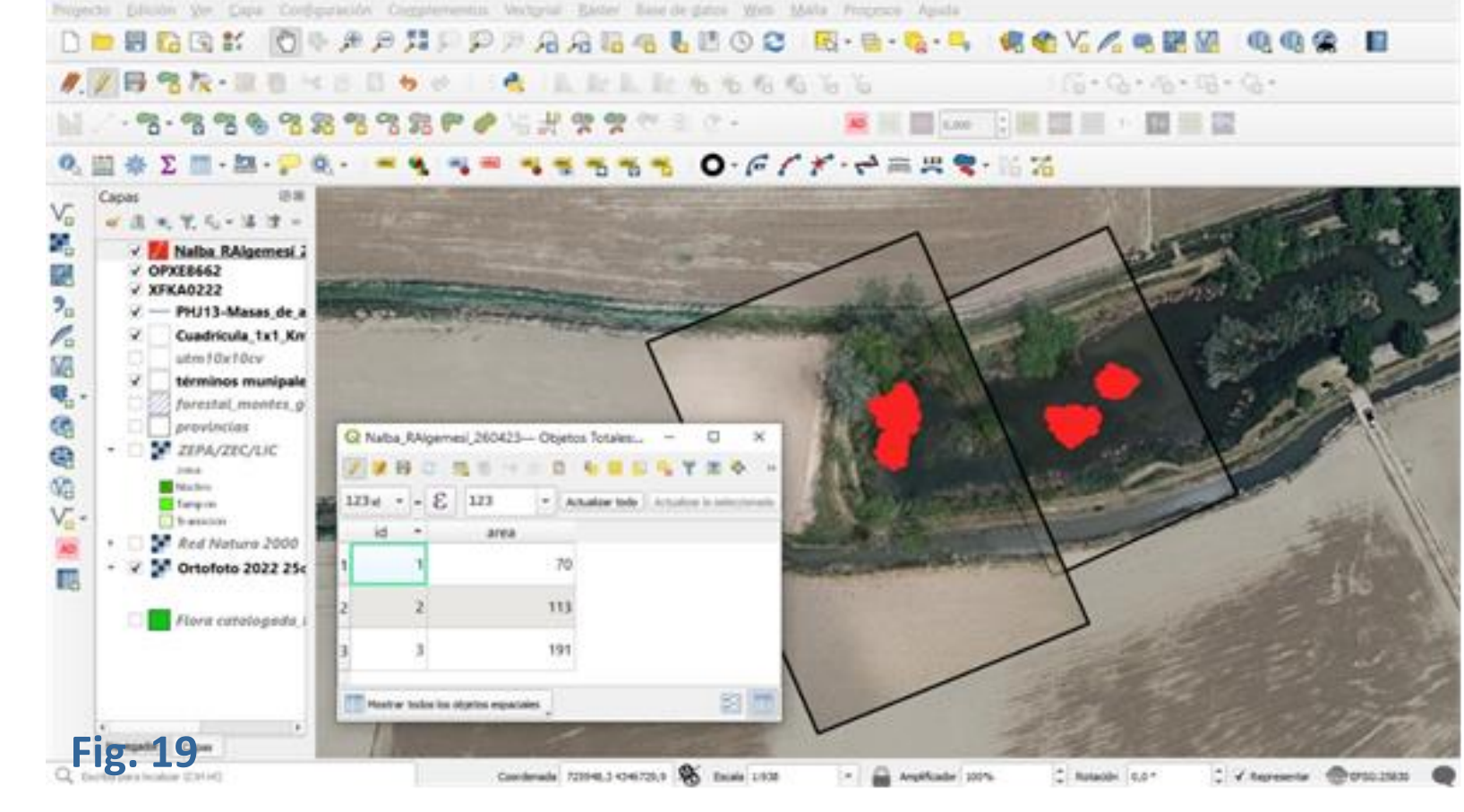


Fig. 19

Fig. 19. Obtaining of the occupied area by the water lily and preparation of the *Nymphaea alba* census layer on the photo obtained by the drone.

