*Water Resources Research*

Supporting Information for

# Abundance and morphometry changes across a high mountain lake-size gradient in the tropical Andes of Southern Ecuador

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## Introduction

The details of the digital bathymetry methods are provided in **Text S1,** and **Figure S1** and the lakes covered by the bathymetry survey in the Cajas National Park are listed in **Table S1**. Four more figures supporting the main text are also included. **Figure S2** shows the altitudinal distribution of the high mountain water bodies of the Cajas Massif. **Figure S3** illustrates some lake shapes across the shoreline development (DL) gradient. **Figure S4,** the volume-area relationship considering two lake morphologies. And, **Figure S5,** the maximum depth ($Z_{max}$), mean depth ($Z_{mean}$) and relative depth ($Z_r$) distribution among the Cajas National Park lakes.

### Text S1. Digital bathymetry method

The process to produce the digital bathymetry of the studied lakes and the derived geomorphological products included: (i) in-situ gathering and office processing of the surveying data so that any incongruence could be filtered out; (ii) preparing the information with the right digital format for the forthcoming steps; (iii) selecting and applying an interpolation algorithm to obtain the bathymetric surface (i.e. the digital bathymetric model) of every surveyed lake; and (iv) obtaining the required geomorphological products derived from the digital bathymetric models of the lakes. For most of these processes, specific-task subroutines were programmed, particularly with PERL (Practical Extracting and Reporting Language) and Matlab®.

The first step included the integration of the depth data collected in the field with the data derived from the digitalization of the orthophotos (i.e. boundaries of the lakes associated with zero-depth) so that the feasible bounds of the following interpolation process could be defined properly (besides adding additional zero-depth data for the interpolation process). For filtering out some potential pitfalls of the data collected in the field, these lake boundaries as

well as other relevant spatial information, together with field annotations, were contrasted with the aid of geographical information systems (GIS) (ArcGis® and IDRISI® Selva).

In the second step, suitable specific-task subroutines, usually programmed with PERL, were used so as to get the different data saved with the right format, as a function of the software that was used later for the interpolation process, particularly Surfer® 13.0.

The third step was obtaining the digital bathymetric model of the surveyed lakes. It included assessing an appropriate interpolation algorithm for the current study, by judging the depth accuracy of the resulting interpolation product (i.e. the bathymetric model of a given lake).

For some of the studied lakes, the implemented quality assessment process considered a visual comparison (Figure S1) of the results of the different alternative interpolation methods. Through this visual analysis, some of the methods were already discarded. In a second approach, similarly to what is typically done in topographic studies (Vázquez and Feyen, 2007), the accuracy assessment was based on the comparison of the depths modelled with a set of field observations (quality control data set), selected randomly from the set of total field observations. It is important to note that the data of this randomly selected set of observations were not included in the interpolation process itself but, instead, they were only used for quality assessment purposes; that is, only 80 % of the available information was used for deriving the interpolated bathymetric surfaces

For a particular interpolation method, the depths comparison was characterised using residuals, that is, the depth difference between the interpolation model and the quality control data set (at the spot locations of these control quality data). This comparison was further aggregated to a single measure depicting the elevation difference between the interpolation product and the quality control data: the Mean Absolute Error (MAE), which is the average of the absolute values of all of the residuals for a particular interpolation product and a particular lake. Absolute values were used to avoid residuals of similar magnitude, but of opposite sign, cancelling to each other, as such, giving the false sensation of low depth discrepancies [*Vázquez and Feyen*, 2007]. For a particular tested interpolation algorithm, the quality of the method was assessed through a frequency distribution (empirical) function of the MAE, calculated considering the respective interpolation products of all of the studied lakes; so that, the outcome of the quality assessment is a plot of frequency distributions of the MAE as a function of the interpolation method (Figure S1c).

In total, ten interpolation methods were tested [*Franke and Nielson*, 1980; *Franke*, 1982; *Renka*, 1988; *Hanselman and Littlefield*, 1998; *Wise*, 2000; *Vivoni et al.*, 2005; *Vázquez and Feyen*, 2007; *Eldrandaly and Abu-Zaid*, 2011], namely, (1) Inverse Distance to a Power, (2) Kriging Standard, (3) Minimum Curvature, (4) Modified Shepard's Method, (5) Natural Neighbour, (6) Nearest Neighbour, (7) Polynomial Regression, (8) Radial Basis Functions, (9) Triangular Interpolation Network (TIN) combined with linear interpolation along the edges of the triangles, and (10) Moving Average.

Finally, in the fourth step, the most suitable interpolation method was applied to obtain the digital bathymetric model of each lake surveyed. Given the significant number of lakes considered in the current study, the interpolation and quality control analyses were carried out automatically, using (i) the programming framework that Surfer® enables by mean of Visual Basic; and (ii) PERL specific-purpose subroutines.

The outcome of the quality assessment on the products of the ten different interpolation methods considered in this study is depicted in Figure S1c, in the form of ten frequency distribution curves. For a given interpolation method, every dot in the respective distribution curve represents the quality (measured by the MAE) of the bathymetric surface of one of the study lakes obtained by applying the method to the available observations. The figure depicts

that indeed these distribution curves enable characterising the differences (and similitudes) among the different interpolation methods since differences (and similitudes) among these curves are systematic. Further, the quality of the products of a given interpolation method, characterized herein by the MAE, shapes the evolution of the respective distribution curve so that better interpolation methods have associated distributions that evolve in a relatively short MAE range, whilst methods that are not that suitable have associated distributions that are spanning (much) longer MAE ranges (Figure S1c).

