Meta-Analysis of CPUE Papers on Jack Mackerel (2022–2025)

Compiled from documents of the 10th through 13th SPRFMO Scientific Committee meetings

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SPRFMO
South Pacific Regional Fisheries Management Organisation
Jack Mackerel Working Group

SPRFMO SC Meetings: Meta-Analysis of CPUE Papers on Jack Mackerel (2022–2025)

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Background for 2026 Benchmark Priorities

Refining and analysing abundance indices is a high-priority focus for the upcoming jack mackerel benchmark workshop, which the Scientific Committee recommended be held in Lima, Peru, in 2026. To support robust stock assessment outcomes, the SC identified specific areas where index standardisation, interpretation, and model use should be improved.

Addressing conflicting trends and sensitivities

- Recent updates showed conflicting index signals. The updated offshore fleet CPUE index declined to a very low level in 2024, while Peruvian CPUE and Chilean acoustic indicators were comparatively more optimistic.
- Sensitivity analyses (including leave-one-out and leave-one-in runs) indicated strong dependence of assessment results on the index set included.
- Benchmark work will include a comprehensive comparison of CPUE indices and acoustic biomass series, including review of sampling levels and expansion protocols for the South-Central and Northern Chile surveys.

Correcting for fish behaviour and spatial shifts

- The south-central Chile purse-seine CPUE may overestimate abundance under recent nearshore concentration of fish.
- A corrected CPUE approach based on the linear relationship between CPUE and acoustic distribution area has been proposed.
- This correction substantially lowers recent index levels (approximately two-thirds in recent years), supporting precautionary interpretation of uncorrected CPUE.

Advanced spatio-temporal modelling

- A key benchmark topic is evaluating advanced standardisation approaches (e.g., `sdmTMB`, `INLA`) that can model spatio-temporal autocorrelation and incorporate habitat/environmental covariates such as SST and chlorophyll-a.
- The workshop may also evaluate integrated frameworks (e.g., `tinyVAST`) that can combine heterogeneous fleet and survey data sources in a coherent spatio-temporal structure.

Other high-sensitivity model settings

- In addition to abundance indices, the benchmark will address highly sensitive structural assumptions, including long- and short-term productivity periods, stock-recruitment steepness, and selectivity configurations.
- Current estimates of MSY and related reference points have been shown to be sensitive to these settings, reinforcing the need for explicit benchmark guidance.

Note on Peru document numbering: Peru submits two annual reports per SC meeting — one for the SPRFMO Area and one for the Area of National Jurisdiction (ANJ). Document numbers shift each year depending on the full ordered list of country reports. The correct SPRFMO Area document numbers are: SC10-Doc26, SC11-Doc27, SC12-Doc28, and SC13-Doc28. Note that SC13-Doc25 is Liberia, not Peru.

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1. Overview Table: All Relevant CPUE Papers (SC10–SC13)

No.	Doc ID	Short title	Authors / Institution	SC Meeting	Date	PDF / Link
1	SC10-JM02	CPUE standardization — offshore fleet	Pastoors, Hintzen / PFA (EU)	SC10, Seoul	Aug 2022	PDF
2	SC10-JM05	CPUE index south-central Chile — update and correction	Payá / IFOP (CL)	SC10, Seoul	Aug 2022	PDF
3	SC10-Doc26	Peru Annual Report — SPRFMO Area (JM section)	IMARPE / PRODUCE (PE)	SC10, Seoul	Aug 2022	Meeting page
4	SC11-JM06	Effort creep — south-central Chilean fleet	Zenteno, Payá / IFOP (CL)	SC11, Panama	Sept 2023	PDF
5	SC11-JM07	Bayesian spatio-temporal CPUE standardization (1st)	Vásquez, Sepúlveda / INPESCA (CL)	SC11, Panama	Sept 2023	PDF
6	SC11-JM10	CJM abundance index — catch per fishing set	Payá / IFOP (CL)	SC11, Panama	Aug 2023	PDF
7	SC11-JM11	CJM CPUE index — catch per trip, standard update	Payá / IFOP (CL)	SC11, Panama	Aug 2023	PDF
8	SC11-JM12	CJM abundance index — SPDE-based spatio-temporal GLM comparison	Payá / IFOP (CL)	SC11, Panama	Aug 2023	PDF
9	SC11-Doc27	Peru Annual Report — SPRFMO Area (JM section)	IMARPE / PRODUCE (PE)	SC11, Panama	Aug 2023	Meeting page
10	SC12-JM04	Jack mackerel CPUE index and acoustic biomass — south-central Chile	Payá / IFOP (CL)	SC12, Lima	Sept 2024	PDF