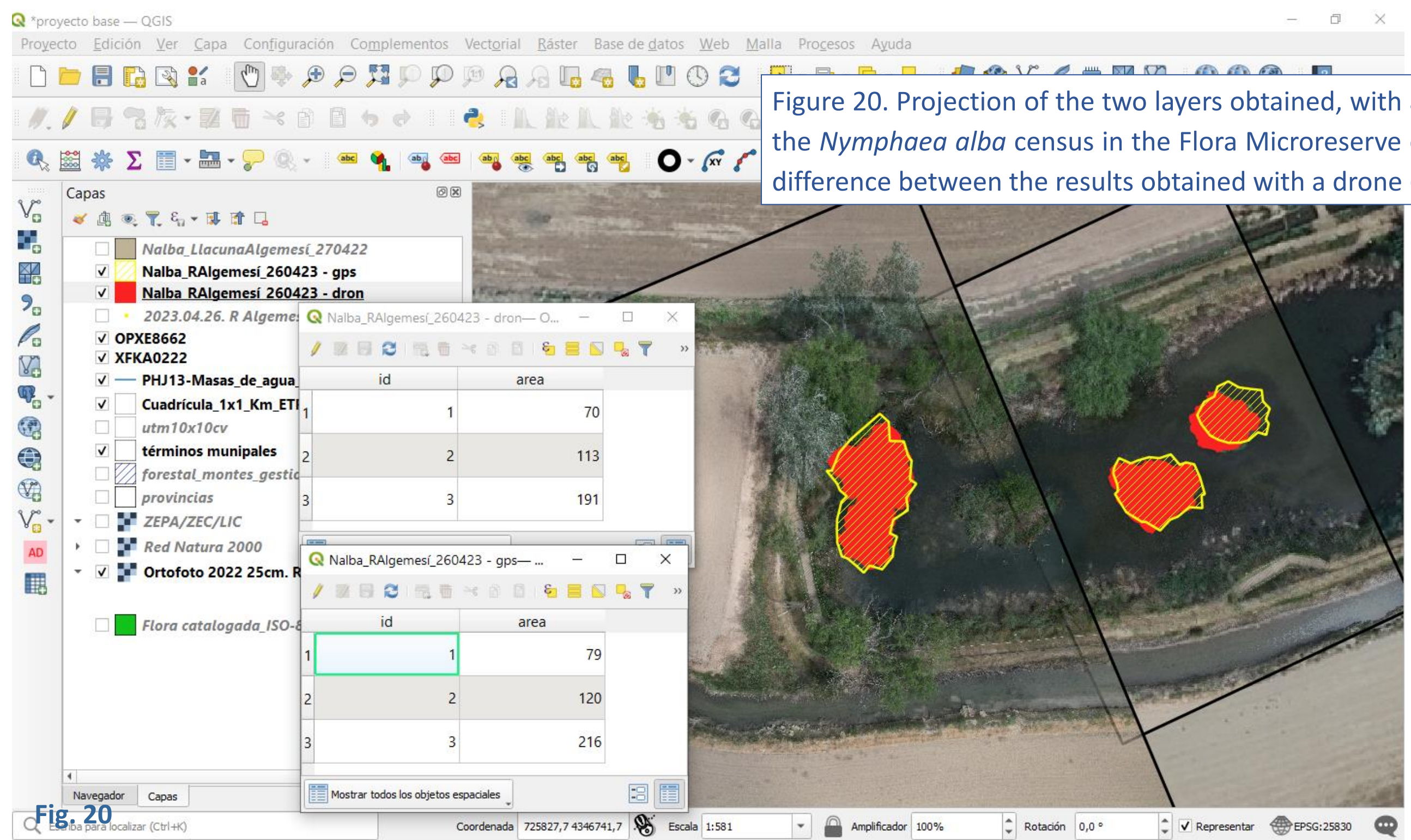


Figure 20. Projection of the two layers obtained, with a drone (red) and with GPS (yellow) as a result of the *Nymphaea alba* census in the Flora Microreserve during 2023. In the image tables you can see the difference between the results obtained with a drone (above) and with GPS (below).

Conclusions

- The drone is a perfect tool for carrying out certain field work. In our case it has been used for 3 types of work:
 - 1 Census of threatened aquatic flora species.
 - 2 Assessment of the state of invasions of exotic aquatic flora in the natural environment.
 - 3 Determination and assessment of the conservation status in some aquatic habitats.
- The results obtained with the drone for the calculation of surfaces occupied by threatened flora or invasive flora or other cases, are more precise since the intrinsic error of the GPS and that generated by manually carrying out the census disappear.
- The drone is an easy-to-use and environmentally friendly tool. The need to physically access the place is avoided. The fauna is not disturbed and the macrophyte meadows or riparian vegetation remain intact.
- The work is more effective and less dangerous for the operator, less time is spent carrying out censuses and allows access to impossible or difficult to access sites, the operator does not run risks by not having to enter the aquatic environment or cross these areas.
- The drone is a perfect tool for prospecting aquatic flora in canals, lagoons, ponds, greatly facilitating the different tasks of locating new populations, tracking invasive species, etc.

In our case we have found certain disadvantages to the use of this tool:

- It does not allow differentiating species with similar morphology, for example, between *Potamogeton pectinatus* and *Ruppia maritima*.
- Impossibility of using in areas with great development of riverside species that cover the water surface.

Results

The census (occupied area) of *Nymphaea alba* carried out on 4/26/2023 in the Llacuna Flora Microreserve of the Algemesi ravine has been carried out with two different techniques. The first, carried out with a drone, resulted in the occupation of 374 m², and the one carried out with GPS, obtained a result of 415 m², 41 m² more than in the first method, approximately 11% overrated in this case. Censuses carried out with drones are more precise than those carried out with GPS, they are direct calculations of the occupied area on a real image taken in the field and the intrinsic error of the GPS itself disappears.