The analysis shows that the best interpolation methods for the conditions of the current study were: (2) Kriging Standard, (3) Minimum Curvature, (5) Natural Neighbour, (6) Nearest Neighbour and (9) TIN with Linear Interpolation, given that the differences among their respective distributions are only marginal and that the associated MAE range is the shortest possible (about 2 m). Thus, we use the Standard version of the Kriging interpolation method for the bathymetry digital development. Nevertheless, statistically, there is not any advantage in using this interpolation method over the other methods with similar MAE distributions in Figure S1c. Indeed, even the simple and traditional (1) Inverse Distance to a Power method performs acceptably compared to methods 2, 3, 5, 6 and 9 (Figure S1c).

References Text S1


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Wise, S. (2000), Assessing the quality for hydrological applications of digital elevation models derived from contours, *Hydrol Process*, *14*(11-12), 1909-1929.

**Figure S1**. Process followed to define the digital bathymetry of the studied lakes: (a) sonar used for the surveying; (b) graphical assessment of the quality of the interpolation methods applied on the observed bathymetric data; and (c) statistical evaluation of the quality of the interpolation methods (i.e., frequency distributions of the mean absolute error, MAE, as a function of the interpolation method).

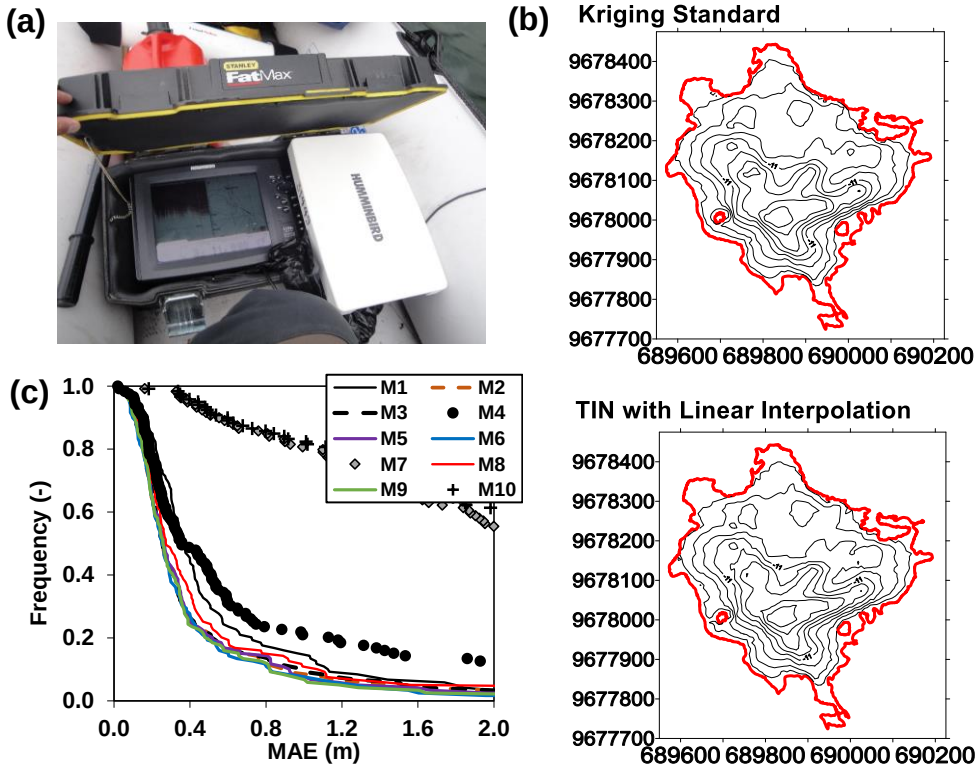


**Figure S2**. Altitudinal distribution of the high-mountain lakes of the Cajas Massif

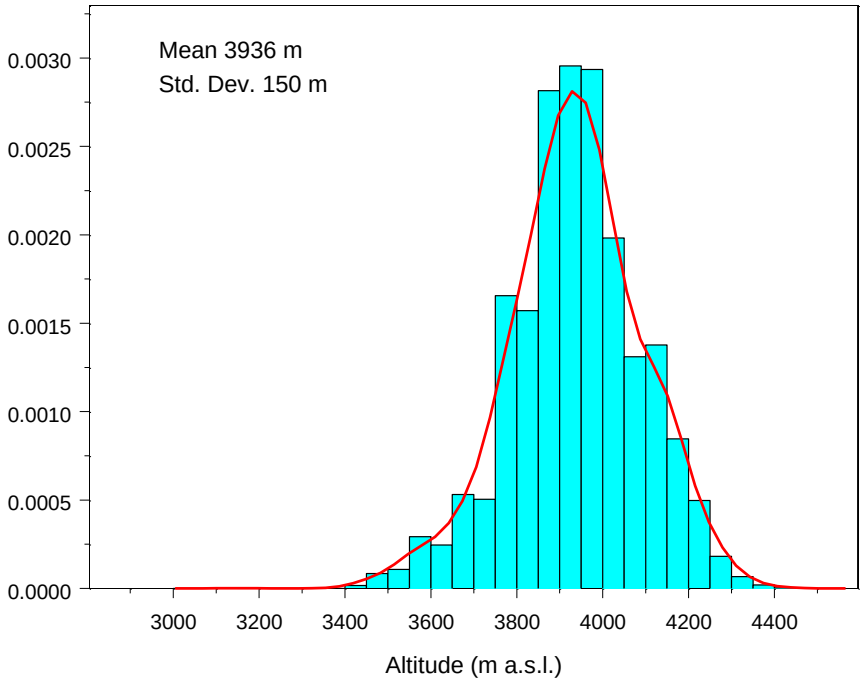


**Figure S3**. Some examples of the lake shapes and their corresponding shoreline development (DL) in the Cajas National Park. a) Laguna de la Cascada , b) Lagartococha , c) Angas , d) Luspa , e) Burín Grande , f) Mamamag , and g) Osohuayco.