No.	Doc ID	Short title	Authors / Institution	SC Meeting	Date	PDF / Link
11	SC12-JM06	Bayesian spatio-temporal CPUE standardization (2nd)	Vásquez, Sepúlveda / INPESCA (CL)	SC12, Lima	Aug 2024	PDF
12	SC12-JM07	Effort creep factor in CPUE standardization	Zenteno, Payá / IFOP (CL)	SC12, Lima	Aug 2024	PDF
13	SC12-Doc28	Peru Annual Report — SPRFMO Area (JM section)	IMARPE / PRODUCE (PE)	SC12, Lima	Aug 2024	Meeting page
14	SC13-JM02	Bayesian spatio-temporal CPUE standardization (3rd)	Vásquez, Sepúlveda / INPESCA (CL)	SC13, Wellington	Sept 2025	PDF
15	SC13-JM04	CJM CPUE index — trip-based GLM, standard update	Payá / IFOP (CL)	SC13, Wellington	Sept 2025	Meeting page
16	SC13-Doc28	Peru Annual Report — SPRFMO Area (JM section)	IMARPE / PRODUCE (PE)	SC13, Wellington	Aug 2025	Meeting page

Note on Peru: Peru does not submit standalone CPUE methodology papers. Peruvian CPUE data are embedded in annual reports and JM Technical Annexes. All four SC meetings are covered.

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2. Combined Metadata Summary Tables

The metadata across all 16 documents is presented in two linked tables. **Table 2a** covers data characteristics; **Table 2b** covers modelling approach and key findings. Both are keyed by Doc ID.

Table 2: Table 2a: Data characteristics

Doc ID	Fleet	Area	Obs. level	Time series	Effort corr.
SC10-JM02	EU, China, Korea, Vanuatu, Russia	SE Pacific high seas	Haul-by-haul (weekly)	2008-2021 (no 2020)	2.5%/yr
SC10-JM05	Industrial purse seiners	South-central Chile	Trip-level	1994-2022 Q1	1%/yr
SC10-Doc26	Industrial + artisanal + small-scale	Peruvian EEZ (far-north)	Trip-level	2000-2022	1%/yr (from SC10)
SC11-JM06	Industrial purse seiners	South-central Chile	Annual (expert survey)	1983-2023	0-4.5%/yr (proposed)
SC11-JM07	Industrial purse seiners	South-central Chile	Set-level	1994-2023	None
SC11-JM10	Industrial purse seiners	South-central Chile	Set-level	1994-2022	1%/yr
SC11-JM11	Industrial purse seiners	South-central Chile	Trip-level	1994-2023 Q2	1%/yr
SC11-JM12	Industrial purse seiners	South-central Chile	Set-level	1994-2022	None
SC11-Doc27	Industrial + artisanal + small-scale	Peruvian EEZ (far-north)	Trip-level	2000-2023	1%/yr

Table 2: Table 2a: Data characteristics *(continued)*

Doc ID	Fleet	Area	Obs. level	Time series	Effort corr.
SC12-JM04	Industrial purse seiners	South-central Chile	Trip-level	1983-2024	1%/yr
SC12-JM06	Industrial purse seiners	South-central Chile	Set-level	1994-2024	None
SC12-JM07	Industrial purse seiners	South-central Chile	Annual (fisher survey)	1983-2024	Survey-based (-38% post-2005)
SC12-Doc28	Industrial + artisanal + small-scale	Peruvian EEZ (far-north)	Trip-level	2000-2024	1%/yr
SC13-JM02	Industrial purse seiners	South-central Chile	Set-level	1994-2025	None
SC13-JM04	Industrial purse seiners	South-central Chile	Trip-level	1994-2025	1%/yr
SC13-Doc28	Industrial + artisanal + small-scale	Peruvian EEZ (far-north)	Trip-level	2000-2025	1%/yr

Table 3: Table 2b: Modelling approach and key findings

Doc ID	Model type	Key covariates	Key conclusion
SC10-JM02	GAM (neg. binomial, log-link)	Year, CP, month, lat x lon smooth, El Nino	CPUE 2021 near historic high; El Nino significant
SC10-JM05	GLM (log-normal) + acoustic ramp correction	Year, quarter, zone, hold capacity	Coastal concentration causes overestimation 2020-2022
SC10-Doc26	GAM	Year, month, hold cap.	Increasing CPUE since 2016
SC11-JM06	Expert-based efficiency factor time series	Technological milestones (sonar, gear, fleet reduction)	Fixed 1%/yr lacks foundation; informed EC differs substantially
SC11-JM07	BHSTM via INLA + SPDE (lognormal)	Year, quarter, hold cap., days at sea, SST, Chl-a, spatio-temp. RF	First INLA approach; SST and Chl-a significant; comparable to GLM
SC11-JM10	Compound Tweedie (Poisson-Gamma)	Year, quarter, zone, hold capacity	Set- vs trip-based indices differ 1994-2006; 10.2% deviance explained
SC11-JM11	GLM (log-normal, standard update)	Year, quarter, zone, hold capacity	Official update for JJM; recovery 2015-2023 confirmed
SC11-JM12	SPDE-based spatio-temporal GLMM/GLM (sdmTMB)	Year, month, hold cap. smooth, SPDE spatial and spatio-temp. RF	SPDE indices match set-based trends; align with trip index after 2006, diverge earlier
SC11-Doc27	GAM	Year, month, hold cap.	Increasing biomass; model underestimates CPUE 2022-2023
SC12-JM04	GLM (gamma CPUE + gaussian catch) + acoustic correction models	Year, quarter, zone, hold cap.; acoustic biomass, density, area	CPUE stable since 2020, but acoustic-linked correction lowers recent values
SC12-JM06	BHSTM via INLA + SPDE (update SC11-JM07)	Year, quarter, hold cap., days at sea, SST, Chl-a, spatio-temp. RF	CPUE 2024 (Jan-Jun) -11%; used as sensitivity in JJM (not adopted)
SC12-JM07	GLM with creep-corrected CPUE as response	Year, quarter, zone, hold cap.; creep pre-/post-2005	Dummy variable fails (multicollinearity); corrected index similar to base
SC12-Doc28	GAM	Year, month, hold cap.	JJM underestimates Peruvian CPUE 2023-2024; stock above BMSY
SC13-JM02	BHSTM via INLA + SPDE (update SC12-JM06)	Year, quarter, hold cap., days at sea, SST, Chl-a, spatio-temp. RF	CPUE 2025 +14% (Jan-Jun); northward expansion; precautionary use recommended
SC13-JM04	GLM (log-normal, standard update)	Year, quarter, zone, hold capacity	Stabilisation 2020-2025; coastal concentration may overestimate abundance
SC13-Doc28	GAM	Year, month, hold cap.	Continued CPUE increase in north; driving upward stock biomass revision

3. Detailed Paper Metadata

Paper 1 — SC10-JM02

CPUE standardization for the offshore fleet | PDF

Authors: Martin Pastoors, Niels Hintzen (EU / Pelagic Freezer-trawler Association) *SC meeting:* SC10, Seoul (26–30 September 2022)

Data

- Fleets: EU, China, Korea, Vanuatu, Russia
- Time series: 2008–2021 (2020 absent due to COVID; only Russia active)
- Observation level: individual hauls (haul-by-haul), aggregated per week per vessel
- Area: Southeast Pacific high seas; haul positions smoothed via spline (lat/lon)
- Effort unit: fishing days per fishing week per vessel

Statistical model

- Primary model: **GAM** (Negative Binomial, log-link)
  - Formula: `catch ~ year + vesselcp + month + s(lat, lon) + ELE + offset(log(effort))`
  - Factors: year, contracting party, month, El Nino effect (ELE), spatial smooth (lat x lon)
- Comparison model: **GLM** with same variables but linear lat x lon
- Efficiency creep: 2.5%/yr cumulative (SCW14 benchmark agreement), applied multiplicatively to effort
- Model diagnostics: Hessian positive-definite; NB parameter = 1.813; k-check passed

Key results and conclusions

- CPUE 2021 substantially higher than 2019; near the historical maximum of the series.
- Clear recovery after low-level period 2008–2017, particularly in 2015 and 2021.
- The 2.5% creep correction results in a downward revision of the perceived stock recovery.
- Spatial component highly significant ($p < 2e\text{-}16$); El Nino effect significant ($p = 7.5e\text{-}07$).
- Recommendation: standardisation guidelines needed; current approach broadly accepted.