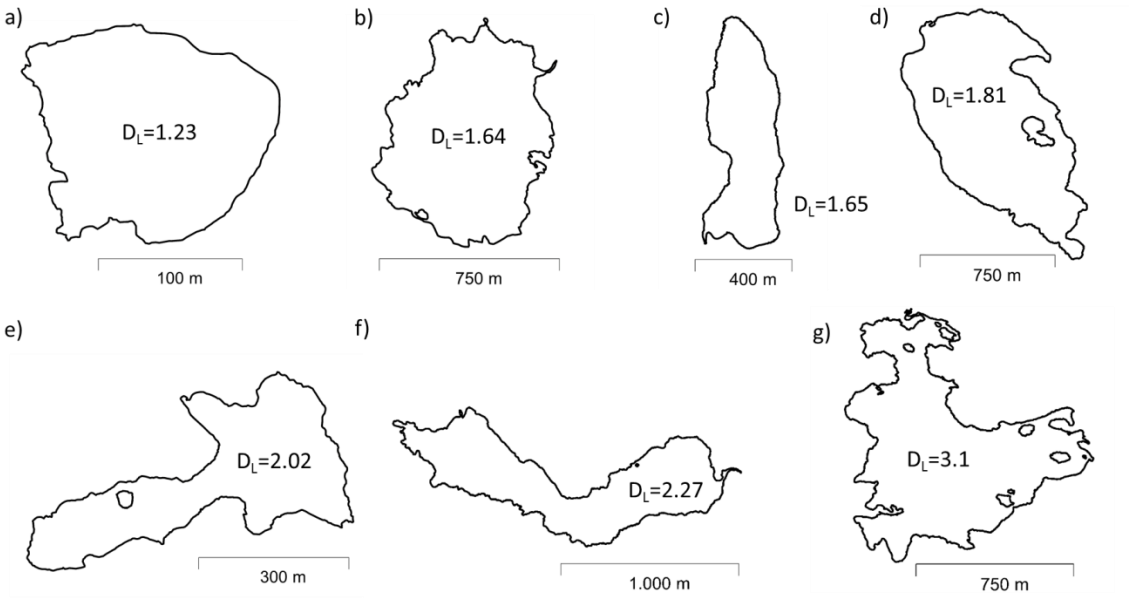


**Figure S4**. The volume-are relationship for the lakes of the Cajas Massif based on a survey of 202 lakes and ponds in the Cajas National Park and assuming two lake morphologies. The lakes were initially classified into two groups (relatively deep (*rd*) and relatively shallow (*rs*)) according to the positive or negative residuals with respect equation (3) in the main text. Then an allometric equation was fit to each group. The new equations were applied to the whole set, and the lakes were reclassified into two groups according to the lowest residual of the two equations. A new fitting with the new two groups was performed, and then a new reclassification. This procedure was repeated until there were no changes in the classification. The resulting equations were:

$$V_{rd} = 0.0084\, A_{rd}^{1.59} \qquad r^2 = 0.97 \qquad n = 130$$

$$V_{rs} = 0.0929\, A_{rs}^{1.14} \qquad r^2 = 0.96 \qquad n = 72$$

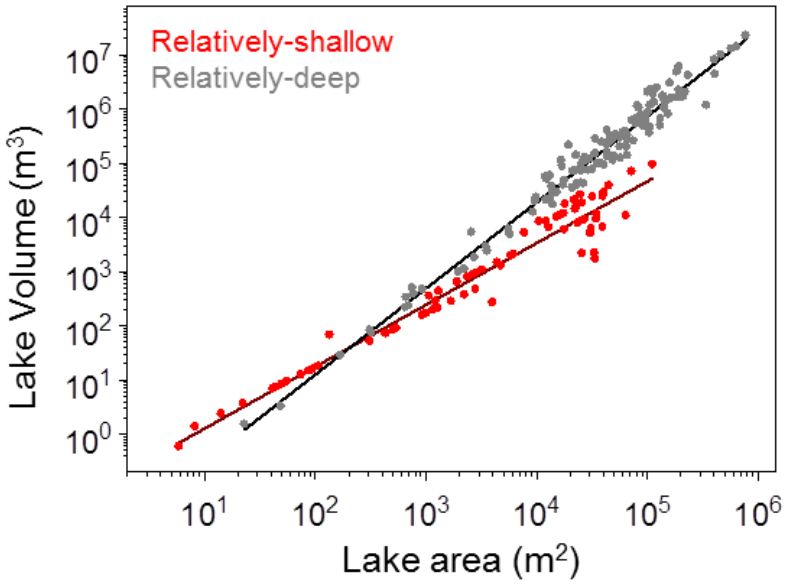
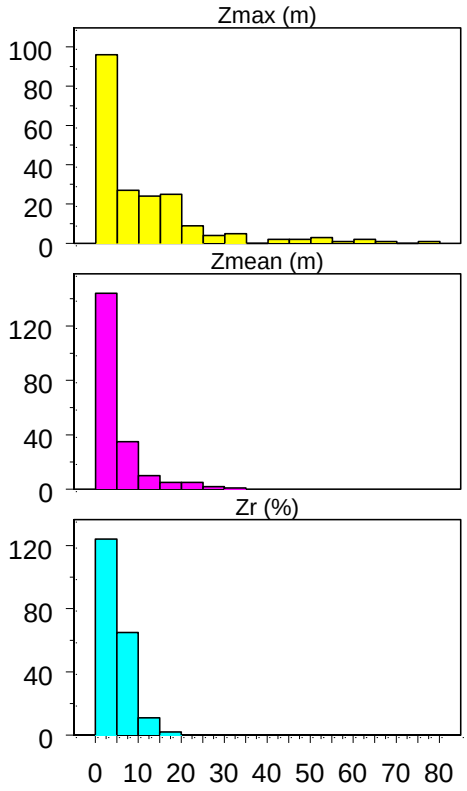