Paper 2 — SC10-JM05

CPUE abundance index in south-central Chile — Update and proposed correction | PDF

Author: Ignacio S. Payá (IFOP, Chile) *SC meeting:* SC10, Seoul (26–30 September 2022)

Data

- Fleet: industrial purse seiners, south-central Chile
- Time series: 1994–2022 Q1 (trip-level)
- CPUE definition: catch (t) / (days at sea x hold capacity)
- Acoustic surveys: 1997–2009 (central-south), 1984–2021 (north)

Statistical model

- Base model: **GLM** (log-normal); factors: year, quarter, zone, hold capacity; 1%/yr correction
- Alternative model: GLM with catch as response (hold capacity as covariate, not in denominator)
- Correction procedure: linear model between CPUE index and acoustic distribution area — addresses hyperconcentration near the coast 2020–2022

Key results and conclusions

- Both models give comparable 2006–2022 trends.
- Coastal fish concentration 2020–2022 causes CPUE overestimation; correction reduces recent values significantly.
- Acoustic biomass recovery consistent with CPUE but breaks down when fish are coastal.
- SC accepted as informative but not as formal correction in JJM.

Paper 3 — Peru Annual Reports (SC10-Doc26 / SC11-Doc27 / SC12-Doc28 / SC13-Doc28)

Peru Annual Reports — SPRFMO Area (jack mackerel sections) | SC10 | SC11 | SC12 | SC13

Author: IMARPE / PRODUCE (Peru) *SC meetings:* SC10 (2022), SC11 (2023), SC12 (2024), SC13 (2025)

> **Important:** Peru does not submit standalone CPUE standardisation papers. Peruvian CPUE data are embedded in annual reports and the JM Technical Annexes. Note: SC13-Doc25 is Liberia — Peru's SPRFMO Area report is SC13-Doc28.

Data

- Fleet: industrial, artisanal, and small-scale purse seine fleets. The industrial purse seine fleet catches either anchovy or jack mackerel, depending on the season. The artisanal and small-scale fleet catches a variety of fish species based on availability and demand. The catches of both fleets have increased since 2018.
- Time series: 2002–present. Between 2015 and 2017, the industrial fleet did not fish for jack mackerel because the resource was concentrated near the coast, outside its operating range, due to El Nino events. During this period, jack mackerel fishing was mainly carried out by artisanal and small-scale vessels.
- Observation level: trip-level
- Area: Peruvian EEZ, far-north stock zone (~3°S–18°S)

Statistical model

- **GAM** model (Gamma distribution, log-link); response = catch per trip. Formula: `catch ~ year + month + hold_capacity`, with year and month treated as factors.
- Covariates: year, month, and hold capacity
- Standardised CPUE estimated at mean hold capacity, with year and month as factors, then averaged by year.
- All trips targeting jack mackerel > Although these are multispecies fleets, the information is pre-filtered by trip type, taking into account fishing seasons, catch composition, and fishing gear characteristics.
- Catchability change modelled at year 2000 (vessel-level quotas introduced)
- Efficiency correction: **1%/yr** since SC10 (2022); not independently investigated

- CV in JJM: 0.2 for 2002–2017, 0.3 for 2018–2025

Annual updates and key findings

SC10 (2022) — SC10-Doc26: Data to June 2022. Increasing CPUE since 2016 confirmed. 1%/yr efficiency correction applied for first time (SCW14 benchmark decision).

SC11 (2023) — SC11-Doc27: Data to mid-2023. Upward trend confirmed; slight decrease in 2023 projection. CPUE trend primary driver of biomass increase SC10→SC11. Intersessional JJM update recommended 2023 TAC <= 144,000 t.

SC12 (2024) — SC12-Doc28: Data to mid-2024. JJM model underestimates Peruvian CPUE 2023–2024 — key diagnostic concern. El Nino 2023–2024 delayed jack mackerel availability. Intersessional update recommended 2024 TAC <= 70,568 t.

SC13 (2025) — SC13-Doc28: Data to mid-2025. CPUE continues to drive upward biomass perception. IMARPE recommended 2025 TAC scenarios: 148,000 t / 212,000 t / 218,000 t. PRODUCE set 2025 industrial TAC at 80,948 t.

Overall pattern

- Peruvian CPUE increased from a trough around 2010–2014 to consistently higher values from 2017 onwards.
- This is one of the strongest stock recovery signals in the JJM assessment across all four meetings.
- The JJM model's tendency to underestimate recent Peruvian CPUE (noted at SC12) is unresolved and under investigation.

Paper 4 — SC11-JM06

Effort Creep in the JM south-central fleet in Chile | PDF

Authors: José Zenteno, Ignacio Payá (IFOP, Chile) *SC meeting:* SC11, Panama City (11–16 September 2023)

Data

- Fleet: industrial purse seiners, south-central Chile
- Time series: 1983–2023 (efficiency factors); July 2023 fisher/skipper survey
- Sources: historical records, regulations, expert interviews, written survey

Statistical model / method

- Expert-based efficiency factor time series: `ECt = SUM(FEi,t)`
- Corrected CPUE: `ECPUE_t = CPUE_t x (1 - EC_t)^(t-y)`
- Applied to SC10 Chile CPUE series; JJM model used to evaluate biomass impact

Technological milestones identified

Milestone	Start year	Direction	Annual effect	Period
GPS/satellite positioning restriction	2000	Negative	-0.5%	18 yrs

Milestone	Start year	Direction	Annual effect	Period
Redirection to direct consumption	2004	Negative	-1.0%	19 yrs
Fleet refrigeration capacity	2004	Positive	+0.5%	15 yrs
Renewed fishing gear (lighter material)	2003	Positive	+1.0%	15 yrs
Fleet reduction I (best captains retained)	1998	Positive	+3%	8 yrs
Fleet reduction II	2006	Positive	+0.5%	17 yrs
Multi-frequency sonar	2003	Positive	+1%	17 yrs
INPESCA satellite information system	2006	Positive	+0.5%	17 yrs

Key results and conclusions

- Informed EC: 0–4.5%/yr, varying over time — substantially different from fixed 1%.
- Corrected CPUE markedly lower than uncorrected and 1%-corrected series.
- Biomass estimates from JJM differ substantially depending on EC used — direct management implications.
- Recommendation: further analysis with July 2023 survey data; GLM implementation as next step (see SC12-JM07).

Paper 5 — SC11-JM07

A Bayesian spatio-temporal approach for the standardization of CPUE in the TM fishery off central-southern Chile | PDF

Authors: Sebastian I. Vasquez (INPESCA/UdeC), Aquiles Sepulveda (INPESCA, Chile) *SC meeting:* SC11, Panama City (11–16 September 2023)

Data

- Fleet: industrial purse seiners, south-central Chile
- Time series: 1994–2023 (individual set-level)
- Dataset: combined IFOP (scientific observers) and INPESCA (industry logbooks)
- Environmental variables: SST (°C) and Chl-a (mg/m³), daily 4×4 km grids (Copernicus)

Statistical model

- **BHSTM via INLA + SPDE** (Rue et al. 2009; Lindgren et al. 2011)
- Spatial structure: Delaunay triangulation; Matern covariance function; lognormal CPUE distribution

- Model: `y_{s,t} = B0 + T + Q + log(H) + log(E) + V + SUM(rho_k * V_{t-k})`
- Four models of increasing complexity; Model 4 (+ SST, Chl-a) = best fit (DIC, WAIC, LCPO)

Key results and conclusions

- SST and Chl-a significantly and positively correlated with CPUE.
- Spatial range ~121 km; temporal autocorrelation rho ~= 0.56.
- Two coastal concentration periods (1995–2001, 2012–2023) and one offshore expansion (2002–2011).
- Comparable trend to standard GLM; better handles spatially shifting stock distribution.
- Candidate index for next benchmark assessment.