**Figure S5**. Distribution of the maximum depth ($Z_{max}$), mean depth ($Z_{mean}$) and relative depth ($Z_r$) among the Cajas National Park lakes.



187 **Table S1** List of the water bodies of the Cajas National Park included in the bathymetry survey
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| Code | Name | Latitude | Longitude | Altitude (m a.s.l.) |
|---|---|---|---|---|
| CJ-001 | Llaviucu | 2° 50' 35.584" S | 79° 8' 46.136" W | 3152 |
| CJ-002 | Patoquinuas | 2° 46' 54.316" S | 79° 12' 30.998" W | 3800 |
| CJ-003 | Toreadora | 2° 46' 45.871" S | 79° 13' 26.144" W | 3917 |
| CJ-004 | Illincocha | 2° 46' 44.674" S | 79° 13' 52.401" W | 3983 |
| CJ-005 | Chica Toreadora | 2° 46' 29.042" S | 79° 13' 48.313" W | 3984 |
| CJ-006 | Piñancocha | 2° 45' 13.787" S | 79° 13' 55.515" W | 4221 |
| CJ-007 | Fondococha | 2° 45' 35.329" S | 79° 14' 10.861" W | 4127 |
| CJ-008 | Pallcacocha | 2° 46' 15.057" S | 79° 13' 57.561" W | 4046 |
| CJ-009 | Riñoncocha | 2° 45' 58.862" S | 79° 13' 46.836" W | 4034 |
| CJ-010 | Toreador | 2° 45' 53.128" S | 79° 13' 22.564" W | 3927 |
| CJ-011 | Ataudcocha | 2° 46' 15.415" S | 79° 12' 52.294" W | 3882 |
| CJ-012 | Tintacocha | 2° 50' 58.385" S | 79° 17' 39.274" W | 4033 |
| CJ-013 | Del Diablo | 2° 50' 39.448" S | 79° 17' 45.972" W | 4063 |
| CJ-014 | Contrahierba | 2° 50' 47.165" S | 79° 18' 8.754" W | 4004 |
| CJ-015 | Totorilla | 2° 50' 5.796" S | 79° 19' 21.697" W | 4090 |
| CJ-016 | Cristales | 2° 50' 27.292" S | 79° 19' 5.25" W | 4148 |
| CJ-017 | Yanacocha de Jerez | 2° 50' 18.087" S | 79° 19' 33.27" W | 4159 |
| CJ-018 | Yantahuaico 1 | 2° 50' 0.697" S | 79° 20' 37.242" W | 4075 |
| CJ-019 | Yantahuaico 2 | 2° 50' 4.024" S | 79° 20' 19.202" W | 4110 |
| CJ-020 | Yantahuaico 3 | 2° 50' 16.909" S | 79° 20' 14.198" W | 4112 |
| CJ-021 | Marmolcocha | 2° 46' 53.399" S | 79° 13' 9.881" W | 3926 |
| CJ-022 | Unidas | 2° 46' 17.781" S | 79° 13' 7.02" W | 3861 |
| CJ-023 | Atugyacu Grande | 2° 50' 26.725" S | 79° 18' 12.249" W | 3969 |
| CJ-024 | Estrellascocha | 2° 51' 8.014" S | 79° 20' 31.706" W | 4128 |
| CJ-025 | Negra de Jerez | 2° 51' 19.484" S | 79° 19' 9.092" W | 4045 |
| CJ-026 | Atascaderos | 2° 51' 20.023" S | 79° 19' 21.913" W | 4038 |
| CJ-027 | Pailacocha de Jerez | 2° 51' 39.945" S | 79° 19' 42.445" W | 3970 |
| CJ-028 | Atugloma | 2° 51' 31.146" S | 79° 18' 52.109" W | 4141 |
| CJ-029 | Angas | 2° 52' 1.014" S | 79° 17' 56.213" W | 3886 |
| CJ-030 | Dublaycocha | 2° 51' 36.005" S | 79° 17' 51.749" W | 3915 |
| CJ-031 | S/N | 2° 52' 11.2" S | 79° 17' 32.173" W | 4023 |
| CJ-032 | Estrellascocha | 2° 54' 47.902" S | 79° 15' 13.615" W | 3818 |
| CJ-033 | Lagunaloma o Verdecocha | 2° 53' 12.162" S | 79° 18' 27.871" W | 3837 |
| CJ-034 | Napalé Vía | 2° 53' 38.702" S | 79° 17' 28.384" W | 3945 |
| CJ-035 | Tinguercocha 1 | 2° 53' 11.919" S | 79° 17' 34.608" W | 3895 |
| CJ-036 | Ingacasa | 2° 51' 31.179" S | 79° 16' 19.544" W | 3977 |
| CJ-037 | Ingacocha 1 | 2° 51' 39.453" S | 79° 16' 1.497" W | 3958 |
| CJ-038 | Chachacomes | 2° 51' 18.704" S | 79° 15' 54.082" W | 4000 |