Paper 6 — SC11-JM10

Update up to June 2022 of the CJM abundance index based on catch per fishing set | PDF

Author: Ignacio S. Paya (IFOP, Chile) *SC meeting:* SC11, Panama City (August 2023)

Data

- Fleet: industrial purse seiners, south-central Chile
- Time series: June 1994–June 2022 (set-level; IFOP observers + INPESCA logbooks)

Statistical model

- Compound probability distribution (Tweedie compound Poisson); update of Caballero et al. (2020) model
- Factors: year, quarter/month, zone, hold capacity

Key results and conclusions

- Set-based and trip-based indices comparable 2006–2022; differ 1994–2006.
- Only 10.2% deviance explained — significant unexplained variation remains.
- Set-level data provide higher resolution but require further methodological development.

Paper 7 — SC11-JM11

Update of the CJM CPUE abundance index based on catch by fishing trip in south-central Chile | PDF

Author: Ignacio S. Paya (IFOP, Chile) *SC meeting:* SC11, Panama City (August 2023)

Data / model: Standard annual update; trip-level GLM (log-normal); 1%/yr correction; time series 1994–2023 Q2. This is the officially used Chilean CPUE index in the JJM stock assessment.

Key results and conclusions

- Official update for JJM stock assessment.
- Recovery trend 2015–2023 confirmed, consistent with previous years.

- SC11 recommendations focus on resolving the coastal concentration issue and improving the creep correction.

Paper 8 — SC11-JM12

CJM abundance index estimated by spatiotemporal SPDE-based GLM and compare with other CPUE indices | PDF

Author: Ignacio S. Paya (IFOP, Chile) *SC meeting:* SC11, Panama City (11–16 September 2023)

Data

- Fleet: industrial purse seiners, south-central Chile
- Time series: June 1994–December 2022 (set-level)
- Sources: IFOP observer data + INPESCA industry logbooks

Statistical model

- SPDE-based models fitted with `sdmTMB` (TMB + R-INLA)
- Two model structures: (1) spatio-temporal model, and (2) spatio-temporal GLM
- Core effects: year, month, vessel hold-capacity smooth, spatial/spatio-temporal random fields

Key results and conclusions

- The two SPDE-based indices were not significantly different.
- Trends were similar to the set-based GLM index (SC11-JM10 update).
- Compared with the official trip-based index, trends were similar for 2006–2022 but different in 1994–2005.
- For 2006–2022 all compared indices showed a V-shape with minimum around 2011; this work was presented as ongoing methodological development.

Paper 9 — SC12-JM04

Jack Mackerel CPUE index and acoustic biomass in the south-central Chile | PDF

Author: Ignacio S. Paya (IFOP, Chile) *SC meeting:* SC12, Lima (30 September–5 October 2024)

Data

- Fleet: industrial purse seiners, south-central Chile
- Time series: 1983–June 2024 (trip-level IFOP database)
- Acoustic context: south-central biomass/density/distribution-area indicators updated with recent surveys

Statistical model / method

- Standard CPUE GLM update (gamma, log-link)
- Alternative catch-based GLM (gaussian) to avoid hold capacity on both sides of the CPUE equation
- CPUE-acoustic relationships evaluated with ramp and linear models; linear CPUE-area relationship used to derive a corrected CPUE series

Key results and conclusions

- CPUE- and catch-model indices were similar through 2019, then diverged, with the catch-model index lower in recent years.
- Acoustic results in the south-central zone showed lower biomass and area with higher density, consistent with concentration near the coast.
- The corrected CPUE series removed the recent step-up seen in the uncorrected index.
- Precautionary use of the standard CPUE index was recommended; north-zone acoustic increases partly offset south-central declines at broader scale.

Paper 10 — SC12-JM06

Update on CPUE standardization for the Chilean JM fishery using spatio-temporal Bayesian models | PDF

Authors: Sebastian I. Vasquez (INPESCA/UdeC), Aquiles Sepulveda (INPESCA, Chile) *SC meeting:* SC12, Lima (30 September–5 October 2024)

Data

- Time series: 1994–2024 (update of SC11-JM07; + July 2023–June 2024 season)
- Environmental: SST and Chl-a (Copernicus, 4×4 km daily)

Statistical model: Same BHSTM/INLA/SPDE as SC11-JM07; Model 4 continued.

Operational context (Jan–Jun 2024): avg trip 2.62 days (+18%); avg distance 194 km (+30%); avg hold capacity 1,586 m³.

Key results and conclusions

- CPUE 2024 (Jan–Jun): -11% vs 2023; negative SST and Chl-a anomalies likely drivers.
- Two coastal concentration periods (1995–2001, 2012–2024) and offshore expansion (2002–2011) confirmed.
- Used as sensitivity in JJM (Models 1.02–1.03); not adopted as official model.
- SC recommends influence plots to understand divergence from GLM series.

Paper 11 — SC12-JM07

Incorporating a creep factor into the Chile Jack Mackerel CPUE index standardization | PDF

Authors: Jose I. Zenteno, Ignacio Paya (IFOP, Chile) *SC meeting:* SC12, Lima (30 September–5 October 2024)

Data / method

- Time series: 1983–2024; fisher survey (July 2023) on perceived reduction in search time
- Two approaches: (1) dummy variable in GLM — fails (multicollinearity); (2) creep-corrected CPUE as response

Creep correction criteria (from survey)

Period	Creep factor (mean +/- sd)	Correction multiplier
1983–2004	0	1.000
2005–2024	0.383 (+/- 0.207)	0.616

Key results and conclusions

- Main efficiency drivers: multibeam sonars and delivery of oceanographic satellite information to vessels.
- Dummy variable approach fails (multicollinearity between creep factor and year/other covariates).
- Alternative approach (creep-corrected CPUE as response) yields comparable trend (AIC = -31,291).
- Method not yet ready for formal implementation; complementary survey data recommended.

Paper 12 — SC13-JM02

Update on CPUE standardization for the Chilean JM fishery using spatio-temporal Bayesian models | PDF

Authors: Sebastian I. Vasquez (INPESCA/UdeC), Aquiles Sepulveda (INPESCA, Chile) *SC meeting:* SC13, Wellington (8–13 September 2025)

Data

- Time series: 1994–2025 (update of SC12-JM06; + July 2024–June 2025 season)
- Environmental: SST and Chl-a (Copernicus, 4×4 km daily)

Statistical model: Same BHSTM/INLA/SPDE; spatial range ~121 km; temporal autocorrelation rho = 0.562. SST and Chl-a both significantly positive.

Operational context (Jan–Jun 2025): avg trip 3.24 days (+12.5%); avg distance 309 km (+36%); avg hold capacity 1,592 m³.

Key results and conclusions

- CPUE 2025 (Jan–Jun): +14% vs 2024; positive SST anomalies, negative Chl-a.
- CPUE 2024 final (including H2): -13% vs mid-year estimate.
- Northward expansion of fishing activity in 2025; abundance clusters at northern model boundary.
- Comparable to GLM index when normalised, but year-level differences remain under investigation.
- Precautionary use recommended; candidate for next benchmark.

Paper 13 — SC13-JM04

Update of the CPUE abundance index, south-central Chile (standard GLM, trip-based) | Meeting page

Author: Ignacio S. Paya / IFOP (Chile) *SC meeting:* SC13, Wellington (8–13 September 2025)

Data / model: Standard annual update; trip-level GLM (log-normal); 1%/yr correction; time series 1994–2025. Officially used Chilean CPUE index in JJM.

Key results and conclusions

- Stabilisation 2020–2025 after recovery period.
- Coastal concentration may cause overestimation; acoustic-area correction reduces index by approximately two-thirds.
- Acoustic biomass declined in south-central zone but offset by strong increase in northern zone.
- SC recommends precautionary use of the uncorrected index.