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|---|---|---|---|---|
| CJ-039 | Larga | 2° 47' 41.422" S | 79° 14' 40.103" W | 3940 |
| CJ-040 | Negra | 2° 47' 0.622" S | 79° 14' 33.915" W | 4043 |
| CJ-041 | Cardenillo | 2° 46' 56.252" S | 79° 14' 49.979" W | 4104 |
| CJ-042 | Togllacocha | 2° 48' 0.985" S | 79° 14' 59.984" W | 3859 |
| CJ-043 | Luspa | 2° 48' 17.395" S | 79° 15' 45.61" W | 3776 |
| CJ-044 | Tinguercocha 2 | 2° 53' 10.185" S | 79° 17' 50.735" W | 3888 |
| CJ-045 | Cucheros | 2° 47' 34.028" S | 79° 12' 7.595" W | 3887 |
| CJ-046 | Canutillos Grande | 2° 49' 10.558" S | 79° 15' 25.102" W | 3851 |
| CJ-047 | Canutillos chica 2 | 2° 49' 50.577" S | 79° 15' 9.534" W | 3942 |
| CJ-048 | Canutillos chica 1 | 2° 49' 40.139" S | 79° 15' 17.255" W | 3934 |
| CJ-049 | Osohuayco | 2° 49' 48.808" S | 79° 13' 37.361" W | 3856 |
| CJ-050 | Mamamag / Taitachugo | 2° 49' 44.619" S | 79° 11' 38.063" W | 3543 |
| CJ-051 | Sunincocha Grande | 2° 49' 49.679" S | 79° 17' 7.03" W | 3842 |
| CJ-052 | Burín Grande | 2° 48' 28.58" S | 79° 12' 44.938" W | 3891 |
| CJ-053 | Burín Chico 1 | 2° 48' 38.229" S | 79° 12' 53.017" W | 3872 |
| CJ-054 | Burín Chico 2 | 2° 48' 19.537" S | 79° 13' 10.69" W | 3900 |
| CJ-055 | El Ocho | 2° 47' 57.211" S | 79° 12' 52.691" W | 3991 |
| CJ-056 | 3ra de Sunincocha | 2° 49' 21.461" S | 79° 17' 33.718" W | 3808 |
| CJ-057 | Las Chorreras | 2° 49' 12.401" S | 79° 17' 5.563" W | 4079 |
| CJ-058 | 2da de Sunincocha | 2° 49' 7.169" S | 79° 17' 55.949" W | 3768 |
| CJ-059 | Quinuascocha | 2° 50' 15.991" S | 79° 16' 6.997" W | 3894 |
| CJ-060 | Potro muerto | 2° 50' 6.73" S | 79° 16' 18.343" W | 3897 |
| CJ-061 | Culebrillas | 2° 49' 45.304" S | 79° 16' 37.056" W | 3955 |
| CJ-062 | Cueva Escrita | 2° 50' 49.7" S | 79° 16' 16.724" W | 4019 |
| CJ-063 | Llipus loma | 2° 50' 59.438" S | 79° 15' 58.223" W | 4023 |
| CJ-064 | Llipus loma 3 | 2° 50' 38.607" S | 79° 16' 22.342" W | 4001 |
| CJ-065 | Llipus loma 2 | 2° 50' 42.737" S | 79° 16' 19.293" W | 4007 |
| CJ-066 | Negra | 2° 47' 29.339" S | 79° 14' 57.895" W | 3973 |
| CJ-067 | Azul | 2° 47' 17.374" S | 79° 14' 46.225" W | 4043 |
| CJ-068 | Pampeada Grande | 2° 46' 4.85" S | 79° 15' 56.877" W | 4121 |
| CJ-069 | Pampeada Chica | 2° 45' 55.309" S | 79° 16' 17.643" W | 4158 |
| CJ-070 | Del Rayo | 2° 46' 7.585" S | 79° 16' 19.826" W | 4149 |
| CJ-071 | Cuchichaspana | 2° 50' 14.266" S | 79° 15' 45.534" W | 3962 |
| CJ-072 | Cuchichaspana Chica | 2° 50' 25.562" S | 79° 14' 37.626" W | 3972 |
| CJ-073 | Piedra Blanca o Llaviucu | 2° 50' 14.636" S | 79° 15' 35.834" W | 3950 |
| CJ-074 | Ojo de Osohuaico | 2° 50' 10.497" S | 79° 13' 42.055" W | 3878 |
| CJ-075 | Patos Colorados | 2° 50' 12.043" S | 79° 13' 10.648" W | 3946 |
| CJ-076 | Lagartococha | 2° 51' 20.322" S | 79° 13' 40.233" W | 4001 |
| CJ-077 | Anexo Osohuayco | 2° 50' 0.759" S | 79° 13' 39.253" W | 3871 |
| CJ-078 | Ingacocha 2 | 2° 51' 40.377" S | 79° 16' 10.206" W | 3959 |
| CJ-079 | J | 2° 52' 0.997" S | 79° 15' 57.288" W | 3919 |
| CJ-080 | Martillo | 2° 51' 16.491" S | 79° 16' 16.199" W | 3977 |
| CJ-081 | Apicocha 1 | 2° 47' 14.254" S | 79° 12' 40.874" W | 3924 |

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| CJ-082 | Apicocha 2 | 2° 47' 9.61" S | 79° 12' 48.133" W | 3924 |
| CJ-083 | Apicocha 3 | 2° 47' 3.046" S | 79° 12' 55.88" W | 3916 |
| CJ-084 | Cascarilla 1 | 2° 52' 0.094" S | 79° 16' 45.694" W | 4008 |
| CJ-085 | Cascarilla 2 | 2° 51' 49.49" S | 79° 16' 51.182" W | 4002 |
| CJ-086 | Cascarilla 3 | 2° 52' 34.23" S | 79° 16' 36.48" W | 3984 |
| CJ-087 | Chica luspa 1 | 2° 48' 35.76" S | 79° 15' 5.145" W | 3806 |
| CJ-088 | Chica luspa 2 | 2° 48' 39.979" S | 79° 14' 56.106" W | 3818 |
| CJ-089 | Trensillas | 1° 48' 37.684" S | 31° 7' 47.755" W | 3997 |
| CJ-090 | Chullacocha | 3° 1' 22.439" S | 79° 13' 20.954" W | 3787 |
| CJ-091 | Quimsacocha 1 | 3° 3' 12.64" S | 79° 14' 43.933" W | 3827 |
| CJ-092 | Quimsacocha 2 | 3° 3' 3.29" S | 79° 14' 59.297" W | 3827 |
| CJ-093 | Vado de los Arrieros 1 | 2° 51' 54.074" S | 79° 14' 39.172" W | 3814 |
| CJ-094 | Vado de los Arrieros 2 | 2° 51' 25.312" S | 79° 14' 49.285" W | 3820 |
| CJ-095 | Botacocha | 2° 51' 38.827" S | 79° 14' 31.554" W | 3839 |
| CJ-096 | Carpahuayco | 2° 50' 42.632" S | 79° 14' 48.799" W | 3917 |
| CJ-097 | Jigeno | 2° 54' 42.645" S | 79° 17' 31.396" W | 3969 |
| CJ-098 | De Patos | 2° 54' 8.287" S | 79° 16' 40.515" W | 3971 |
| CJ-099 | De la Cascada | 2° 45' 48.633" S | 79° 12' 58.808" W | 3967 |
| CJ-100 | Cardenillo | 2° 45' 25.534" S | 79° 12' 46.573" W | 4137 |
| CJ-101 | Derrumbo Amarillo | 2° 45' 52.536" S | 79° 12' 35.558" W | 4036 |
| CJ-102 | Perro Grande | 2° 45' 37.052" S | 79° 13' 47.775" W | 4000 |
| CJ-103 | Chica Ventanas | 2° 52' 31.268" S | 79° 15' 32.668" W | 3856 |
| CJ-104 | Bejuco | 2° 52' 57.996" S | 79° 14' 30.203" W | 3628 |
| CJ-105 | Tintacocha | 2° 52' 42.586" S | 79° 15' 4.32" W | 3679 |
| CJ-106 | Ventanas | 2° 52' 47.451" S | 79° 15' 56.312" W | 3913 |
| CJ-107 | Chusalongo 1 | 2° 55' 48.502" S | 79° 14' 42.631" W | 3778 |
| CJ-108 | Chusalongo 2 | 2° 55' 38.583" S | 79° 14' 48.702" W | 3794 |
| CJ-109 | Chusalongo 3 | 2° 55' 45.875" S | 79° 14' 28.227" W | 3780 |
| CJ-110 | Chusalongo 4 | 2° 55' 56.395" S | 79° 14' 31.578" W | 3764 |
| CJ-111 | Del Sharo | 2° 46' 1.264" S | 79° 16' 38.548" W | 4253 |
| CJ-112 | Negra | 2° 46' 8.977" S | 79° 16' 36.627" W | 4228 |
| CJ-113 | De Patos Blancos | 2° 45' 40.312" S | 79° 16' 24.755" W | 4210 |
| CJ-114 | Juan Pasana | 2° 45' 30.525" S | 79° 16' 33.057" W | 4294 |
| CJ-115 | Chica Hunanchi | 2° 51' 58.855" S | 79° 13' 54.419" W | 3874 |
| CJ-116 | Hunanchi | 2° 52' 19.022" S | 79° 14' 4.328" W | 3834 |
| CJ-117 | Verdes | 2° 51' 33.277" S | 79° 12' 57.346" W | 3886 |
| CJ-118 | Estrellascocha 2 | 2° 55' 10.523" S | 79° 15' 11.119" W | 3769 |
| CJ-119 | Estrellascocha 3 | 2° 55' 4.383" S | 79° 14' 58.274" W | 3802 |
| CJ-120 | Estrellascocha 4 | 2° 55' 15.687" S | 79° 15' 23.674" W | 3761 |
| CJ-121 | Dos Choreras | 2° 46' 12.542" S | 79° 9' 36.858" W | 3690 |
| CJ-122 | Taquiurco | 2° 46' 44.076" S | 79° 11' 57.279" W | 3623 |
| CJ-123 | Barros | 2° 46' 38.203" S | 79° 12' 10.108" W | 3815 |
| CJ-124 | Charco-Anex-Barros | 2° 46' 41.038" S | 79° 12' 11.82" W | 3824 |