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4. Cross-Cutting Themes and Evolution of CPUE Methodology (2022–2025)

4.1 Peruvian CPUE: A Structural Overview

- **No standalone papers.** Unlike Chile, Peru does not submit dedicated CPUE methodology papers. The index is documented in annual reports and JM Technical Annexes.
- **GAM model (Gamma distribution, log-link).** Stable methodology since SC4, using monthly trip-level data with covariates year, month, and hold capacity. Standardised CPUE estimated at mean hold capacity, with year and month as factors, then averaged by year.
- **Fleet transition (pre- vs post-2018).** Since 2018, the artisanal and small-scale fleet has increased significantly in fishing capacity. The industrial fleet continues to fish for jack mackerel and switches to anchovy depending on the season.
- **Efficiency correction.** 1%/yr applied since SC10 (2022); unlike Chile, no methodological investigation of this correction has been submitted to the SC.
- **Key pattern.** Consistent upward trend since 2017; one of the strongest stock recovery signals in the JJM assessment. JJM's tendency to underestimate recent Peruvian CPUE (noted at SC12) remains unresolved.

4.2 Efficiency Creep

- **SC10 (2022):** SCW14 benchmark set fixed 1%/yr (Chile + Peru) and 2.5%/yr (offshore) — pragmatic choices without quantitative foundation.
- **SC11 (2023):** SC11-JM06 introduced a time-varying, expert-informed creep series (0–4.5%/yr) for Chile. Promising but requiring further validation.
- **SC12 (2024):** SC12-JM07 attempted GLM integration but encountered multicollinearity. Alternative approach (corrected CPUE as response) comparable to base model.
- **SC13 (2025):** Issue remains unresolved. Precautionary approach still recommended. Peru's creep correction has not been independently evaluated.

4.3 Transition from GLM to Bayesian Spatio-Temporal Models

- Standard GLM assumes a uniform time effect across spatial strata — problematic when stock distribution shifts (as observed post-2019 in Chile).
- SC11-JM07 introduced BHSTM/INLA as a methodological alternative, explicitly modelling spatio-temporal interaction.
- SC11-JM12 expanded this track with `sdmTMB` SPDE-based set-level models and showed broad trend agreement with other Chilean indices.
- Updated annually: SC12-JM06 (2024 data) and SC13-JM02 (2025 data).
- Tested as sensitivity in JJM at SC12 (Models 1.02–1.03) but not adopted as the official model; decision deferred to next benchmark.
- Applied only to the Chilean purse seine fleet; no Bayesian alternative proposed for Peruvian or offshore indices.

4.4 Coastal Concentration Issue (Chile)

- Since 2019–2020: jack mackerel increasingly concentrated near Chile's coast, raising CPUE without proportional biomass increase.
- SC10-JM05 introduced a correction procedure using the relationship between CPUE and the acoustic distribution area.
- SC12-JM04 updated the CPUE-vs-acoustic analysis and again supported a precautionary interpretation of uncorrected recent CPUE levels.
- Not yet formally implemented in the JJM model as of SC13; SC recommends precautionary use of the uncorrected index.

4.5 Offshore Fleet CPUE (EU/PFA)

- Only one dedicated paper in the period (SC10-JM02); methodology stable since SCW14.
- GAM with Negative Binomial distribution, spatial smooth, and El Nino covariate; 2.5%/yr efficiency creep.
- SC12: flexibility added in offshore fleet selectivity (break at 2021); CPUE values for the current year downweighted in the final assessment model (h1_1.07).

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5. Bibliographic References

Reference	Document ID	Link
Pastoors and Hintzen (2022)	SC10-JM02	PDF
Paya (2022)	SC10-JM05	PDF
IMARPE/PRODUCE (2022)	SC10-Doc26	Meeting page
Zenteno and Paya (2023)	SC11-JM06	PDF
Vasquez and Sepulveda (2023)	SC11-JM07	PDF
Paya (2023a)	SC11-JM10	PDF
Paya (2023b)	SC11-JM11	PDF

Reference	Document ID	Link
Paya (2023c)	SC11-JM12	PDF
IMARPE/PRODUCE (2023)	SC11-Doc27	Meeting page
Paya (2024)	SC12-JM04	PDF
Vasquez and Sepulveda (2024)	SC12-JM06	PDF
Zenteno and Paya (2024)	SC12-JM07	PDF
IMARPE/PRODUCE (2024)	SC12-Doc28	Meeting page
Vasquez and Sepulveda (2025)	SC13-JM02	PDF
Paya (2025)	SC13-JM04	Meeting page
IMARPE/PRODUCE (2025)	SC13-Doc28	Meeting page

End of report. All data drawn directly from original PDF documents published at sprfmo.int.