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|---|---|---|---|---|
| CJ-125 | Humedal Totora | 2° 46' 44.464" S | 79° 12' 17.448" W | 3824 |
| CJ-126 | Charco Pardo Anex Humedal | 2° 46' 44.174" S | 79° 12' 19.358" W | 3832 |
| CJ-127 | Barros 2 | 2° 46' 18.392" S | 79° 12' 19.624" W | 3871 |
| CJ-128 | Barros 3 | 2° 46' 24.609" S | 79° 12' 18.675" W | 3873 |
| CJ-129 | Charca Anexo Barros 3 | 2° 46' 28.025" S | 79° 12' 17.181" W | 3863 |
| CJ-130 | Charca 2 Anexo Barros 3 | 2° 46' 28.48" S | 79° 12' 17.018" W | 3859 |
| CJ-131 | Totoras | 2° 46' 50.554" S | 79° 12' 40.424" W | 3810 |
| CJ-132 | Verdecocha | 2° 48' 54.131" S | 79° 9' 35.117" W | 3659 |
| CJ-133 | San Antonio 1 | 2° 49' 17.978" S | 79° 10' 7.034" W | 3846 |
| CJ-134 | San Antonio 2 | 2° 49' 34.423" S | 79° 10' 10.925" W | 3721 |
| CJ-135 | Patococha 1 | 2° 48' 34.226" S | 79° 10' 27.498" W | 3841 |
| CJ-136 | Charca Anexo Pato 2 | 2° 48' 21.486" S | 79° 10' 19.586" W | 3801 |
| CJ-137 | Patococha grande 1 | 2° 48' 22.024" S | 79° 10' 9.873" W | 3783 |
| CJ-138 | Charca Anexo Patococha 1 | 2° 48' 11.467" S | 79° 10' 3.512" W | 3754 |
| CJ-139 | Lago Anexo Estrellascocha 1 | 2° 51' 5.881" S | 79° 20' 19.729" W | 4125 |
| CJ-140 | Charca Anexo Estrellascocha 1 | 2° 51' 9.305" S | 79° 20' 23.933" W | 4116 |
| CJ-141 | Estrellascocha 2 | 2° 51' 20.09" S | 79° 20' 52.508" W | 4074 |
| CJ-142 | Estrellascocha 3 | 2° 51' 15.583" S | 79° 20' 42.283" W | 4092 |
| CJ-143 | Estrellascocha 4 | 2° 51' 19.298" S | 79° 20' 45.192" W | 4088 |
| CJ-144 | Charca Anexo Estrellascocha 4 | 2° 51' 18.876" S | 79° 20' 45.937" W | 4095 |
| CJ-145 | Lago somero anexo Estrella 2 | 2° 51' 28.681" S | 79° 20' 49.55" W | 4073 |
| CJ-146 | Estrellas 5 | 2° 51' 22.036" S | 79° 20' 47.034" W | 4084 |
| CJ-147 | Lago somero anexo Yantahuaico 1 | 2° 50' 7.428" S | 79° 20' 31.696" W | 4085 |
| CJ-148 | Lago somero anexo Yantahuaico 4 | 2° 50' 7.787" S | 79° 20' 32.019" W | 4086 |
| CJ-149 | Cocha totorilla 1 | 2° 50' 4.336" S | 79° 19' 47.213" W | 4223 |
| CJ-150 | Cocha totorilla 2 | 2° 50' 4.435" S | 79° 19' 48.41" W | 4229 |
| CJ-151 | Cocha totorilla 3 | 2° 50' 4.274" S | 79° 19' 49.479" W | 4232 |
| CJ-152 | Cocha totorilla 4 | 2° 50' 20.934" S | 79° 19' 21.351" W | 4169 |
| CJ-153 | Cocha Jerez 1 | 2° 51' 23.571" S | 79° 19' 21.52" W | 4040 |
| CJ-154 | Cocha Jerez 2 | 2° 51' 17.444" S | 79° 19' 16.769" W | 4029 |
| CJ-155 | Cocha Jerez 3 | 2° 51' 16.337" S | 79° 19' 16.35" W | 4036 |
| CJ-156 | Cocha totorilla 5 | 2° 49' 46.18" S | 79° 19' 31.568" W | 4078 |
| CJ-157 | Culebrillas | 2° 25' 25.25" S | 78° 51' 38.535" W | 3901 |
| CJ-158 | Paredones | 2° 25' 36.083" S | 78° 51' 35.508" W | 3946 |
| CJ-159 | Charca anostraceos | 2° 47' 2.928" S | 79° 14' 51.944" W | 4131 |
| CJ-160 | Charca L2 | 2° 47' 2.359" S | 79° 14' 41.261" W | 4070 |
| CJ-161 | Lago somero anexo L2 | 2° 47' 2.23" S | 79° 14' 42.427" W | 4071 |
| CJ-162 | Lago somero anexo larga | 2° 47' 34.331" S | 79° 14' 44.257" W | 3955 |
| CJ-163 | Lago somero anexo luspa | 2° 48' 12.803" S | 79° 15' 22.306" W | 3819 |
| CJ-164 | Charca anostraceos 2 | 2° 48' 1.836" S | 79° 15' 46.96" W | 3804 |
| CJ-165 | AN-CH001 | 2° 52' 22.047" S | 79° 17' 57.639" W | 3884 |
| CJ-166 | Charca anostraceos anexo angas | 2° 52' 22.346" S | 79° 18' 1.685" W | 3881 |
| CJ-167 | Lago Azul | 2° 52' 56.986" S | 79° 17' 19.412" W | 3974 |

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| CJ-168 | Charca Anexo a tinguercocha 1 | 2° 53' 10.27" S | 79° 17' 20.72" W | 3894 |
| CJ-169 | Las Chorreras 2 | 2° 49' 10.655" S | 79° 16' 51.806" W | 4085 |
| CJ-170 | Mangacocha 1 | 2° 49' 52.989" S | 79° 16' 16.097" W | 4009 |
| CJ-171 | Mangacocha 2 | 2° 49' 49.301" S | 79° 16' 10.048" W | 3995 |
| CJ-172 | Mangacocha 3 | 2° 49' 52.261" S | 79° 16' 8.619" W | 4009 |
| CJ-173 | Charca SU 1 | 2° 49' 49.433" S | 79° 16' 33.294" W | 3966 |
| CJ-174 | 1ra de Sunincocha | 2° 48' 54.454" S | 79° 18' 5.195" W | 3752 |
| CJ-175 | Charco 1 anexo Ingacocha 1 | 2° 51' 19.642" S | 79° 16' 32.674" W | 4046 |
| CJ-176 | Lago somero 2 anexo a Ingacasa | 2° 51' 15.586" S | 79° 16' 41.519" W | 4045 |
| CJ-177 | Charco 3 anexo a Ingacasa | 2° 51' 22.125" S | 79° 16' 38.693" W | 4007 |
| CJ-178 | Lago somero anexo a Ingacocha 2 | 2° 51' 42.128" S | 79° 15' 44.042" W | 3960 |
| CJ-179 | Lago somero 2 anexo a Ingacocha 2 | 2° 51' 41.357" S | 79° 15' 50.81" W | 3975 |
| CJ-180 | Lago somero 3 anexo a Ingacocha 2 | 2° 51' 37.646" S | 79° 15' 50.654" W | 3984 |
| CJ-181 | Charco 1 anexo a tintacocha | 2° 52' 42.367" S | 79° 12' 23.534" W | 3705 |
| CJ-182 | Hato de Chocar | 2° 52' 10.414" S | 79° 12' 12.123" W | 3706 |
| CJ-183 | Lago somero Hato de Chocar 1 | 2° 52' 22.521" S | 79° 12' 9.74" W | 3703 |
| CJ-184 | Totoracocha | 2° 52' 55.054" S | 79° 11' 36.535" W | 3583 |
| CJ-185 | Hato de chocar 2 o Tintacocha | 2° 52' 31.435" S | 79° 12' 26.789" W | 3968 |
| CJ-186 | Chuspihuaycu | 2° 51' 36.54" S | 79° 11' 19.014" W | 3578 |
| CJ-187 | Perro chico | 2° 45' 41.136" S | 79° 13' 36.212" W | 3950 |
| CJ-188 | L-SU1 | 2° 50' 9.413" S | 79° 16' 27.404" W | 3886 |
| CJ-189 | LSO2 | 2° 50' 6.975" S | 79° 16' 29.739" W | 3897 |
| CJ-190 | L. somero anexo a Culebrillas | 2° 49' 42.518" S | 79° 16' 46.255" W | 3971 |
| CJ-191 | Charco anexo Culebrillas | 2° 49' 49.114" S | 79° 16' 37.762" W | 3957 |
| CJ-192 | Charco anexo Culebrillas | 2° 49' 50.548" S | 79° 16' 38.893" W | 3953 |
| CJ-193 | Charco anexo Osohuayco | 2° 50' 0.99" S | 79° 13' 41.228" W | 3865 |
| CJ-194 | Charco anexo Osohuayco 2 | 2° 49' 59.753" S | 79° 13' 41.359" W | 3867 |
| CJ-195 | Charco anexo Osohuayco 3 | 2° 49' 58.971" S | 79° 13' 41.166" W | 3883 |
| CJ-196 | Chico Juan Manuel | 2° 50' 12.024" S | 79° 12' 37.171" W | 3775 |
| CJ-197 | Charco anexo Osohuayco 4 | 2° 49' 59.768" S | 79° 13' 51.363" W | 3894 |
| CJ-198 | Charco anexo Osohuayco 5 | 2° 50' 2.587" S | 79° 13' 42.488" W | 3866 |
| CJ-199 | Atucpamba 1 | 2° 52' 1.934" S | 79° 18' 45.685" W | 4143 |
| CJ-200 | Atucpamba 2 | 2° 51' 55.38" S | 79° 18' 38.539" W | 4156 |
| CJ-201 | Atucpamba 3 | 2° 51' 53.233" S | 79° 18' 40" W | 4148 |
| CJ-202 | Atucpamba 4 | 2° 51' 47.079" S | 79° 18' 39.329" W | 4147 |

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